

ELECTRONIC DESIGN

SEPTEMBER 30, 1959

THE LIBRARY OF
CONGRESS
SERIALS ACQUISITION
SEP 30 1959



Isolated Outputs from Twin Double-Plate Triode . . . p. 82



A PARTIAL SHOWING. OVER 60 DIFFERENT SIZE 8 ROTARY COMPONENTS AVAILABLE

Clifton Precision's size 8 rotary components have been tried and proven by customers over the past 4 years. More than 50,000 have been shipped. These are the most accurate and best tested (because they are use tested) size 8 rotary components on the market today.

1. Torque transmitter (26v. input) 2. Torque transmitter (115v. input) 3. Control transformer (lo Z) 4. Control transformer (hi Z) 5. Control transformer (very hi Z) 6. Torque receiver (26v. input) 7. Torque receiver (115v. input) 8. Torque differential (lo Z) 9. Torque differential (hi Z) 10. Electrical resolver (.5 t.r.) 11. Precision computing resolver (feedback winding) 12. Electrical resolver (1 t.r.) 13. Linear transformer (115v. input) 14. Linear transformer (26v. input) 15. Servo motor (1" length, .40 in-oz stall torque) 16. Motor generator (10v. input) 17. Servo motor (53/64" long) 18. Servo motor (35v. center tap) 19. Servo motor (26v. center tap) 20. Motor generator (26v. input) 21. Servo motor (.30 in-oz stall torque) 22. D.C. motor (14v. input) 23. D.C. motor (28v. input)

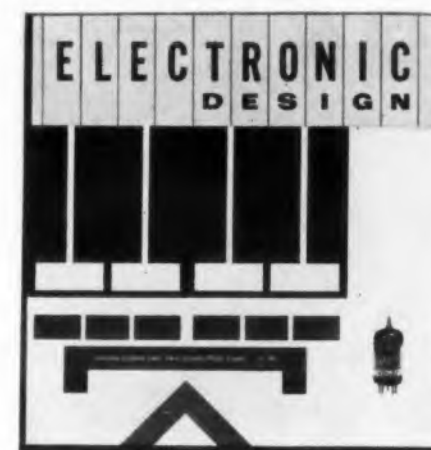
ENGINEERS — Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. E9

CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS

cppe
P. A.

Sales Office: 9014 W. Chester Pike, Upper Darby, Pa.—Hilltop 9-1200, TWX Flanders, Pa. 1122
CIRCLE 1 ON READER-SERVICE CARD

HIGHLIGHTS OF ISSUE



Isolated Outputs From Twin Double-Plate Triode 82

12FQ8 tube provides excellent isolation between outputs in addition to savings in cost and space. Two plates are brought out to separate base pins for each triode section.

Using Photoconductive Cells 24

Cadmium-sulfide photoconductors offer many advantages over photo-emissive types. Among these is their small size. Proper application of these devices promises new concepts of light beam controls. This article describes several typical applications. It's possible that these applications may be the start toward the solution of some of your difficult control problems.

Seven Rules for Scaling Impedance Level And Frequency 28

Network designs are easy to extend using seven simple rules. Basically normalization procedures, they can be used to design new networks from old ones.

The WESCON Winners! 74

Here are the electronic products that won awards for outstanding design at the first design competition held at a WESCON show. A jury of industrial designers judged the entries.

NEWS

- Ferroelectric Converter Gives High-Voltage AC, DC 3

EDITORIALS

- Reliability—Our Goal, Too 23
More Reader Convenience 23

FEATURES

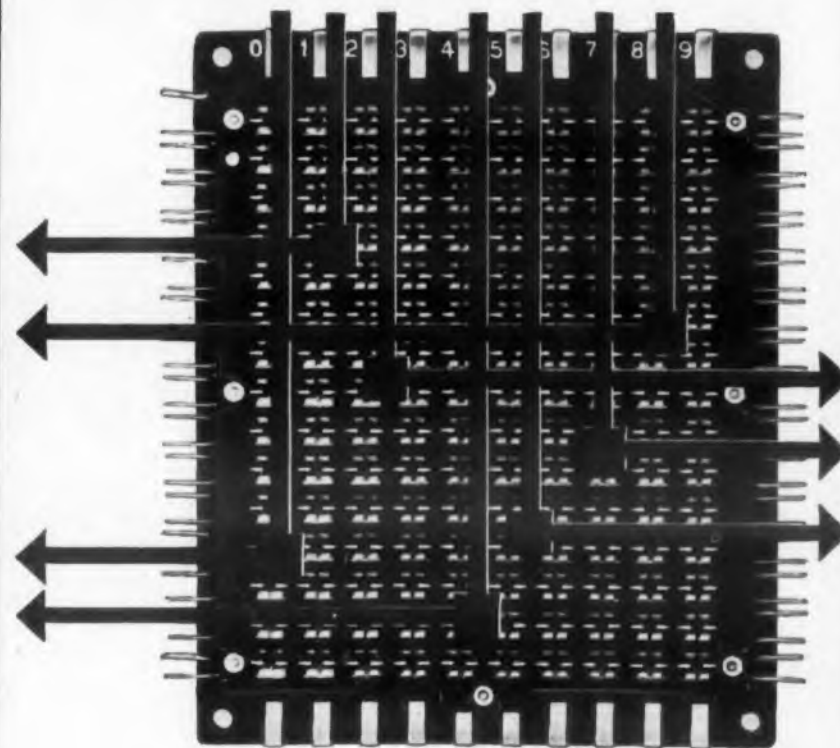
- Using Photoconductive Cells 24
Advantages and applications of photoconductive cells
- Seven Rules For Scaling Impedance Level And Frequency 28
Easy rules for changing networks E. Brenner, S. Parker
- Simple Aluminum Soldering 32
How to make successful solder joints to aluminum H. Hirst
- Design Of Transistorized DC-to-DC Converters—2 36
Data and step-by-step procedure for designing transformer-coupled dc-to-dc converters C. R. Turner
- Multiphase Discriminator Uses Transformer Logic 40
Ideas for Design
- Transistorized DC Millivoltmeter 50
Russian Translations
- Ferrite Isolators 52
German Abstract
- Unsymmetrical Push-Pull Stage 53
German Abstract
- 1959 Transistor Data Chart Revisions 73
A list of corrections to be added to the July 22 Transistor Tables
- The WESCON Winners! 74
Awards earned by outstanding designs in the products at the WESCON Industrial Design competition
- Isolated Outputs From Twin Double-Plate Triode 82
Isolation, economy, and space-saving with 12FQ8
- The ABC Of Teaching Engineering 154
Key principles of learning and what good teachers should do

DEPARTMENTS

- | | | | |
|----------------------|----|----------------|-----|
| Washington Report | 18 | Report Briefs | 54 |
| Meetings | 20 | Books | 58 |
| Ideas for Design | 40 | New Literature | 60 |
| Patents | 46 | New Products | 78 |
| Russian Translations | 50 | Careers | 154 |
| German Abstracts | 52 | Career Notes | 159 |
| Advertisers' Index | | 163 | |

systems translation...

KELLOGG MATRIX



easy-to-position • never needs adjustment

USES MINIATURE SELENIUM DISC RECTIFIERS

—mounted without soldering or wiring.

SIMPLE CIRCUIT REARRANGEMENT

—remove covers, reposition discs.

MOUNTED ON PHENOLIC GRID

—with 2 sets of vertical and horizontal conductors.

HIGH MATRIX CAPACITY

10 x 30 or 300 miniature rectifier discs.

Ideal for systems requiring translation or various diode matrices, such as:

1. Automatic warehouses—to seek out or sort order parts.
2. Chemical processing plants—all controls made from a central point.

Another fine product for the growing electronics industry backed by Kellogg and International Telephone and Telegraph Corporation.

Write for full details and complete catalog of Kellogg systems and components.



Kellogg Switchboard and Supply Company, 6650 South Cleere Avenue
Chicago 38, Ill. Communications Division of
International Telephone and Telegraph Corporation.

Manufacturers of Relays, Hermetically Sealed Relays,
Switches, Miscellaneous Telephone Type Components

CIRCLE 2 ON READER-SERVICE CARD



under all conditions . . . the world over

RAYTHEON bonded SILICON DIODES

are the standard of reliability

Temperature — Humidity every Raytheon Bonded Silicon Diode receives three cycles of 15 minutes at -65°C and 15 minutes at $+150^{\circ}\text{C}$; also four cycles totaling 32 hours at 95% relative humidity from 70°C to 25°C .

Vibration per MIL-E-ID, par. 4.9.19.1.

Shock 500G, one millisecond duration through

each of the three mutually perpendicular axes.

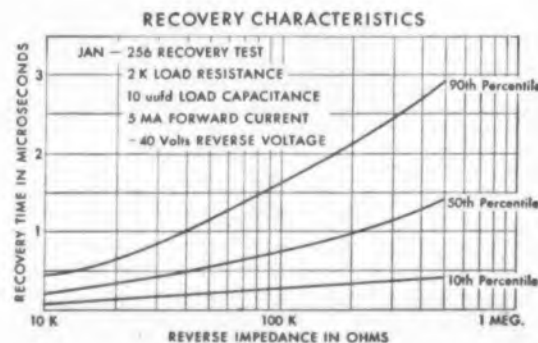
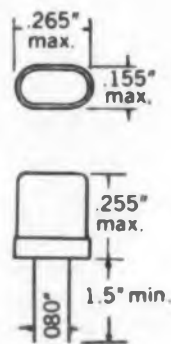
Life 2000 hours as rectifiers with both maximum reverse voltage and rectified current.

Stability excellent throughout operating or shelf life.

Raytheon Bonded Silicon Diodes are also available in precisely balanced matched pairs and quads.

Type	PIV	I_F min. at 1v mA	I_{REV} max. at -10v μA	I_{REV} max. μA at specified voltage				I_O max. mA		Type	PIV	I_F min. at 1v mA	I_{REV} max. at -10v μA	I_{REV} max. μA at specified voltage			I_O max. mA	
				volts	25°C	150°C	25°C	150°C	volts					25°C	150°C	25°C	150°C	
1N300	15	15	.001	10	0.001	2.0	65	18	1N303B	125	50	.01	100	0.1	14.0	65	20	
1N300A	15	30	.001	10	0.001	2.0	80	25	1N433	145	3	.01	125	0.1	16.0	40	10	
1N300B	15	50	.001	10	0.001	2.0	100	30	1N433A	145	10	.01	125	0.1	16.0	50	16	
1N432	40	10	.005	10	0.005	3.0	55	15	1N433B	145	50	.01	125	0.1	16.0	60	20	
1N432A	40	20	.005	10	0.005	3.0	70	22	1N434	180	2	.01	150	0.1	18.0	35	10	
1N432B	40	50	.005	10	0.005	3.0	85	30	1N434A	180	7	.01	150	0.1	18.0	45	15	
1N301	70	5	.01	50	0.05	8.0	45	12	1N434B	180	20	.01	150	0.1	18.0	60	20	
1N301A	70	18	.01	50	0.05	8.0	65	20	1N302	225	1	.01	200	0.2	20.0	30	8	
1N301B	70	50	.01	50	0.05	8.0	75	25	1N302A	225	5	.01	200	0.2	20.0	40	13	
1N460	90	5	.01	75	0.1	10.0	45	12	1N302B	225	20	.01	200	0.2	20.0	55	20	
1N460A	90	15	.01	75	0.1	10.0	60	18	CK863	300	1	.01	275	0.3	30.0	20	6	
1N460B	90	50	.01	75	0.1	10.0	70	25	CK863A	300	3	.01	275	0.3	30.0	30	8	
1N303	125	3	.01	100	0.1	14.0	40	10	CK863B	300	20	.01	275	0.3	30.0	50	15	
1N303A	125	12	.01	100	0.1	14.0	55	16										

Ratings at 25°C unless otherwise indicated



SEMICONDUCTOR DIVISION

SILICON AND GERMANIUM DIODES AND TRANSISTORS
SILICON RECTIFIERS • CIRCUIT-PAKS

New York, Plaza 9-3900 • Boston, Hillcrest 4-6700
Chicago, National 5-4000 • Los Angeles, Normandie 5-4221
Baltimore, Southfield 1-1237 • Cleveland, Winton 1-7716
Kansas City, Plaza 3-5330 • Orlando, GArden 3-1553
San Francisco, Flerside 1-7711

Government Relations: Washington, D.C. MEtropolitan 8-5205

CIRCLE 3 ON READER-SERVICE CARD

STAFF

EDITOR: Edward E. Grazda; **MANAGING EDITOR:** J. A. Lippke; **ASSOCIATE EDITORS:** L. D. Shergalis, G. H. Rostky, H. Bierman, R. N. DeFloria; **ASSISTANT EDITORS:** T. E. Mount, D. S. Viebig, L. N. Tolopko, A. Corneretto, A. Caprioglio; **CONTRIBUTING EDITORS:** S. H. Hubelbank, E. Brenner, B. Bernstein, E. Kahn, B. B. Daien; **EDITORIAL ASSISTANTS:** M. S. Buckley, A. M. Sickler, A. R. Abramoff, R. N. Ross, R. M. Moore; **ART DIRECTOR:** R. A. Schulze; **TECHNICAL ILLUSTRATOR:** B. L. Armstrong; **ART ASSISTANT:** C. Bank; **PRODUCTION MANAGER:** T. V. Sedita; **ASST. PRODUCTION MANAGER:** H. De Polo; **PRODUCTION ASSISTANTS:** M. C. Alexich, C. E. Moodhe; **CIRCULATION MANAGER:** N. M. Elston; **ASST. CIRCULATION MANAGER:** A. C. Lovett; **READER-SERVICE:** J. E. Medina.

CO-PUBLISHERS

T. Richard Gascoigne

James S. Mulholland, Jr.

ADVERTISING REPRESENTATIVES

ADVERTISING SALES MANAGER: Bryce Gray, Jr.; **NEW YORK:** Owen A. Kean, Robert W. Gascoigne, Richard Parker, Blair McClenachan, James P. Quinn 830 Third Avenue, PLaza 1-5530; **CHICAGO:** Thomas P. Kavooras, Berry Conner, Jr., Fred T. Bruce 664 N. Michigan Avenue, SUPERior 1-8054; **LOS ANGELES:** Robert E. Ahrensford, John V. Quillman, Stanley I. Ehrenclou 3275 Wilshire Blvd., DUNkirk 2-7337; **SOUTH-EASTERN:** Lucien Neff 15 Castle Arbor Isle, Fort Lauderdale, Florida, LOGan 6-5656.

SUBSCRIPTION POLICY

ELECTRONIC DESIGN is circulated only to qualified electronic design engineers of U. S. manufacturing companies, industrial consultants, and government agencies. If design for manufacturing is your responsibility, you qualify for subscription without charge provided you send use the following information on your company's letterhead: Your name and engineering title, your company's main products, and description of your design duties. The letter must be signed by you personally.

ANY ADDRESS CHANGES FOR OLD SUBSCRIBERS NECESSITATE A RESTATEMENT OF THESE QUALIFICATIONS. Subscription rate for non-qualified subscribers—\$25.00 per year U.S.A., \$30.00 per year all other countries. Single copy \$1.50.



ELECTRONIC DESIGN is published bi-weekly by Hayden Publishing Company, Inc., 830 Third Avenue, New York 22, N.Y., T. Richard Gascoigne, President; James S. Mulholland Jr., Vice-President & Treasurer; and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Accepted as controlled circulation at Bristol, Conn. Additional entry, New York, N.Y. Copyright 1959 Hayden Publishing Company Inc., 36,150 copies this issue.

Ferroelectric Converter Gives High-Voltage AC, DC

A NEW POWER SOURCE, the ferroelectric converter, may become available to designers if a long-recognized effect can be exploited efficiently.

At International Telephone and Telegraph Laboratories, Nutley, N.J., S. R. Hoh has directly converted thermal to electrical energy by alternately heating and cooling barium titanate and other ferroelectric materials incorporated in circuits as capacitive elements.

Power sources based on this pyroelectric-like principle could give designers high voltages at efficient power-to-weight ratios, reports Mr. Hoh. Practical work and theoretical studies indicate that ferroelectric conversion of heat to electrical energy could compare favorably in cost and power-weight-ratio with other methods. Mr. Hoh singles out space devices requiring high ac voltages as particularly appropriate applications of ferroelectric conversion.

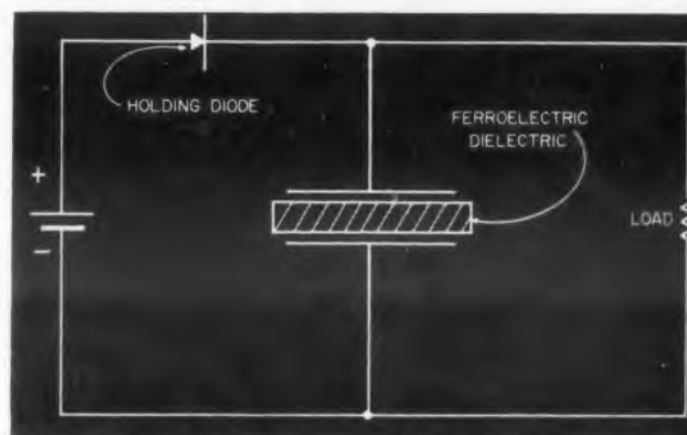
ITT is writing proposals for Air Force support of the converter research on the basis of its suitability for space use. And Rome Air Development Center has started work on a program of its own, designed to give the Air Force first-hand knowledge of the potential of ferroelectric conversion. The Air Force researchers will make use of both ITT studies and materials.

The principle behind the converter has been known for some time in a ferromagnetic parallel and in relation to pyroelectric materials. If a ferroelectric, like barium titanate or strontium titanate is heated to its Curie temperature, permittivity rises to a peak.

Further heating decreases permittivity, reducing capacitance and increasing voltage. Voltage rises because of the $Q=VC$ relationship in a capacitor circuit.

It is this gain of potential between two faces of a ferroelectric crystal or film, caused by a temperature change, that makes the converter and its variations possible.

Another effect, which makes the ferroelectric



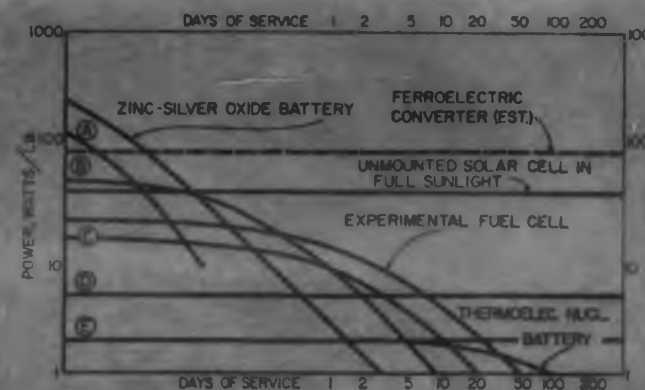
How It Works

A ferroelectric capacitor, charged through a holding diode, is heated until its polarization is overcome. The capacitor's ability to maintain an electric field then decreases, reducing its capacitance. But because voltage on the capacitor is a direct function of charge and capacitance ($Q=VC$), the voltage rises with: decrease in capacitance, maintenance of the charge, and prevention of leakage by the diode. The cycle ends with discharge of the capacitor through the load and cooling to permit recharging.

converter attractive to designers, is that affecting energy in the system. Energy is gained in the same ratio as voltage when a given charge is raised to a higher potential by heating. This is because energy W of a charged capacitor equals $1/2 QV$.

High field strengths make most efficient use of ferroelectric materials, reports Mr. Hoh. With strengths of roughly 100 v per mil, voltages range between 500 and 1000 for the ceramic ferroelectrics used at ITT. Cascading of stages, however, could provide 1,000,000 volts. But, states Mr. Hoh, materials with much higher dielectric strengths are needed.

With 5-mil barium strontium titanate of room-



Why It's Significant

Length of service plotted against power-per-pound in this ITT-supplied graph shows how a ferroelectric converter can be expected to provide steady power at ratios exceeding those of other known sources. Pre-supposed is a space-type environment for the ferroelectric converter, where unlimited solar energy is available at no cost. Curves not labeled in the graph are: A-monopropellant fuel turbine; B-gas turbine; C-engine generator; D-turboelectric nuclear reactor; E-mounted and protected solar cell in full sunlight.

Four Types of Energy Converters Compared

Type	Area of Application Advantages	Disadvantage	Conversion Efficiency % Predicted	Watts Per Pound
Thermoelectric	up to 1300° K also cooling	High Weight	34 (Multistage)	2.5
Thermionic	1300° to 2500° K	Limited Life Low Voltage	90% of Carnot	?
Solar Cells	Solar Radiation	High Cost (\$400/Watt) Temperature Limitations	20-30	40
Ferroelectric	High Voltages Alternating Current Low Cost	Requires Temp. Cycling	< Carnot	90?



CONTROLLED RELIABILITY BEYOND



DESIGN

Basic reliability of an electronic component lies in its design. U.S. Relay has gone beyond this step by protecting already-proven designs with a new, contaminant-free production and test facility that is unique in the industry.

A 12,000 square foot manufacturing and test area which incorporates a most elaborate system of temperature, humidity and dust controls, is now in use. Positive pressure rooms, automatic shoe scrubbers, special lint-free garments for employees and air locks are a few of the precautions in effect. Control systems automatically record and warn of increases in air-borne particles, changes in room pressures and ambient temperatures.

Complete laboratories have been installed for testing components under all operating conditions encountered by missiles and conventional aircraft. This includes a specially designed Random Motion, Sine Wave, Vibration test system. Solid state switching for pulsing circuits and Flip-Flop network designs are now being investigated and formalized for production.

Specify U.S. Relay-Electronics components for unparalleled reliability.



For information write to:

U.S. RELAY-ELECTRONICS



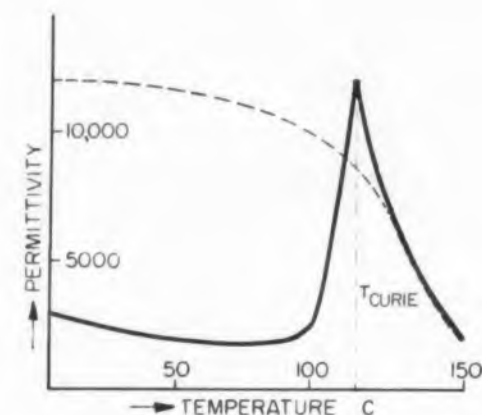
A Division of A-S-R Products Corporation

717 NORTH CONEY AVENUE, AZUSA, CALIFORNIA, DEPT. ED

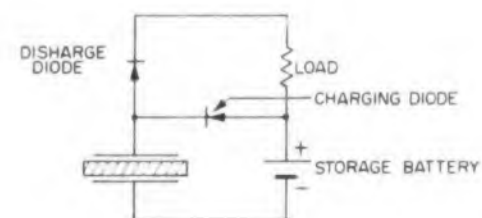
Engineers with relay and/or electromechanical experience desiring employment under ideal working conditions with above average advancement program, contact J. Kendall, Chief Engineer.

CIRCLE 4 ON READER-SERVICE CARD

NEWS



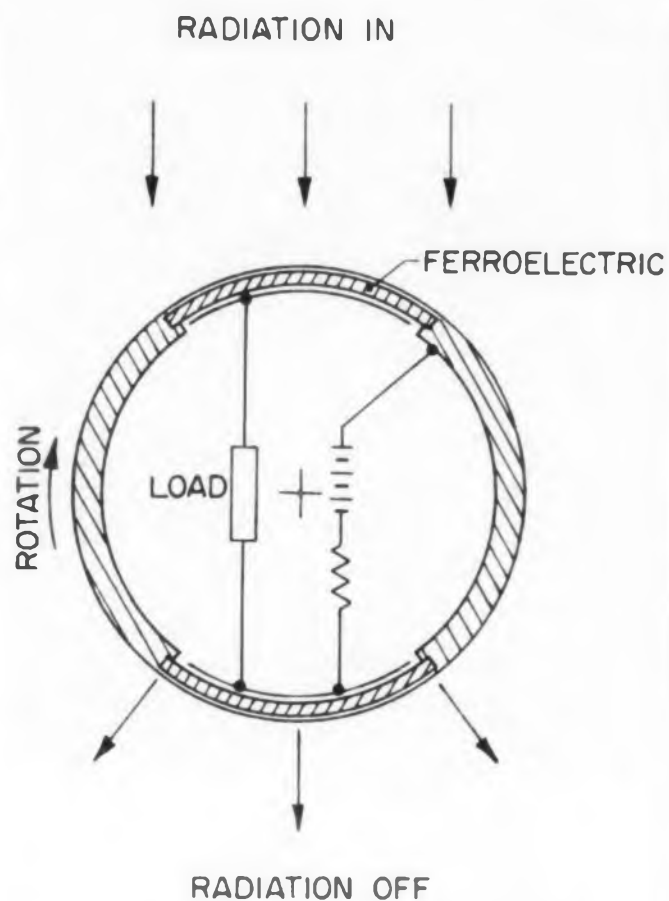
How permittivity of barium titanate varies with Curie temperature. Drop in permittivity caused by heating beyond T_c lowers capacitance of ferroelectric capacitor, thereby raising its potential. This effect is the basis of the new converter. Solid curve is for low field strength, dotted curve, for high field strength.



Simple ferroelectric converter requires no primary input power. The battery receives and delivers (through holding diode, load, battery) the same charge during each cycle, discharging potential built up during heating of capacitor.

temperature Curie point, voltage gains of from 3 to 10 times input have been achieved. Mr. Hoh believes still better gains are possible with specially developed materials. Barium titanate is being used primarily because it is one of the best known ferroelectrics.

Conversion efficiencies achieved in thermoelectric units (about 8 per cent), thermionic and solar-cell converters (about 13 per cent) and nuclear converters (about 10 per cent) could probably be exceeded soon with ferroelectric converters.



How ac is generated is illustrated in this suggestion for a satellite power source. Because the converter requires temperature cycling, the normal spinning of a satellite is put to work. The capacitors on each side of the rotating satellite are alternately heated and cooled, which charges and discharges them in sequence through the load. The battery makes up leakage. ITT is actually proposing a satellite incorporating many pairs of capacitors, and company researchers envision a satellite coated with a sprayed film of ceramic ferroelectric for maximum capacitance.

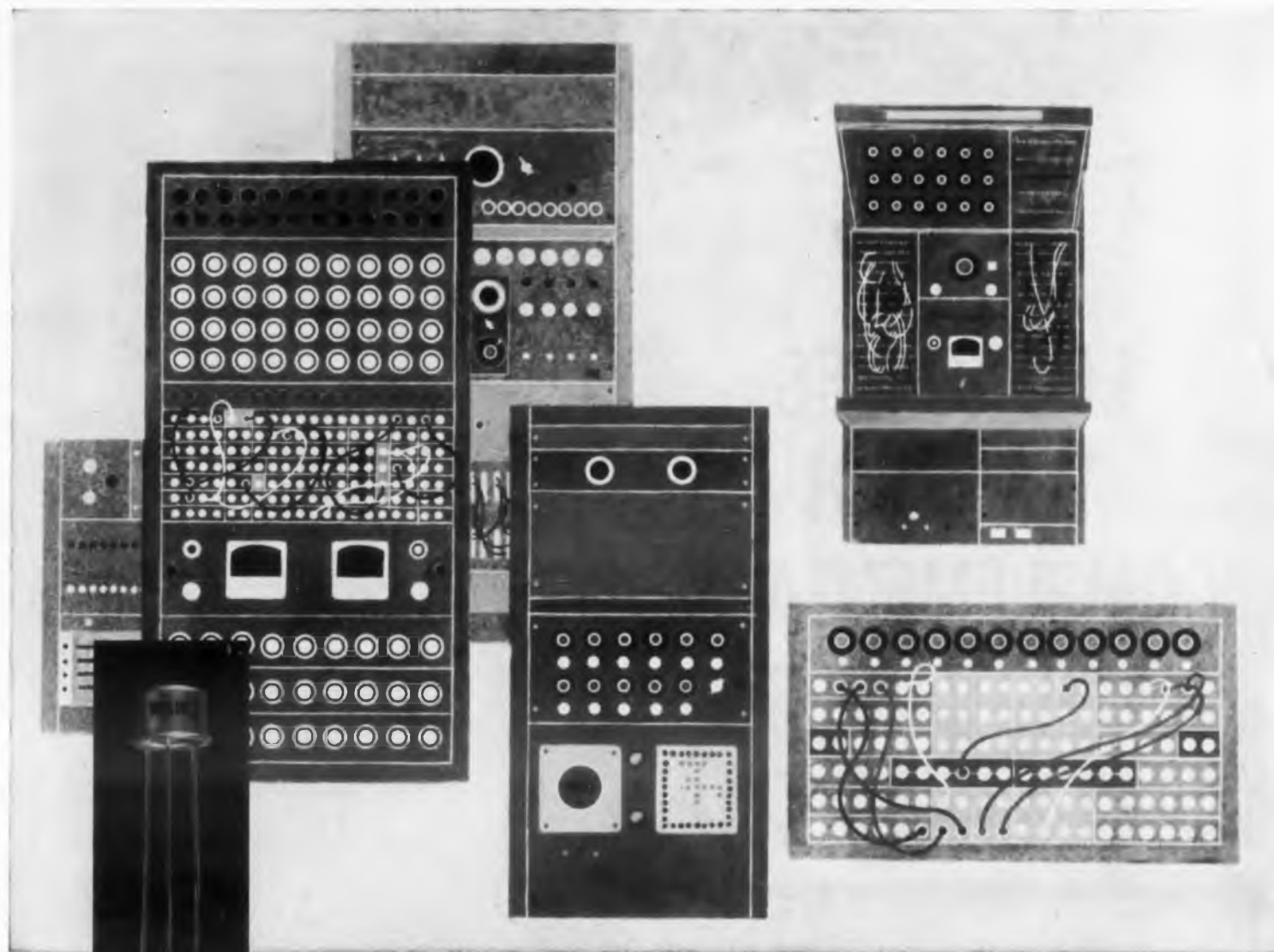
The Air Force is optimistically looking for efficiencies on the order of 20 per cent.

For space applications, however, Mr. Hoh points out, solar energy is limitless and free, and power-to-weight ratios are more important than efficiency.

Ferroelectric converters, he believes, could deliver about 90 watts per pound, compared with 40 for solar cells and only 2.5 for present thermoelectric devices.

Cost of ferroelectric materials is very low compared with that of solar cells, which deliver power at costs of \$1000 per watt and more, and cost of ferroelectric converters should be low relative to other types of converters.

In addition to use in space, other advantageous applications for ferroelectric converters would be in portable X-ray units, portable high-powered radars, and signalling buoys, which could apply the bobbing induced by wave action to temperature cycling. ■ ■



HIGH-SPEED COMPUTER SWITCHING TRANSISTORS

SILICON DDMT—Double Diffused Mesa Transistor . . . now available from Hughes to solve your high-speed

switching problems. This new silicon PNP transistor, which operates at low and medium current levels, gives you a cut-off frequency greater than 50 megacycles. In addition, Beta—as a function of collector current—is flat over 80 per cent of the operating range.

Two other advantages: 1. This Hughes transistor offers you all the desirable characteristics inherent in the solid state diffusion technique. 2. The tiny flexible leads of its gold plated package may be soldered directly into circuits or used with standard plug-in sockets.

This new device, while designed primarily for computers, is also an excellent amplifier and oscillator, lending itself to an unusually broad range of applications.

As in all Hughes semiconductor devices, reliability has been specifically designed into this mesa transistor. They are manufactured in the new multi-million dollar Hughes Semiconductor facility . . . using the finest equipment and newest techniques.

Your inquiry regarding these transistors will be given prompt attention. Just write or call the Hughes sales office nearest you.

They are located in:

Boston, 4 Federal Street; Woburn, Mass.; WElls 3-4824
Minneapolis, 6121 Excelsior; Minneapolis 16, Minn.; WEst 9-0461
Newark, 80 Mulberry Street; Newark 2, N. J.; MArk 3-3520
San Francisco, 535 Middlefield Road; Palo Alto, Calif.; DA 6-7780
Syracuse, 224 Harrison Street; Syracuse 2, N. Y.; GRanite 1-0163
Chicago, 1515 N. Harlem Ave.; Oak Park, Ill.; NAtional 2-0283
Cincinnati, 816 Swifton Center; Cincinnati, Ohio; ELmhurst 1-5665
Philadelphia, 1 Bala Avenue; Bala-Cynwyd, Penn.; MOhawk 4-8365
Los Angeles, 690 N. Sepulveda; E; Segundo, Calif.; OR 8-6125

Or write, Hughes Products, Marketing Department,
 SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA.

For export, write: Hughes International, Culver City, Calif.

SPECIFICATIONS: Absolute Maximum Ratings (25°C)

	2N1254	2N1255	2N1256	2N1257	2N1258	2N1219
BV_{CEO}	15V	15V	30V	30V	50V	50V
BV_{CBO}	15V	15V	30V	30V	50V	50V
BV_{EBO}	5V	5V	5V	5V	50V	3V
Power Dissipation	250 mw					
Ambient Temperature	-65°C + 175°C					

SEMICONDUCTOR DIVISION

Creating a new world with *ELECTRONICS*

HUGHES PRODUCTS

© 1959, HUGHES AIRCRAFT COMPANY

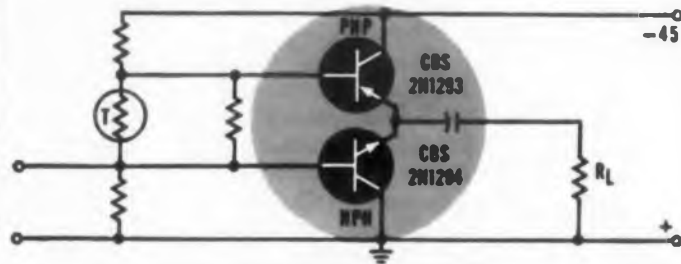
SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE • OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

CIRCLE 5 ON READER-SERVICE CARD

First of a series of
complementary power transistor lines

NEW CIRCUIT ECONOMIES THROUGH COMPLEMENTARY POWER TRANSISTOR PAIRS

Complementary pairs of CBS NPN and PNP power transistors eliminate input and output transformers in push-pull circuits. Resulting advantages are many: Economy. Miniaturization. Improved frequency response. Ease of applying negative feedback. Etc.



COMPLEMENTARY CLASS B AMPLIFIER

NOTE THE IDENTICAL DATA FOR THESE NPN-PNP PAIRS

NPN Type	Max. W. Diss.°	Max. V_{CE0} †	Max. V_{CES} ‡	Min. h_{FE} ($I_C = 0.5A$)	Max. Thermal Res. °C/W	PNP Type
2N326	7	35	35†	30	8	2N1291
2N1202	20	35	30‡	30	3	2N1291
2N1294	20	60	45‡	30	3	2N1293
2N1296	20	80	60‡	30	3	2N1295
2N1298	20	100	80‡	30	3	2N1297

All types have: Max. collector current, 3 amps; storage temperature, -65 to +85°C. *25°C base mounting temperature. †Polarity: NPN positive, PNP negative. ‡ $I_{CES} = 1$ ma max. † $I_{CES} = 10$ ma.



A SURVEY of customer applications resulted in this planned line of five CBS NPN-PNP pairs that make possible new design economies in complementary circuitry. Mounted in the popular TO-3 diamond package, they feature high voltages . . . up to 100 volts, and proven reliability (they exceed the MIL-T-19500A specification). They offer the first complete line of complementary power transistors . . . with more coming in flexible ranges of ratings and packages . . . for audio, control, voltage-regulation, servo and computer applications. Check the basic simplicity of the circuit and the abbreviated data for this first versatile and comprehensive CBS line. Write for complete technical Bulletin E-332A.

More reliable products
through Advanced Engineering



CBS ELECTRONICS, Semiconductor Operations
A Division of Columbia Broadcasting System, Inc.

Sales Offices: Lowell, Massachusetts, 900 Chelmsford St., GLEview 4-0446 • Newark, N. J., 32 Green St., MArket 3-5832 • Melrose Park, Ill., 1990 No. Mannheim Rd., ESTebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAymond 3-9081

CIRCLE 6 ON READER-SERVICE CARD

NEWS

Quotes in the News . . .

"Possible benefits of an acceptable, inexpensive depotting technique for encapsulated electrical components would be reduced cost of repairs, reduced downtime, greater material savings through salvage, and reduced cost of design changes,"

. . . said G. C. Lehritter of the Air Materiel Command in a letter sent to the electronics industry to find out whether depotting is feasible and how it should be done.

"The systematic study of the binary semiconducting compounds is still in its infancy, yet products utilizing them are already on the market. Beyond this there are ternary, organic, and even more complex compounds which are known to be semiconductors and which, as the technology progresses, will add immeasurably to the scope and utility of solid-state electronics,"

. . . said T. S. Shilliday of Battelle Memorial Institute in the current issue of the Battelle Technical Review.

And a pre-Moon-Sputnik quote:

"There is no real evidence that Russian Science is seriously outpacing ours. But it may well be true that the Russians are putting their scientific progress to work faster than we are,"

. . . said F. B. Turck, an ASME consultant, during the announcement of ASME's study of the time lag in the U.S. between scientific discoveries and their practical application.

NASA Awards Electronic Industry Million Dollars in One Month

Latest contract awards announced by the National Aeronautics and Space Administration show that for July alone the electronics industry received \$970,000 directly, and as part of other NASA industrial and research contracts probably more.

Money was obligated in July, 1959 to these organizations:

University of Illinois—\$60,000 — and Stanford University—\$90,000 — For continuing studies of satellite radio signals to study makeup of the ionosphere.

Massachusetts Institute of Technology—\$200,000 — For assistance in evaluating Project Mercury tracking facilities and ground instrumentation.

Minneapolis Honeywell Co.—\$70,000 — Acoustica Associates Inc.—\$90,000 — To investigate the use of sound waves to control the burning rate of solid rockets.

Air Force Ballistic Missile Division (ARDC)—\$280,000 — For installation of special radio acquisition equipment at the Kaena Point, Hawaii, tracking station for use in communications with Tiros, a meteorological satellite.

Army Ordnance Missile Command—\$150,000 — For instrumentation to duplicate a 91-pound satellite payload that failed to get into orbit July 16, 1959, when its booster was destroyed because of an electronic failure five seconds after liftoff.

AOMC—\$100,000 — Funds to cover the cost of the project Beacon payload launched August 14, 1959, which failed to get into orbit because of a guidance failure.

Packaged Switching Circuits Designed for On-Site Processing

The National Bureau of Standards has designed seven special-purpose transistorized computer packages for in-shop recording and processing of data.

The units, designed as building blocks can be combined to accept data from experimental equipment and adapt them for use in high-speed computers.

So far, seven logical components have been developed, all operating at 50-mc pulse repetition rates. They are: a flip-flop, a gating circuit, a one-shot pulse generator, a logical OR-inverter, an indicator, an analog switch, and a power gate driver.

Standard stock parts are used, and in most of the packages, some components or subassemblies are left unconnected and must be wired externally to the package.



Special-purpose computer packages developed at NBS are used for recording and processing experimental data.



DOUBLE YOUR RANGE!

WITH ONLY ONE CHANGE—ON X-BAND AND S-BAND MICROWAVE SYSTEMS

You can now double the effective range of your X-band or S-band microwave system applications with no change in power requirements, no change in antennas, no change in other system equipment!

How? By using Hughes PAX-1 or PAS-2B backward-wave amplifiers in your microwave systems you will achieve noise characteristics much lower than from any other traveling-wave tube. The lower the noise level, the longer the effective range!

Recent advances in electron gun design (resulting from noise phenomena studies conducted by Hughes R & D laboratories) make possible the extremely low noise characteristics

of the Hughes PAX-1 and PAS-2B tubes.

In your microwave system applications, these amplifiers alone offer you advantages not obtainable by any combination of other low-noise devices.

Only one voltage to vary... Another important feature of the PAX-1 and PAS-2B backward-wave amplifiers is a narrow, electronically tunable passband covering the entire X-band or S-band spectrum. This feature automatically provides image rejection, excellent selectivity and anti-jamming capability. And, once the initial setup has been made, only the tuning voltage needs to be varied for complete operation.



SPECIFICATIONS:	PAX-1 (X-Band)	PAS-2B (S-Band)
Minimum noise figure	4.5 db	under 4.0 db
Gain	over 20 db	10-25 db
Tuning voltage	420-650 v	180-1150 v
Maximum voltage	1500 v	2750 v
Bandwidth	12 mc	11 mc
Input-output isolation	over 50 db	over 50 db
Filament power	6 w	10 w
Magnetic field	1300 gauss	1000 gauss
Saturation power output	0.2 mw	1 mw

Write now for detailed specifications on the PAX-1 and PAS-2B: HUGHES PRODUCTS, Electron Tube Division, International Airport Station, Los Angeles 45, Calif. For export information, write: HUGHES INTERNATIONAL, Culver City, Calif.

ELECTRON TUBE DIVISION

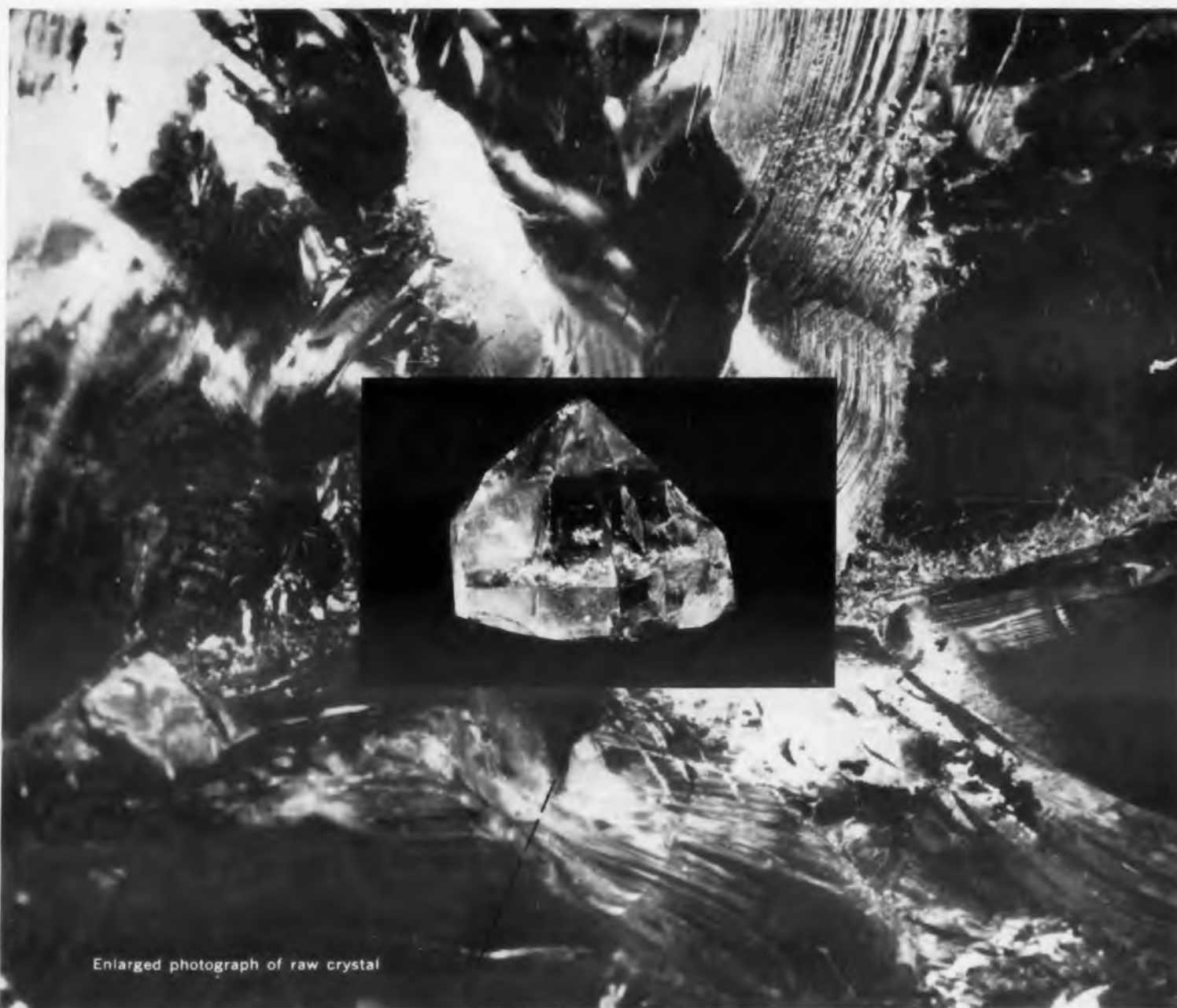
Creating a new world with ELECTRONICS

HUGHES PRODUCTS

© 1959 HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

CIRCLE 7 ON READER-SERVICE CARD



Enlarged photograph of raw crystal

BULOVA CRYSTAL CONTROLLED VARIABLE FREQUENCY OSCILLATORS


Bulova Crystal Controlled Variable Frequency Oscillators are the *advance* in electronics most engineers have been seeking.

Why? . . . Because Bulova VCF packages combine small size and high repeatability with automatic frequency control or with a variation of nominal frequency by application of external voltage.

The ranges available extend from 10kc to 20mc. Variation at 10kc is up to 6cps, at 20mc up to 12kc. Resolution on these shifts is infinite, it's dependent on stability and resolution of modulating voltage, only. Drift, after stabilization, can be kept to less than $1 \text{ pp } 10^6$.

These unique crystal controlled variable frequency oscillators are only one of many recent advances made by Bulova Electronics. For information on these units, or on how Bulova experience in mastering component and system reliability can help your program, write Department A-1231, today.



 **BULOVA**

ELECTRONICS DIVISION • WOODSIDE 77, NEW YORK
CIRCLE 8 ON READER-SERVICE CARD

NEWS

Component Tailored to Climate



This is the first in a series of temperature-controlled memory planes being developed for data-processing systems that operate in climatic extremes. The ferrite cores, insulated with pads of polyurethane, are enclosed, together with the temperature-control assembly, in a 4-by-5-by-1-inch magnesium case. This design for an airborne application functions at 85 C in an ambient temperature range from minus 55 C. Warm-up time from minus 55 C is less than five minutes, according to the developer, General Ceramics Corp. of Kearsbey, N. J.

Infrared Horizon Sensor For Satellite Excludes Sun

A new wide-angle infrared sensor is designed to be carried aloft to detect the thermal horizon between the earth and space. With two of the sensors, it is planned to establish the stable vertical reference, vital for precise orientation control of a missile or satellite in space.

Developed by the Barnes Engineering Co. of Stamford, Conn., the sensor reacts to the earth's radiation and not to reflected solar radiation. It does this by using thermistor detectors that respond to far infrared wavelengths and filters that eliminate visible and near infrared radiation.

The detectors convert the incident radiant energy into electrical output signals to space-vehicle control systems. The output is precise and almost independent of variations in the temperature and radiance of the earth, the developer has reported.

Completely transistorized, weighing two and a half pounds and consuming only four watts, the sensor is destined for use in the National Aeronautics and Space Administration's manned satellite capsule, Project Mercury.

New Crystal Process Promises Transistors for 1800-F Operation

High-purity, single crystals of silicon carbide have been produced by a new process that promises to raise the temperature limit of transistors and diodes to about 1800 F.

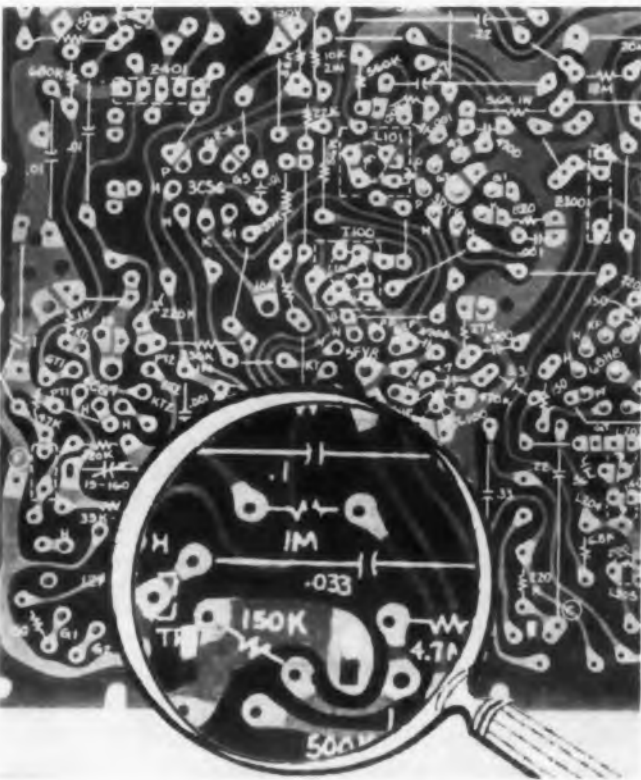
The process, developed at the Stanford Research Institute, works this way:

Pure silicon is melted in a carbon crucible of a modified crystal-pulling furnace. The carbon of the crucible diffuses into the molten silicon and saturates the solution. A cool spot produced in the solution by careful temperature control results in a portion of supersaturated solution, from which silicon carbide crystals can be grown.

Though crystals now produced by this method are too small for semiconductor use, the Navy has financed another year of research.

Pure single crystals of silicon carbide in transistors would make possible production of semiconductor devices that could operate in hot environments, and extremely small devices that would have minimal heat-dissipation problems.

Circuits Identified Easily



Printed circuit board for TV receiver has both circuits and identification on bottom of board. According to Westinghouse, which is using the new boards in its 1960 TV line, the new arrangement allows for these advantages: tube pins can be identified with respect to the elements they connect to, point-to-point connections can be shown, identifications can be placed where they are unobscured by soldering. It also provides space for special identifications. Values are yellow, circuits green.



If you're looking for a high-performance crystal filter

At your service is a group of highly talented Hughes Crystal Filter engineers who specialize in solving difficult network problems. These men can design and produce a crystal filter to meet your most exacting requirements! In addition, Hughes offers you tremendous production capacity—over 10,000 filters per month of a single type. With Hughes Crystal Filters you get:

Precise Selectivity—Eliminates cross talk between channels, makes new systems possible.

Small Size—Reduces overall equipment size, makes filter more reliable by eliminating air space, results in higher stress factor.

High Frequency—Saves circuit costs, eliminates the need for double conversion. Center frequencies 30 kc to 40 mc.

Low Passband Ripple—Eliminates errors in information, enables end equipment to be more precise.

Wide Temperature Stability—Provides flexibility of use, contributes to high reliability.

Low Insertion Loss—Enables system to operate on low signal level—thereby combating noise and cutting circuit costs.

To avail yourself of the Hughes applications engineering service, or for additional information concerning performance levels please write: HUGHES PRODUCTS, Industrial Systems Division, Marketing Dept., International Airport Station, Los Angeles 45, California. For Export, write: Hughes International, Culver City, California.

Creating a new world with *ELECTRONICS*

HUGHES PRODUCTS

© 1959 HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

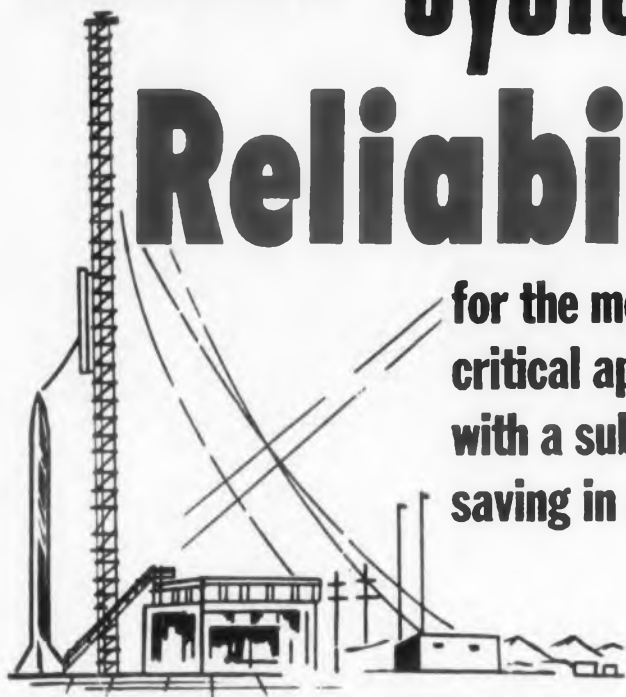
CIRCLE 9 ON READER-SERVICE CARD

ELMENCO** DIPPED MYLAR*-PAPER CAPACITORS (TYPE MPD)

achieve
missile system
Reliability

for the most
critical applications
with a substantial
saving in cost!

These capacitors will exceed all the electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.



RELIABILITY Exhaustive evaluation of ELMENCO Type MPD (ARCO dp) Dipped Mylar*-Paper Capacitors has been conducted during the past four years and the product refined to its present high level of quality. As an example, a 0.1 mfd. capacitor operated at full rated voltage and at 105°C. will have a life expectancy of more than 5,000,000 unit-hours to first failure. The number

of unit-hours to first failure is inversely proportional to the capacitance value in mfd. This quality level is continually verified by accelerated life testing on all production. ELMENCO dipped tubulars are non-inductively wound and vacuum dipped to obtain solid impregnation and a rugged moisture-proof coat. They are MINIA-TURIZED and have radial leads for printed circuit & transistor application.

SPECIFICATIONS

TOLERANCE	± 10%.
VOLTAGE RATINGS	100VDCW, 200VDCW, 400VDCW, 600VDCW, 1600VDCW.
INSULATION RESISTANCE	@25°C.: 5000 megohm-microfarads or 100,000 megohms minimum, whichever is the lesser. @110°C.: 70 megohm-microfarads or 1400 megohms minimum, whichever is the lesser.
POWER FACTOR	1.0% maximum at 1kc.
Temperature Range	-55°C. to +110°C. with no voltage derating.
Capacitance Change vs. Temperature	From 25°C. to -55°C. [- 9.0% max.] From 25°C. to +110°C. [+10.0% max.]
LONG TERM OPERATING STABILITY AT FULL RATED VOLTAGE AND RATED TEMPERATURE EXTREMES IS ± 2% MAXIMUM.	

**The Electro Motive Mfg. Co., Inc. Trademark
*DuPont Trademark



ARCO electronics inc.

64 White St., New York 13, N. Y. Branches: Dallas 19 • Los Angeles 35

CIRCLE 10 ON READER-SERVICE CARD

NOW AVAILABLE FROM THESE
AUTHORIZED
ARCO
DISTRIBUTORS

ARIZONA
RADIO SPECIALTIES & APPL. CORP.
917 N. 7th St., PHOENIX
STANDARD RADIO PARTS INC.
218 N. First Ave., TUCSON

CALIFORNIA
BRILL ELECTRONICS
610 East 10th St., OAKLAND 8
ELECTRONIC SUPPLY CORP.
2085 E. Foothill Blvd., PASADENA
FEDERATED PURCHASER INC.
11275 W. Olympic Blvd., L. A. 64
HOLLYWOOD RADIO SUPPLY INC.
5606 Hollywd Blvd., HOLLYWOOD 28
PACIFIC WHOLESALE CO.
1850 Mission St., SAN FRANCISCO 3
PENINSULA ELECTRONICS
656 South 1st Street, SAN JOSE
SHELLEY RADIO CO. INC.
2008 Westwood Blvd., L. A. 25
R. V. WEATHERFORD CO.
6921 San Fernando Rd., GLENDALE 1
ZACK ELECTRONICS
654 High St., PALO ALTO

COLORADO
DENVER ELECTRONICS SUPPLY CO.
1254 Arapahoe St., DENVER 4

DISTRICT OF COLUMBIA
CAPITOL RADIO WHOLESALEERS INC.
2120 14 St., N.W., WASH. D. C.

ILLINOIS
NEWARK ELECTRIC CO.
223 W. Madison St., CHICAGO 8

MARYLAND
KANN-ELLERT ELECTRONICS INC.
Howard & Redwood Sts., BALT. 1

MASSACHUSETTS
CRAMER ELECTRONICS INC.
811 Boylston St., BOSTON 16
RADIO SHACK CORP.
730 Commonwealth Ave., BOSTON 17

NEW JERSEY
FEDERATED PURCHASER INC.
1021 U. S. Rte. 22, MOUNTAINSIDE
RADIO ELEC. SERVICE CO., INC.
513 Cooper St., CAMDEN 2

NEW MEXICO
MIDLAND SPECIALTY CO.
1712 Lomas Bl. N.E., ALBUQUERQUE
RADIO SPECIALTIES CO., INC.
209 Penn Ave., ALAMOGORDO

NEW YORK
ARROW ELECTRONICS INC.
525 Jericho Turnpike, MINEOLA, L.I.
TERMINAL RADIO INC.
85 Cortlandt St., NEW YORK 7

PENNSYLVANIA
ALMO RADIO CO.
412 N. 6th St., PHILA. 23
PHILA. ELECTRONICS INC.
1225 Vine St., PHILA. 7
RADIO ELEC. SERVICE CO., INC.
701 Arch St., PHILA. 8

TEXAS
ALL-STATE DISTRIBUTING CO.
2411 Ross Ave., DALLAS 1
BUSACKER ELEC. EQUIP. CO. INC.
1216 West Clay, HOUSTON 19
ENGINEERING SUPPLY CO.
6000 Denton Drive, DALLAS 35
MIDLAND SPECIALTY CO.
500 W. Paisano Drive, EL PASO

WASHINGTON
C & G RADIO SUPPLY CO.
2221 Third Ave., SEATTLE

NEWS

U.S. Sees Electronics Output Heading for New Peak in 1959

Electronics output this year should reach a new record of \$8.5 billion—a billion and a half more than last year—according to an estimate by the United States Department of Commerce.

The department's Business and Defense Services Administration reports that all sectors of the electronics industry increased output in the first half of 1959. This contrasts sharply with 1958, when several sectors suffered setbacks in the early part of the year.

The anticipated output of consumer electronic equipment, at factory prices, is put at \$1.7 billion for 1959, up 30 per cent from 1958.

Production of equipment for the military has accounted for the greatest single spurt in the industry this year.

Commercial and industrial electronic equipment continued to be produced in increasing amounts in the first six months of 1959. "In another decade," according to the report, "the commercial and industrial electronic industry may be the largest sector of all the electronic industries."

An increase of 10 per cent in electron tube manufacturing, or a new high of about \$900 million, is forecast for 1959. Most of this rise is likely to be concentrated in transmitting and special-purpose tubes, the agency says. Receiving tubes are expected to show only a moderate increase.

The gain for semiconductor output is forecast at about 40 per cent—from an estimated \$210 million to more than \$300 million.

Other electronic components are expected to share in the prosperity, with an increase in production of \$250 million, or 20 per cent over 1958.

Flywheel Converters Installed At Swedish Power Stations

To support Sweden's transition from wire to coaxial and microwave telephony links, the Swedish Board of Telecommunications is installing flywheel converters at repeater stations.

The converters, which consist of a three-phase induction motor joined through an energy-storing flywheel to a single-phase synchronous generator, supply continuous alternating current at constant voltage.

During power breaks, energy stored in the flywheel drives the generator until stand-by plants take over.

The wheel assures full output for 30 seconds with a voltage accuracy of 3 per cent and a frequency drop of from 3 to 20 per cent.

Direct-current converters are also used in some Swedish telecommunications applications.

Optical Scanning Standards Sought by Retail Group

The National Retail Merchants Assoc. is planning to draw up standards for optical scanning equipment in data-processing systems used by retail stores.

Forms and procedures will be surveyed, then a sub-committee of the retailing group will meet with electronics industry representatives to develop suitable equipment specifications. A final report is expected within one year.

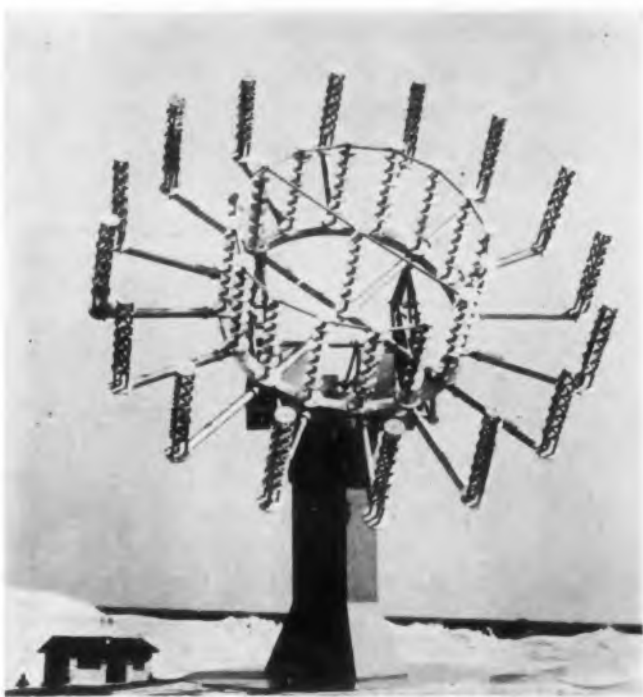
Why Not Pigeon Guidance?

Harvard's Dr. B. F. Skinner told a meeting of psychologists that pigeons could be trained to guide a rocket to the moon.

He reported that in a World War II project he and his colleagues had trained pigeons in a missile to peck at a target image flashed on a screen. As the target moved off-screen, the pigeon's movements, transmitted by a harness, corrected the missile's flight.

Though the pigeons performed well and could be trained in only 30 days, authorities were unimpressed. Dr. Skinner still has faith in the idea.

SVE Antenna Improves on Dish



Space target acquisition is said to be easier and tracking more accurate with this swept-volume-efficiency uhf tracking antenna shown as a model and developed for the National Aeronautics and Space Administration by General Bronze Corp., Valley Stream, N.Y. The 40-inch lightweight array of 33 end-fire elements can be moved in azimuth and elevation and will be installed at NASA's Wallop Island, Va., test site, to replace a 60-inch parabolic dish.

THE FIRST ALL TRANSISTOR 1/3 WATT 215 TO 260 MC TELEMETRY TRANSMITTER

Crystal controlled corrected phase modulation ± 125 KC deviation. Operational temperature range -25 to $+71^\circ\text{C}$. Dimension 2.6" diam. x 1.5" thick or 2.6" x 2.6" x 1.5" thick.

RF amplifiers available to increase the output of the transmitter to any desired value.

WRITE DEPT. G, VECTOR MFG. CO., SOUTHAMPTON, PENNA.



ACTUAL SIZE



CIRCLE 11 ON READER-SERVICE CARD



3

NEW CERAMIC TRANSDUCER ELEMENTS

U. S. SONICS
new transducer elements
US600, US500, and US100
are characterized by their:

•
High activity over wide tempera-
ture ranges (US500, US600)

•
High coupling coefficient (US500,
US600)

•
Stability over wide temperature
ranges (US500, US600)

•
Demonstrates excellent activity at
temperatures to -300°F .

•
Advanced production techniques
assure reproducibility.

PROPERTIES

	US600	US500	US100
Dielectric Constant	1350	1200	500
Curie Temperature	310C	330C	150C
Rad. Coupling Coefficient	0.46	0.50	0.31
d Constant (d_{31}) <small>(constantly variable)</small>	-120×10^{-12}	-170×10^{-12}	-62×10^{-12}
g Constant (g_{31}) <small>volt/meter newtons/meter²</small>	25.3×10^{-4}	38×10^{-4}	31×10^{-4}

Transducer elements are intended for use as drivers, resonators, and sensors.

Applications include: missile systems, underwater sounding, thickness detectors, depth and liquid level sensing gages, IF filters, ladder networks, microphone elements, and power drivers.

For further information write or call:

U. S. SONICS CORPORATION
625 McGRATH HIGHWAY SOMERVILLE 45 MASSACHUSETTS

MOnument 6-5100

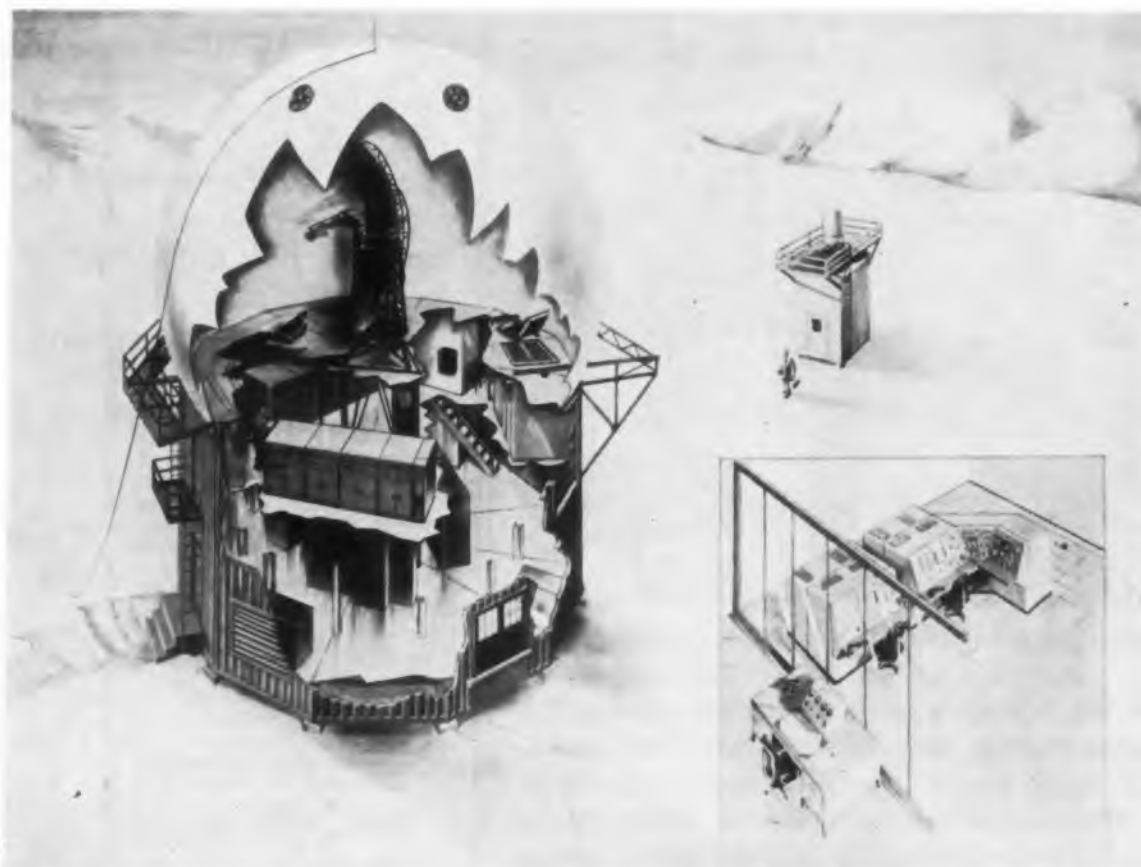
CIRCLE 12 ON READER-SERVICE CARD

NEWS

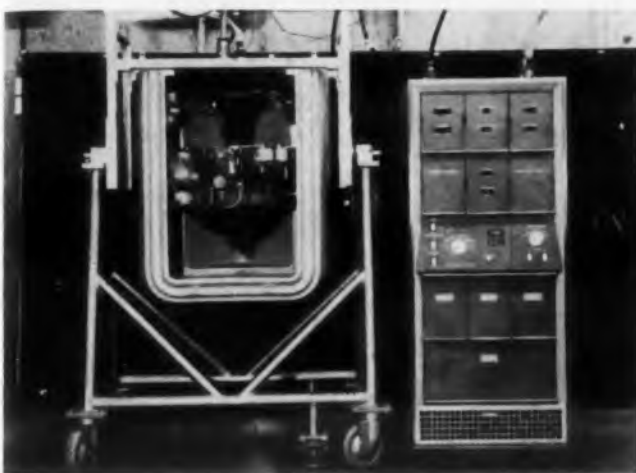


How Minuteman-generation of missiles could be launched from mobile sites is shown in this railway car mockup by American Machine and Foundry and ACF Industries.

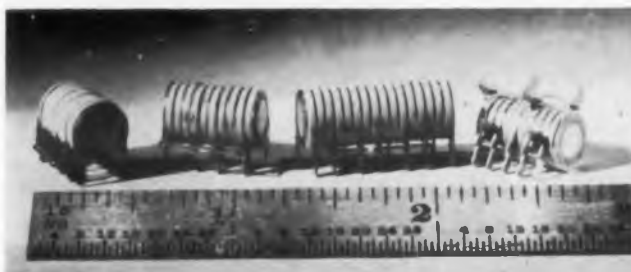
Design News in Photos



New radar for Dew-line will look like this. Now in production, the Avco FPS-26 will weigh 70 tons, be housed in a dome 50-feet across.



First photo of inertial navigation system that will fix submarine position for Polaris launching. System, developed by Autonetics, is being sea-tested aboard the USS Compass Island. In uncovered binnacle at left are stabilized platform, precision gyroscopes and velocity meters. Navigation console at right houses all other electronic equipment.



Engineering mockups of General Electric's TIMMS show degree of miniaturization possible with integrated modules. At left is a double cathode follower with two triodes, four resistors and two capacitors, next to it is a cascade amplifier incorporating two triodes, four resistors and one capacitor. The two modules at right are a multiple-element logic unit and a multivibrator.



Precast concrete acoustic horn weighing 53 tons will be part of a 100 ton assembly for directing sound to plane-wave and reverberant-type chambers. The entire assembly will be used by Goodyear Aircraft to test electronic components at Litchfield Park, Ariz.

after routing,
clip and save

a continuing series on technical topics
of specific interest to engineers

Folio 59-6

REFERENCE
DATA FILE



the significance of envelope delay in communication networks ...

The design of electronic wave filters is an exact science requiring painstaking attention to even the most minute detail. Of no less importance is the preparation of filter performance specifications. The transmission of pulsed sinusoids, steep-front modulation envelopes and other complex wave forms in modern telemetry, speech and facsimile systems has made the preparation of adequate component specifications an absolute necessity. The omission of a single required performance detail can lead to serious malfunctioning of the component in the completed system.

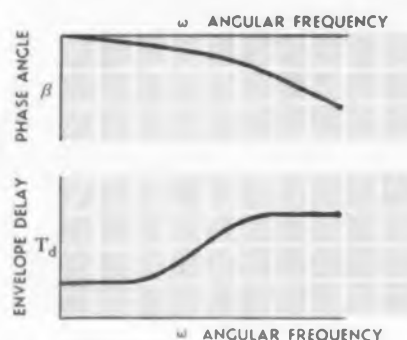
Envelope delay is one of the important characteristics in filter applications requiring minimum distortion of the transmitted signal. The systems engineer must give proper attention to this requirement. Mathematically, envelope delay may be defined as:

$$T_d = - \frac{d\beta}{d\omega}$$

Where: T_d = envelope delay in seconds
 β = phase shift in radians
 ω = angular frequency in radians per second

To hold distortion to a minimum, the envelope delay must be nearly constant over the entire frequency spectrum of the transmitted signal. It is the constancy of envelope delay rather than the actual magnitude of the delay which governs a network's ability to transmit a complex wave form without introducing objectionable distortion. The distortion arising from non-constant envelope delay is termed envelope delay distortion. From the above equation it is apparent that T_d is constant as long as phase shift varies linearly with frequency. Unfortunately, the realization of a filter network with perfectly linear phase shift over its entire pass band is not always practical or even possible. For this reason, the systems engineer should carefully evaluate the degree of constancy of T_d which his system requires as well as the range of frequencies over which T_d must be maintained nearly constant.

FIG. 1 Illustrates the relationship between phase shift and envelope delay.



The effect of envelope delay distortion on a transmitted signal is illustrated in figure 2. Figure 2 (a) shows the input signal. It is composed of a fundamental frequency plus the third and fifth harmonics. Figure 2 (b) shows the output signal. The network has shifted the fundamental frequency by 45°, the third harmonic by 90° and the fifth harmonic by 180°. The net result of such non-linear phase shift is a highly distorted output signal. If components of the wave had been shifted 45°, 135° and 225° respectively, the signal would have been transmitted without distortion.



Since envelope delay is defined as the derivative of phase with respect to frequency, exact measurement of envelope delay is difficult. In practice, however, envelope delay may be approximated by the following definition:

$$T_{\Delta d} = - \left(\frac{\theta_2 - \theta_1}{f_2 - f_1} \right) \frac{1}{360}$$

Where: θ_2 = phase angle in degrees at f_2
 θ_1 = phase angle in degrees at f_1
 f_2 = frequency in cycles per second at which phase shift equals θ_2
 f_1 = frequency in cycles per second at which phase shift equals θ_1

$T_{\Delta d}$ is the average envelope delay between f_2 and f_1 . By convention, $T_{\Delta d}$ is assumed to be the envelope delay at a frequency equal to $\frac{1}{2}(f_1 + f_2)$. When the approximate formula is used to calculate envelope delay from empirical phase shift versus frequency data, it should be remembered that the approximation holds only for small differences between f_1 and f_2 .



The IBM "650" computer services maintained at Sangamo materially aid our design engineers in solving complicated networks for envelope delay, phase shift and attenuation characteristics.

Write for Inductive Component Bulletin Series IC-260

SC-59-7

SANGAMO ELECTRIC COMPANY, Springfield, Illinois
--designing towards the promise of tomorrow

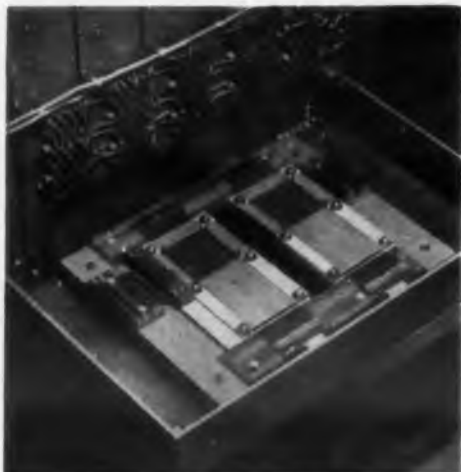
CIRCLE 13 ON READER-SERVICE CARD

NEWS

First Magnetic-Film Memory Use Successful

After operating its TX-2 high-speed digital computer for three months with a magnetic thin-film memory, MIT's Lincoln Laboratory has announced that it is satisfied with performance of the component.

Read-and-write cycle times of 0.8



Prototype magnetic thin-film memory has capacity of 32 ten-bit words. Surrounding the memory are transistor drive and sense circuits.

microseconds have been achieved, though bench tests indicated potential speeds of 0.4 microseconds.

Net driving current for writing in the Permalloy-film memory is 150 ma. Output signals of 1 mv are produced by the Permalloy elements.

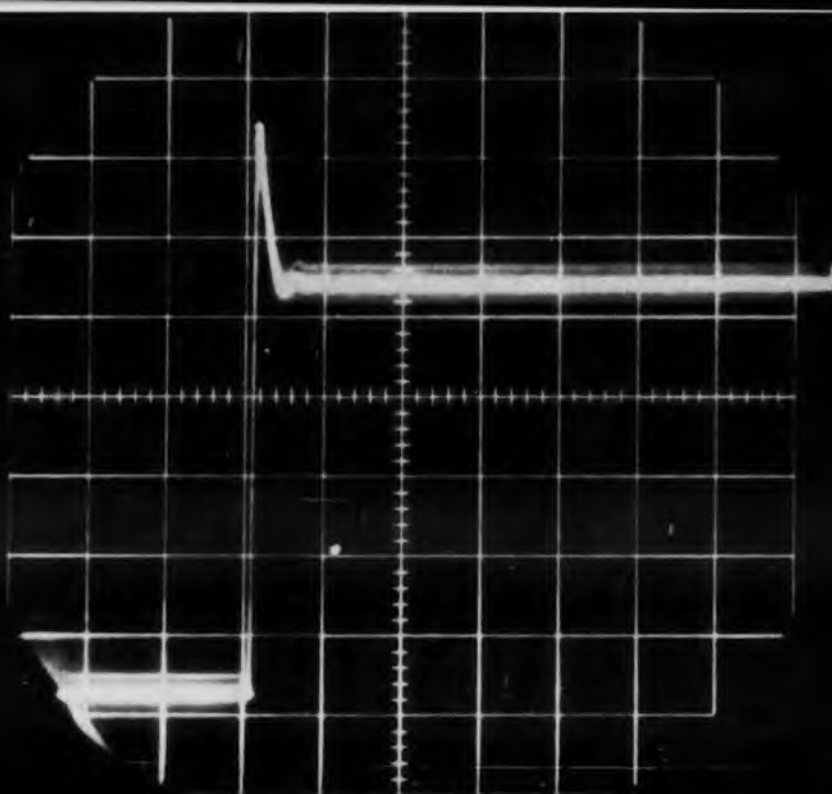
According to MIT, potential advantages of thin-film memories over ferrite toroidal cores are: faster cycle time, lower power dissipation, and greater compactness and simplicity.

Three-Way Thermoelectric Unit to be Designed

The Navy has contracted for an experimental thermoelectric system that will operate as an air conditioner, a space heater, and a refrigerator-freezer.

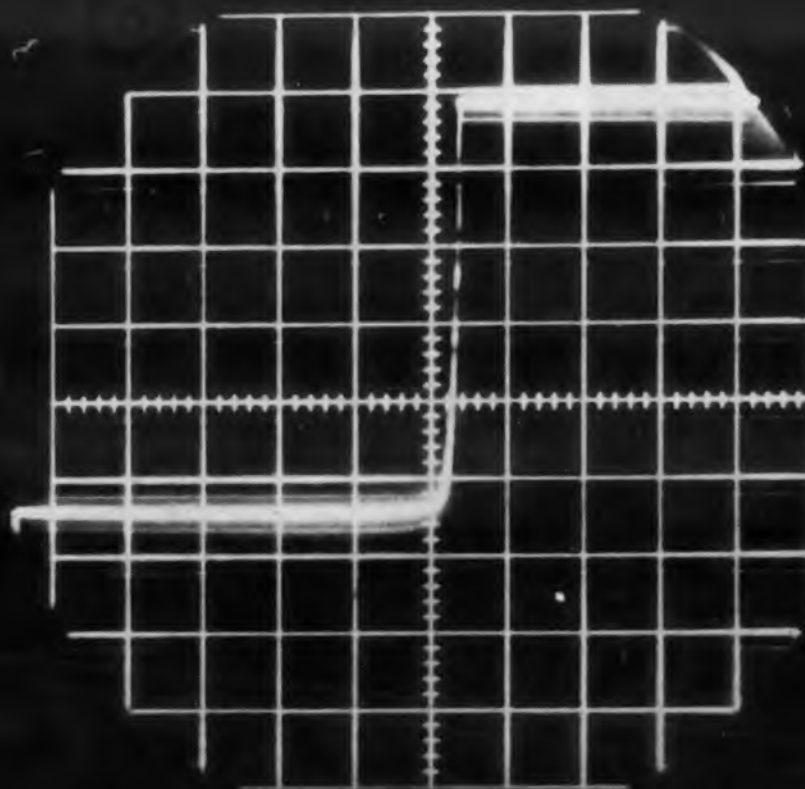
The solid-state system will be designed by Westinghouse so that it will lend itself to construction of a full-scale system.

For operating flexibility and ease of gathering test data, the system



Actual photographs of power supply turn-on at 28v setting. Scope settings: 5v per cm vertical, 0.2 sec. per cm horizontal.

TRANSISTOR KILLER: THE VOLTAGE SPIKE...



TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

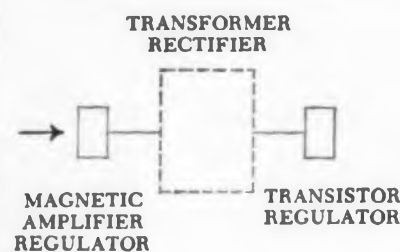
The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For complete protection against line and load transients, use new Perkin MTR power

supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation. Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant... even if an internal transistor fails, your Perkin MTR power supply continues to regulate smoothly and safely!

PERKIN



MODEL NO. MTR-636-15



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES

prompt delivery

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple RMS
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	±.2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	±.3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	±.2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	±.2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Over-

loads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.



PERKIN
ENGINEERING CORPORATION

345 Kansas Street, El Segundo, California • ORegon 8-7215

New England Area Office: 46 Amesbury St. • Lawrence, Mass. • MURdock 3-3252

SALES REPRESENTATIVES

Albuquerque, N.M.—AMherst 8-1724
Angola, Ind.—217 & 8101-R
Atlanta, Ga.—BLackburn 5-6660
Chicago, Ill.—JUniper 8-0905
Cleveland, O.—REdwood 2-7444
Dallas, Tex.—FLeetwood 7-7080

Dayton, O.—CHapel 4-5551
Denver, Colo.—SUnset 1-7375
Detroit, Mich.—HOward 8-2461
Indianapolis, Ind.—STate 7-0009
Kansas City, Mo.—HEdrick 2-2528
Los Angeles, Calif.—HOLlywood 9-7294

Minneapolis, Minn.—MIdway 6-2621
New York City, N.Y.—DlGby 4-2997
Orlando, Fla.—CHerry 1-2128
Philadelphia, Pa.—WAlnut 7-1820
Phoenix, Ariz.—WHitney 6-2111
St. Louis, Mo.—PARKview 1-6403

San Diego, Calif.—ATwater 3-2081
San Francisco, Calif.—EMerson 9-3354
Seattle, Wash.—PARKway 3-9000
Syracuse, N.Y.—GIBson 6-0220
Washington, D.C.—JUniper 5-7550
Agincourt, Canada—AXminster 3-7011

will have separate heating and cooling units.

Capacity of the air conditioning unit will be one ton.

The refrigerator-freezer will be a two-cubic-foot unit capable of maintaining 0 F continuously.

Extended Visual Ranging Used in Recovery System

A direction-finding system for recovery operations locates low-intensity signals and provides visual-display homing of am, fm, or cw signals as weak as two microvolts.

This performance is said to be made possible by these features:

- A high-gain receiver (with crystal calibration oscillator) linked to directional, tuned antenna arrays,
- Dual trace and polarity switching methods that help lock on the beacon signal and provide directional information, and

- Phase-loop, lobe switching that provides left-right information without antenna rotation.

In the Lockheed LAS 103 system, the operator monitors a receiver output signal on an azimuth indicator and visually analyzes it for direction finding.

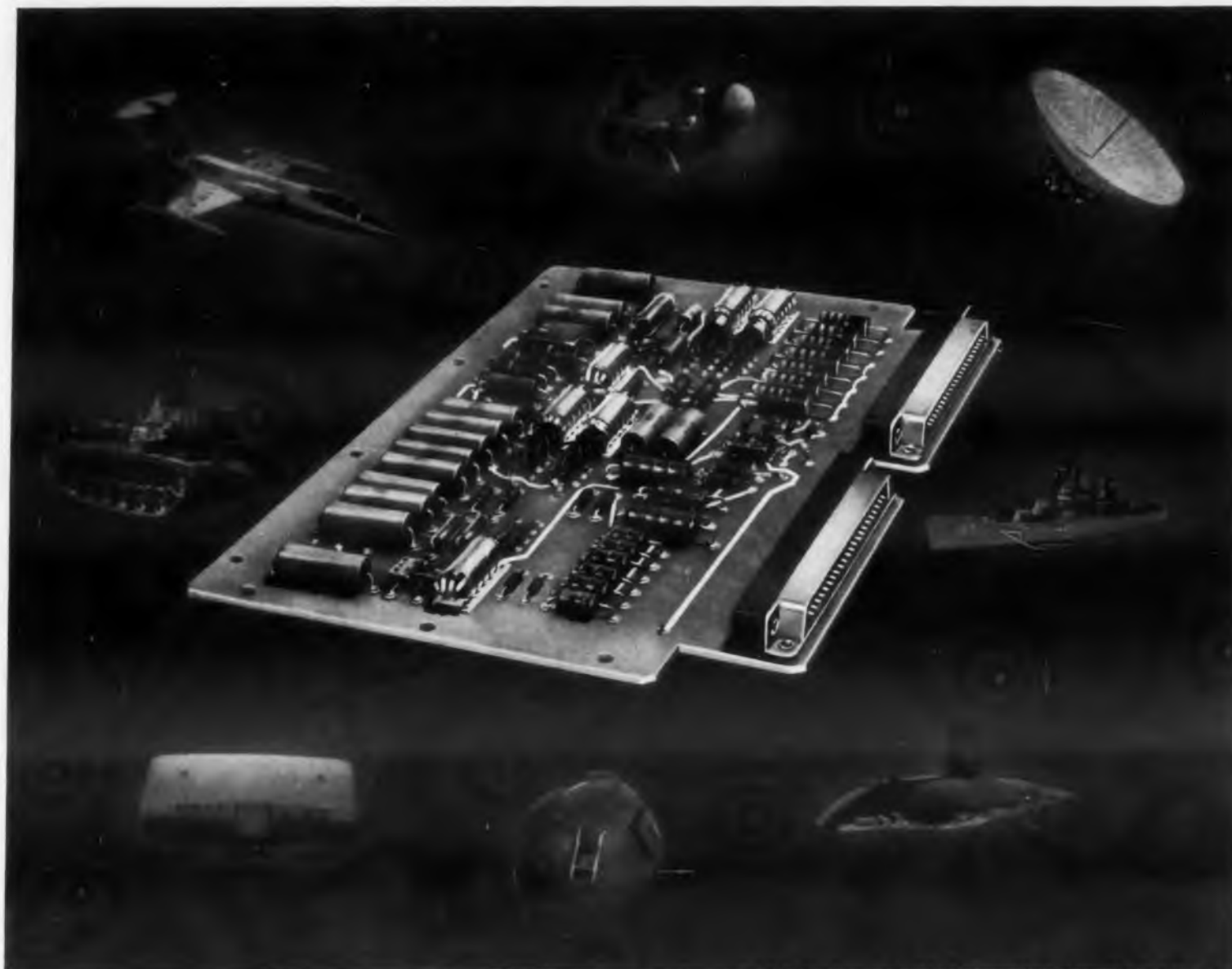
Largest RF Heating System Designed

A radio-frequency generation system that will concentrate 10 million watts of rf energy into an area of about 100 square feet has been designed for heat-testing space equipment.

The system, to be installed by General Electric at the Wright Field Air Force base, will consist of 40 power loops and associated load-matching networks. Each loop will be capable of inducing 250,000 watts of rf power into a test specimen at frequencies ranging from 200 kc to 2 mc.

Future extension to 5 mc generation will be provided for.

◀ CIRCLE 16 ON READER-SERVICE CARD



Official photographs: U.S. Army, U.S. Navy, U.S. Air Force

CUSTOM PRINTED CIRCUIT SUB-ASSEMBLIES

another area where *Photocircuits* does it better

Photocircuits—the world's largest supplier of printed circuits for exacting requirements—offers contractors "missile reliability" in complete, *tested sub-assemblies* for military equipment.

Photocircuits is equipped with assembly and test facilities to carry over the same precision quality control from circuit board to final package. Our Inspection and Quality Control Departments are continuously working with Military Specifications such as MIL-Q-5923C, MIL-Std-105A, MIL-P-1877A, etc.; our quality control system is under continual surveillance by the Air Force.

Photocircuits has the experience, equipment and personnel necessary to produce your sub-assemblies . . . quantity or prototype . . . faster, more dependably and at less cost. All under the same roof! This eliminates divided responsibility during fabrication and assembly and assures you the same fine quality in sub-assemblies that is already available in printed boards.

Your nearby Photocircuits Factory Engineer will be happy to give you more complete data on Photocircuits' facilities, or write direct to Dept. A-1374, Photocircuits Corporation, Glen Cove, New York.

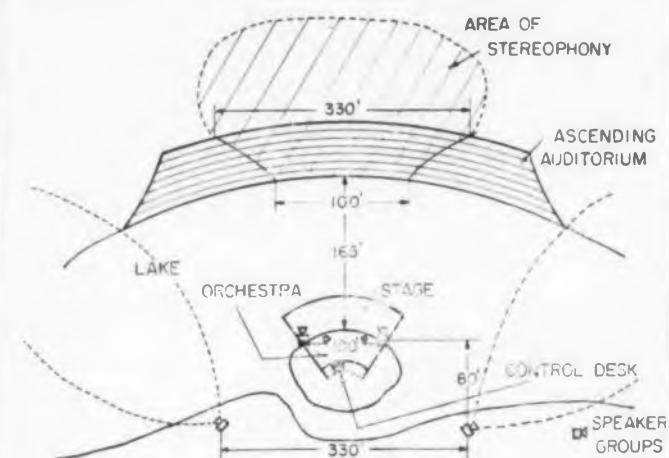


Photocircuits
CORPORATION

CIRCLE 14 ON READER-SERVICE CARD

NEWS

Outdoor Stereo Installed in Germany



Open-air stereophonic setup in Dortmund, Germany, uses 300 watts for each channel. Sound is radiated from two towers of 48 loudspeaker systems each, permitting stereo seating for about 6000 listeners. According to Telefunken, the installation is the world's largest stereo system and Europe's first open-air stereo facility.

NEWS BRIEFS . . .

. . . **CARBOX AS WELL AS HYDROX** fuel cells will be developed in the U.S. by Universal Winding Co. under a licensing agreement with Britain's National Research Development Corp. (*ED* Sept. 16, p. 9). Prototype Hydrox cells have been built here; a prototype Carbox cell is still being developed.

. . . **CHAIN OF COMPUTER CENTERS** to be established by CEIR, Inc., Arlington, Va., will start off using IBM 7090 units. Added later will be one of the 1960-generation computers, and another unit to become available in 1961.

. . . **A COMMUNICATION NETWORK** for TV and telephony proposed by ITT is based on signal reflection from ultra-thin strips of aluminum shot into space.

. . . **HOW ROCKET EXHAUSTS** attenuate microwave signals will be studied by Stanford Research Institute under the Minuteman ICBM program.

. . . **MOST BASIC RESEARCH** money in industry goes to physics and mathematics research (54 per cent), reports the National Science Foundation. Of 1957's \$241 million in industrial basic science funds, 36 per cent went to engineering, only 10 per cent to life sciences.

... THE SOVIET MOON ROCKET was tracked during the last five hours of its flight by Britain's Jodrell Bank radiotelescope, and trackers at Fort Monmouth, N.J. Jodrell Bank was able to measure with Doppler techniques, changes in the rocket's velocity caused by the moon's gravitational pull.

... TREND IN SILICON is toward lower purity according to a survey of semi-conductor device users conducted by Aries Associates. Survey suggests most silicon used in future will be of low purity, will cost less than \$100 per ton. Reason: higher purity silicon costs more, competition in semiconductors is toughening.

... CALIBRATION SERVICE for vibration pickups has been established by National Bureau of Standards. Pickups can be calibrated from 10, to 2000 cps at accelerations up to 10 g, NBS reports.

... BOOMING CITIZENS' BAND radio is leading to abuse of FCC rules and may result in equipment manufacturers being advised not to encourage "fun" use of sets. According to FCC, too many people are talking too long in the Citizens' band.

... GROUPS INTERESTED in standards for nuclear instruments and controls have been asked by the American Standards Association to submit suggestions to an ASA committee working on nuclear standards.

SIGNIFICANT CONTRACT AWARDS

... TO TELEMETER MAGNETICS, INC., Los Angeles, \$200,000 from the Office of Naval Research for a large scale, high-speed computer memory with capacity in excess of 850,000 bits. Read-write speeds of 6 microwatts will permit 150,000 computer operations per second.

... TO DATA-CONTROL SYSTEMS, INC., Danbury, Conn., about \$750,000 in a subcontract from Boeing for the Minuteman ICBM test program fm/fm ground telemetry system.

... TO BENDIX AVIATION CORP, Ann Arbor, Mich., \$8,500,000 from the Air Force for the communication system of the Notus space satellite relay program.

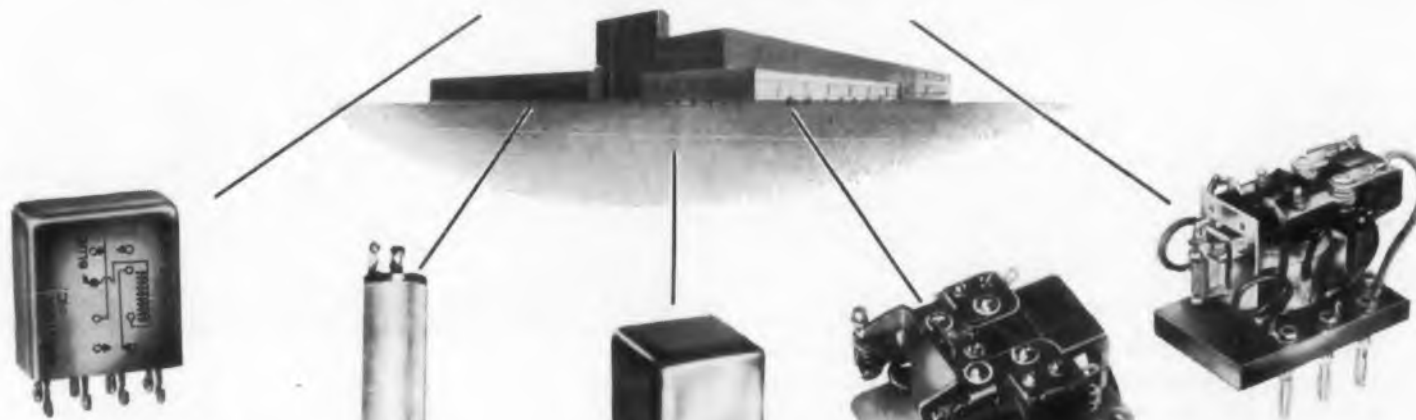
... TO MELPAR, INC., Applied Science Div., Boston, from the Air Force, a contract for a study of long-range communications interference to evaluate interference between ground based systems and satellites.



RELAYS • RELAYS • RELAYS

Complete Selection from one source

... WHEELLOCK SIGNALS



CRYSTAL CASE RELAY, Series 165: The microminiature concept for airborne applications demanding the ultimate in small size, light weight. Contact life 100,000 operations minimum at rated load and temperature range (-65°C. to +125°C.) Hermetically sealed, rugged and reliable, the Series 165 is available in a variety of terminal and mounting arrangements for plug-in, printed circuit or soldered lead connections. Designed to MIL-R-5757C and MIL-R-25018.

CONTACTS: DPDT
CONTACT RATING: 2 AMPERES
COIL VOLTAGE: MAY BE SPECIFIED
DC COIL RESISTANCE: 5K
SENSITIVITY: 0.350 WATTS
COIL DISSIPATION: 1.1 WATTS
WEIGHT: 0.4 OZ.

TUBULAR RELAYS, Series 120, 121, 123: For military, airborne and missile applications. High immunity to shock, vibration and temperature cycling. Hermetically sealed, dropout at up to 50% of pull-in current. Available in lengths down to 1 inch.

CONTACTS: SPDT
CONTACT RATING: 2 AMPERES
COIL VOLTAGE: MAY BE SPECIFIED
DC COIL RESISTANCE: 8K
SENSITIVITY: .080 WATTS
COIL DISSIPATION: 2 WATTS

MINIATURE SENSITIVE RELAYS, Series 100, 105, 106: Ideal for navigation, radar, telemetry and communications. Can function in dry circuit applications. Hermetically sealed with high shock, vibration and temperature immunity. Meets MIL-R-5757C

CONTACTS: DPDT
CONTACT RATING: 2 AMPERES
COIL VOLTAGE: MAY BE SPECIFIED
DC COIL RESISTANCE: 12K
SENSITIVITY: .020 WATTS
COIL DISSIPATION: 1 WATT

MULTIPLE ARM GENERAL PURPOSE RELAYS, Series 10, 20: Balanced armature, superior shock and vibration resistance. Available hermetically sealed. As keying relay will respond faithfully to DC impulses up to 50 per second. Long life and high operating stability.

CONTACTS: 4PDT
CONTACT RATING: 5 AMPERES
COIL VOLTAGE (MAX.): 230 VOLTS
SENSITIVITY: 0.125 WATTS
COIL DISSIPATION: 3 WATTS

GENERAL PURPOSE INDUSTRIAL RELAY, Series 130, 140: Extremely versatile and conservatively rated. Contact life runs to millions of operations. Supplied with screw connections or plug-in base, with or without DPDT auxiliary contacts (5 amperes rating), with or without dust cover. Meets U. L. requirements.

CONTACTS: DPDT
CONTACT RATING: 20 AMPERES
COIL VOLTAGE (MAX.): 230 VOLTS
SENSITIVITY: 2.7 WATTS
COIL DISSIPATION: 3.3 WATTS

CATALOG LITERATURE ON ONE OR MORE OF THESE RELAYS WILL BE MAILED UPON REQUEST. LETTERHEAD INQUIRIES ON SPECIAL RELAY PROBLEMS ARE INVITED.

Wheelock SIGNALS INC.
LONG BRANCH, N. J.

CIRCLE 15 ON READER-SERVICE CARD

WASHINGTON REPORT



Ephraim Kahn

Tighter Procurement Coming Especially in Subcontracting

Scandals aired in Congress are about to have an impact on electronics firms that deal with the military. With the Air Force taking the lead, a tightening of procurement practices all down the line can be foreseen. High officials figure that they must be able to point to significant progress under their own steam by early 1960 or the lawmakers will be tempted to jump in, make radical changes in Pentagon purchasing procedures, and, as a by-product, junk much of the experience that has been gained in working with today's rules.

Likely to have immediate and direct effect on electronics companies is the Air Force's determination to keep a tighter rein on subcontracting. Though the Air Force has had the right for many years to check into subcontractors, it has not chosen to use its money for this. Now that Congress is casting a jaundiced eye in its direction, there is every reason to expect that checks on spending will become more rigid and more frequent. In some areas of government, it is felt that auditing and inspection programs are not being efficiently run unless they save the government more money than it costs to operate them.

Primes and Subs to Feel Pressure

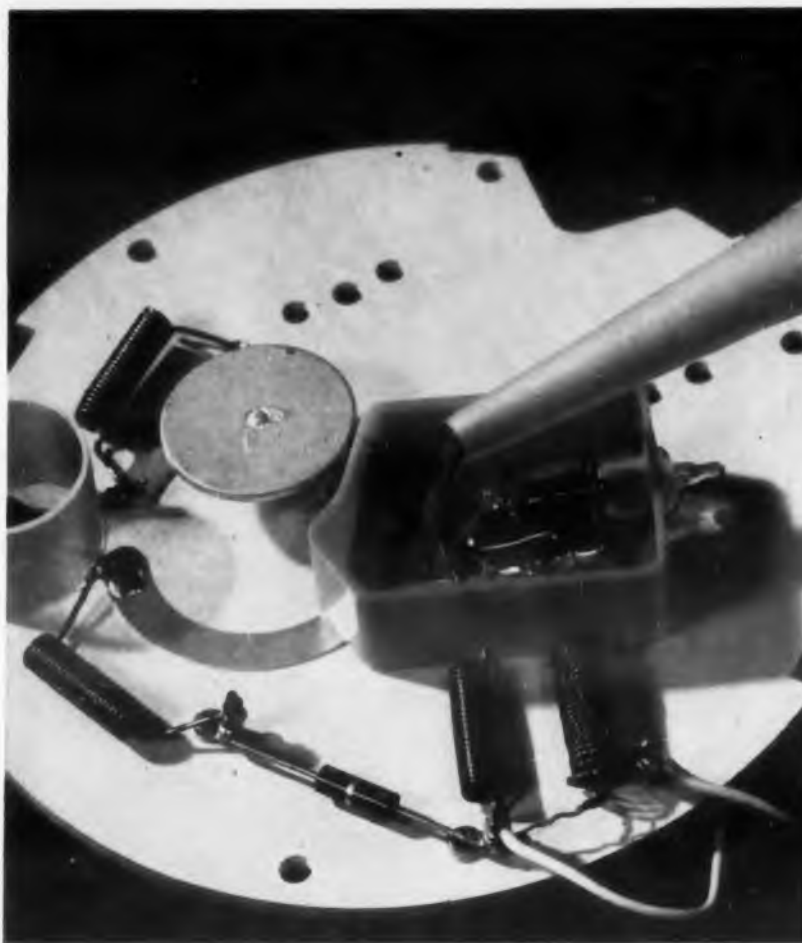
Monitoring of subcontracts will go through first tier, and possibly lower. Furthermore, pressure will be put on prime contractors—who are themselves subject to audit—to spend Air Force funds as carefully as they spend their own in making deals with subcontractors.

To make assurance doubly sure, the military will impose upon subcontractors the requirement that costs be certified as accurate and current. This must now be done by prime contractors where \$350,000 or more is involved. In addition, pricing and cost data will be double-checked by Air Force teams. Cost certification will soon be extended to first tier subcontractors who, without effective competition, have obtained contracts worth \$100,000 or more.

Types of contracts to be let will also be scrutinized with great care. Cost-plus fixed-fee contracts, which have drawn heavy Congressional fire, will be placed only after the government

SILICONE NEWS from Dow Corning

As Environments Grow Tougher



SILASTIC RTV
SILICONE RUBBER

Supplies Both Physical and Electrical Protection

The ideal encapsulating material should prevent mechanical damage to sub-assemblies and at the same time improve electrical properties. It should retain these protective qualities in all operating environments and put no stress on delicate parts. Just such a material is Silastic® RTV, the Dow Corning silicone rubber that vulcanizes at room temperature.

Take the case of the Radio Sondes manufactured by the General Instrument Corporation, Newark, N.J. These meteorological instruments linked to integral transmitters are designed to be launched from aircraft at altitudes up to 60,000 feet and speeds up to 565 knots. This means reduced air pressure and a definite hazard of arcing and corona due to the high potentials involved. It also means slipstream shock and vibration at launch.

As shown in the photos, critical areas of these Radio Sondes are encapsulated with Silastic RTV, applied with a calking gun into reusable retainer rings. By encapsulating the most vulnerable areas with Silastic RTV, excellent protection is achieved with no degradation of power factor.

Silastic RTV is easy to apply, has good dielectric and physical properties, resists moisture, arcing, corona, and ozone. Rapidly changing ambients will not cause Silastic RTV to put excessive stress on fragile parts . . . it remains resilient and soaks up shock. Silastic RTV is available in different consistencies, set-up time can be varied from minutes to hours, depending upon the RTV system.

Typical Properties of Silastic RTV

- Temperature range . . . (-70 to 260 C) -100 to 500 F
- Dielectric strength, volts/mil 300 to 500
- Surface resistivity at 50% relative humidity, ohms 2.8 x 10¹²
- Dielectric constant, 10⁶ cycles per second 2.5
- Dissipation factor, 10⁶ cycles per second 0.0001
- Moisture absorption after 7 days at room temperature, % + 3 to 5

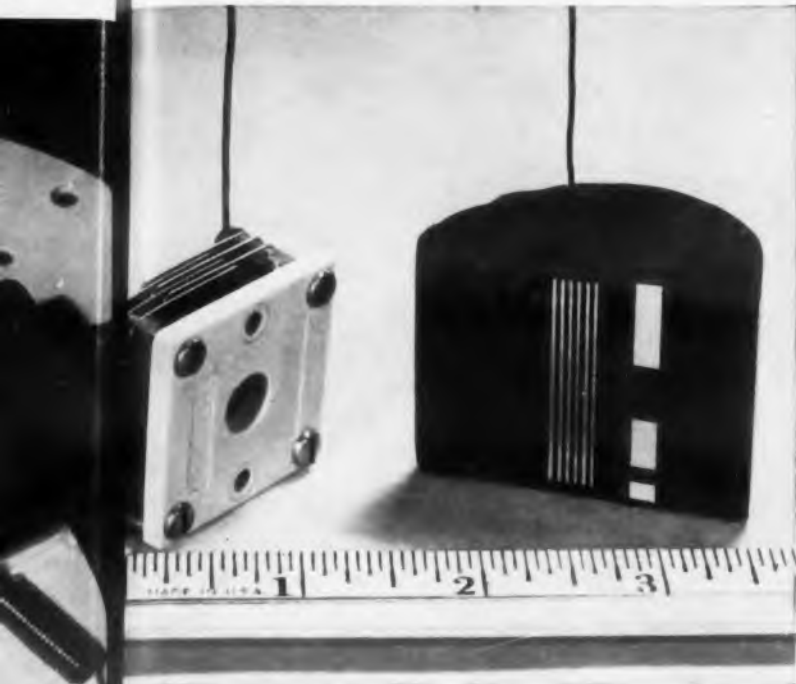
Your nearest Dow Corning office is the number one source for information and technical service on silicones.



CIRCLE 600 ON READER-SERVICE CARD

Dow Corning

the silicones provide required service



Solventless Resin For Top Heat Stability

When you need a rigid potting or encapsulating material, be sure the resin you choose is one that will keep its properties under adverse conditions. Dow Corning solventless silicone resins will withstand temperatures above 260 C (500 F). With no solvent to evaporate, they set up to a continuous bubble-free mass. The capacitor in the picture is a good example. After potting with one of these thermosetting materials, it was sawed in half . . . notice the excellent bubble-free fill between plates. Solventless silicone resins are clear, tough solids; they accept a variety of fillers. The pot life is over 6 months.

CIRCLE 601 ON READER-SERVICE CARD

Highly Stable Diffusion Pump Fluids

Dow Corning silicone diffusion pump fluids resist oxidation when exposed to air at operating temperatures. They do not decompose into gums and tars . . . can be cycled many times. They recover far faster than organics and produce very short pump-down times.

These fluids produce vacua in the range of 10^{-5} to 10^{-7} torr. They are chemically inert, non-corrosive, non-toxic, free from impurities.

Shown are vacuum pump jet assemblies that were tested on various pump fluids. The pump operating on Dow Corning fluids still had not broken down after 100 cycles, with exposure to air between cycles!



A Varnish With Greater Heat-Resistance

Dow Corning 997 Varnish permits operation at temperatures up to 250 C . . . gives electronic and electrical equipment protection against overloads, moisture, many chemicals, corrosive atmospheres and other hazards.

The unit pictured is a servo motor that actuates controls in aircraft automatic pilots. Insulated throughout with high temperature materials, and dipped in 997 Varnish, such motors have proven much more reliable operation in United Airlines planes . . . running as long as 5 years without need for replacement, as against scheduled replacement after 1000 hours for Class A insulated motors.

CIRCLE 602 ON READER-SERVICE CARD



CIRCLE 603 ON READER-SERVICE CARD

is sure that the costs stated by the contractor leave no room for a windfall profit. Similar precautions will be observed in incentive-type contracts, so that the contractor will not be able to increase his fee unjustifiably by overstating costs in his original proposal.

Cost Control to Weigh Heavily

Cost control, as the Air Force sees it, will be a key element in doing business in the future. Budgets are tight, and prospects are bleak for obtaining enough money to do all the things that might be done. This puts a premium on getting as much for each dollar as is possible. Since the Air Force expects to be putting more and more dollars into the electronics industry, it will be under increasing pressure to cut its overhead and other costs.

Guidelines Set for Grants to Non-profit Institutions

Policy for making basic research grants to non-profit institutions—which sometimes compete with business for certain types of contracts—has been set by the Defense Department. Under the law, the Department can choose between research contracts or grants when it wants basic research done by a non-profit group.

Guidelines for grants have now been set. They may be made only for basic research concerned with a broad scientific area, not solution of specific problems. Grants may also be made, however, where the military desires to hold to a minimum its administrative and supervisory burdens, as well as when more latitude than can be conferred in a research contract is desired. Recipients of grants may also be given title to government-owned and supplied equipment when this is convenient or economical for the government.

Procurement Rules Won't Apply

Funds from military appropriations for Research, Development, Test and Evaluation will be used for these grants. As a rule, grantees will not be required to conform to military purchasing rules. The costing principles stated in the Armed Service Procurement Regulation will, however, be used in determining the amount of a grant.

Costing principles will not be followed slavishly. Proposals for grants must include budget estimates, but the Department says that the money may be spent "without strict adherence to the original budget estimates."

Service Secretaries may authorize grants up to \$1 million, as may the Director of the Advanced Research Projects Agency, and the Director of Defense Research and Engineering. The Secretary of Defense must approve grants that exceed \$1 million.

DOW CORNING CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON D.C.

MEETINGS

Calendar of Events

October

- 6-9 High Temperature Symposium, Stanford Research Institute, Asilomar Conference Grounds, Calif.
- 7-9 Sixth National Symposium on Vacuum Technology, American Vacuum Society Inc., Sheraton Hotel, Philadelphia, Pa.
- 7-9 IRE Canadian Convention on Electronics and Nucleonics, Exhibition Park, Toronto, Canada.*
- 12-14 Fifteenth National Electronics Conference, AIEE, Illinois Institute of Technology, IRE Northwestern University, and University of Illinois, Hotel Sherman, Chicago, Ill.*
- 13-14 National Technical Conference, Society of Plastics Engineers, Ambassador Hotel, Los Angeles Calif.
- 22-23 Fifteenth Annual National Conference on Industrial Hydraulics, Illinois Institute of Technology and Armour Research Foundation, Hotel Serman, Chicago, Ill.
- 26-28 Sixth Annual East Coast Conference, IRE Professional Group on Aeronautical and Navigational Electronics, Baltimore, Md.
- 28-29 Michigan Industrial Electronics Exposition, Electronic Representatives, Inc., Detroit Artillery Armory, Oak Park, Michigan.*
- 28-30 Annual Industry Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.
- 29-30 Fifth Annual Electron Devices, IRE Professional Group on Electron Devices, Shoreham Hotel, Washington, D. C.*

November

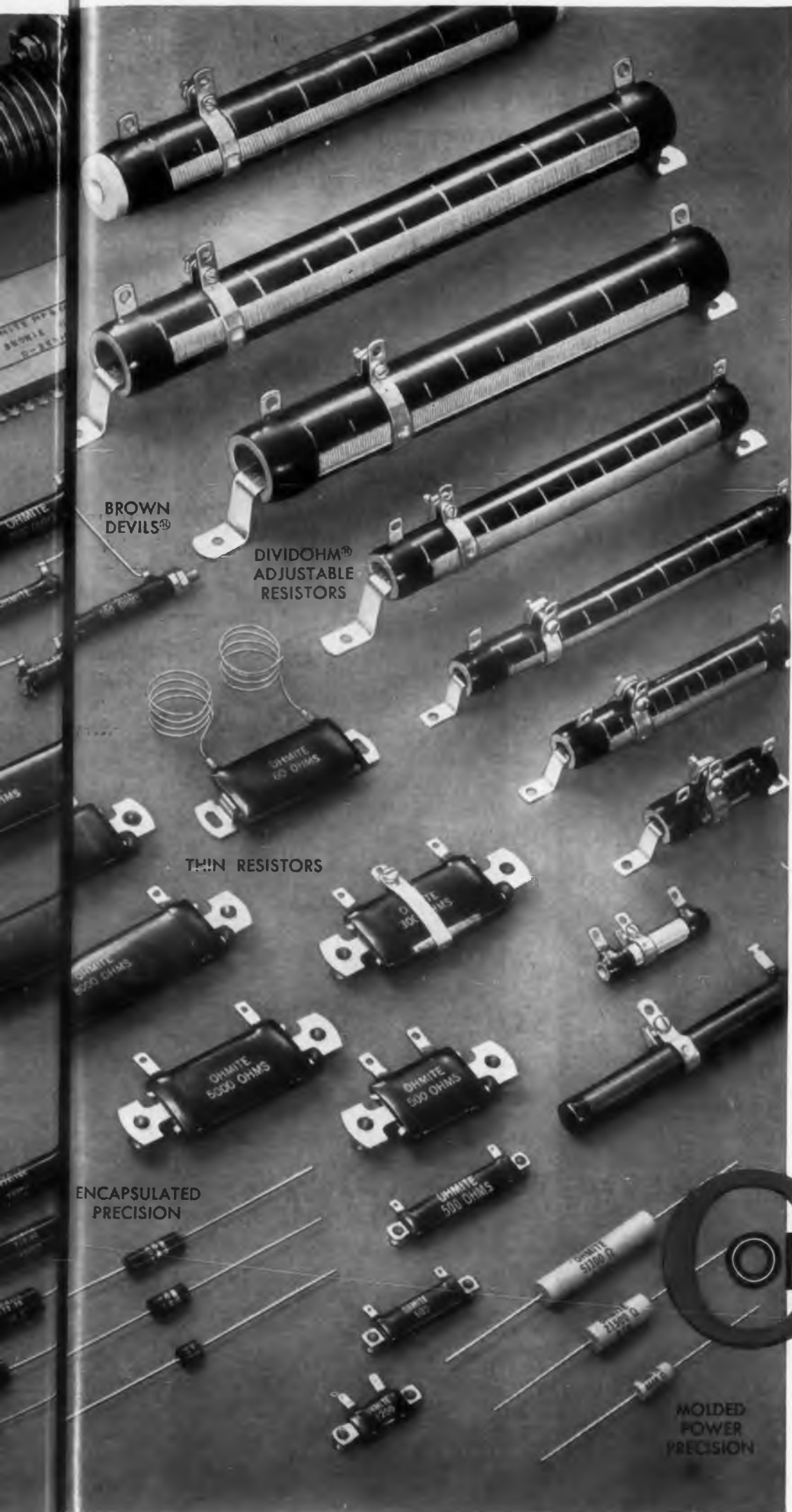
- 2-5 11th Exposition of the ARI, Air-Conditioning and Refrigeration Industry, Atlantic City, N. J.
- 3-5 Mid-America Electronic Conference, Kansas City Section of the IRE, Kansas City Municipal Auditorium, Kansas City, Mo.
- 4-6 National Automatic Control Conference, IRE, Sheraton-Dallas Hotel, Dallas, Texas.
- 4-6 Eastern Analytical Symposium and Instrument Exhibit, Baltimore-Washington, Delaware Valley, New York and New England Sections of the Society for Applied Spectroscopy, Analytical Groups of the N. Y. and N. J. Sections of the American Chemical Society, Metropolitan Microchemical Society, Hotel New Yorker, N. Y.
- 4-6 ANS Winter Meeting, American Nuclear Society, Sheraton Park Hotel, Washington, D. C.

*Includes meetings described herewith.

5th National Communications Symposium, October 5-7

The requirements, progress, and challenge of communications will be stressed at the 1959 symposium. Sponsored by the IRE PGCS, the sessions will cover two major areas: (1) communications systems and (2) communications equipment and related techniques. Approximately 50 engineering and manufacturing concerns from the communications field will exhibit their prod-

The advertisement features a collection of various resistor types arranged on a dark surface. The central focus is the text 'OHMITE RESISTORS' in large, bold, outlined letters. Below this, the slogan reads 'THE EXACT RESISTOR YOU NEED—WHEN YOU NEED IT—FOR EVERY INDUSTRIAL AND MILITARY REQUIREMENT'. Several specific resistor models are labeled: 'CORRIB®' (a large cylindrical resistor with a corrugated surface), 'POWR-RIB®' (a cylindrical resistor with a ribbed surface), 'ENCAPSULATED PRECISION' (small resistors in protective cases), 'AXIAL LEAD' (small resistors with leads), 'FIXED RESISTORS' (various cylindrical and rectangular resistors), and 'METAL FILM PRECISION' (small resistors with thin metal film). The background is dark, making the metallic and ceramic components stand out.



Fixed . . . adjustable . . . tapped . . . noninductive . . . precision metal film and encapsulated wire-wound . . . thin type . . . high-current—practically anything you need, whether it be for commercial or military equipment, you can find in the Ohmite line. It's the most comprehensive, most complete selection available to resistor users.

WORLD'S LARGEST STOCK FOR IMMEDIATE DELIVERY—You don't have to assume that the resistor you need is special. Chances are Ohmite's huge stock of several million resistors in more than 2000 sizes and types contains a unit that fits your requirements. Many types of Ohmite resistors are also available from stock, locally, through hundreds of Electronic Parts Distributors located across the Nation.

If, however, you do need special resistors, Ohmite can make them promptly to your exact needs—including a *complete line of units that meet military specification MIL-R-26.*

YOUR CUSTOMERS KNOW THE VALUE OF OHMITE QUALITY—When a purchaser sees Ohmite resistors in a piece of equipment, he knows that equipment is designed and built for dependability. He knows about the quality features found in Ohmite resistors—features such as balanced thermal expansion of all parts in vitreous-enameled power resistors, plus all-welded construction. He knows there are no thin spots in the coating, no cracks or crazing to let moisture in. He also knows of the exhaustive tests behind Ohmite units which are coated with silicone-ceramic, epoxy resin, and other materials.

OHMITE ENGINEERING ASSISTANCE ASSURES THE RIGHT UNIT—Selecting the right resistor for the job is sometimes a tough proposition. Why not call on Ohmite application engineers to help out. Take advantage of their specialized skills and background. You'll get the exact resistor you need and in a lot less time. Contact them today.

Write on Company Letterhead for Catalog and Engineering Manual 58

OHMITE®

Quality Components

OHMITE MANUFACTURING COMPANY
3643 Howard Street, Skokie, Illinois

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

ucts during the three-day meeting. The symposium will be held at the Hotel Utica, Utica, N.Y. Technical program chairman is Ralph L. Marks, Griffiss Air Force Base, Rome, N.Y.

Value Engineering Symposium, October 6-7

The Electronic Industries Assoc. will sponsor this symposium at the University of Pennsylvania. Participating will be those industry members and military personnel acquainted with the successful use of value engineering tools. R. S. Mandelkorn of Lansdale Tube Co., a subsidiary of Philco Corp., is general chairman of the symposium.

4th IRE Canadian Convention, October 7-9

The Automotive Building at Exhibition Park, Toronto, Canada, will be the site of this convention. Over 100 papers covering the latest developments and techniques in electronics and nucleonics will be presented. Among the branches of the industry to be represented will be audio, components, computers, industrial electronics, transistors, and tubes. The Canadian Sections of the IRE are sponsoring the show. Eric L. Palin at Exhibition Park is general chairman.

15th National Electronics Conference, October 12-14

Virgil H. Disney, president, reports that the NEC will hold its sessions at the Hotel Sherman in Chicago, Ill. Sponsored by the AIEE, Illinois Institute of Technology, IRE, Northwestern Univ., and Univ. of Illinois, the conference will include discussions on circuit theory, communications systems, microminiaturization, servo mechanisms, value engineering, and other topics.

Michigan Industrial Electronics Exposition, October 28-29

Electronic Representatives, Inc. will sponsor this show at the Detroit Artillery Armory, Oak Park, Mich. Exhibitors will include manufacturers of industrial electronic equipment and components as well as Michigan electronics representatives. Technical papers will be presented at sessions scheduled to run concurrently with the exhibitions. Show manager is R. G. Wood, 830 W. Vernor, Detroit 1, Mich.

5th Electron Devices Meeting, October 29-30

To be held at the Shoreham Hotel, Washington, D.C. The conference, sponsored by the IRE PGED, will present papers dealing with material of an applied or developmental nature in the field of electron devices. This should include electron tubes, semiconductor devices, masers, parametric amplifiers, and other solid state device configurations. John A. Hornbeck of Bell Telephone Labs, Murray Hill, N.J., is technical program chairman for the meeting.

CIRCLE 18 ON READER-SERVICE CARD

now...
another space-age specialist joins the Telecomputing galaxy

Since its inception, Telecomputing Corporation has become a recognized specialized and integrated efforts of its divisions and subsidiaries, contributing significantly to advancements in all phases of space-age technology. Now, another leader through the contributing significantly space-age specialist, industry the highest degree of scientific and engineering skills and production capability... extending the ability of Telecomputing Corporation to solve the critical control problems of space-age progress. DIVISIONS AND SUBSIDIARIES OF TELECOMPUTING CORPORATION **CB** **COOK BATTERIES** Proven specialists in the design, development, and manufacture of miniaturized automatically and manually activated silver zinc primary batteries, rechargeable batteries and cells. Ultimately reliable electric power sources of highest energy-to-weight ratio. **BE** **BRUBAKER ELECTRONICS** An R & D leader in the field of ground and airborne IFF components, test & checkout equipments—IFF systems analysis—Air Traffic control systems—radar beaconry—detection equipments. **WG** **WHITTAKER GYRO** Leading producer of electrically driven and spring-wound free gyros, rate and floated rate gyros for advanced missile systems—rate of roll, pitch, and yaw indicators for manned aircraft — precise gyro systems. **DI** **DATA INSTRUMENTS** Pioneers in equipments for fast and accurate analysis of test data, with automatic recording of punched cards, tapes, or printed lists—for aircraft and missile flight tests, industrial and scientific applications. **ES** **ENGINEERING SERVICES** A technical service and development organization skilled in the engineering, instrumentation, operation, and maintenance of data processing and control centers. **WC** **WHITTAKER CONTROLS** The largest exclusive developer and builder of custom-built high-performance hydraulic, pneumatic, and fuel valves, controls, and regulators for advanced missile, aircraft, and industrial applications. **NI** **NUCLEAR INSTRUMENTS** Designers and builders of high quality, reliable equipments for prelaunch checkout and testing of nuclear special weapons.

TELECOMPUTING CORPORATION 915 North Citrus Ave., Los Angeles 38, California

CIRCLE 19 ON READER-SERVICE CARD



COOK BATTERIES

is a pioneer in research and development of chemical batteries for missile, aircraft, and torpedo applications. As America's foremost designer and manufacturer of specialized silver-zinc batteries, COOK presents a complete line of self-contained power sources featuring highest reliability, energy-to-weight ratio, resistance to environmental forces, and simplicity of installation and operation. COOK's advances in battery design now make the silver-zinc battery ideal for use as an auxiliary power unit during missile flight. Available in both primary (one-shot) and secondary (rechargeable) models, COOK's silver-zinc batteries can be produced in practically any shape, size, and weight. Primary types may be activated either manually or automatically. Write, wire, or phone for engineering information.

TYPICAL MODELS

P51A—PRIMARY BATTERY, MANUAL ACTIVATION



S70M2—SECONDARY BATTERY



P14A—PRIMARY BATTERY, AUTOMATIC ACTIVATION

Packaged Energy Charged With Reliability

COOK BATTERIES SUBSIDIARY OF TELECOMPUTING CORPORATION

3850 Olive St., Denver, Colorado, DUdley 8-4836

FIELD OFFICES

LOS ANGELES, 915 North Citrus Avenue, Los Angeles, California - HO 4-0181

ATLANTA, 3120 Maple Drive, N. E., Room 101-A, Atlanta 5, Georgia - CEdar 3-5297

DAYTON, Talbot Bldg., Suite 313 - 131 North Ludlow Street, Dayton 2, Ohio - BAldwin 2-5545

NEW YORK, Suite 327 - 600 Old Country Road, Garden City, L.I., New York - PIeuner 1-4440

SEATTLE, 3308 White Bldg., Seattle 1, Washington - M'An 3-6150

WICHITA, 6427 East Renogy Street, Wichita 1, Kansas - MURray 2-0322

CIRCLE 20 ON READER-SERVICE CARD

EDITORIAL

Reliability—Our Goal, Too

Design engineers need accurate, authoritative information for their work. We spend most of our editorial efforts making sure that material published in *ELECTRONIC DESIGN* is reliable and therefore useful to design engineers. We do this by constantly checking all the data we get before it gets into print.

We check manuscripts before acceptance—not only with our staff, but often with outside authorities to be sure the information presented is correct. We check news releases to be sure we get the correct names, dates, places, and significance of the event. We question claims made in new product releases to be sure the items are new or basically improved and that their performance is correctly described.

Short of building the circuit or trying out the new product ourselves, we do all we can to make sure readers get accurate information. We usually take a manufacturer's word that the claims he makes for his product are honest. He has little to gain from exaggerated or false claims.

We check copy before it goes to the printer and again when it returns in galley form. We check copy when we send it to the printer in dummy form and again when it returns in page form.

We make these efforts because we realize the power of the printed word. In order to avoid misusing this power, we are guided by some simple rules: It is our policy

- To make all reasonable efforts to insure accuracy of editorial matter presented in *ELECTRONIC DESIGN*.
- To promptly publish corrections brought to our attention.
- To not knowingly publish misleading advertisements in *ELECTRONIC DESIGN*.
- To reserve the right to refuse any advertisement.

We have and will continue to operate under this policy.

More Reader Convenience

Observant readers of *ELECTRONIC DESIGN* may have noticed the recent change in our binding. An experiment since the July 8 issue, or new method of binding (known as "Perfect Binding" in the trade) offers readers these advantages: a magazine that lies flat for easier reading, a spine that shows the dates for easier issue identification, and a pad-like back from which pages can be torn out easily for article filing.

All this in the name of more reader convenience.

Edward S. Graydon



Let's not kid ourselves — *nothing* is perfect. But we think you'll agree that the x-band radar antenna shown is about as close as you'll ever get. For example, reliability has been *Ingeneered* into the scanner of this knee-high package simply by keeping the number of moving parts to a minimum: *one*.

That isn't the whole story, of course. We could talk about things like modular packages for az-el drives, how the feed exhibits circular symmetry to r-f, how we get high-speed nutation by rotation and on and on . . . But we figure your requirements are probably different than the next fellow's anyway, so why don't you write us if you want all the specs? 15330 Oxnard St., Van Nuys.

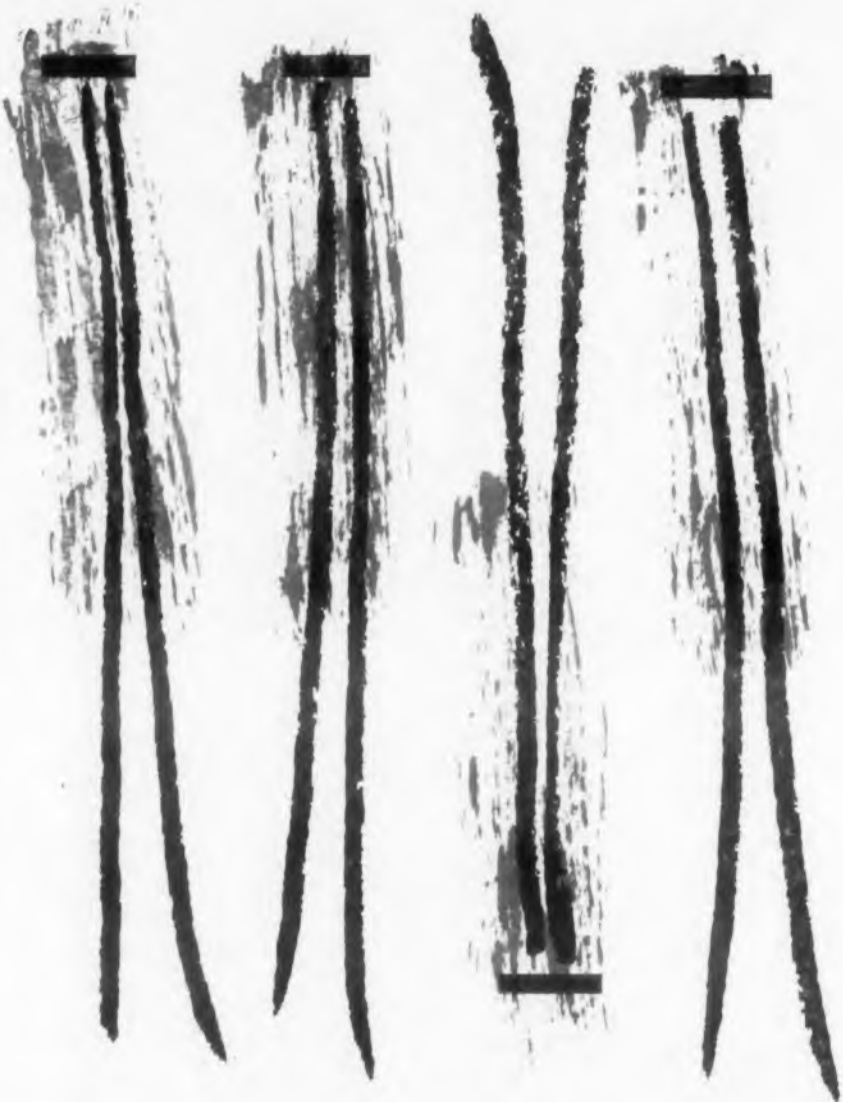


underwood

CANOGA DIVISION

VAN NUYS CALIFORNIA • FORT WALTON BEACH FLORIDA

CIRCLE 21 ON READER-SERVICE CARD



DESIGN FORUM

Using Photoconductive Cells

Photoconductive cells offer advantages of light weight, small size and high sensitivity. These features offer many new opportunities for designers to utilize light operated devices. This article discusses the principal advantages of these cells and discloses some representative applications. Information contained in this article was supplied by Clairex Corp., 19 W. 26th St., New York, N. Y.

SENSITIVITY of conventional photocells has always been a problem. This problem has been alleviated through the development of a semiconductor light-sensitive component—the cadmium sulfide and cadmium selenide photoconductive cells. These photoconductive cells now offer the design engineer a component about a million times more sensitive than the conventional photoemissive tube.

The cell is basically a variable resistor in which

the resistance varies with the light intensity. Therefore, by replacing a fixed resistor as a critical circuit element with a photoconductive cell, the circuit becomes a critical function of light. Note in Fig. 1 that these cells are useful over a wide range including very low light levels.

Design Parameters

One of the important advantages of cadmium sulfide and selenide cells is their small size and

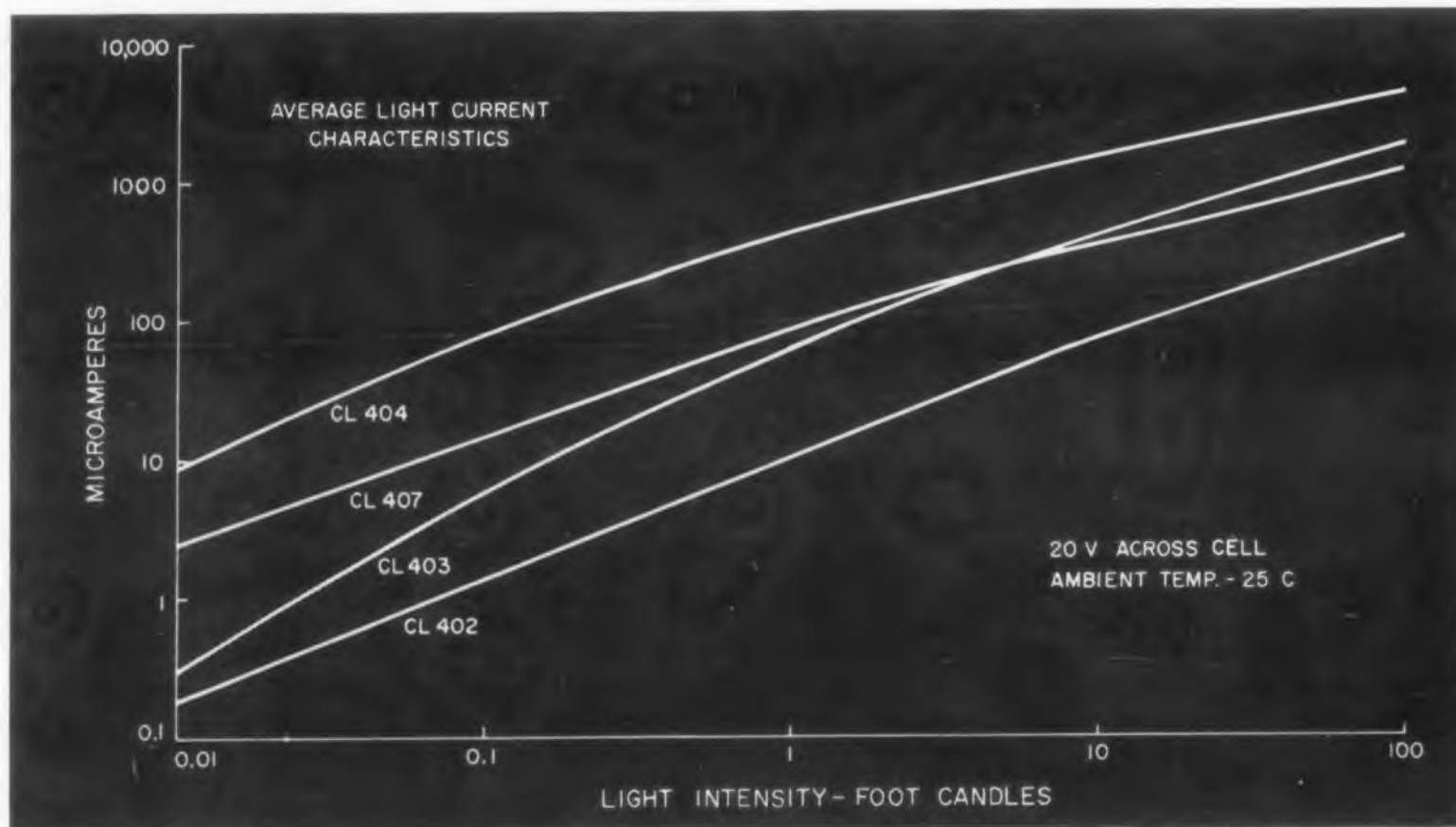


Fig. 1. Sensitivity of four typical Clairex cells.



Fig. 2. Small size and weight is one advantage of photoconductive cells. This is one packaging method.

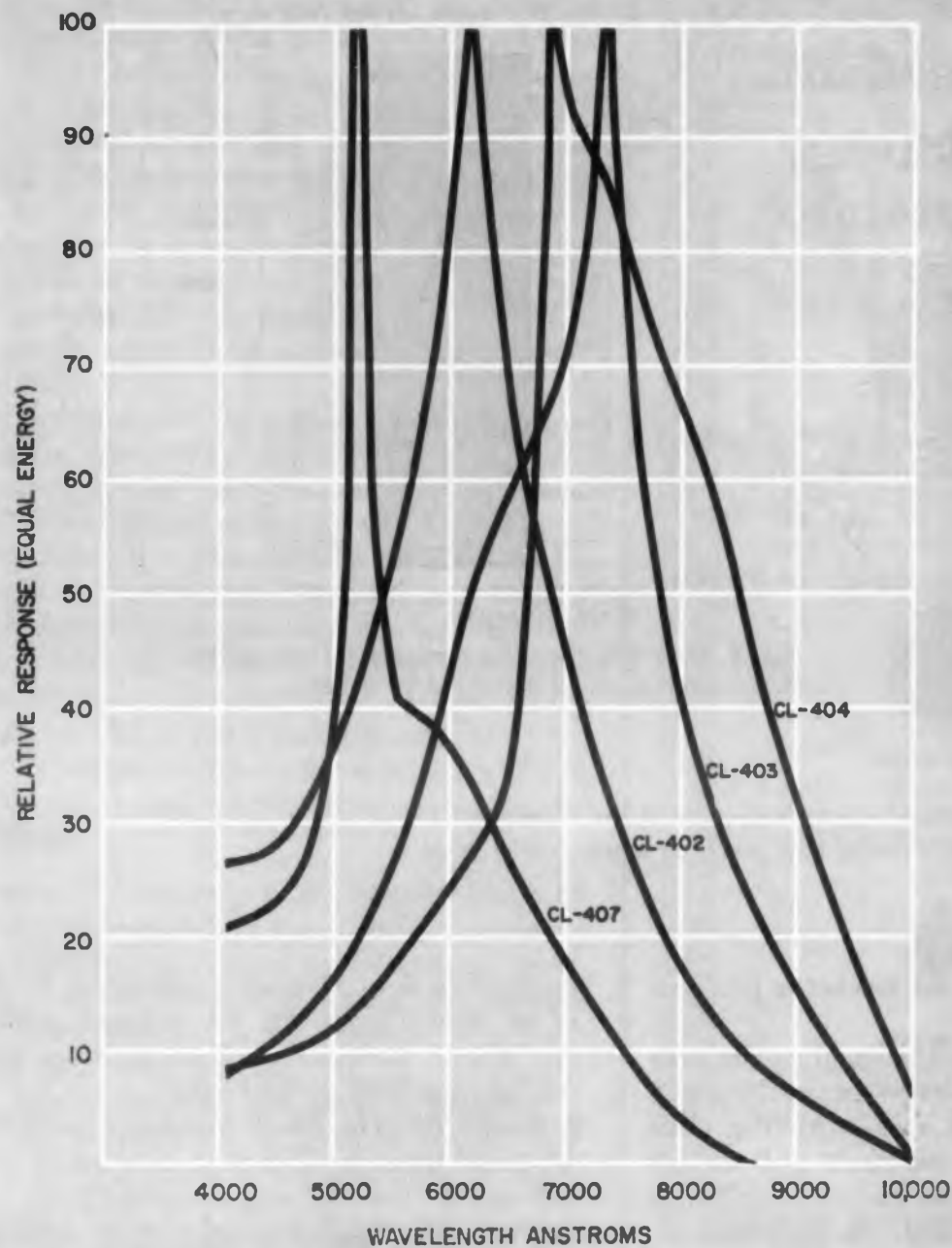


Fig. 3. Average spectral response of typical photoconductive cells.

weight (Fig. 2). Nucleus of the unit is the rectangular semiconductor element receiving the light; the balance of the cell consists of the carefully designed enclosure for this element, either glass or plastic.

In addition, the photoconductive cell has one of the widest ranges of application. Circuits may be transformed into functions of light by "switching resistors." Though all the cells are sensitive in the visual range, some types are also sensitive in the near infrared region, others, even into the ultraviolet region.

Various cells are also able to distinguish between visible colors. This may be of importance where many interfering light sources are available but only one is of controlling interest.

Another of the interesting facets of the photoconductive cell is that it can operate over a wide

range of voltages from microvolts to a few hundred volts. In many instances, a 12 v battery is the power source for the unit. This feature again reduces the size of the system by reducing the related equipment needed.

Operating temperature characteristics of the photoconductor depends upon the exact formulation of the materials used, polycrystalline cadmium sulfide and cadmium selenide. The range is -50 to $+75$ C.

Power dissipation for the cells is in the range of 50 to 75 mw depending upon the enclosure. The cells may be soldered directly into a system's circuit without the use of a heat sink. Equal conducting properties irrespective of polarity permit the use of the cell as a modulator. This also facilitates production in that no polarity markings need be followed for correct usage.

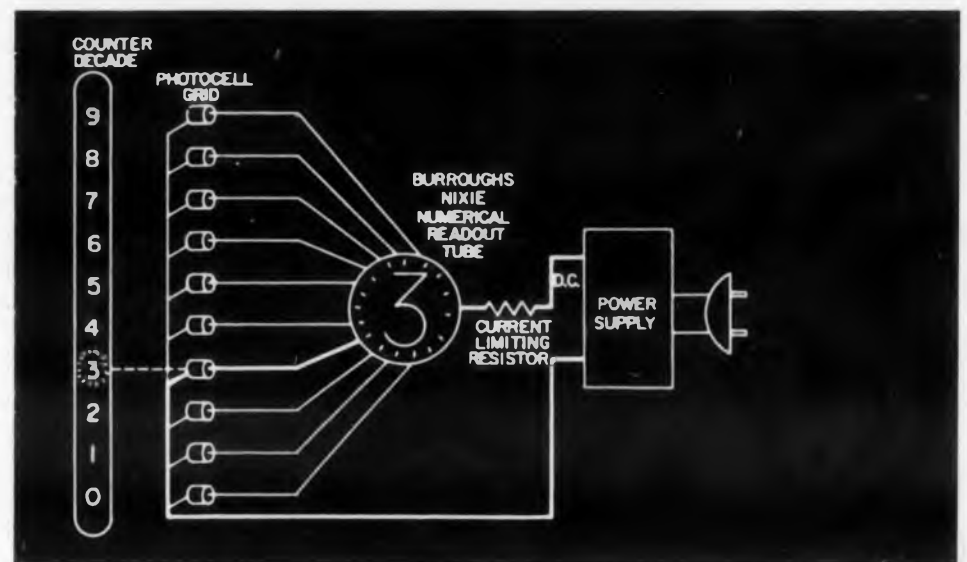


Fig. 4. Basic "Digi" system showing how photocells pick up neon light indication and convert it to numerals.

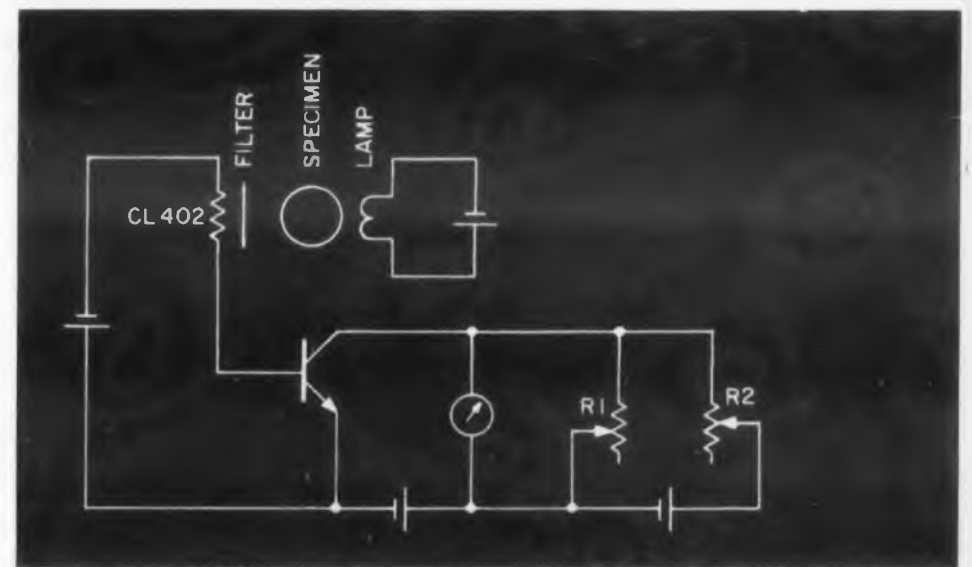


Fig. 5. Transistor Circuit of this blood hemoglobin tester uses a Clairex 402 photocell as detector.

Time constant may be rather large for some applications. It varies inversely with light intensity and is different for different cell types. The time constant is essentially the only limitation of cadmium sulfide and cadmium selenide photoconductive cells.

The spectral response, shown in Fig. 3 is one of the most important parameters of the cells as it allows different cells to distinguish between different colors.

Applications

Digital-to-Digital Converter. Converting vertical decimal presentation into "in-line" direct reading presentation is accomplished with the circuit shown in Fig. 4. Its purpose is to provide the operator with numerals large enough for easy, rapid, nonambiguous reading.

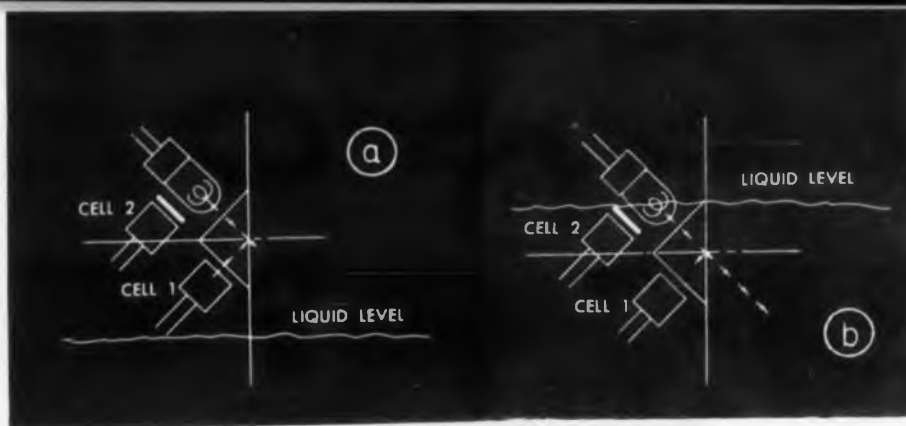


Fig. 6. Two photocells detect liquid level in this optical level indicator. Dry condition is at (a); wet condition at (b).

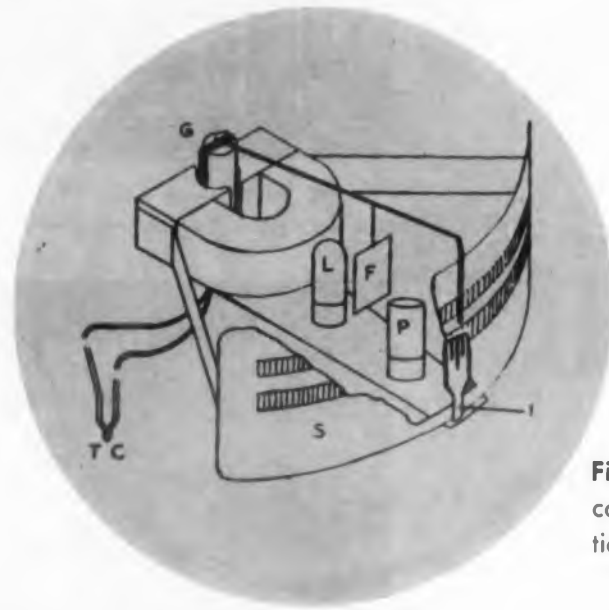


Fig. 8. Sketch of working parts of the West furnace controller showing how photocell senses pointer position.

Basically, the system consists of a line of ten photoconductive cells, each lined up so it is energized by one of the neon lamps. When the lamp is illuminated, the photocell allows the appropriate cathode of a Burroughs Nixie tube to fire.

Radio Frequency Laboratories, Inc., Boonton, N. J., manufacture two models of the converter, the Digidec and the Digiverter.

Photoelectric Colorimeter. For medical applications, Hughes Instrument, Berkeley, Calif., is marketing an Hg B Meter for rapid blood hemoglobin determinations. In the circuit of Fig. 5, a Clairex CL 402 cell was chosen as detector because its spectral peak is near the absorption peak of hemoglobin (5200 Angstroms). Output from the cell, which is proportional to the light transmission of the sample, is fed to the emitter base of the transistor, which acts as a simple current amplifier. Both ends of the meter scale are adjusted with $R1$ and $R2$ using known samples. An unknown sample may be read directly from the scale. Low input voltage and low current drain are features of this portable unit.

Optical Level Indicator. Two photoconductive cells are the heart of an optical level indicator made by Revere Corp. of America, Wallingford, Conn. Designed for use in water-alcohol mixtures, aviation gas, jet and hydrocarbon fuels, and hydraulic and lubricating oils, these units actuate indicator lamps, valves, pumps or other electrical

equipment when the liquid reaches a predetermined level.

Detection of liquid level is based on the principle of total internal reflection. In the dry condition, Fig. 6(a), the light rays strike the plane between the prism of the surrounding air and are reflected on to the sensitive surface of cell 1. In the wet condition, Fig. 6(b), the light rays are not reflected, thus changing the resistance of cell 1.

This change in resistance is used to control a circuit in which a power transistor applies power to the load in the wet condition, and removes power in the dry condition. With different circuitry, the operation may be reversed.

A filter between the lamp and photocell 2 adjusts the light intensity so that the resistances of the two cells are about equal in the dry condition. Thus, temperature and voltage changes have little effect on the system.

Because operation of the unit does not depend upon lightrays passing through the liquid, the unit is not affected by coloring or contamination of the liquid.

Watt-hour Meter Tester. A cadmium sulphide cell provides the sensitivity necessary for accurately testing watt-hour meters. This General Electric Co. unit is able to measure light and dark variations caused by light shining through the anti-creep holes in the rotating disk. All relays are

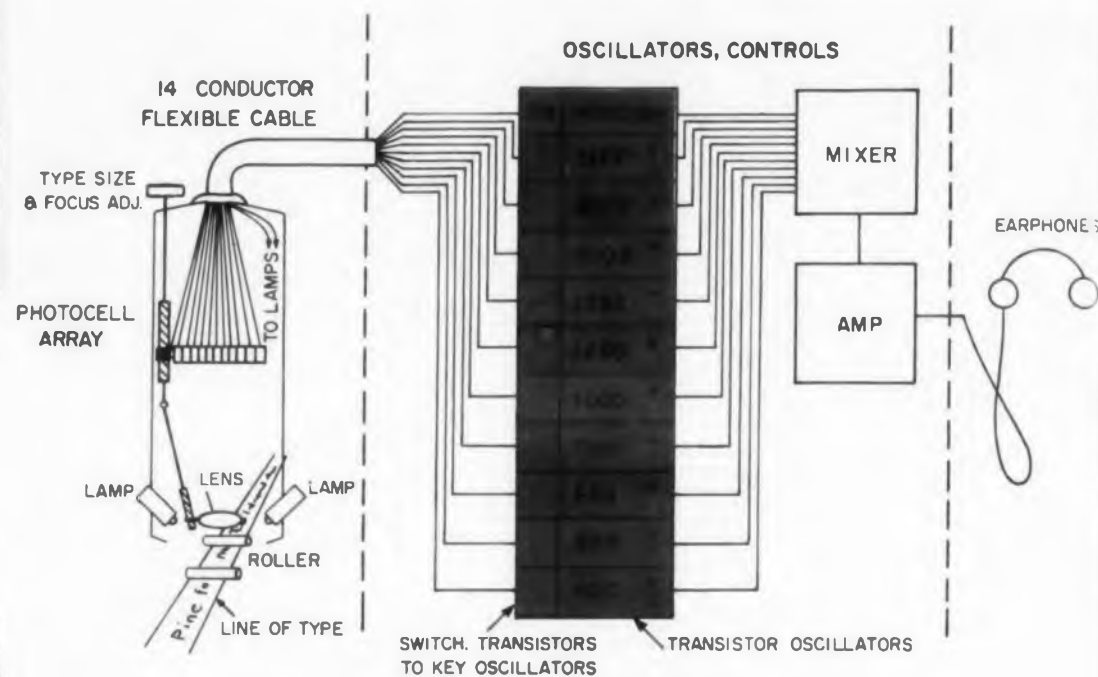


Fig. 7. Block diagram of the experimental type reading machine for the blind developed by Battelle.

operated on dc to eliminate timing errors. Because of its greater sensitivity, the cadmium sulphide cell is able to detect the light impulses under conditions of high ambient light.

Reader For The Blind. Developed at Battelle Memorial Institute, Columbus, Ohio under sponsorship of the Veterans Administration, this machine utilizes a number of separate oscillators controlled by an equal number of photoelectric cells (Fig. 7). The cells, each responding to a specific level in the black areas making up a letter, cause their associated oscillators to produce tones whenever letter segments are present. The tones are heard for as long a time as the lens of the reader is held over a given letter segment. Thus, if a letter like lower-case "l" is being read, several tones would be heard simultaneously, whereas the vertical middle section of the letter "o" would activate only two tones, one of low and one of medium pitch.

In the design, it was necessary to determine the number of photocells to be used in the reader. Too few photocells would not provide a basis for discrimination among similar letters, while too many would increase the cost and complexity of the device. An analytical study of the problem revealed that there was no appreciable difference in the ability of subjects to discriminate letters with 8, 9, 10, 11, or 12 photocells. However, engineering work which was progressing concurrently with the psychological research indicated

that the reliability factor would be poor with less than 10 photocells. To insure high reliability of oscillator triggering for a variety of conditions that might be encountered, it was decided to include 11 photocells.

In operation, the lens projects a magnified image of the letter being read upon a linear array of 11 photoconductors mounted in the reading probe. The letter image normally is focused on only nine of the photocells, as the two end cells are provided primarily for tracking purposes. The combined height of the nine photocells receiving the image is 0.675 in.

The photoconductor is connected in a voltage-dividing circuit. When one or more of the photoconductors "sees black," i.e., when a dark image of a letter segment covers it, resistance and voltage across the photoconductor increase. This causes the base voltage of the switching transistor to become more positive than the collector voltage, closing the "switch." In this manner the photoconductor controls the output signal of the oscillator. The output signal is attenuated by the mixing circuit; therefore, a single stage of amplification is used before the signal reaches the earphones.

Furnace Controller. On a controller made by West Instrument Corp. the controlling action of the instrument is obtained by the use of a photocell. A manually operated setting arm carrying the index pointer may be positioned at any desired point along the scale (Fig. 8). On this arm, but behind the scale, are small light source (*L*) and the photocell (*P*), so arranged that the light from the light source is projected upon the sensitive surface of the photo cell.

As long as the light strikes the photocell, sufficient current flows so that it can be used to control a magnetic amplifier which in turn is used to activate a relay. The relay may control the fuel or power to the furnace. When the temperature reaches a point where the positions of the millivoltmeter and the preset pointers coincide, the opaque flag (*F*) on the millivoltmeter pointer arm interrupts the light beam and the current flowing in the photo cell circuit is insufficient to energize the relay so that it now drops out, shutting out the power to the furnace.

To obtain control action a slight movement of the indicating pointer is required; however, since the photocell permits varying degrees of current to pass depending upon the position of the opaque flag with respect to the light and cell, proportioning control action can be obtained. Proportioning control action is obtained by using a variable bias along with the photocell. In a reasonably balanced thermal system the on and off time of the instrument is maintained or varied by slight changes in photocell current. ■ ■

increasing
component
density



MODEL 1

Component Density 9 per cu. in.*
Diameter 0.625"; Depth 0.371"
Rating 1/10 watt



MODEL 6

Component Density 18 per cu. in.*
Diameter 0.502"; Depth 0.155" ± 10%
Rating 1/10 watt



MODEL 8

Component Density 158 per cu. in.*
Diameter 0.286"; Depth 0.110" ± 5%
Rating 1/10 watt

your job . . . and **Centralab's**

for military, commercial,
transistor, and
communication applications

Here is a graphic illustration of how Centralab has met your needs for greater and greater miniaturization. Pictured (actual size) are three ultra-miniature Centralab Radiohms.® When introduced, each was the smallest variable resistor on the market—and was superseded in that position only by the introduction of the next smaller Centralab unit.

These variable resistors are available in a variety of mounting styles, to meet the most stringent space requirements—further testimony of Centralab leadership in the development of ultra-miniature components. Increasing component density is your job . . . and Centralab's.

ultra-miniature
high reliability

SPECIFICATIONS:

Model 8 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 250° rotation, minimum rotational life 25,000 cycles.

Model 6 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 250° rotation, minimum rotational life 25,000 cycles. Also available with SPST switch.

Model 1 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 260° rotation, minimum rotational life 25,000 cycles. Also available with SPST switch.

Detailed specifications are available in Centralab Technical Bulletins. Write for your free copies.

Model 1 and Model 6 Radiohms® are stocked by your Centralab distributor, available as the B16 and SM control series respectively.

*Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparison.

A DIVISION OF GLOBE-UNION INC.
9601 EAST KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto 17, Ont.

Centralab

VARIABLE RESISTORS • ELECTRONIC SWITCHES • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS
CIRCLE 22 ON READER-SERVICE CARD

Seven Rules for Scaling Impedance Level and Frequency

E. Brenner and S. R. Parker

The City College of New York
New York City, N. Y.

Network transformations are easy with these seven rules.

SEVEN RULES, applied to linear passive networks, make it easy to extend existing network designs and synthesis procedures beyond their immediate purpose. In addition, these rules, essentially normalization procedures, enable the designer to do the bulk of numerical work with convenient numbers which minimize the chance of numerical error.

This article deals with four such procedures:

- Impedance level adjustment
- Frequency scaling
- Frequency inversion
- Frequency translation.

Objectives and Definitions

Impedance Level Adjustment. If a network has been designed for a particular value of a certain element (e.g. a load resistance of 1 ohm or a coupling capacitance of unit value) then the rule of impedance level adjustment makes it possible

to use the same design for any value of that element. The procedure is also useful for adjusting the input impedance of networks to avoid the loading of sources.

Frequency Scaling. A network which has been designed to have a specified frequency response with a certain "critical" frequency (e.g. half-power point) can be converted to one having the same frequency response with any other critical frequency. For example, a low-pass filter with cut-off frequency f_1 and an attenuation α at a frequency f_2 can be converted to a low-pass filter with a cut-off frequency at f_1' and an attenuation α at $f_2' = f_2 (f_1'/f_1)$.

Frequency Inversion. A design which results in a certain frequency response $H(j\omega)$, can be used to realize a network which has the frequency response $H(1/j\omega)$, so that the new frequency response curve can be obtained by replacing ω with $1/\omega$ on the abscissa of the old curve. Thus a low-

pass network design can be converted into a high-pass network.

Frequency Translation. A network design which gives a certain frequency response between dc and f_1 can be converted to a network which has the same response curves in a different band of frequencies. Thus a low pass filter, with cut-off frequency f_1 , can be used to realize a band-pass filter with center frequency f_0 and a band width

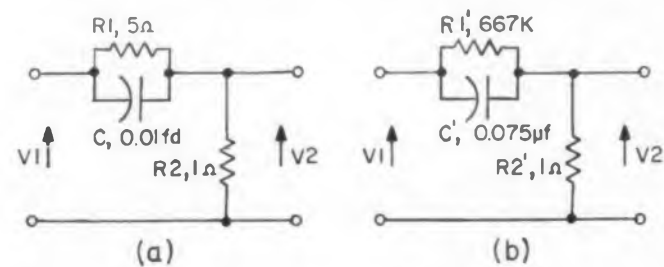


Fig. 1. Impedance level scaling. (a) Lead network with input impedance of six ohms at dc. (b) Network of (a) with impedance level changed to give 800 K at dc.

Rules for Network Conversions

Rule	Original Network Property	New Network Property	Obtain the new circuit by replacing in the original circuit every		
			L by	C by	R by
1.	$\frac{Z(j\omega)}{Z_{max}}$	$k_L \frac{Z(j\omega)}{Z_{max}}$	$k_L L$	C/k_L	$k_L R$
2.	$H(j\omega)$	$H(jk_F\omega)$	L/k_F	C/k_F	R
3.	Time constant τ . Natural freq f_0	Time constant τ/k . Natural freq kf_0	L/k	C/k	R
4.	$H(j\omega)$	$H\left(\frac{1}{j\omega}\right)$	$1/C$	$1/L$	R
6.	Low pass cut-off $\omega = 1$	Bandpass cut-off $\omega_1, \omega_1 + 1, \omega_0^2 = \omega_1(\omega_1 + 1)$	Series LC circuit $(1/\omega_0^2 L)fd$	Parallel LC circuit $(1/\omega_0^2 C)h$	R
7.	Bandpass Bandwidth B	Bandpass Bandwidth KB	L/K if in series with a C LK if in parallel with a C	CK if in series with L C/K if in parallel with L	R

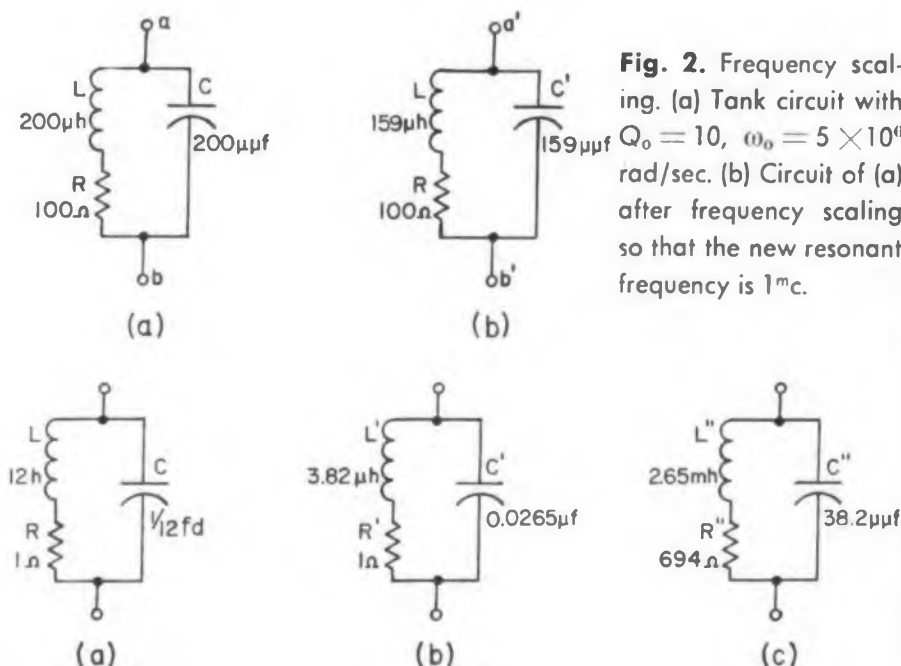


Fig. 2. Frequency scaling. (a) Tank circuit with $Q_0 = 10, \omega_0 = 5 \times 10^6$ rad/sec. (b) Circuit of (a) after frequency scaling so that the new resonant frequency is 1 mc. (c) Circuit of (b) after impedance level is raised to give 100 K at resonance.

f_1 . It is also possible to use frequency translation to expand or compress the bandwidth to kf_1 .

Combinations. It is possible and usually necessary to apply several of these transformations in a single network to achieve the desired results. It is also noted that changes in the frequency response correspond to changes in the (transient) time response. These effects are also summarized here.

Impedance Level Scaling

Rule 1. "The impedance level of a linear, passive network is multiplied by a constant k_L if every resistance value and every inductance is multiplied by k_L and every capacitance value is divided by k_L ."

A change in impedance level by the factor k_L means that, at every frequency, the new network requires k_L times as many volts from a source to produce the same current (in every branch of the circuit) as in the original network.

Thus the shape (amplitude and phase) of the frequency response curves remains unchanged—only the scale of the amplitude curves is changed by the factor k_L . A change in impedance level has no effect on the time constants, natural frequencies or frequencies of transient oscillations in the network.

Example. A "lead" network (Fig. 1a) is proportioned to give maximum phase lead of 45.5 deg at a frequency of 7.33 cps. Scale the network so that the dc input impedance is 800 K.

Solution. In the original network the dc input impedance (resistance) is 6Ω. Hence $k_L = 8 \times 10^5 / 6$, and the elements in the scaled network (Fig. 1b) are given as follows.

$$R_{1'} = 5(800 K) / 6 = 667 K$$

$$R_{2'} = 1(800 K) / 6 = 133 K$$

$$C' = (0.01) (6) / (8 \times 10^5) = 0.075 \mu fd.$$

The network of Fig. 1b has the same amplitude and phase response for the voltage ratio V_2/V_1 as the network of Fig. 1a, but the impedance at terminal pair $a'-b'$ is $8 \times 10^5 / 6$ times the impedance at terminals $a-b$ at every frequency.

Frequency Scaling

Rule 2. "The frequency scale of any frequency response curve of a linear, passive network is multiplied by the factor k_F if every inductance value and every capacitance value is divided by k_F and every resistance value is left unchanged."

This rule follows from the observation that an inductance L has a reactance $\omega_1 L$ at the radian frequency ω_1 ; while an inductance, L/k_F , has the same reactance at the radian frequency $k_F \omega_1$. The same reasoning applies to capacitive susceptance and reactance. A change in frequency scale influences the time scale in accordance with Rule 3.

Rule 3. "When the frequency scale of the fre-

(Continued on page 30)

300° C stabilization of FAIRCHILD SILICON TRANSISTORS is a regular step

WHY?

TO ACHIEVE MAXIMUM RELIABILITY! Every completed Fairchild Transistor is stored at 300° C for at least 60 hours before final inspection. Most types would not survive. For Fairchild's Diffused Silicon Mesa Transistors, this step stabilizes parameters an equivalent of thousands of hours at 175° C. Many of our customers are verifying the resulting reliability in test programs of their own.



545 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161
New York Area: WElls 1-4500, ext. 287 — Chicago Area: BRowning 9-5680 — Philadelphia Area: TUrnner 6-6623 — Los Angeles Area: OLeander 5-6058
CIRCLE 23 ON READER-SERVICE CARD

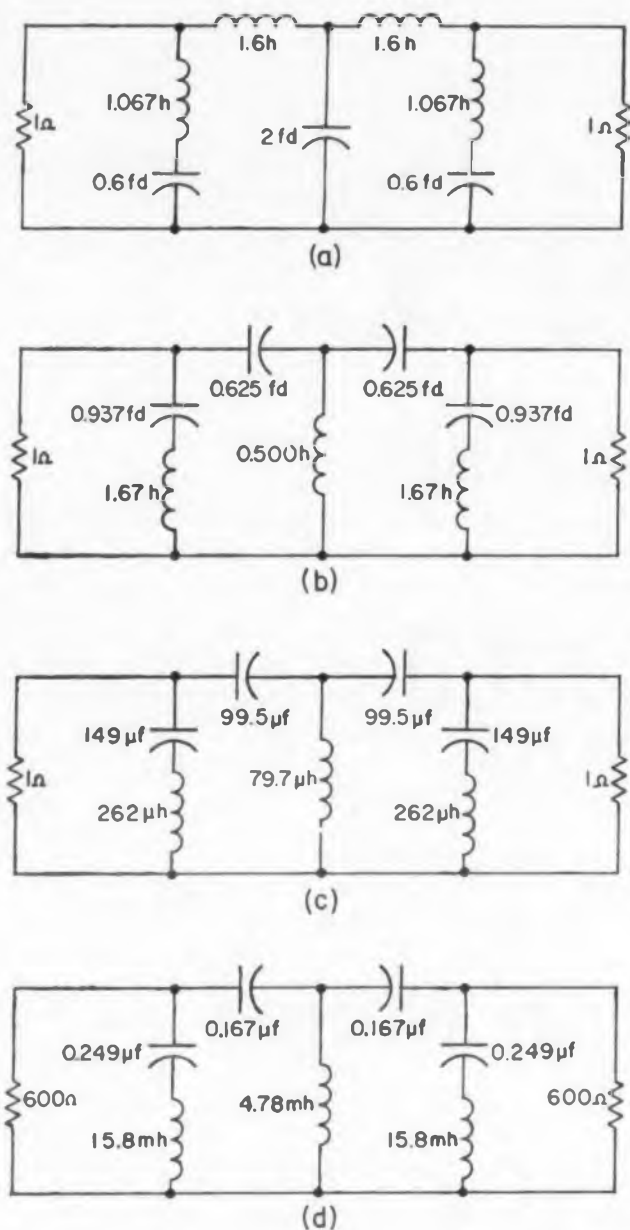


Fig. 4. Combined frequency inversion, amplitude response shifting, and impedance level scaling. (a) Constant k low-pass filter with radian cut-off frequency of 1 and nominal characteristic impedance of 1 ohm. (b) High pass filter obtained from (a) by frequency inversion. (c) Filter of (b) with cut-off shifted to 1000 cps. (d) Filter of (c) with impedance level raised to 600 ohms.

quency response of a linear passive network is changed by the factor k_F in accordance with Rule 2, then the time scale of any transient response waveform is divided by k_F .

The interpretation of Rule 3 is illustrated by the following example: suppose that a sinusoidal source of frequency f_1 is applied to the original network and results in a steady state response of amplitude A , and a transient response which decays in t_1 seconds.

If the frequency scale of the frequency response curve is now multiplied by k_F , then a sinusoidal source of frequency $k_F f_1$ results in a response of amplitude A and a transient which decays in t_1/k_F seconds.

All time constants are divided by k_F and natural

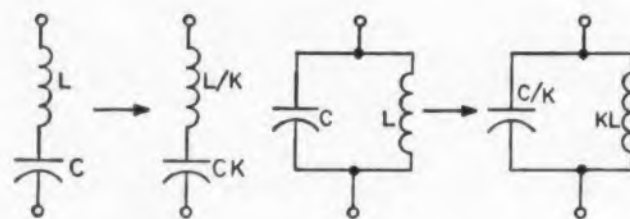


Fig. 5. Bandwidth multiplication by use of Rule 7.

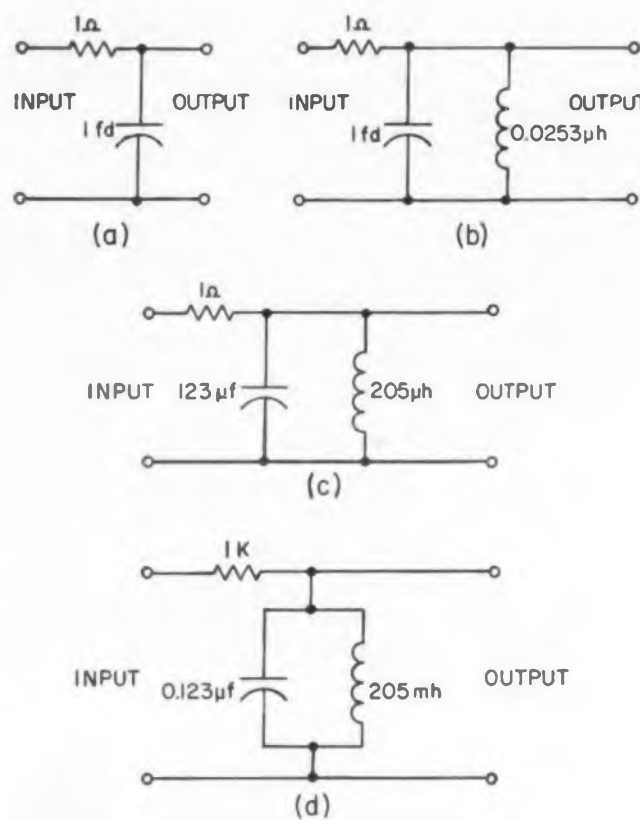


Fig. 6. Band shifting, band expansion, and impedance scaling. (a) An RC low pass filter with radian cut-off frequency of unity. (b) Bandpass revision of (a) with center frequency 1000 cps and bandwidth $\frac{1}{2}\pi$ cps. (c) Bandpass filter of (b) after expansion of band to 450 cps. (d) Filter of (c) with dc input resistance revised to 1 K.

frequencies are multiplied by k_F independently of the source. It is also noted that the impedance level is not affected by frequency scaling since the frequency response curves of the scaled network have the same maxima and minima, etc., but each value occurs at k_F times the original frequency.

Example. A tank circuit (Fig. 2a) has a required $Q = 10$ and a resonant frequency $f_0 = 5(10)^6/2\pi$. It is desired to transform the resonant frequency of the tank to 1 mc and to maintain the Q at 10. The impedance level is to remain unchanged.

Solution. Since the new resonant frequency is $(2\pi/5)f_0$, $k_F = 2\pi/5 = 1.256$. The new circuit (Fig. 2b) is given by:

$$R' = R = 100 \text{ ohms}$$

$$L' = 200/1.256 = 159 \mu\text{h}$$

$$C' = 200/1.256 = 159 \mu\text{fd}$$

Example. In this example, the combined use of impedance level adjustment and frequency scaling make it possible to use convenient but unrealistic numbers in the basic design.

Design a tank circuit which has a Q of 12, a resonant frequency of 500 kc, and a resonant impedance of 100 K.

Solution. Start with the circuit of Fig. 3a where $R = 1$ ohm. Let the resonant frequency be 1 rad/sec. Since Q is 12, $L = 12$ hy and $C = 1/12$ fd, the circuit of Fig. 3a has the desired Q , it has a resonant impedance (using the customary high Q approximation) of $Q^2 R = 144\Omega$ at $\omega = 1$.

The frequency scale is now changed so that resonance occurs at a radian frequency of $2\pi \times 500 \times 10^3$ rad/sec. Using $k_F = 3.14 \times 10^6$ the circuit of Fig. 3b results:

$$R' = 1 \text{ ohm}$$

$$L' = 12 \times 10^{-6}/3.14 = 3.82 \mu\text{hy}$$

$$C = 10^{-6}/(12)(3.14) = 0.0265 \mu\text{fd}$$

The resonant impedance of this circuit is 144 ohms. Hence the impedance level must be raised by $k_L = 100 \times 10^3/144 = 694$. The desired circuit is shown in Fig. 3c.

$$R'' = 694 R' = 694\Omega$$

$$L'' = 694 L' = 2.65 \text{ mhy}$$

$$C'' = C'/694 = 38.2 \mu\text{fd}$$

Frequency Inversion

Rule 4. "If in a linear, passive network every inductance of L henries is replaced by a capacitance of $(1/L)$ farads and if every capacitance of C farads is replaced by an inductance of $(1/C)$ henries then, provided that the resistance values remain unchanged, the amplitude response curves of the new network are identical to those of the old network if the radian frequency variable ω is replaced by $1/\omega$."

This rule is frequently combined with Rule 2 so frequency inversion and scale change can be carried out in one operation. Thus a radian "center" frequency ω_c is chosen, every inductance L is replaced by a capacitance $(1/\omega_c^2 L)$ and every capacitance C is replaced by an inductance $(1/\omega_c^2 C)$.

The two networks then have the same amplitude response but the "new" network, at a radian frequency ω_c^2/ω , has the response which the "old" network has at ω_1 .

Rule 5. "The application of Rule 4 results in a new network whose phase response is the negative of the phase response of the original network."

Example. A constant k low-pass filter (Fig. 4a) has a radian cut-off frequency of unity. It is terminated at each end in an m derived half-section ($m = 0.6$) and the nominal characteristic impedance of

(Continued from page 29)

1 ohm. Very high ("infinite") attenuation results at $\omega = 1.25$. Convert Fig. 4a to a high pass filter with cut-off frequency 1000 cps with 600 ohm termination.

Solution. By application of Rule 4 the circuit of Fig. 4b is deduced. This high-pass filter has a radian cut-off frequency of unity. Rule 2 is now applied with $k_F = 6280$ to shift the cut-off frequency to 1000 cps and the circuit of Fig. 4c results. Rule 1 is now applied with $k_L = 600$ to shift the impedance level and the design is completed as shown in Fig. 4d. This filter has "infinite" attenuation at $f = 1000/1.25 = 800$ cps.

Frequency Translation (Low-Pass to Band-Pass)

Rule 6. "A linear, passive low-pass network with cut-off frequency $\omega = 1$ can be converted into a band-pass network with a bandwidth of 1 radian/sec, and cut-off frequencies ω_1 and $\omega_2 = \omega_1 + 1$, centered about ω_0 such that ω_0 is the geometric mean value

$$\omega_0 = \sqrt{\omega_1 \omega_2}$$

or

$$\omega_{1,2} = \frac{1}{2} (1 \pm \sqrt{1 + 4\omega_0^2})$$

if one connects in series with every inductance of value L henries a capacitance with value $(1/\omega_0^2 L)$ farads and if one connects in parallel with every capacitance C an inductance of value $(1/\omega_0^2 C)$ henries.

While one can use Rule 6 in conjunction with the preceding rules to convert either a low or a high-pass filter into band-pass filter with any desired value of ω_0 , it is convenient to cite an additional rule which can be used to "expand" the band by a factor K (i.e. change the bandwidth from 2 radians/sec to $2K$ radians/sec).

Rule 7. "If in a bandpass filter every series LC combination is replaced by an $L/K, CK$ series combination and every parallel LC combination is replaced by a $KL, C/K$ parallel combination (see Fig. 5), the bandwidth of the filter is multiplied by K and the center frequency of the band remains unchanged.

Example. Convert an RC low pass filter with cut-off at unity radian frequency (Fig. 6a) to a band-pass filter whose band extends from 800 to 1250 cps. The dc input resistance is to be 1.0 K.

Solution. Applying Rule 6, $f_o^2 = 800 \times 1250$, $f_o = 1000$, $\omega_0 = 6280$. Hence in Fig. 6b, $L' = 1/(6280)^2 = 0.0253 \mu\text{hy}$. The band in Fig. 6b is 1 rad/sec. It must now be expanded to $2\pi (450)$ radians/sec.

Apply Rule 7: The 1 fd capacitance is replaced by $1/900\pi = 123 \mu\text{fd}$ and the inductance L' is replaced by $900\pi L' = 205 \mu\text{hy}$. The result is shown in Fig. 6c. The impedance level is now adjusted to 1 K (Rule 1) ($k_L = 1000$). The result is shown in Fig. 6d. ■ ■



*most economical,
most compact, most efficient
cooling fan of its size!*

ROTRON MUFFIN FAN

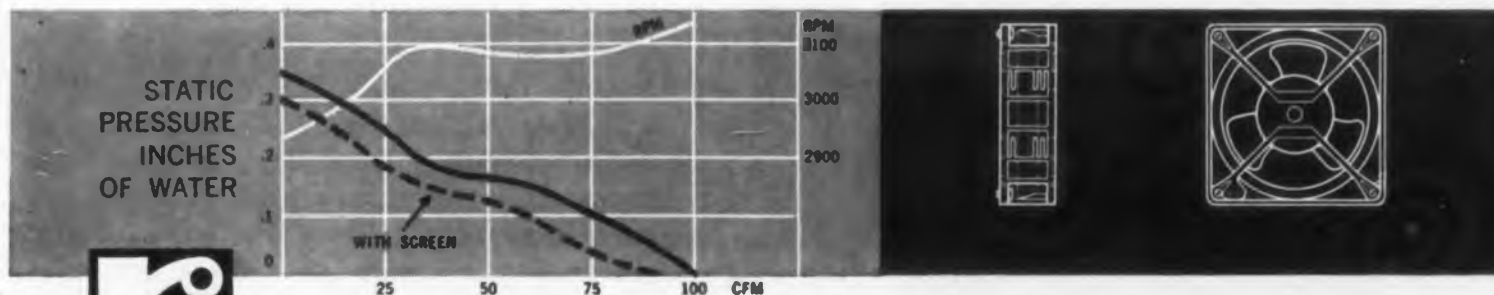
Unlike conventional or phonograph motor assemblies, the MUFFIN FAN boasts a high air performance of 100 CFM free delivery from a basic package only 4-11/16" square and 1 1/2" deep and weighing just 1.2 pounds.

Power requirement is 105 to 120 VAC, 60 cycles, single phase. Electrical connections made to convenient terminal lugs accepting standard 18 gauge lamp cord. Completely original aero-dynamic design permits operation through a dust filter and tightly packed electronic equipment. Airflow instantly reversible by turning fan end-for-end.

The MUFFIN FAN is a completely integrated cooling unit

consisting of propellor, stator assembly and venturi block. It is also available in combination with a grille assembly and all-purpose mounting clips to form a complete package. Unbelievably thin, the MUFFIN FAN can be installed in seconds in cabinet cutout, imposing practically no space requirement within the enclosure.

Cool economically... the MUFFIN FAN can be supplied at a price less than \$8.00 per unit in quantity. The low cost, high performance, compact size and maintenance-free design provide efficient air cooling previously unobtainable. Write for complete details...



ROTRON mfg. co., inc.

WOODSTOCK, NEW YORK • ORiole 9-2401
In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 24 ON READER-SERVICE CARD

Simple Aluminum Soldering

H. Hirst

Chief, Mechanical Design Group
Andrew Corp.
Chicago, Ill.

Aluminum solders have not gained widespread usage in spite of the advertised ease in handling the solder process. Harry Hirst (below), author of this article, backs up these claims of easy handling and presents data to show how well aluminum solders work.

SOLDERING ALUMINUM presents tricky difficulties: the metal has high thermal conductivity (a problem in working with large sections); a large coefficient of expansion (severe distortions may result), and an oxide coating on the surface that forms rapidly in oxygen (preventing the solder from adhering).

Successful soldering calls for careful craftsmanship, removal of the coating and selection of the correct solder.

The oxide coating, Al_2O_3 , essentially ceramic in nature, is thin and nonporous. It can be removed only by a strong flux, by abrasion in the absence of oxygen or by an electric arc. Since aluminum will melt before the oxide coating will, the best method for removal in soldering is either abrasion, a flux or a combination of the two. The electric arc process is used mainly in welding.

The oxide coating must be removed during the application of the solder; otherwise the solder will not adhere to the aluminum.

Removing Oxide Film

There are many methods for removal of the oxide film by the abrasion process. One method uses ultrasonics. This system is relatively expensive and consists of the solder gun and a high frequency power pack to vibrate the tip of the gun. A large joint requires a more powerful unit.

Other abrasion means use stainless steel wool or brushes, and brushes made of glass fibers. These materials are used to abrade the oxide film through the molten solder pool. This abrasion process loosens the oxide from the metal surface

and allows it to come to the solder surface. The solder can then contact the surface of the aluminum. "Friction soldering" is the term used for this type of process which can also be accomplished by using the soldering stick itself to scrape the oxide loose beneath the solder pool. The solder stick in this case should be of a suitable shape to facilitate scraping and of a high melting point solder alloy.

The most common method of oxide removal is by use of fluxes. Two types of fluxes can be used depending on the solder and the temperature at which it is applied. The first type is made up of metallic salts, usually zinc chloride or another metal halide with smaller amounts of other chlorides and fluorides. These fluxes are extremely effective, highly hygroscopic, very corrosive, and must be thoroughly removed after the joint is made. The second type of flux is for use on items that do not lend themselves to thorough removal after the joint is made and contain no chlorides. These latter fluxes are used when the soldering temperature is less than 525 F with a soldering alloy containing four metals.

Choice of Solder

Solders that can be used on aluminum are made up of metals that will alloy with each other and to a certain extent with aluminum. In considering an aluminum solder, the combination of metals in the solder alloy should be known in order to define the working temperature, the strength of the joint, and the corrosion resistance of the alloy combination at the joint.



Four basic metals are used in the alloys for soldering aluminum. They are zinc, tin, cadmium, and lead, in various combinations and mixtures. Some of these combinations have been used as die casting alloys.

Zinc base solders of 90 per cent zinc minimum, have the highest strengths and melt points with the greatest corrosion resistance. One alloy of this type has a tensile strength of 51,000 psi, is used as a die casting alloy under the name of Zamak III and works well as a friction solder. These alloys are very useful in any atmosphere in which galvanizing is recognized as good corrosion protection. The soldering temperatures of these alloys are from 700 to 820 F.

Tin base alloys are set up usually in two combinations with zinc as the secondary metal. Some other alloys are now being used with the ultrasonic process consisting of tin in various percentages with copper or cadmium as the second metal in the alloy. These solders are easier to apply than the zinc base solders and provide medium strength joints with fair corrosion resistance. In humid atmospheres, these alloys should be used on long lap joints to prevent moisture penetration, but in salt atmospheres, the solder may swell and crack if the secondary element is incorrect for the required condition. One method of protection against corrosion is to seal the joint with adequate coats of paint. The melt points of these alloys is from 500 to 750 F.

Lead base solders are similar to those used for ordinary soft soldering but require extremely active special fluxes. These solders are very weak in comparison to the zinc base materials, will not withstand prolonged humidity, and should only be used for interior applications. These solders are applied at approximately 450 F.

Cadmium base solders have strengths slightly less than the zinc base solders. These solders are very susceptible to swelling and cracking if aged over a period of years in humid atmospheres. Soldering temperature of these alloys is from 510 to 750 F.

The strength of a joint made up of any of the solder alloys is dependent on the adhesion to the base metal, the strength of the solder alloy, the size of the fillet, and the penetration of the alloy through the joint. Zinc base alloys have tensile strengths of 15,000 to 41,000 psi. Tin base alloys have tensiles of 8000 psi, and the lead base solders are in the range of 5000 psi. All of the above strengths are for the alloys alone and will vary depending on the metal mixture in the alloys. If the metal items being joined are of 1100 series aluminum the maximum tensile of this material is 13,000 psi, and if the joined metals are of 6061 alloy, the maximum tensile is 18,000 psi. From the above figures it can readily be seen that it is possible to create a joint that is stronger than the ma-



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



... WHERE RESEARCH IS THE KEY TO TOMORROW

MINCOM DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

2049 SOUTH BARRINGTON AVENUE • LOS ANGELES 25, CALIFORNIA

CIRCLE 25 ON READER-SERVICE CARD



Fig. 1. Typical sample used in the tensile testing of the aluminum solder joints. Joint section is $1 \times \frac{1}{8}$ in.

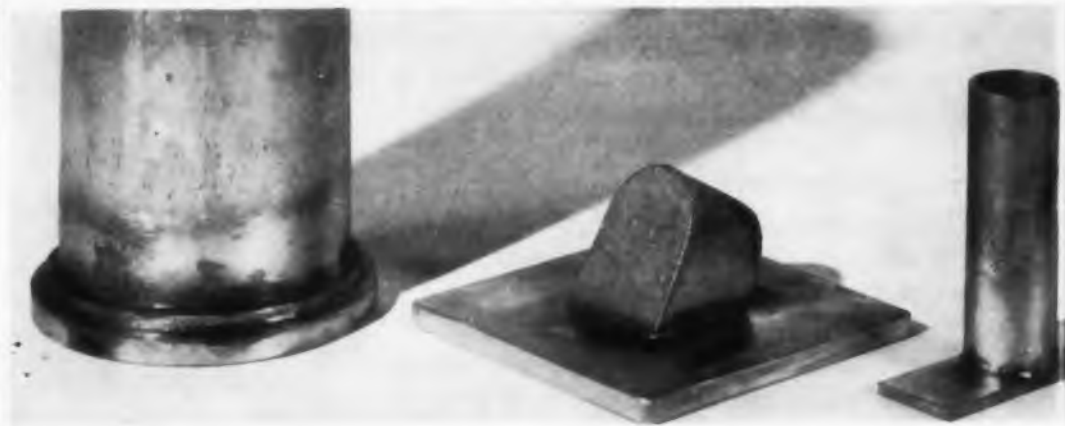


Fig. 3. (above) Various shapes that have been soldered with excellent results. The center is a casting soldered to 6061 aluminum sheet.

Fig. 2. (left) View of lap joints made with aluminum solder. The joint on the bottom shows excellent capillary action and full penetration due to tinning. The joint on the top was not tinned and has very little penetration.

materials being joined if the proper solder alloy is correctly applied at the joint.

In using a solder on an aluminum joint, it must be remembered that the higher the solder temperature, the more fully annealed the materials being joined become. Temperatures over 400 F will create some annealing of aluminum during the solder process. The amount of the annealing is controlled by the temperature involved and the length of time this heat is applied to the work pieces.

Table 1. Tensile Test Results on "T" Joints

Melt Point, F.	Sample	Breaking Load, lb. before salt spray	Breaking load, lb. after 72 hr salt spray ASTM B117-49T
750 - 820	1A	2150	1730
600 - 750	1B	2130	2130
	2B	1650	997
	3B	1730	—
	4B	1400	1390
	5B	1350	1350
340 - 500	1C	1463	980
	2C	1837	705
	3C	910	905
	4C	100	—
	5C	1657	1600
	6C	760	745

Results of tensile test on "T" joints. Hours of salt spray are length of time that it took to cause failure of the 6061-T6 aluminum alloy test samples. Samples which show no tensile readings after salt spray were samples on which the solder had failed in the salt spray chamber.

Tensile Tests

To get the solder alloys that are described above was a problem in itself, for the producers of aluminum solders are much opposed to revealing the special mixtures that they use in their alloys. One manufacturer that was asked about the corrosion resistance of his solder admitted that it would not hold up under severe humidity conditions but that a new alloy they were working on would. Another manufacturer merely stated that their alloys had been used on some government work and proved satisfactory for the required application. Since listing the solders tested by the elements they contain was not feasible, it was decided to set up a list by melt points and numbers (Table 1). Fifteen solder alloys were tested for capillary action, strength, and corrosion resistance. All but two of the solders were readily obtained at local welding supply houses. In the solder tests on these alloys, only twelve of the fifteen operated in a satisfactory manner.

Soldering of the aluminum samples for the tests was done with a torch as the heat source. Flux, when used, was applied before heating, and in the case of the low temperature solders (600 F or less), the torch flame was not allowed to touch the flux coating. All grease, oil, and dirt was removed from the samples to be joined, and garnet cloth was used to partially remove the oxide coating. The samples that were flux soldered were rinsed with hot water after soldering. These samples were made up in the form of tees with the vertical leg of $\frac{1}{8}$ by 1 inch 6061 T6 aluminum (Fig. 1). The horizontal leg was also of this material with the same dimensions.

Human Factor Important

The importance of the solderer cannot be overlooked in the soldering of aluminum. Three solderers were tried on this process and it was found that the best results were obtained by a solderer with considerable experience in soft solder and silver solder techniques on copper and brass, also one who had welded thin steel sections with a torch. The third solderer was one who had made very few solder joints on any type of material. This man was tried to test the saying, "now anyone can solder aluminum," and it was found that he could only produce worthwhile results with one of the solder alloys. These solderers had never soldered aluminum before, but the first two had made braze joints on aluminum using a torch as the heat source. The torch welder had made very few of these joints, but his experience on steel served him well on this new process.

Although the "T" joints were the only ones on which tensile tests were made, a considerable amount of other joints were also made to check the solders completely. On lap joints, Fig. 2, it was found that edge sealing would occur with no penetration of the joint. This condition occurred steadily in our trials until the pieces were first tinned and then slid together while still hot. Additional solder was then added which fully penetrated the joint. The joints referred to above were all horizontal lap joints in which the oxides floating on top of the molten pool of solder on the lower piece of aluminum prevented adhesion to the upper aluminum section. If both pieces are tinned the oxide will not form and adhesion to both surfaces does occur.

It was also found that no large build up of the fillet occurred when soldering with a torch. "T" joints made of 1/32-in. thick material had the same size fillets as those made of 1/8-in. material.

Some of the solder alloys used were recommended for use with and without flux. The flux was for use on joints that involved the filling of small cracks and the friction type of soldering over the fluxless or friction method. The most useful item provided by a flux is an indication of when to apply the solder. The solder fluxes, when heated, first dry out and then produce white fumes. When the fumes occur the temperature is said to be correct for solder application. In all of our tests with flux soldering we found this reaction to be extremely accurate.

Soldering of aluminum should not be compared to the soldering of copper or brass with soft solders for they are definitely not alike in appearance or actions. It was found that with most aluminum soldering alloys the time required to make an acceptable joint was longer than when soldering copper or brass and that more care had to be exercised in the handling of the torch and the solder. The solder joints are much different in appearance and tend to resemble a cold solder joint in some cases. The fuming of the flux and the oxide floating on the surface of the solder pool is confusing to an inexperienced operator who cannot understand where all the dirt is coming from on previous-clean metal. In one case with the above mentioned condition the operator gave up on the joint and was very surprised to find that when it was tested after cooling he had made a perfect joint.

Application of these aluminum solder alloys can be found in sheet metal work, plumbing, and wire joining Fig. 3 illustrates a few typical examples of pieces fabricated from aluminum. Model shop work on aluminum designs can be accomplished cheaply and easily with these solders. Further uses of these materials could be in the sealing of minor cracks and holes, reinforcing of a riveted seam for water tightness filling in dents, and reinforcing small framed structures.

In using these solders several aspects of these materials must be remembered. First, that the capillary action of the solders is very poor and secondly, that contact to the metal and the joint is dependent on the size of the fillet and that the proper solder choice can lead to a joint with equal or greater resistance to salt spray corrosion than the sections being joined. ■ ■

Acknowledgements

Aluminum Company of America
Kaiser Aluminum Inc.
Reynolds Metals Company
Modern Metals
Aluminium Company of Canada



BELDEN

MAGNET WIRE HANDBOOK 14

1960 Edition

Now Available

Over 90 pages . . . handy desk and pocket size (4¾" x 7½")
A special feature dealing with "Factors Involved in Selection of Magnet Wire"
A discussion of "Winding Tensions"
Performance data on all types of magnet wires
Dimensional tables on all types of magnet wires . . . including bare aluminum, bare copper, and tinned copper
Ask for no-charge copy of Belden Magnet Wire Handbook 14

BELDEN MANUFACTURING COMPANY
P. O. Box 5070-A, Department 11
Chicago 80, Illinois

one wire source for everything electrical and electronic



lead wire • magnet wire • power supply cords •
cord sets • portable cordage • electronic wire •
automotive replacement wire and cable •
aircraft wire • electrical household replacement cords

1-1-9

Design of Transistorized DC-to-DC Converters

Part II. Push-Pull Transformer-Coupled

Carl R. Turner

Semiconductor and Materials Div.
Radio Corporation of America
Somerville, N. J.

Complete procedures and equations are presented to enable the circuit engineer to design transistorized push-pull transformer-coupled dc-to-dc converters. A typical example is worked out to demonstrate the simplicity offered by the convenient step-by-step procedure together with tabulated key parameter data.

PUSH-PULL transformer-coupled converters, with full wave rectification, supply power to their load continuously and are, therefore, ideal for low-impedance, high-power applications.

Although not as economical and simple as the ringing-choke design (Part I, *ED* Sept. 16, 1959, p. 40), the push-pull configuration provides superior efficiency and output regulation.

Fig. 3 shows the basic circuit of a push-pull transformer-coupled dc-to-dc converter, using the common-emitter connection for the transistors. Fig. 4 shows typical waveforms in this circuit during a complete operating cycle.

Energy Transformation

During a complete cycle the flux density in the transformer core, Fig. 3, varies from one saturation value to the other and back. At the start of the conduction period for one transistor, the flux density in the core is at either its negative maximum value ($-B_{sat}$) or positive maximum value ($+B_{sat}$).

For example, transistor A switches on at ($-B_{sat}$) (Fig. 4a). During conduction of transistor A, the flux density changes from its initial level of ($-B_{sat}$) and becomes positive as energy is simultaneously stored in the inductance of the transformer and supplied to the load by the battery.

When the flux density reaches ($+B_{sat}$), transistor A is switched off and transistor B is switched on. During the entire period of conduction through transistor A, energy is supplied to the load at a constant rate as a result of transformer action. This energy transformation cycle is repeated during the conduction period for transistor B.

Operating Details and Waveforms

Initially, sufficient bias is applied to transistor A to saturate it, with the result that a substantially constant voltage (Fig. 4b) is impressed across the upper half of the primary winding by the dc source V_{in} . This bias can be a temporary bias, a small fixed bias or even a small forward bias developed across the bias winding as a result of leakage and saturation current flowing in the primary. The constant primary voltage causes a dc component and a linearly increasing component of current to flow through transistor A (Fig. 4c). As in the ringing-choke converter, the linearly increasing primary current induces substantially constant voltages in the bias winding (Fig. 4d) and secondary winding. Also, as in the ringing-choke converter, the induced voltage in the base winding limits the maximum value of the base current and, therefore, of the collector current.

In the push-pull transformer-coupled circuit,

the transition to switch-off is initiated when the transformer begins to saturate. As long as the transistor is saturated, the product of the transformer inductance and the time rate of change of the collector current remains constant. When the transformer core saturates, the inductance de-

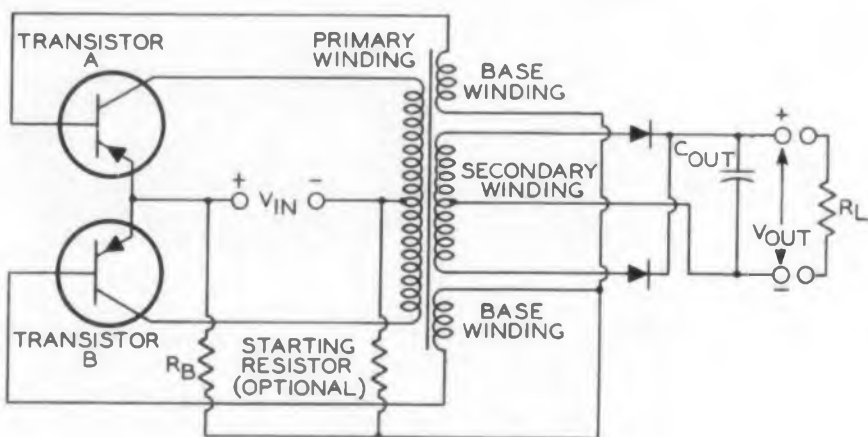


Fig. 3. Basic circuit of a push-pull, transformer-coupled dc-to-dc converter, using transistors with common-emitter connection.

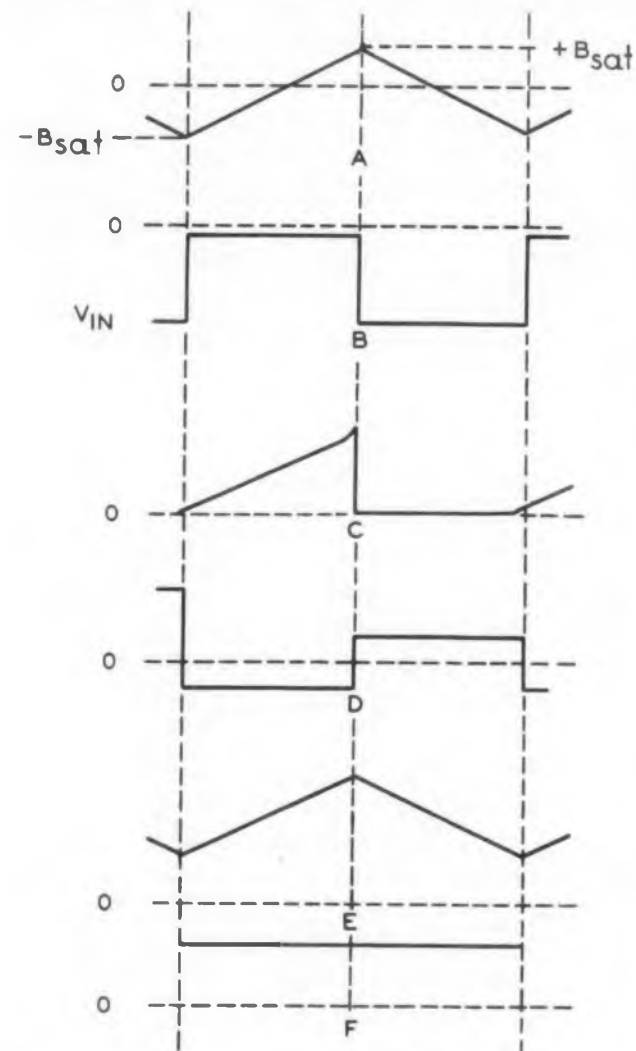


Fig. 4. Typical waveforms in the circuit of Fig. 3 during a complete operating cycle: (a) flux density in the transformer core, (b) collector voltage for one transistor, (c) collector current for one transistor, (d) base voltage for one transistor, (e) primary current, (f) secondary current.

increases rapidly toward zero, with the result that the time rate of change of the collector current increases towards infinity. When the collector current reaches its maximum value, transistor A moves out of its saturated condition, the winding voltages decrease and then reverse, thereby causing transistor A to switch off. The reversal of the winding voltages switches on transistor B, and the switching operation repeats.^{1,2}

Design Procedure

1. The procedure for selection of a suitable transistor type, transformer core, and operating frequency is the same as for the ringing-choke type circuit (ED, Sept. 16, p. 40) except that the data in Table III is used. Because the transformer core must be operated in the saturation region, an air gap is not normally required.

2. Determine the maximum permissible value for the input voltage V_{in} (Eq. B11). Select a value of V_{in} less than this maximum value or use a different transistor type that will permit use of a higher value for V_{in} .

3. Determine the required number of turns for each half of the center-tapped primary winding N_p (Eq. B7).

4. Determine the required inductance for each half of the primary winding L_p .

$$L_p = \left(\frac{4\pi N_p^2}{10^9} \right) \left(\frac{\mu_1 A}{l_1} \right) \quad (\text{Eq. A8, Part I})$$

5. Determine the peak primary current I_p (Eq. B3).

6. Determine from the published data for the transistor type selected, or from the transistor manufacturer, the maximum value of V_{BE} necessary to provide the peak primary current I_p determined in Step 5.

7. Determine the required number of turns for each section of the base winding (Eq. B9).

8. Determine the required value for the external base resistance R_B .

$$R_B = \frac{V_{BE \max} - V_{BE}}{I_B} \quad (\text{Eq. A8, Part I})$$

9. Determine the required number of turns for each half of a center-tapped secondary winding, or the total number of turns for an untapped secondary winding N_s (Eq. B10).

10. Select a transformer core having the magnetic circuit parameters determined in Step 1, and adequate winding space. The wire size for each winding is determined from the peak current, the maximum allowable copper losses, the minimum available transformer winding space, and the number of turns on each winding. If winding-space requirements indicate that an unduly large rectangular core is necessary, the use of a toroidal core should be considered. If EI, EE, CI, or CC cores are used, the approximate window area required can be determined from the Winding Data Chart (Table 70) given on pages 1416-1417 of the "Radiotron Designer's Handbook."⁵

11. Determine the peak secondary current I_s (Eq. B12) and peak secondary voltage V_s (Eq. B13).

12. Select a rectifier type meeting the peak secondary voltage and current requirements. Se-

Table III. Design Data for Push-Pull, Transformer-Coupled DC-to-DC Converters

Application Requirements			Transistor Requirements				Recommended Parameters				EXPECTED CIRCUIT-EFFICIENCY FACTOR (η)
POWER OUTPUT (P_o) WATTS	MAX. OUTPUT VOLTAGE (V_{OUT})	DC INPUT VOLTAGE (V_{IN})	SATURATION RESISTANCE (R_{SAT}) MAXIMUM VALUE OHMS	COLLECTOR-TO-BASE BREAK-DOWN VOLTAGE (V_{CBmax}) MINIMUM VALUE VOLTS	PEAK COLLECTOR CURRENT (I_c) MINIMUM VALUE AMPERES	PERMISSIBLE DISSIPATION AT CASE OR FLANGE TEMPERATURE OF 55°C MINIMUM VALUE WATTS	Transformer Core				
							MATERIAL	CROSS-SECTIONAL AREA (A) CM ²	MAGNETIC-PATH LENGTH (l_m) CM	OPERATING FREQUENCY (f) KILOCYCLES PER SECOND	
2	250	6-12	2	30	0.5	0.1	Ferrite	0.5-4	2.5-10	1-5	0.85
	500	12-20	2	45	0.4	0.075					
10	400	12-18	1.5	45	2	1	Ferrite	0.5-5	2.5-10	1-5	0.85
	600	18-28	1.5	60	1	0.5					
25	400	12-18	1	45	5	3	S _i iron or grain-oriented S _i steel	1-5	5-15	0.1-0.8	0.85
	600	18-28	1	60	3	1.5					
50	250	8-18	0.5	45	12	10	S _i iron or grain-oriented S _i steel	2-7.5	7.5-20	0.1-0.8	0.85
	500	18-28	0.5	60	8	5					
	800	28-38	0.5	80	5	2					
100	400	12-18	0.5	45	18	15	S _i iron or grain-oriented S _i steel	3-12	10-25	0.1-0.8	0.85
	600	18-28	0.5	60	10	10					
	800	28-38	0.5	80	7.5	5					
200	400	12-24	0.2	60	20	25	S _i iron or grain-oriented S _i steel	5-15	15-35	0.1-0.8	0.8
	600	24-36	0.2	80	15	15					
	800	36-48	0.5	100	10	10					

lect a value for C_{OUT} which will provide the desired degree of filtering of the output (Eq. B14).

Example

To illustrate the use of the design procedure given above, the design of a push-pull transformer-coupled dc-to-dc converter is worked out below. The converter is to have a power output of 100 w and an output voltage of 400 v, and is to operate from a 28 v source.

1. From the transistor requirements given in Table III for $P_{out} = 100$ w, $V_{out} = 400$ v, and $V_{in} = 28$ v, a suitable transistor type would be the RCA-2N561. This transistor has a maximum saturation resistance P_{sat} of 0.2 ohm, a collector-current rating I_C of 10 amp, and a dissipation rating of 30 w at a case temperature of 55 C.

A suitable transformer core would be one made of grain-oriented silicon steel, having a cross sectional area A of 8.22 sq cm and a magnetic-path length of 17.14 cm, such as the Magnetic Metals Co., 112 EI type, "Crystaligned 33" core. This core has 0.014 in. thick lamination, a saturation flux density B_{sat} of 8000 gauss, and a permeability μ_i of 12,000.

A suitable operating frequency f would be 400 cps and the expected circuit efficiency would be 85 per cent.

2. From Eq. B11, the maximum permissible value for the supply voltage V_{in} is $V_{in} \leq 0.9$

$$\left(\frac{V_{CB\ max} - V_{BE\ max}}{2} \right) = 0.9 \left(\frac{80 - 3.5}{2} \right) = 34.5 \text{ v}$$

The desired value of V_{in} (28 v) is substantially less than the maximum permissible value.

3. From Eq. B7, the required number of turns for each half of the primary is

$$N_P = \frac{V_{in} 10^8}{4 f A B_{sat}} = \frac{28 (10^8)}{(4) (4) (10^2) (8.22) (8) (10^3)} = 27 \text{ turns}$$

The total number of primary turns is, therefore,

$$2 N_P = 2(27) = 54 \text{ turns}$$

4. The required inductance for one half of the primary is

$$L_P = \left(\frac{4\pi N_P^2}{10^9} \right) \left(\frac{\mu_i A}{l_1} \right) = \left[\frac{4\pi (7.3) (10^2)}{10^9} \right] \left[\frac{12 (8.22) (10^3)}{17.14} \right] = 0.0529 \text{ henry}$$

5. From Eq. B3, the peak primary current is:

$$I_P = \left(\frac{V_{in}}{4 f L_P} \right) + I_{AV}$$

$$I_P = \frac{28}{(4) (4) (10^2) (0.0529)} + \frac{100}{(85) (28)}$$

$$= 0.33 + 4.20 = 4.53 \text{ amp}$$

6. From information furnished by RCA for its transistor Type 2N561 the maximum value of V_{BE} required to provide the calculated peak primary current of 4.53 amp is:

$$V_{BE\ max} = 3.5 \text{ v}$$

7. From Eq. B9, the required number of turns for each section of the base winding is:

$$N_B = N_P \left(\frac{V_{BE\ max}}{V_{IN}} \right) = \frac{27 (3.5)}{28} = 3.4 \text{ turns}$$

(use 4 turns)

The total number of turns for the base winding,

$$2 N_B = 2(4) = 8 \text{ turns}$$

8. The required value for the external base resistance R_B is $R_B = \frac{V_{BE\ max} - V_{BE}}{I_B}$ where V_{BE}

and I_B are values required to obtain $I_P = 4.53$ amp for the 2N561. For a typical 2N561 transistor, the values of V_{BE} and I_B required to provide the calculated peak primary current of 4.53 amp are, respectively, 1.1 v and 200 ma. The required value of R_B for this typical 2N561, therefore, is

$$R_B = \frac{3.5 - 1.1}{0.2} = \frac{2.4}{0.2} = 12 \text{ ohms}$$

9. From Eq. B10, the required number of turns for each half of a center-tapped secondary winding or a total number of turns for an untapped secondary winding is

$$N_S = N_P \left(\frac{V_{out}}{V_{in}} \right) = \frac{27 (400)}{28} = 385 \text{ turns}$$

10. A 112 EI core having the necessary magnetic parameters was selected. The peak currents in the primary and secondary windings are, respectively: $I_P = 4.53$ amp and $I_S = 0.25$ amp. The peak base current is dependent upon the dc current gain (β) at $I_P = 4.53$ for the specific 2N561 used. For a 2N561 having a minimum β , the peak base current I_B for $I_C = 4.53$ amp is 0.230 amp. For the purposes of this design, $I_B = 0.230$ amp will be used.

Because the core selected is an EI type, the Winding Data Chart of the "Radiotron Designer's Handbook" is used to determine the required wire sizes, turns per layer, and number of layers on the core.

Based on the peak current requirements, the wire sizes are: primary—No. 15 AWG, secondary—No. 27 AWG and base—No. 28 AWG. For a lamination size of 1.5 in., the turns per layer on the

primary is 28. Therefore, two layers $\left(\frac{2 N_P}{28} \right)$ are required, and the primary will have a thickness of $(2) (0.0588) = 0.1176$ in.

The base winding is wound over the primary,

and requires one layer having a total thickness of 0.0136 in. The secondary requires four layers having a total thickness of $(4) (0.0152) = 0.0608$ in. The height of the window, therefore, must be greater than $0.1176 + 0.0136 + 0.0608 = 0.1920$ in. The 112 EI core has a window thickness of 0.562 in., and, therefore, provides adequate room for the wire, wire form, and insulating tape.

11. From Eq. B12, the peak secondary current

$$\hat{I}_S = I_{RL} = \frac{P_{out}}{V_{out}} = \frac{100}{400} = 0.25 \text{ amp}$$

and from Eq. B13, the peak secondary voltage is

$$\hat{V}_S = N_{IN} \left(\frac{N_S}{N_P} \right) = 28 \left(\frac{385}{27} \right) = 400 \text{ v}$$

12. A suitable rectifier type is the RCA-1N1764 diffused-junction silicon rectifier. For a single-phase, full wave rectifier circuit using a center-tapped secondary winding, four of these rectifiers (two series-connected pairs) will be required. For a single-phase, full-wave rectifier circuit not using a center-tapped secondary winding, four of these rectifiers will also be required. From Eq. B14 a suitable value for C_{out} is

$$C_{out} = \frac{1}{(R_L) (2\pi) (2f)} = \frac{1}{(2\pi) (1600) (800)}$$

$$= \frac{10^{-6}}{0.803} = 0.122 \mu f$$

Additional Considerations

In addition to the considerations listed in the foregoing design data for ringing-choke-type and transformer-coupled-type dc-to-dc converters, there are others, such as starting bias methods, the use of voltage-multiplication techniques, and maximum operating temperature, which may require consideration in practical designs. Excellent starting under heavy load conditions may be obtained by the use of a transistor-type switch which will provide a large starting bias and then be cut off by the buildup of the output voltage. It is also possible to obtain satisfactory starting by the use of a fixed bias resistance, provided the value of this resistance is high enough so that it does not materially affect normal switching.

If dc output voltages higher than those shown in Tables I and III are required, they should be obtained by the use of voltage-multiplier-type rectifier circuits rather than by the use of step-up ratios larger than those indicated in the data for transformer design. Although the use of a voltage-multiplier circuit results in a reduction in over-all efficiency, it is less disadvantageous than the higher copper losses, magnetic-coupling problems, and higher core losses resulting from the use of higher transformer step-up ratios.

The transistor requirements given in Tables I

and III are for operation at a case or flange temperature of 55 C. To convert case or flange temperature to ambient temperature, it is necessary to know the thermal resistance between the transistor and free air. This resistance is a function of the contact resistance between the transistor case or flange and the chassis, the thermal resistance of any insulating washer used, the size, thickness, and material of the chassis, and the method used to cool the chassis—for example, forced-air cooling, water cooling, or simple convection cooling.

To assure reliable operation at any permissible ambient temperature, care must be taken that the collector-junction temperature of the transistor is

Equation Derivation for Push-Pull Transformer-Coupled DC-to-DC Converter

Assuming that the full dc supply voltage V_{in} is impressed across one-half of the primary winding, Fig. 3, the current flowing in the collector circuit of the conducting transistor may be determined from

$$L_P \frac{dI_P}{dt} = V_{in} \quad (B1)$$

where L_P is the inductance of one-half the primary winding, in henries

dI_P is in amps

dt is in seconds

V_{in} is in volts.

For a triangular current waveform such as that shown in Fig. 4,

$$\frac{dI_P}{dt} = \frac{2 \hat{I}_P}{0.5 T} = \frac{4 \hat{I}_P}{T} = 4f \hat{I}_P \quad (B2)$$

where

T is in seconds

f is in cps

The peak value of the current in the collector of the conducting transistor is, therefore,

$$\hat{I}_P = \frac{V_{in}}{4f L_P} \quad (B3)$$

From Eq. All the required inductance for one-half of the primary is

$$L_P = \left(\frac{N_P \Delta \phi}{\hat{I}_P} \right) 10^{-8}$$

In the push-pull transformer-coupled converter, however, the swing on the B-H saturation curve is symmetrical about the origin. The residual flux

not greater than that specified by the manufacturer. The average temperature of the junction is equal to the ambient temperature plus the product of the average power dissipated in the transistor, and the thermal resistance between junction and case plus case and air

$$[T + P(R_{TJC} + R_{TCA})]$$

As a final note, it is important to emphasize that the material of the transformer core should have the highest permeability and permissible flux density that are economically practicable. These characteristics will permit the use of the fewest possible turns for the transformer windings. It is also desirable that the core material have the

density ϕ_{res}/A , therefore, is zero and

$$\frac{\Delta \phi}{A} = \frac{\phi_{max}}{A} - \frac{\phi_{res}}{A} = \frac{\phi_{max}}{A} = B_{max} \quad (B4)$$

The required inductance for one-half of the primary, may therefore, be expressed as

$$L_P = \frac{N_P B_{max} A}{\hat{I}_P} (10^{-8}) \quad (B5)$$

where B_{max} is in gauss.

The value of N_P may be determined by combining Eqs. B3 and B5—i.e.,

$$V_{in} = 4N_P f B_{MAX} A (10^{-8}) \quad (B6)$$

$$N_P = \frac{V_{in}}{4f B_{max} A} (10^8) \quad (B7)$$

Because no air gap is required, the required inductance for one-half the primary is

$$L_P = \left(\frac{4\pi N_P^2}{10^9} \right) \left(\frac{\mu_1 A}{l_1} \right) \quad (B8)$$

To determine the required number of turns for each section of the base winding, it is necessary to know the maximum base-to-emitter voltage, $V_{BE max}$, at which the transistor type used will provide the peak primary current I_P . This voltage may be obtained from the published data for the transistor type or from the transistor manufacturer. The number of turns for each half of the base winding is, then

$$N_B = N_P \left(\frac{V_{BE max}}{V_{in}} \right) \quad (B9)$$

The required number of turns for each half of the secondary winding is

$$N_S = \left(\frac{N_P}{V_{in}} \right) (V_{out} + R_{out} I_{out}) \quad (B10)$$

where R_{out} is the resistance of the secondary and

highest practical value of resistivity to allow operation with a minimum of core losses. ■ ■

References

1. L. H. Light and Prudence M. Hooker, "Transistor DC Converters," The Institution of Electrical Engineers' Paper No. 1862R, April 1955.
2. L. H. Light, "The Design and Operation of Transistor DC Converters," Mullard Technical Communications, Vol. 2, 17, Feb. 1956. Reprint pp. 12-17, p. 45.
3. C. R. Eshelman, RCA Semiconductor Div., Somerville, N. J. Private Communication.
4. W. D. Williams, RCA Semiconductor Div., Somerville, N. J. Private Communication.
5. "Radiotron Designer's Handbook," Fourth Edition, edited by F. Langford-Smith, pp. 1416-1417.

reflected primary resistance.

Because R_{out} is usually very small in transformer-coupled converters it can be neglected in the initial calculations.

The value of the external base resistance R_B is found in the same manner as for the ringing-choke converter (see Eq. A18, Part I). If extreme flexibility of operation is desired, a separate external resistor may be used in each base circuit.

In the push-pull transformer-coupled circuit, the dc input voltage V_{in} should not exceed the maximum collector-to-base-voltage rating for the transistor type used. The maximum permissible for V_{in} is given by

$$V_{in max} \leq \frac{V_{CB max} - V_{BE wind}}{2} \quad (B11)$$

where $V_{CB max}$ is the maximum collector-to-base-voltage rating for the transistor type used, $V_{BE wind}$ is the induced voltage in one-half of the base winding. Eq. B11 is based on the assumption that there is zero leakage inductance in the transformer. In practice V_{in} should not be more than about 90 per cent of the value given in Eq. B11.

The peak secondary current is approximately equal to the dc load current.

$$\hat{I}_S = I_{RL} = \frac{P_{out}}{V_{out}} \quad (B12)$$

and the peak secondary voltage is given by

$$\hat{V}_S = V_{in} \left(\frac{N_S}{N_P} \right) \quad (B13)$$

For good filtering of the output voltage, the value of C_{out} should be chosen to give an output time constant of at least one-half of the period of oscillator, therefore,

$$C_{out} \geq \frac{1}{4\pi R_L F} \quad (B14)$$

Multiphase Discriminator Uses Transformer Logic

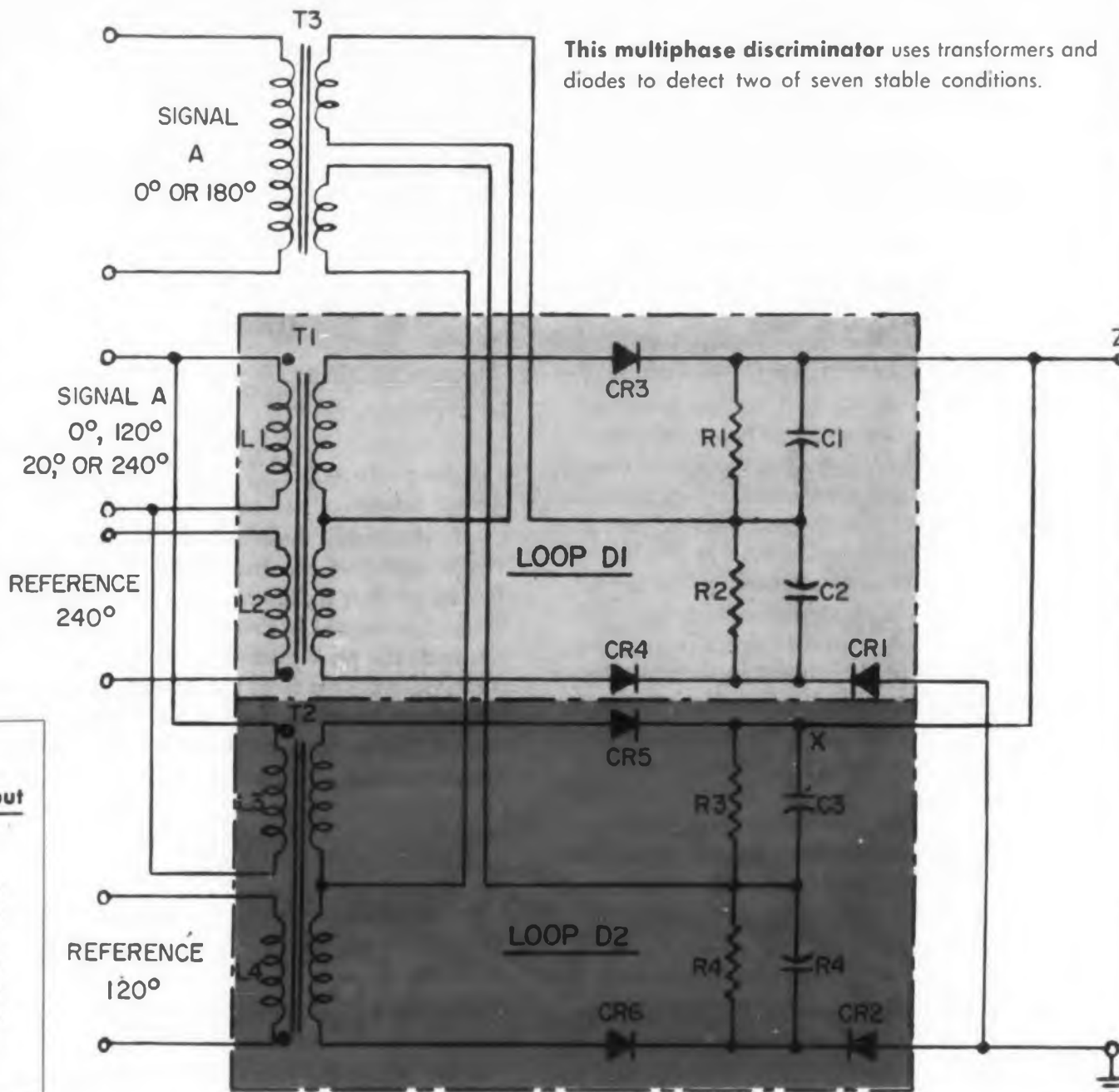
TRANSFORMERS CAN be used to implement some rather fancy logic. In this case they help sense the presence or absence of various 400 cps signals and help detect their phase relationships.

Two and three phase signals are involved. The discriminator must provide an output in accordance with the requirements of the truth table shown here. An analysis of the truth table shows the difficulty in distinguishing between stable states 4 and 5 and between stable states 6 and 7.

The circuit shown in the figure solves the problem rather simply. It consists of two diode discriminators which are conventional except for the special transformers *T1* and *T2* and the addition of two diode gates (*CR1* and *CR2*) in the output.

Stable conditions 1, 2, and 3 are satisfied easily since the absence of any one input signal results in the absence of an output. Stable conditions 4 and 5 are obtained in the following way:

A signal at a 240 degree phase angle, applied



Truth Table for Multiphase Discriminator

Stable Conditions	Input					Output
	400 cps Signal "A"		400 cps Signal "B"			
	0°	180°	0°	120°	240°	
1	0	0	1	0	0	0
2	0	0	0	1	0	0
3	0	0	0	0	1	1
4	1	0	0	0	1	0
5	0	1	0	0	1	0
6	1	0	0	1	0	0
7	0	1	0	1	0	1

0 = absence or low level signals, 1 = presence or high level signals

to *L1* and *L3*, immediately desensitizes loop *D1* since *L1* and *L2* are wound "flux-opposing" and the presence of two equal signals on both windings cancels the magnetic flux. This results in a zero signal at the secondary winding, so there is no dc output from this discriminator section.

But loop *D2* operates normally since the 240 degree signal on *L3* adds vectorially to the 120 degree signal on *L4*. They combine to present a 180 degree signal on the secondary of *T2*.

Depending on whether the *A* signal is at zero or 180 degrees, the dc output between *X* and *Y* is either positive or negative. However *CR2* allows only the positive signal to appear at point *Z*.

Thus, conditions 4 and 5 are satisfied: an output signal appears at point *Z* if—and only if—signal *A* is at a phase angle of zero degree and *B* is at a phase angle of 240 degrees.

For stable conditions 6 and 7 the same performance is repeated, except that loop *D1* is operated while loop *D2* is deactivated.

Ernest Hartog, Project Engineer, Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N.J.

Semiconductors for Fast Brakes and Clutches

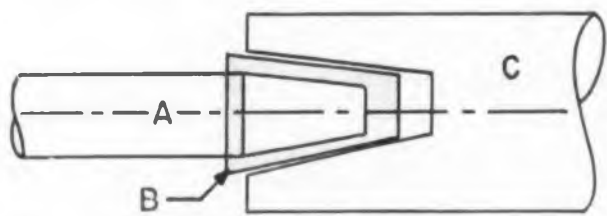
We needed a braking and/or coupling mechanism with a response faster than standard audio frequencies. It had to be both small and light. We solved our problem by using the little-known "Johnson-Rahbeck effect."

As shown in the figure, a conductive cone *A* is covered with a semiconductor *B* which, in turn, is surrounded by conductor *C*. Voltage, applied through slip rings across *A* and *C*, determines the coefficient of friction between the surfaces of *B* and *C*. Thus, the power of coupling or braking between the coaxial shafts can be varied in response to the output of a sensing mechanism.

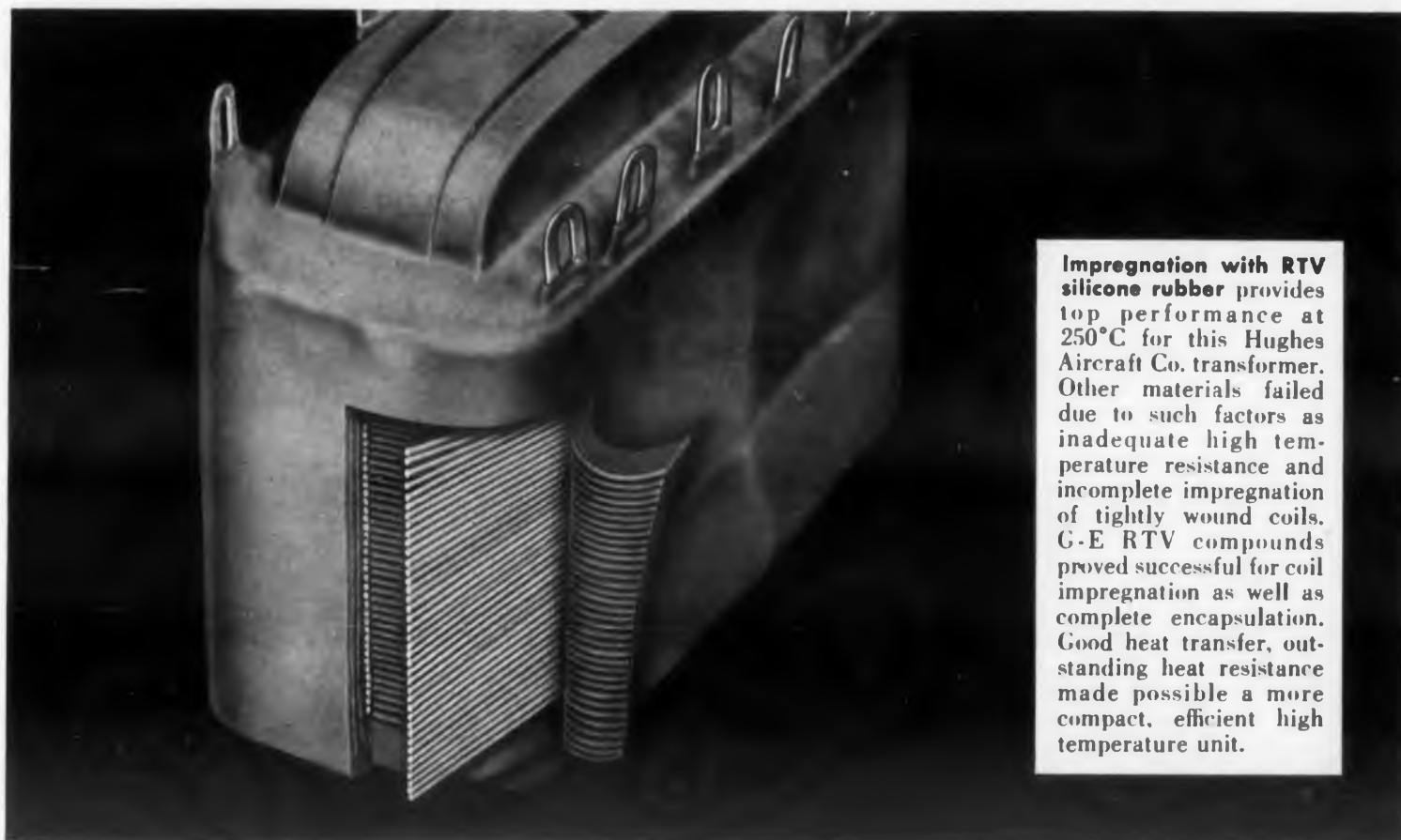
The response time and torque required determine the voltage levels and the type of semiconductor.

The process is sensitive to changes in atmospheric conditions. Though this is often a problem, it can be used to advantage when readout is to be a function of the atmosphere.

Dr. Erwin J. Saxl, President, Tensitron, Inc., Harvard, Mass.



Voltage between conductors *A* and *C* varies coefficient of friction of semiconductor *B*.



Impregnation with RTV silicone rubber provides top performance at 250°C for this Hughes Aircraft Co. transformer. Other materials failed due to such factors as inadequate high temperature resistance and incomplete impregnation of tightly wound coils. G-E RTV compounds proved successful for coil impregnation as well as complete encapsulation. Good heat transfer, outstanding heat resistance made possible a more compact, efficient high temperature unit.

Added protection, easier application with General Electric RTV silicone rubber insulation

Outstanding heat resistance and electrical properties combined with room temperature cure



New resilient, shock-absorbent RTV sponge offers improved shock and vibration protection at elevated temperatures; permits easier fabrication than previous methods of cutting, inserting and sealing sponge in place. With RTV, just add sponging and curing agents to compound and mix.



Protection from high altitude arc-over and corona is provided for this cathode ray tube by encapsulating all lead wires with RTV (room temperature vulcanizing) silicone rubber. Designed for airborne operation and installed in a non-pressurized section of the aircraft, tube is protected from arc-over and corona at altitudes up to 70,000 feet.



Extended service life for motors through RTV encapsulation of stator windings, introduced by General Electric motor departments. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring totally enclosed units. RTV has low viscosity, rapid cure.

For application data and samples of General Electric RTV silicone rubber, write General Electric Company, Silicone Products Department, Section L108, Waterford, New York

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

CIRCLE 27 ON READER-SERVICE CARD

RELIABILITY

RELIABILITY

RELIABILITY

RELIABILITY

R

R

R

R

R

R

R

R

R

R

you specify **RELIABILITY**

ELCO'S NEW SERIES 8007-8008

PACKAGING DEVICES • CABLE CONNECTIONS



NOW! The latest application of the industry's most reliable contact — the Varicon — in a connector which provides the highest contact density! Series 8007 provides you with screw actuating device offering positive lock against vibration plus easiest engagement and disengagement. 75, 100 or 130 contacts. Series 8008, without screw actuating device, available with 80, 95, 110, 125, 140 contacts. Both series offered with or without covers. The instant removal of contacts; various contact terminations; intermixing of various contact types within a connector; all molded body; and 36 different polarizing position possibilities are but a few more of its many features. Want more information? Or data relating to our Tube-Sockets/Shields and Varicon Connectors . . . the industry's most reliable lines for transistorization and printed circuitry! Drop us a line on your company letterhead; we'll rush Bulletins and Catalogs by return mail.

IF IT'S NEW... IF IT'S NEWS... IT'S FROM



"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 2200 Centinela Ave., West Los Angeles 64, Cal., GR 8-0671

See You at
NEC
BOOTH
129

CIRCLE 28 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Reject Modulating Signal To Cut Modulator Distortion

Conversion of a single-ended low frequency signal to a modulated ac carrier is often attempted without adequate attention to the problem of rejecting the modulating signal itself. This can result in distortion in following stages due to the modulating signal causing additional grid modulation.

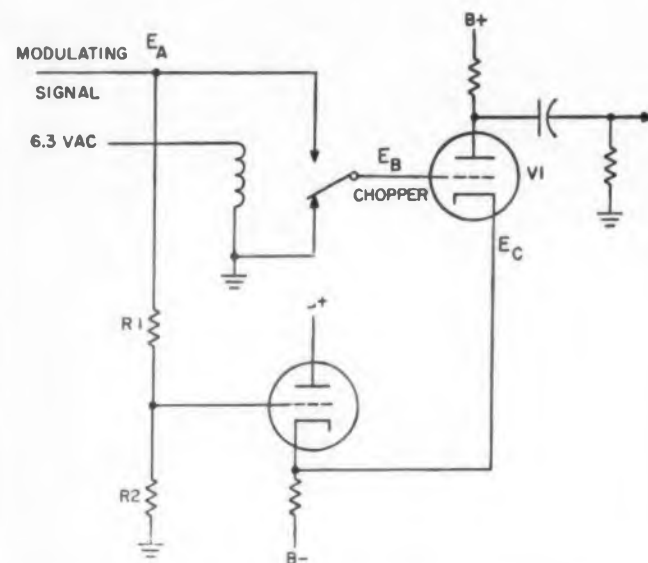


Fig. 1. Improved modulator cancels undesirable modulating signal through suitable choice of R_1 and R_2 .

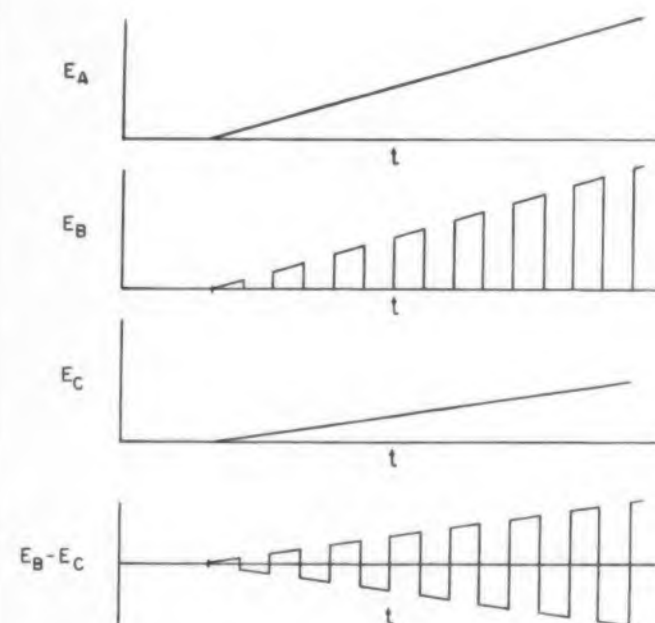


Fig. 2. Waveforms for the improved modulator.

The usual solution is to reject the modulating signal by means of high pass ac coupling networks. But where the modulated spectrum overlaps the modulating spectrum, this method re-

quires compromises. The schematic of Fig. 1 shows a more direct approach to canceling the modulating spectrum.

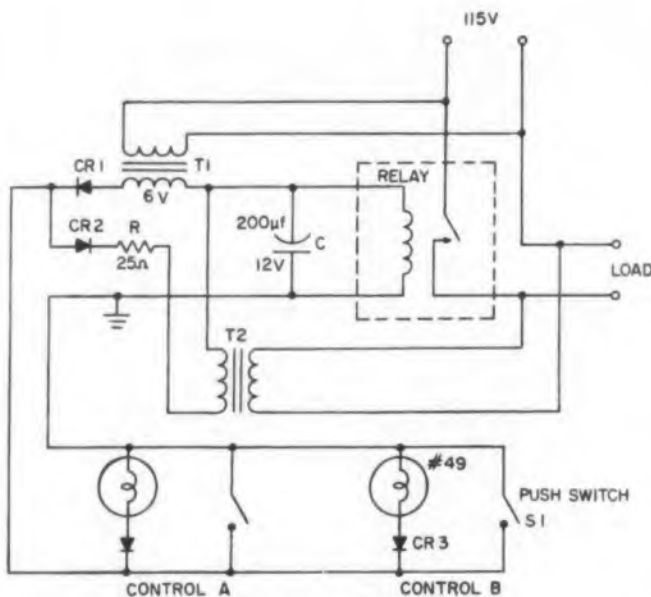
In this circuit, R_1 and R_2 are chosen so that the difference between E_B and E_O results in the modulated signal alone appearing at the plate of V_1 .

Jack W. Goodwin, Unit Supervisor, Hoffman

One Pair of Wires For Relay Control From Many Points

We had to control an on-off cycling relay from several control points and to indicate the relay's position. We could only use one pair of wires. Since one wire was ground, a simplex system could not be used. It was desirable to have the remote control point as simple as possible.

The solution uses opposite polarity, half-wave signals to control the relay and to signal its position. In the drawing, transistor T_1 supplies the relay current which is rectified by CR_1 and filtered by C . The indicator lamps are not lit when the relay is open, since the series diode CR_3 opposes CR_1 .



The six-volt relay is operated from remote points A or B through only one pair of wires.

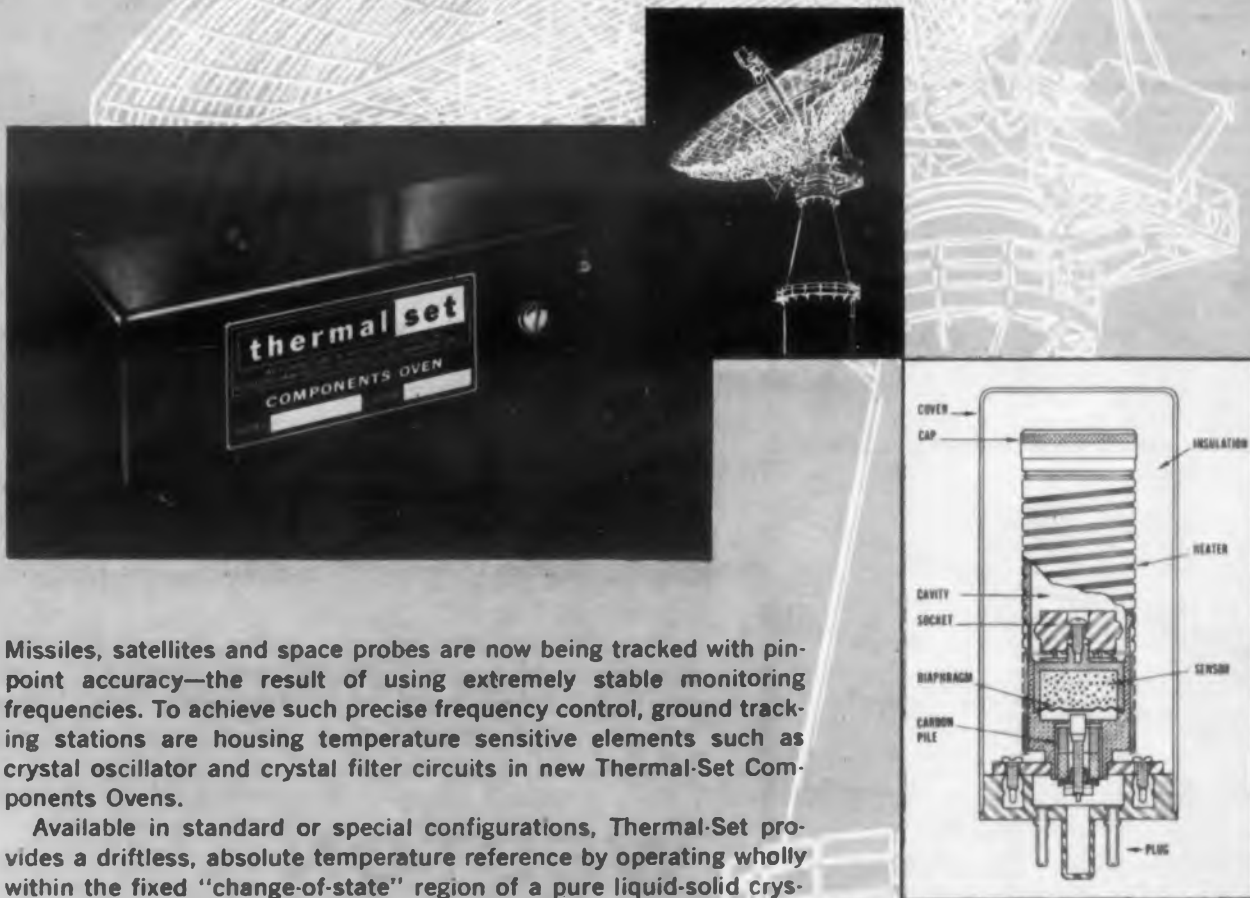
Momentarily depressing S_1 rocks the relay armature to its *on* position to operate the load. T_2 is then energized, supplying a small current through CR_2 and R . This signal is of the correct polarity to light the lamp through CR_3 , indicating closure of the relay.

The value of R depends on the type and number of lamps in the circuit. A value of 25 ohms is used with two type 49 lamps. Diodes are low voltage, 500 ma silicon units.

John T. Lamb, Research Engineer, The Tappan Co., Mansfield, Ohio.

THERMAL-SET...Robertshaw's New Change-of-State Components Oven with Proportional Heat Control System

NOW-TEMPERATURE CONTROL TO 0.003°C PER DEGREE AMBIENT CHANGE



Missiles, satellites and space probes are now being tracked with pinpoint accuracy—the result of using extremely stable monitoring frequencies. To achieve such precise frequency control, ground tracking stations are housing temperature sensitive elements such as crystal oscillator and crystal filter circuits in new Thermal-Set Components Ovens.

Available in standard or special configurations, Thermal-Set provides a driftless, absolute temperature reference by operating wholly within the fixed "change-of-state" region of a pure liquid-solid crystalline salt. The absence of cyclical noise results from Robertshaw's unique carbon pile proportional heat control system.

Typical cavity-mounted components include crystals, zener diodes, thermocouple reference junctions, thermistors, reference networks, transistorized circuitry and LC and RC oscillator circuits. For thousandths of a degree accuracy at a price only slightly higher than 1° to 2° thermostat ovens, investigate Thermal-Set. Send for Technical Bulletin RF-594.

ENGINEERS! Dynamic growth offers expanding opportunities to qualified EE's and ME's. Send resume to R. A. Sweeney.

AERONAUTICAL AND INSTRUMENT DIVISION

Robertshaw

ROBERTSHAW-FULTON CONTROLS COMPANY

SANTA ANA FREEWAY
AT EUCLID AVENUE
ANAHEIM
CALIFORNIA

CIRCLE 29 ON READER-SERVICE CARD

1092 SENSITROL®

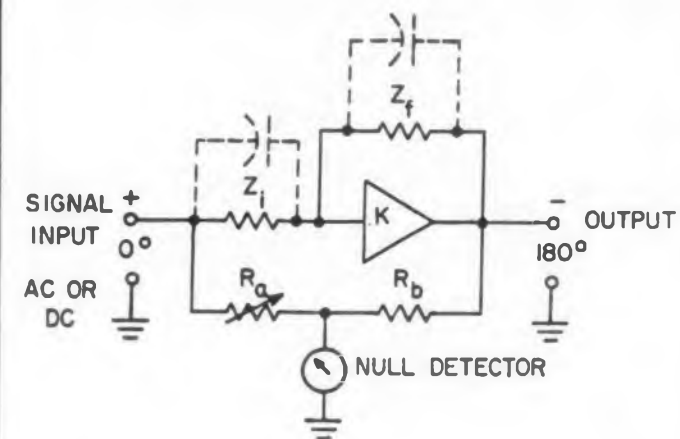
IDEAS FOR DESIGN

Phase Shift Must Be 180 Degrees To "Measure Gain of Operational Summer"

"Measure Gain of Operational Summer," published in Ideas for Design of July 8th, is based on an assumption which is not always valid.

The assumption that the output is exactly out of phase with the input allows one to use the decade resistor ratio R_b/R_a as the closed loop gain of the amplifier.

This assumption requires that the Z components are pure resistors or capacitors, or that they are networks whose phase shifts are matched. If this is not true, the resistor ratio at the null point is not equal to the closed loop gain and the error is a function of the difference between the actual output phase shift and 180 deg.



Adjustment of a variable capacitor across either Z_i or Z_f , and adjustment of R_a allows the phase shift of this operational amplifier to be brought to exactly 180 deg. Then the closed loop gain equals the ratio R_b/R_a .

A simple technique may be used to adjust the phase shift to exactly 180 deg. If Z_i and Z_f are both resistors with stray capacitance, the respective phase shifts may be equalized by adjusting a variable capacitor across one of the components.

Successive adjustment of the variable capacitor and resistor R_a for minimum null can bring the phase shift to 180 deg. Then the resistor ratio R_b/R_a equals the amplifier closed loop gain.

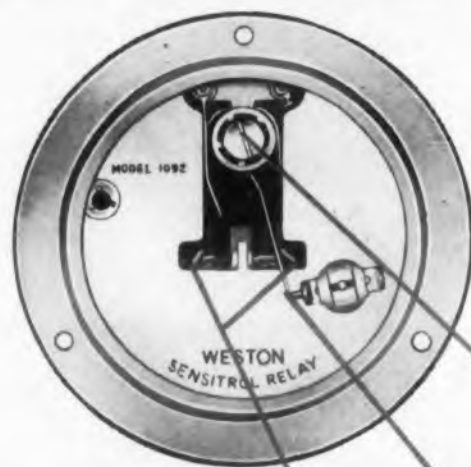
R. Nitzberg, Engineer, Defense Electronics Div., General Electric, Ithaca, N.Y.

Simple Circuit Reads Per Cent Voltage Change

In circuit design work it is desirable to have a device which can read the change in power supply voltage directly as a percentage change. The cost should be low.

the versatile relay

LOOK AT THIS RANGE OF APPLICATIONS FOR WESTON'S FULLY-ADJUSTABLE, ULTRA-SENSITIVE RELAY. SENSITROL CAN SIMPLIFY YOUR ALARM OR CONTROL PROBLEM!



In breadboard circuits, the 1092 makes it unnecessary to pinpoint electrical operating values through elaborate calculations or measurements. A single movable contact adjuster 1 provides variable and accurately repeatable settings. In production equipment, the 1092 eliminates the need for stocking a variety of relays.

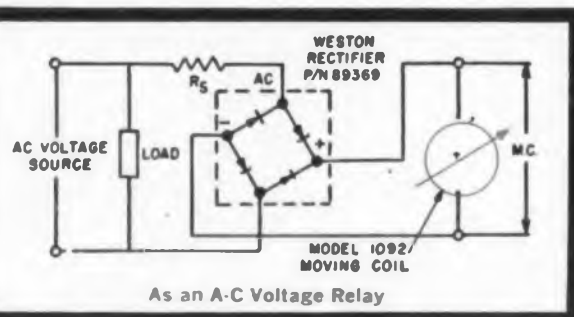
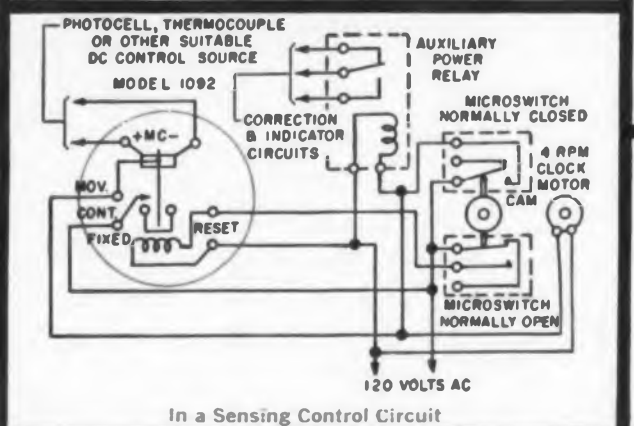
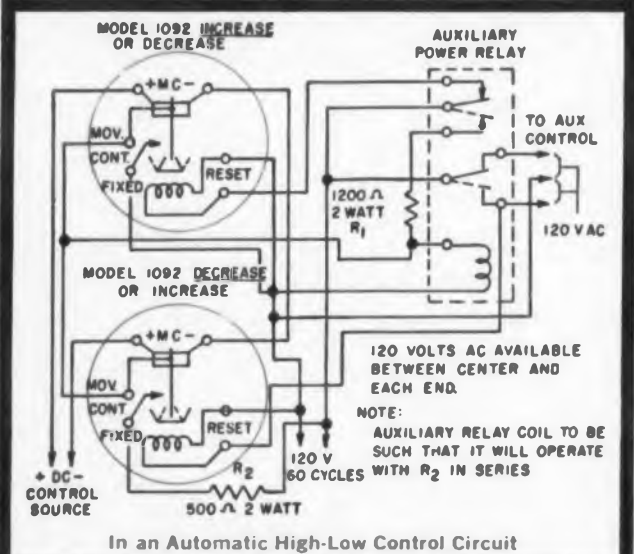
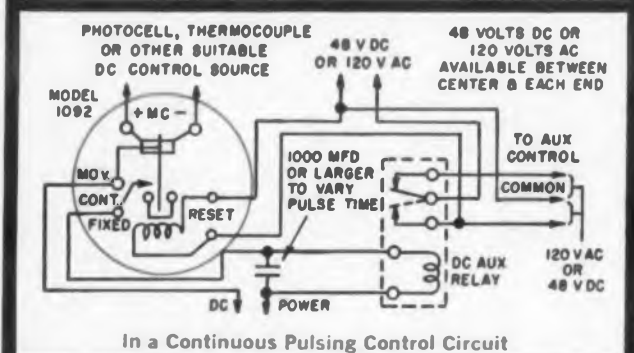
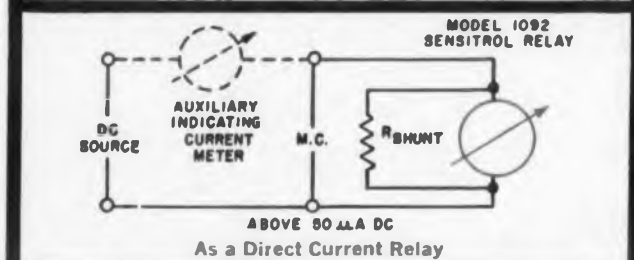
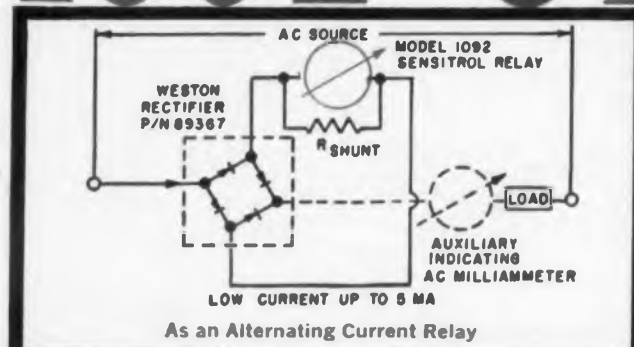
Model 1092's contain built-in reset mechanisms 2 and chatter proof locking magnetic contacts 3. They can be set to close at any value of D-C from 5 to 50 microamps, or a comparable millivolt span of 10 to 100 . . . and will handle 100 milliamps at 120 volts A-C or D-C.

For full information, or for the address of your nearest distributor, contact your local Weston sales office . . . or write to Daystrom-Weston Sales Division, Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.

WESTON

Relays

WORLD LEADER IN MEASUREMENT AND CONTROL

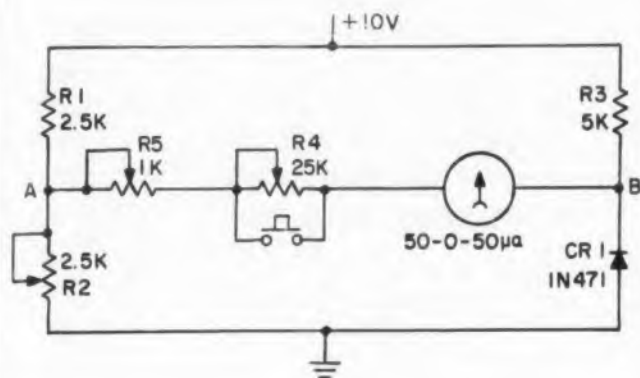


CIRCLE 30 ON READER-SERVICE CARD

The figure shows a circuit which can read percentage on the high scale, 0 to 50 per cent with accuracy of 2.5 per cent, and on the low range, 0 to 10 per cent, within 1/2 per cent accuracy.

$R1$ and $R2$ form a voltage divider and draw enough current so that meter loading is small. $R3$ and $CR1$ form a voltage reference.

Choosing a low voltage Zener helps to prevent serious nonlinear effects. $R3$ zeros the meter for different Zeners.



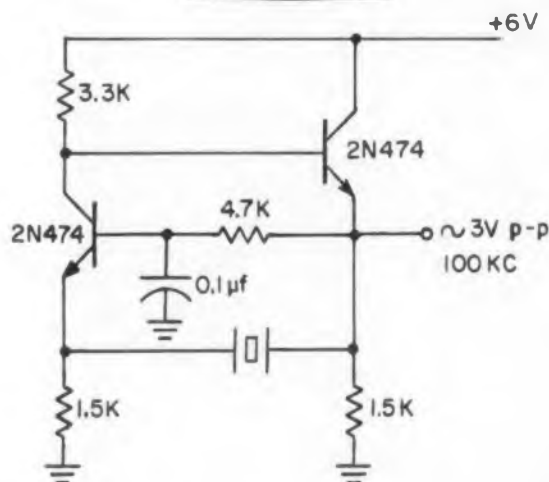
Line voltage percentage change reads out directly with this simple circuit.

Here's how the circuit works: If $CR1$ is a four volt Zener, $R2$ is adjusted so that the level at point A is 4 v with a 10 v input to the circuit. If the input swings high, say 50 per cent, point A rises to 6 v, leaving a net voltage drop of 2 v across A-B. The $R4$ is adjusted for a full-scale reading of 50 μ a.

A lower percentage meter reading is achieved by shorting $R4$ and adjusting $R5$ for full-scale reading with a smaller voltage variation.

The potentiometers will have to be readjusted for different line voltage references.

William T. Rhoades, Member Technical Staff, Hughes Aircraft Co., Fullerton, Calif.



Ultra-simple crystal oscillator suitable for wide temperature range. Emitter currents are stabilized with dc feedback and are insensitive to changes in leakage currents and beta.

McKenny W. Egerton, Engineer, Hoover Electronics, Timonium, Md.

POWER

handling capacity
of the new
Westinghouse
Silicon



transistor!

Greater than 99% efficiency when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).

- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

HERE ARE A FEW OF THE APPLICATIONS . . .

- Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

YOU CAN BE SURE...IF IT'S **Westinghouse**

Westinghouse Electric Corporation, Semiconductor Department Youngwood, Pa.

CIRCLE 31 ON READER-SERVICE CARD



ACTUAL SIZE

solve

YOUR LOGIC CIRCUIT PROBLEMS WITH EPSCO'S NEW

TDC COMPONENTS

Typical Epsco TDC system application



Available now . . . a complete line of fully encapsulated high-loading TRANSISTOR DIGITAL CIRCUITS . . . plug-in components to give you true reliability at very low cost. Epsco TDC's save you engineering time . . . slash space requirements . . . provide flexible, compatible operation.

AVAILABLE CIRCUITS

Flip-Flops and Counters
Diode AND Gates
Diode OR Gates
Nor Gates — An Epsco Exclusive
Parallel Gates
Cascade Gates
Inverter Amplifiers
Non-Inverting Amplifiers
Emitter Followers
Power Drivers
Delay Multivibrators
Pulse Shapers
Level Converters
Neon Indicators
Incandescent Indicators
Blocking Oscillators
Level Shapers
6, 12, 18 volt Power Supplies
Clock Multivibrators (0-200 KC)

Coming soon: complete 1 mc. logic circuit family . . . and we're adding others all the time

- Save Time and Space
- Cut Costs
- Permanent Encapsulation
- Vibration-Moisture Resistant
- Field Proven Circuits
- Low Power Requirements
- High Loading
- Completely Compatible
- In-Line or Tube Socket Mounting
- Easy-Access Test Points

SPECIFICATIONS

Frequency Ranges . . . up to 400 KC
Switching Times
Diode Logic 0.7 μ sec max
Transistor Logic 1.5 μ sec max
Signal Voltage Levels
 ± 18 volts, ± 6 volts
Temperature Range
-55°C to +75°C

UNIQUE STARTER KIT now available — practical, economical introduction to TDC's . . . contains wide variety of units allowing application to large number of logic circuits. Write EPSCO, Inc. Components Division, 275 Massachusetts Ave., Cambridge, Mass.

Epsco

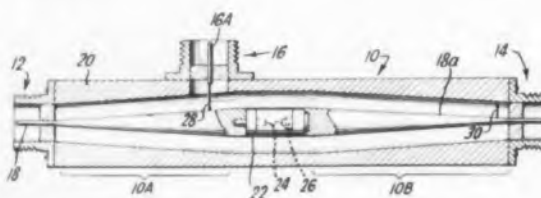
COMPONENTS

CIRCLE 32 ON READER-SERVICE CARD

PATENTS

Branched Coaxial Waveguide Structure
Patent No. 2,896,075. Lloyd A. Adlleman.
(Assigned to Sylvania Electric Products Co., Inc.)

This patent describes how the heterodyne signal may be taken out from a broadband crystal detector which is flat from 1 to 12 kmc.



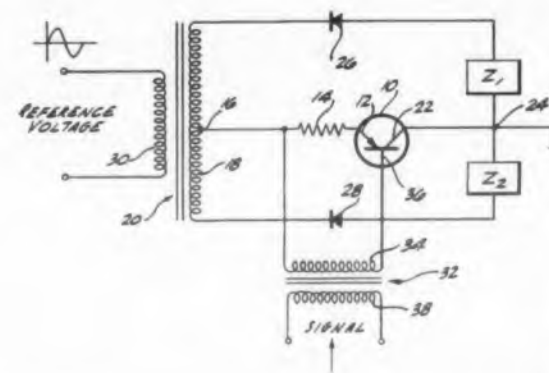
Center conductor 18a of the coaxial device is tapered to support crystal 22 and to maintain constant impedance over the pass band. The signals to be mixed are inserted by means of connectors 12 and 14. The beat signal is coupled out by a direct connection by means of a very fine wire 28, for example, No. 36 AWG "Advance" high resistance alloy.

This high resistance makes the connector a very high impedance so that very

little reactance at operating frequency is inserted into the guide. The broadband characteristics are retained and the low frequency signal is easily removed.

Transistor Phase Discriminator
Patent No. 2,897,379. James G. Hinsdale
(Assigned to Lear, Inc.)

A semiconductor power amplifier delivers current to either one of two load impedances according to whether the control signal is in phase or out of phase with a reference signal. The improvement over prior circuits consists in the use of a



JERROLD'S

900A Sweep Generator Covers the Range of Three Regular Instruments!

The industry's most versatile Sweep Generator! Covers all your needs from 1/2 MC to 1200 MCS for IF's, radar, video, telemetering, communications.

Specifications: In two ranges—0.5 MC to 400 MC and 275 MC to 1200 MC—with center at any frequency from 500 KC to 100 MC and with sweep widths as broad as 400 MC and as narrow as 100 KC. The RF output is flat within ± 0.5 db at full sweep width up to 800 MCS and ± 1.5 db from 800 MCS to 1200 MCS. When using sweep widths as narrow as 20 MCS flatness is approximately ± 0.15 db. **\$1260.00**

Write today for on the spot demonstration of Jerrold 900A!

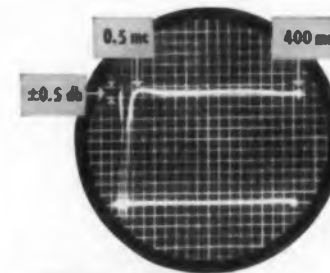
JERROLD

ELECTRONICS CORPORATION • Industrial Products Division
Dept. TED 48, The Jerrold Building, Philadelphia 32, Pa.

Jerrold Electronics (Canada) Limited
Export Representative: Rocke International, New York 16, N.Y.

CIRCLE 33 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959



- **HIGH OUTPUT!**
.25 volt RMS on VHF—.5 volt RMS on UHF
- **WIDE SWEEP WIDTHS!**
VHF—100 KC to 400 MCS
UHF—100 KC to 40% or more of C.F.
- **FLAT OUTPUT!**
Flat to $\pm .5$ db on widest sweep width

single transistor circuit; other circuits required at least two matched transistors.

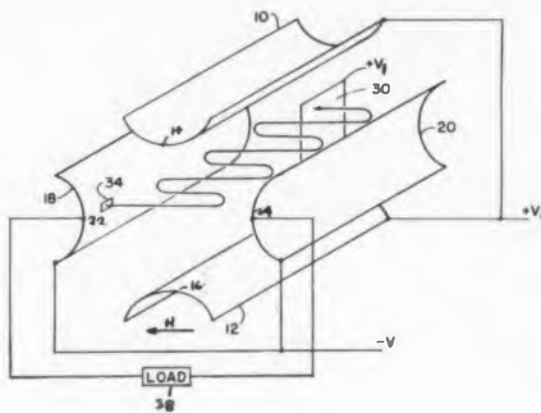
Transformer 20 delivers power to the loads Z_1 and Z_2 through back-to-back forward conducting diodes 26 and 28. When the emitter pnp transistor 10 is positive with respect to the base, the transistor conducts, effectively connecting the junction point of the loads to transformer midpoint 16.

Suppose the relative phase of signal and reference voltage causes diode 26 to conduct. Current flows through Z_1 exclusively. When the reference voltage changes phase, Z_2 conducts. Since the transistor impedance varies with the applied signal, the phase discriminator amplifies the signal voltage.

Strophotron

Patent No. 2,897,393. Stanley A. Iorio. (Assigned to Sylvania Electric Products, Inc.)

Improvement in strophotron efficiency is obtained by orientating the plane collector so that it is perpendicular to both the magnetic and electric vectors. Elec-

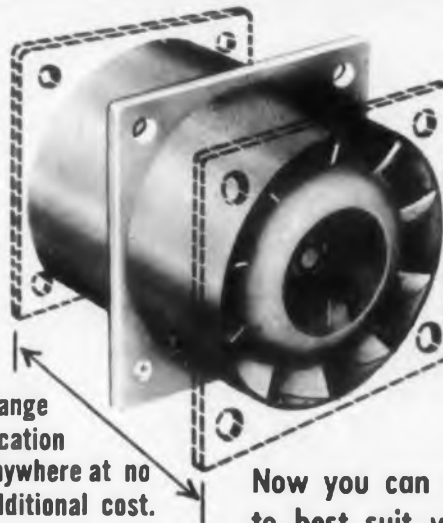
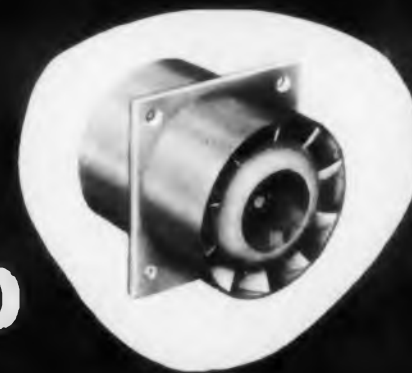


trons now strike the collector normally and are collected on both sides. In conventional strophotrons, electrons travel parallel to the collector surface and therefore few electrons are collected.

As shown in the illustration, the collector 30 is located midway between the hyperbolic accelerators 10 and 12 and reflectors 18 and 20 as well as perpendicular to magnetic field H . Electrons emitted from cathode 34 drift to the collector in a path which is a trochoid in one plane and a damped sine wave in the plane normal to the first plane. Collector 30 receives the electrons on either surface.

POW AIR

A NEW CONCEPT IN STANDARD 2" BLOWERS



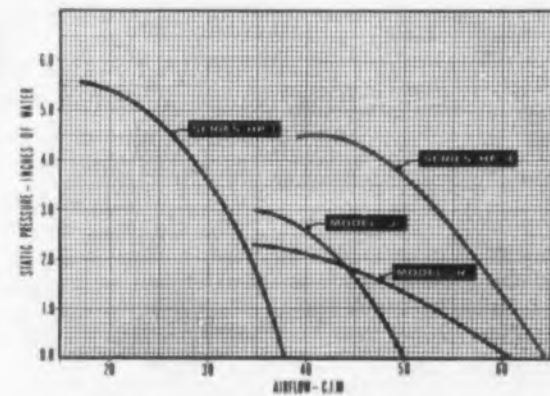
Introduces New Series HP and HF

Flange location anywhere at no additional cost.

Now you can select a mounting flange location to best suit your application. Complete tooling available for either square or round flanges with a choice of hole size and positioning. AC or DC Motors, up to 22,000 RPM.

3 TIMES THE PERFORMANCE

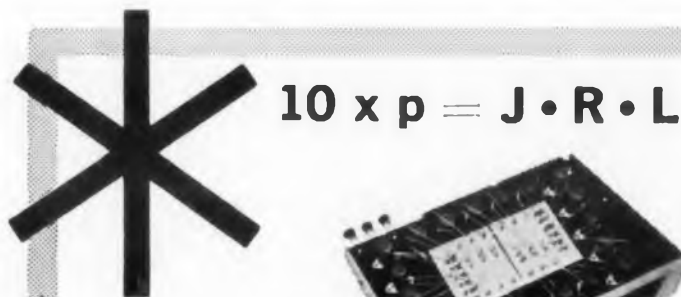
Yes, up to 3 times the pressure at comparable flows of similar units, or the same performance at a 15% speed reduction. Change your design thinking now.



Consult our Sales Engineering Staff for full information.

DEAN & BENSON RESEARCH

Division of Benson Manufacturing Co., Kansas City 1, Mo.



.001%

* This enigmatic equation was invented to emphasize that JRL instruments permit measurements ten times as precise as those possible with other currently-available "precision" equipment. Model RVD-105 Relay-Operated Voltage Divider, for example, permits automatic or manual conversion of digital data to analog equivalents with an accuracy of ten parts per million. (1, 2, 2, 4 binary-decimal code is standard, but any desired code can be furnished). The built-in high-speed relays can also be programmed for rapid synthesis of resistance values, ratios, voltages, or currents, with the same high resolution and accuracy. Price, \$1280. Write for bulletin L-59-3.



RESISTOR NETWORKS, INC., A DIVISION OF
JULIE RESEARCH LABORATORIES, INC.
556 West 168th Street, New York 32, N. Y. LOrraine 8-8700

CIRCLE 34 ON READER-SERVICE CARD

CIRCLE 35 ON READER-SERVICE CARD



40 KV at 3 amp.

The ripple frequency of this unit is extremely low due to a full wave 6 ϕ power supply. The model shown here is a 130 KVA, 3 phase unit and can be furnished with either askarel or ordinary transformer oil.—This unitized power supply is just one of many special transformers and equipment that are custom-built by NOTHELPER.

Each NWL DC Power Supply is tested for core loss, polarity, voltage, corona, insulation breakdown and aging characteristics and must meet all customer's requirements before shipment. We shall be pleased to quote you up to 300 KV and up to 500 KVA, depending on your individual requirements.

Casing & Wiring manufactured by
Research-Cottrell, Inc.
Bound Brook, N. J.



ESTABLISHED 1920



Nothefeler

SAY: NO-TEL-FER

NOTHELPER WINDING LABORATORIES, INC., P. O. Box 455, Dept. ED-9, Trenton, N. J.
(Specialists in custom-building)

CIRCLE 36 ON READER-SERVICE CARD

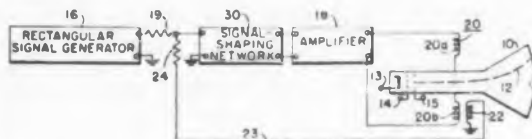
PATENTS

Linear Deflection System

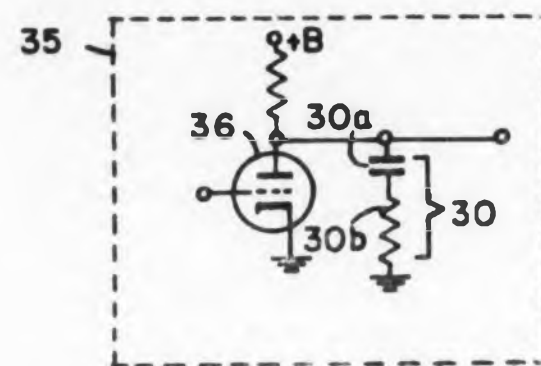
Patent No. 2,890,381. John Sinnott. (Assigned to Hazeltine Research, Inc.)

A pickup coil in the output of a pentode amplifier is combined with an integrating network to linearize the sweep in a magnetic deflection cathode ray tube indicator.

The applied rectangular waveform is integrated in amplifier-shaping network 35 to generate the sawtooth voltage wave-



form which is applied to the control grid of pentode amplifier 18. A linear current flows in deflection coil 20 and part of the magnetic flux couples to pickup coil 22. The rectangular voltage developed across the pickup coil is fed back degeneratively



to linearize the sawtooth voltage waveform.

Phase Shifter

Patent No. 2,897,459. Louis Stark (Assigned to Hughes Aircraft Co.)

Adjustable coupled helices cyclically shift the phase of the rf energy fed to the elements of an antenna array so that the radiator may scan a region of space. In the spectrum range of 100 to 1000 mc, the

WHAT DOES GOOD DESIGN MEAN IN A RACK CABINET

The function of a metal rack cabinet is to accommodate most effectively the instruments it houses. Chassis and components should be stably anchored, well protected and readily accessible for maintenance and repair.

Falstrom Standardized rack cabinets are manufactured from stock tools and dies and easily adaptable to your individual specifications at truly economical cost.

Write, wire or telephone for complete information.

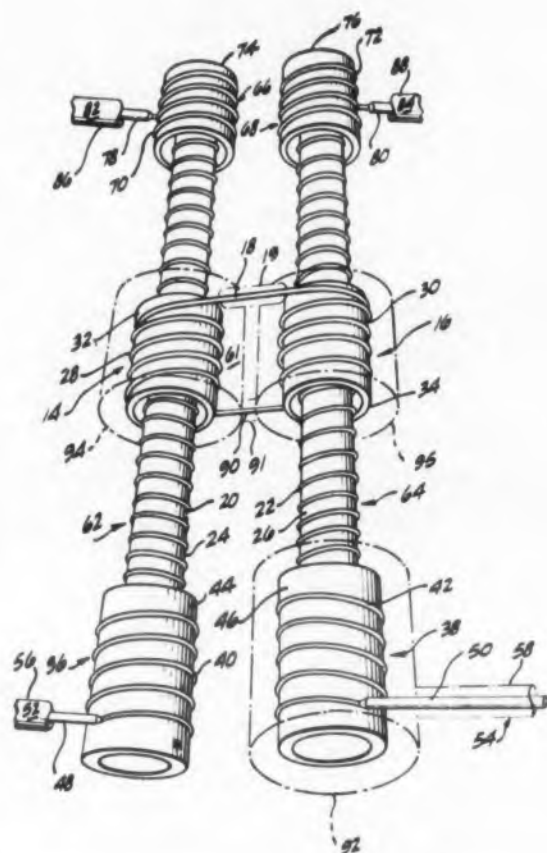
FALSTROM COMPANY

171 Falstrom Court, Passaic, N. J. PRescott 7 0013



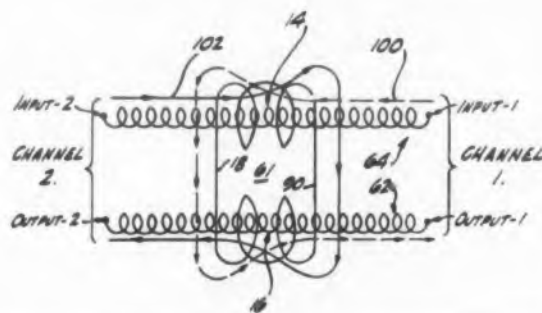
CIRCLE 37 ON READER-SERVICE CARD

CIRCLE 38 ON READER-SERVICE CARD



phase shifter has advantages of size, simplicity and efficiency of operation when compared to waveguide devices.

A double-ended trombone helical phase shifter is shown. Its operation is evident from the equivalent network. Energy coupled to input travels along helix 64, transfers to section 14 and travels along helix 62 to output 1. In like manner, input 2 travels along line 64 through section 14 and output 2 is connected through line 62. As the trombone is caused to slide, one wave energy path shortens as the other path lengthens so that the corresponding phase changes.



ANOTHER FIRST...



THE ONLY *Electro-Reliable* A.C. TIMING MOTOR

*Thinner... Quieter...
More Reliable... More Versatile*

FINGER-THIN...

Only 9/16 Inches Short... Only 1 3/4 Inches in Diameter... very compact... reduces the size of your equipment.

WHISPER-QUIET...

Strictly an electrical motor... practically noiseless... no rattling of gears or ratchets.

HIGH TORQUE...

1/4 oz. inch at the rotor with an instantaneous start and stop... requires only 2 1/2 watts... can replace larger motors in recorders, controls and telemetering equipment.

HIGHEST RELIABILITY...

Longer life... no one-way gears or ratchets to fail... provides millions of operations without any trouble.

SPECIFICATIONS

Standard Voltage Ratings:
6, 12, 24, 115, 230 Volts
Frequency:
60 CPS Standard
25, 50 CPS Available
Power Input: 2.5 Watts
Maximum (60 CPS)

BASIC MOTOR

Weight: 4 ounces
Speed: 300 RPM
Torque: 1/4 oz.-in.
Length: 9/16 inch

WITH INTEGRAL GEAR TRAIN
Weight: 5 ounces
Speed: 300 RPM to 1/6 RPH
Torque: 30 oz.-in. @ 1 RPM
Length: 7/8 inch



WITH INTEGRAL GEAR TRAIN



Send for Special Illustrated Bulletin AWH MO-806
A.W. HAYDON Company

227 NORTH ELM STREET
WATERBURY 20, CONNECTICUT

Custom Design & Manufacture Of Electronic
And Electro-Mechanical Timing Devices

CIRCLE 39 ON READER-SERVICE CARD

CIRCLE 38 ON READER-SERVICE CARD

NEW... 1 3/4-inch
slide... saves space

2 NEW Chassis-Trak Slides

NEW... lightweight,
extra-thin slide

Engineering progress at Chassis-Trak, keeping pace with the equipment mounting needs of the electronics industry, has resulted in two new slide designs. They are:

1 3/4-inch slide

Ideal for light-duty slide applications—loads up to 50 lbs. Chassis-Trak "pencil thin" design plus an overall height of only 1.687" saves cabinet space, permits easy mounting without cabinet modification. Cadmium-plated cold-rolled steel construction. Phenol epoxy coating provides permanent dry lubrication. Tilt and non-tilt styles in eight standard lengths—10, 12, 14, 16, 18, 20, 22 and 24 inches.

Lightweight slide

Newly developed model for special equipment mounting problems. Exceptionally compact (1" high, 1/2" wide), yet supports up to 150-lb. loads. Saves space without sacrificing heavy-duty strength. Low in cost, easy to install. All stainless steel construction. Precision roller and ball bearings for effortless operation.

Check with Chassis-Trak engineers for the solution to your rack or cabinet application. Slides available in tilt, non-tilt, and tilt-lock models. Supports up to 275 lbs.

For further information contact:

525 S. Webster, Indianapolis 19, Indiana

CIRCLE 40 ON READER-SERVICE CARD



BRISTOL miniature DPDT chopper

C1430 Series

- Excellent tracking
 - Miniature size
- Phase stability with temperature
 - High vibration rating
 - High contact rating
- Long life • Reliability
 - Versatility

Also available in . . .

- 2 Hole flange
- 4 Hole flange
- Side mounting



actual size

For complete specifications, write:
Aircraft Components Division,
The Bristol Co.,
150 Bristol Road,
Waterbury 20, Conn.

BRISTOL FINE PRECISION INSTRUMENTS
FOR SEVENTY YEARS

CIRCLE 41 ON READER-SERVICE CARD

RUSSIAN TRANSLATIONS

Transistorized DC Millivoltmeter

K. B. Karandeev,
M. G. Mazyuk and
N. I. Smirnov

This transistorized dc millivoltmeter has the following features:

- A measurement range from several microvolts to one volt
- An input impedance not lower than 1 meg
- An error not exceeding 2.5%
- Direct reading
- Battery power

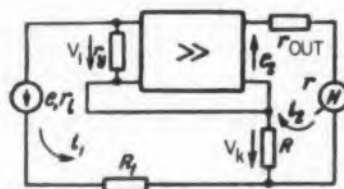


Fig. 1. Block diagram of dc millivoltmeter.

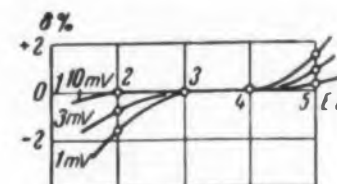


Fig. 3. Errors due to variations in the supply voltage.

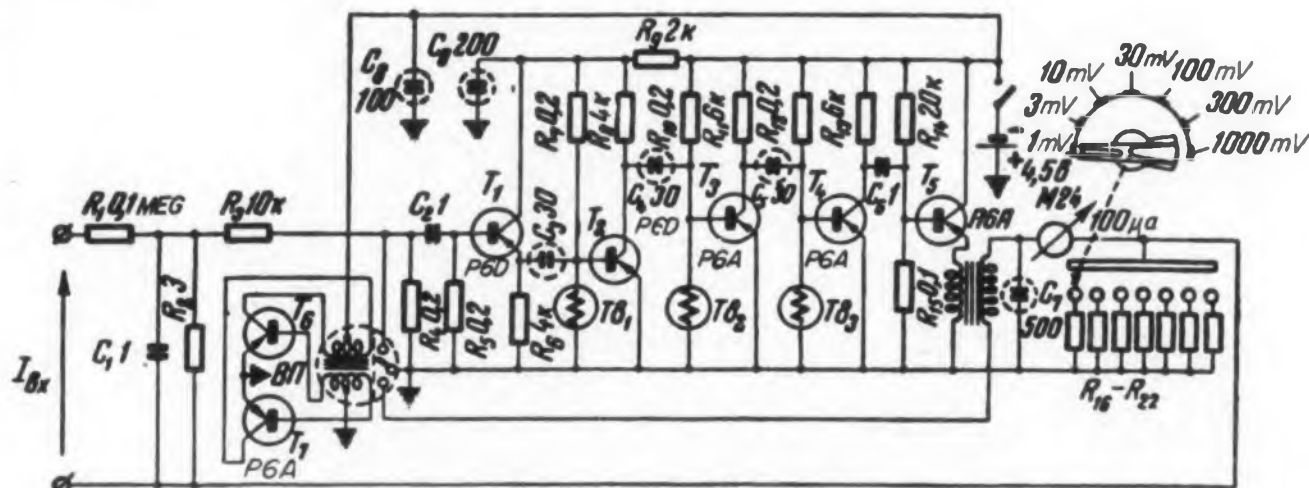


Fig. 2. Complete schematic of dc millivoltmeter.

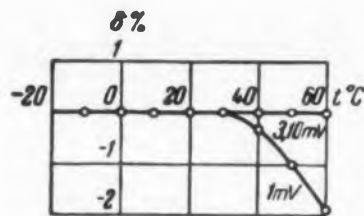


Fig. 4. Errors due to variation in the ambient temperature.

- Constancy of readings from -20 to $+60$ C
- Small dimensions, low weight
- Sufficient mechanical and vibration strength

A block diagram of the instrument is shown in Fig. 1. The input voltage is v_1 ; it is nulled by the voltage drop produced across feedback resistor R by the output current i_2 . It may be shown that

$$i_2 = \frac{e}{R(1 + 1/\beta_1\beta_2 K_\infty)}$$

where $\beta_1 = r_v/(r_v + r_i + R_1 + R)$, $\beta_2 = R/(r_{out} + r + R)$, and K_∞ is the dc amplifier gain at no load, expressed in terms of the conversion, rectification, and ac-gain factors of the amplifier (K_c , K_r , and K_{ac}).

$$K_\infty = \beta_1 K_c K_{ac} K_r$$

If the gain is sufficiently large, $\beta_1\beta_2 K_\infty \gg 1$ and the current in the meter becomes $i_2 \approx e/R$, i.e., the meter scale can be calibrated in terms of the measured voltage and can be made linear. The range can be switched by including the set of resistances R .

The error in this instrument caused by changes in its parameters is given by the following equation:

$$\delta_e = \left(\frac{\Delta\beta_1/\beta_1 + \Delta\beta_2/\beta_2 + \Delta K_\infty/K_\infty}{1 + \beta_1\beta_2 K_\infty} + \frac{\Delta R}{R} + \frac{\Delta c_i}{c_i} \right) 100\%$$

It is seen that by making $\Delta R/R$ small (use of manganese wire) and by making the meter error $\Delta c_i/c_i$ small, the accuracy can be made quite high. The use of large gain will make the factor $1 + \beta_1\beta_2 K_\infty$ large and reduce the error further. This feedback factor also reduces the null drift.

The complete schematic is shown in Fig. 2. Figs. 3 and 4 show the errors due to variations in the supply voltage and the ambient temperature.

This article was abstracted from the Soviet journal *Instrument and Measurement Engineering*, No. 2, March-April, 1959.

Electronic Products NEWS

by CARBORUNDUM
Registered Trade Mark

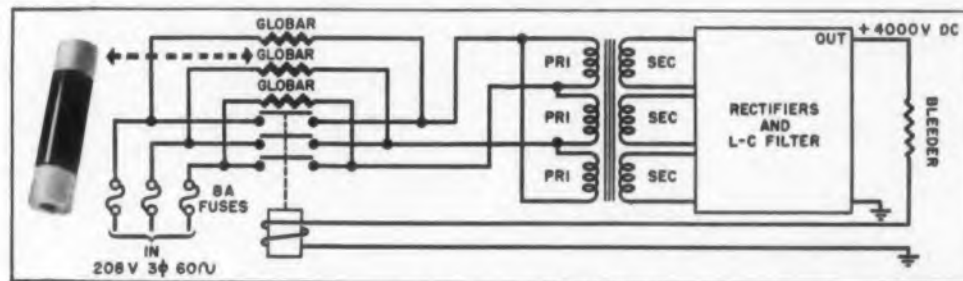
High Energy Resistor Delays Fuse Opening— Collins Radio uses GLOBAR® resistor to handle short-time overload

A unique application of a GLOBAR high energy resistor is made in a radio power supply unit manufactured by Collins Radio, Cedar Rapids, Iowa. The resistor is used for delaying the opening of a fuse under a short-time overload current condition.

Requirements are rigorous. The resistor has to be capable of handling 21 amps for 3 seconds (140 times rated load) and 10 amps for 5 seconds and must not arc, burn, char or change in resistance by more than $\pm 5\%$ when subjected to 5 seconds of the specified overload currents for 5 cycles on with 5 minutes off. It must

operate continuously under 35 watts loading for 1,000 hours in a room temperature ambient, the resistance change being not more than 10%.

A GLOBAR Type SP resistor, $3\frac{1}{4}$ " long, $\frac{3}{4}$ " O.D. and $\frac{5}{8}$ " I.D. is used. This resistor will operate continuously in ambients up to $1,000^\circ$ F. It is supplied with metalized ferrule type ends for fuse clip mounting. For information on GLOBAR resistors for similar high temperature, high energy applications, write to Global Plant, Refractories Division, Dept. EDR-99. The Carborundum Company, Niagara Falls, N. Y.



4000 VOLT SUPPLY FOR AN/FRW-2 SHOWING STEP-START CIRCUITRY
CIRCLE 712 ON READER-SERVICE CARD

CERAMIC IGNITER for oil and gas burners A development of high temperature resistors

The versatility of silicon carbide for high temperature resistors is further demonstrated by its application as a ceramic igniter for fuel oil and gas furnaces.

Conventional igniters utilize either a hot wire, which has a relatively short life, or a spark discharge system, necessitating a high potential transformer.

Requirements for the ceramic igniter were that it should operate directly from 12, 24 and 115 volt sources, have high stability, be inex-

pensive and effective for up to 25,000 cycles of operation. A composition similar to that of the GLOBAR Type SP resistor proved to be the answer. By varying resistivity, operation is possible on any of the desired voltages.

To alert electronics engineers, the success of this application may suggest the many possibilities of utilizing similar resistors in high temperature circuits with ambients up to $1,000^\circ$ F. Terminals which can be spot-welded or brazed into circuits have been developed. Prototypes of such resistors are now actually being evaluated by several customers as potential components for missiles and other critical applications.

Technical assistance and information can be secured by writing to Global Plant, Refractories Division, Dept. EDC-99. The Carborundum Company, Niagara Falls, N. Y.

CIRCLE 715 ON READER-SERVICE CARD



CIRCLE 712 THROUGH 715 ON READER-SERVICE CARD

Matched or Compression Seals?

Which metal-to-glass combination should you choose for packaging rectifiers and other housings?



Two types are available. The first type is represented by KOVAR® matched seals in which the identical thermal expansion characteristics of KOVAR Alloy and borosilicate hard glasses result in a fused hermetic bond. Since KOVAR has about the same expansivity as silicon and germanium, stability in operation is assured. The second type is represented by the compression seal which relies on differences in contraction between glass and metals, like mild steel, to provide a tight joint.

Both types give excellent service depending upon the design and application of the unit. Compression seal applications are often those where the use of heavier metal parts is advantageous.

Among other advantages, KOVAR "top hats" have special value as high voltage seals. The insulating glass does not need to be contained within a compression band and thus can be extended for higher flash-over voltage ratings.

For help in your choice of seals, write Latrobe Plant, Refractories Division, Dept. EDS-99. The Carborundum Company, Latrobe, Pa.

CIRCLE 713 ON READER-SERVICE CARD

NEW BULLETIN DESCRIBES FIXED NON-INDUCTIVE CERAMIC RESISTORS



Gives data on Types A, B, and CX resistors recommended for general-purpose applications in electronic and electric power circuits. A wide range of sizes, shapes and compositions provide desired resistivities and watt ratings. For a copy, write: Global Plant, Refractories Division, Dept. EDR-99. The Carborundum Company, Niagara Falls, N. Y. CIRCLE NO. 714

Technical assistance and information can be secured by writing to Global Plant, Refractories Division, Dept. EDR-99. The Carborundum Company, Niagara Falls, N. Y.

To Solve ANY Problem
in NOISE and VIBRATION
Measurement
There is a **GR** Instrument



The Type 1555-A Sound-Survey Meter (illustrated) is the basic instrument in G-R's sound and vibration measuring instrumentation line.

The sound-survey meter is simple, portable, self-contained and easy to operate. In many cases the complete answer is readily obtained with this meter alone. Its accuracy meets American standards.

Price: \$150.00.

For complete information on this and the many other instruments in the G-R line write for the Sound Bulletin



GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

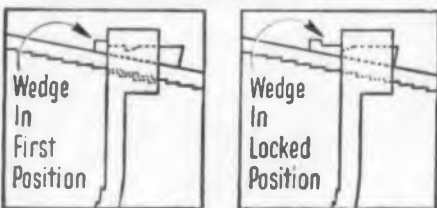
Broad Avenue at Linden, Ridgefield, N. J. NEW YORK AREA 1000 N. Seward St. LOS ANGELES 38
8055 13th St., Silver Spring, Md. WASHINGTON, D. C. 1150 York Road, Abington, Pa. PHILADELPHIA
1182 Los Altos Ave., Los Altos, Calif. SAN FRANCISCO 6605 W. North Ave., Oak Park, Ill. CHICAGO
In CANADA: 99 Floral Parkway, TORONTO 15

CIRCLE 550 ON READER-SERVICE CARD

new! **Weckesser** nylon
**Wedge Lock
BAND CLAMP**

TWO-POSITION
WEDGE PERMITS
ADJUSTMENT FOR
TEMPORARY ASSEMBLY . . .

Patent
Pending



BUT . . .
ONCE
IT'S LOCKED,
YOU'VE GOT
TO CUT IT LOOSE!

- Another Weckesser "first" • Just introduced at the I.R.E. Show • First practical band clamp that locks and holds permanently • Solid DuPont Zytel 101 (Nylon) • Easy assembly with screwdriver or forked tool—One size for cable diameters 1/8" to 1 1/4"

Send for free samples and bulletin

See us at Booth 16 NEC Show—Chicago

Weckesser COMPANY

5703-05 Northwest Highway • Chicago 46, Ill.

CIRCLE 43 ON READER-SERVICE CARD

GERMAN ABSTRACTS

E. Brenner

Ferrite Isolators

ISOLATING ELEMENTS which have a ratio of reverse to forward attenuation up to 150:1 can be constructed using ferrite and ceramic strips in a rectangular waveguide (Fig. 1). Moreover, the device may be made temperature insensitive.

Defining the damping in the reverse and forward directions as a_+ and a_- respectively, a practical figure of merit for the directional device in a given frequency band is:

$$V = a_+ / a_-$$

Typical curves showing the dependence of this figure of merit (V) on the reverse attenuation per unit length (a_-/l) are shown in Fig. 2 for various geometrical arrangements and ferrite materials; the addition of ceramic strips increases V . Curve four (Fig. 2) shows this effect using ceramic material with a relative dielectric constant 40.

The cross-sectional dimensions of the ferrite strips may be chosen* to make the gyromagnetic resonance frequency independent of temperature (See German Abstracts, ELECTRONIC DESIGN, Aug. 5, 1959, p 100). Since, however, the slope of the reverse attenuation vs. frequency curve varies unsymmetrically with temperature, bandwidth considerations indicate choice of dimensions such that a small resonant frequency temperature variation is tolerated. Equal temperature variation at the upper and lower limits of the frequency band can then be achieved through correct choice of dimensions.

In Fig. 3, curves of a_+ as a function of frequency at two temperatures are shown for a 4 kmc isolator.

In the original paper, in addition to the 4 kmc isolator, a 6 kmc and a 7 kmc model are described in detail.

Abstracted from an article by J. Deutsch, W. Haken and Chr. V. Haza-Radlitz, Nachrichtentechnische Zeitschrift, Vol. 12, No. 7, July, 1959 pp. 367-370.

See "Improved Rectangular Waveguide Resonance Isolators" M. T. Weiss, IRE, Trans. MTT 4, (1956), p 240.

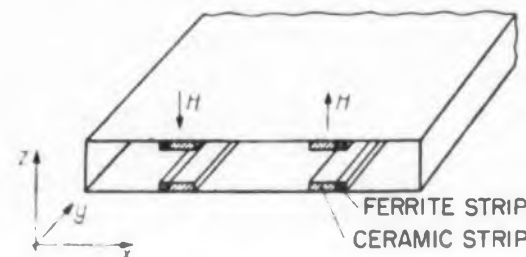


Fig. 1. Ferrite and ceramic strips in a waveguide.

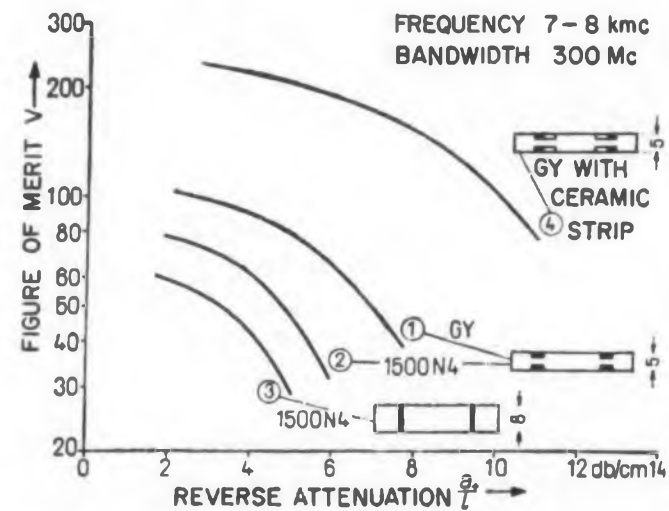


Fig. 2. Figure of merit as a function of reverse attenuation. The materials, 1500N4 and GY, are German trade designations.

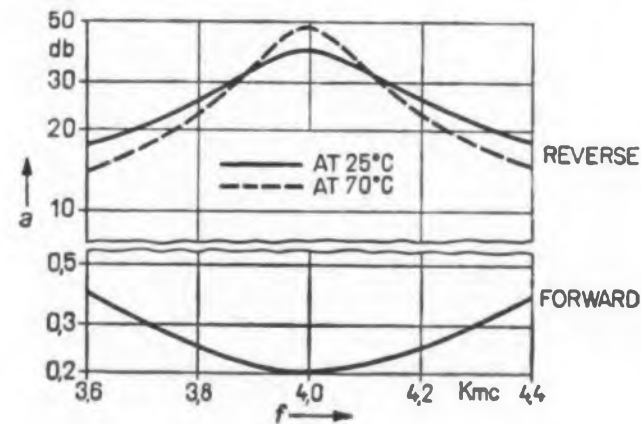
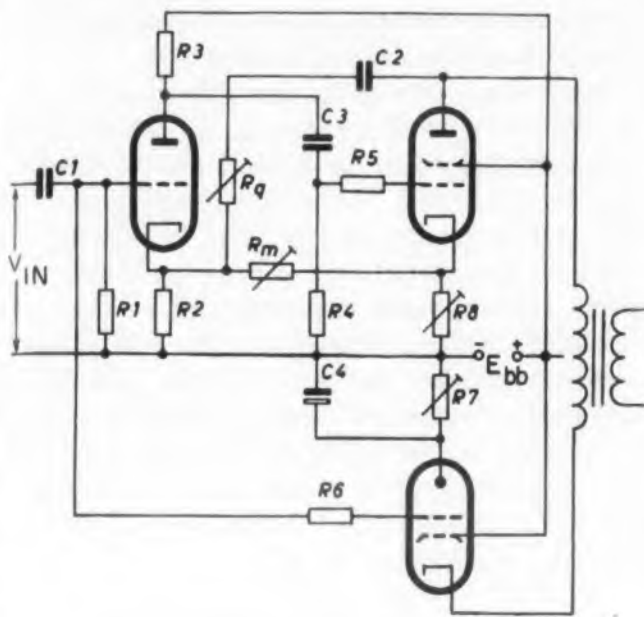


Fig. 3. Attenuation characteristics of a 4 mc isolator.

Unsymmetrical Push-Pull Stage



An unsymmetrical push-pull stage

FEEDBACK may be used in the unsymmetrical output stage, shown in the Figure 1, to reduce the output impedance without affecting the symmetry of the output waveform. In this circuit, the first triode is not used for the generation of symmetrical driving waveforms but is considered part of the "upper" push-pull section.

The distortion in practical examples, for the unsymmetrical circuit, is only slightly more than for the conventional circuit. In class-A operation, the third harmonic distortion is less than in the conventional circuit while the second harmonic distortion is increased.

Although the values of the feedback resistors R_q and R_m can be calculated, adjustment can be made experimentally. The output transformer is replaced with two coils and with a small signal, the large R_m (about 50K) and R_q (200K) controls are adjusted for symmetrical output. Next R_m is adjusted until the desired low output impedance is obtained (e.g. the output amplitude is not changed when the output is shunted with, say 200 ohms). Finally R_q is readjusted for symmetrical operation.

In the original paper, the small signal equivalent circuit as well as large signal calculations and results are given.

Abstracted from an article by H. Voelz, Elektronische Rundschau, Vol. 13, No. 7, July, 1959, pp. 242-442.

only CMC makes a solid state DIGITAL PRINTER

Plug-in transistorized drive



Announcing
the 400 CT.

The most versatile
digital printer
ever made

SPECIFICATIONS

Printout capacity	6 digits standard.
Accuracy	determined by basic counting instrument.
Display time	0.2 seconds minimum, maximum controlled by the counter.
Weight	60 lbs.
Power requirements	115 volts $\pm 10\%$, 50-60 cps 25 watts
Dimensions	17" W x 8½" H x 16½" D. (Rack mounting available as option D.)
Warranty	One year on electronics; 1.5 million lines @ 4 lines per second on matrix; 10 million lines @ 4 lines per second on printer assembly, or 1 year, whichever occurs first.
Price	\$1350.00. Add \$10.00 for rack mount.

* 4 lines per second printout * Takes 1-2-2-4 or 1-2-4-8 four line code * No stepping switches * Operates from only 6 volt input * Parallel entry * Special options available including 10 line and analog output * 6 digit printout, up to 12 digits on special order * Rugged unitized construction * Completely compatible with CMC's new solid state frequency-period counters, and other types of transistorized counting equipment.

For a demonstration of this remarkable new printer and complete technical information, call your nearby CMC engineering representative or write to us direct. Please address Dept. 19-A.

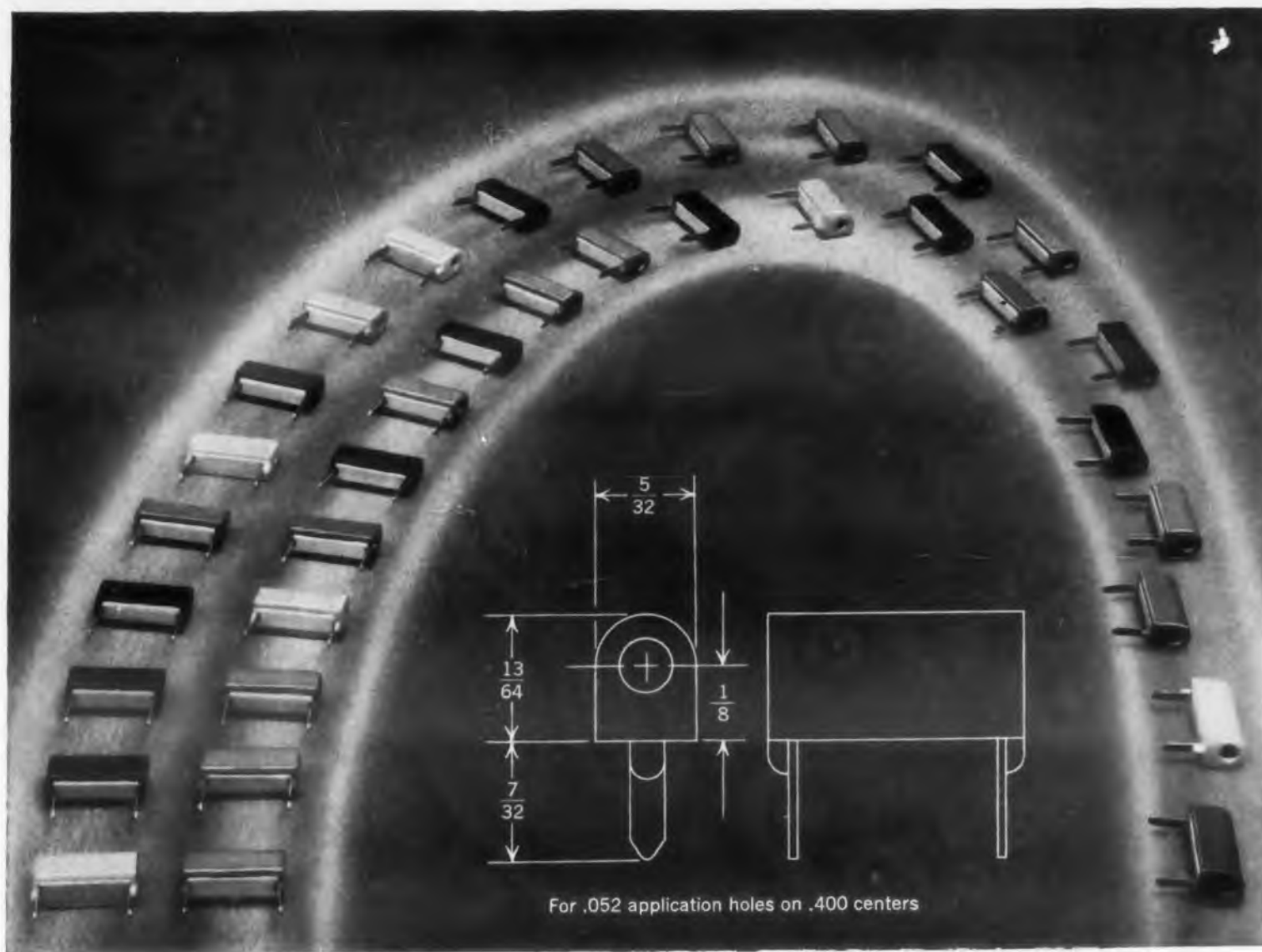


**Computer-Measurements
Company** A Division of Pacific Industries, Inc.

12970 Bradley Avenue • Sylmar, California

Phone: EMpire 7-2161

CIRCLE 44 ON READER-SERVICE CARD



For .052 application holes on .400 centers

Patent Pending

New Test Jacks for Printed Circuits

Designed for permanent assembly to printed circuit boards, these new test jacks by Ucinite are easily accessible to standard .080 test probes and eliminate the need for individual adaptor boards.

Simple, economical construction ensures reliability and reasonable cost. Gold-over-silver-plated beryllium copper contacts provide dependable, low-resistance connections. Nylon bodies are available in eleven standard code colors specified as follows: Part number (119437) plus letter suffix . . . A-Opaque

White, B-Red, C-Black, D-Brown, E-Green, F-Orange, G-Blue, H-Yellow, J-Gray, K-Violet, L-White translucent.

With an experienced staff of design engineers plus complete facilities for volume production of metal and plastic parts and assemblies, Ucinite is capable of supplying practically any requirement for fasteners, connectors, switches and other small metal and metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

Manufactured by

The UCINITE COMPANY

Division of United-Carr Fastener Corporation, Newtonville, Mass.



REPORT BRIEFS

Analysis Of Carrier Systems

In this report a modulation-equivalent method of analysis is presented which applies to carrier systems employing suppressed-carrier amplitude modulation, such as ac analog computers, ac servo systems and ac control systems. The method presented is based on the Laplacian transfer function of the system and its components. By means of the theorem of complex translation, the modulation-equivalent 2 by 2 transfer matrix of a transfer function is derived. The system can then be directly analyzed with respect to the Laplace transforms of the modulating signals by means of matrix algebra. Rules and examples for the manipulation of the modulation-equivalent transfer matrices are given. *Analysis of Carrier Systems by Modulation-Equivalent Transfer Matrices*, Hans H. Hosenthien, Army Missile Agency, Redstone, Ala., Mar. 1956, 58 pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 137668 from Library of Congress, Washington 25, D.C.

X-Band Propagation Beyond Line Of Sight

X-band tropospheric scatter measurements were made to determine the feasibility of a proposed 100-mile X-band link. The data and results are given for signal strength measurements up to 77 miles. Short-time amplitude distributions were determined. The operational capability and reliability of the 100-mile link is discussed, based on the results of the measurements. It was concluded that the increased gain necessary to meet the reliability requirements for the proposed X-band link would be prohibitive at the present time. *Study of X-Band Propagation Beyond Line of Sight*, Joseph W. Page and Herbert E. Whitney, Air Force Cambridge Research Center, Bedford, Mass., July 1958, 31 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 140164 from Library of Congress, Washington 25, D.C.

Magnetron Traveling-Wave Tube

A transition between a coaxial line and a bi-periodic structure has been designed. Considerable work has been done on an electron gun to achieve spiral motion of electrons in a hollow beam. Several possibilities have been investigated. In the most promising device, the spiral lens, potential energy is converted into rotational kinetic energy; the axial kinetic energy is not influenced by the lens. To investigate cross-field flow, an experimental tube which employs a spiral lens has

FS
been built. *Bi-Periodic Magnetron Traveling-Wave-tube Study*, J. Berghammer and F. Paschke, David Sarnoff Research Center, Princeton, N.J., Sept. 1, 1957, 19 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 135519 from Library of Congress, Washington 25, D.C.

Oscillator Circuits, I

Principles of nonlinear mechanics are applied to oscillatory systems of one and two degrees of freedom to determine a physical basis for their operation. The method of equivalent linearization is described briefly and is applied to these systems. Starting from simple relations between power supplied by the nonlinear element and power dissipated in the linear portion of the system, criteria for stability of oscillation are developed in general terms. *Theoretical Investigation of Oscillator Circuits*, Norman R. Scott, Electrical Engineering Research Laboratory, University of Illinois, Oct. 1, 1949, 33 pp. Microfilm \$3.00, Photocopy \$6.30. Order PB 139945 from Library of Congress, Washington 25, D.C.

Oscillator Circuits, II

The work during the period covered by this report has been devoted to an attempt to clarify the visualization of energy relationships in multiple-oscillating systems and also to generalize the stability criteria. The notation used is the same as in the first report, and the equations and figures are numbered in sequence following the numbers of the first report. *Theoretical Investigation of Oscillator Circuits*, Norman R. Scott, Electrical Engineering Research Laboratory, University of Illinois, Urbana, Jan. 1, 1950, 14 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 139946 from Library of Congress, Washington 25, D.C.

Oscillator Circuits, III

In extension of previous work, this report considers first a question of the stability of two simultaneous oscillations and then a generalization of the single-loop oscillator, as exemplified by a tuned-plate oscillator. The major part of the report is devoted to the question of frequency stability. The effect of amplitude perturbations on the emitted spectrum is considered first, and then the problem of instantaneous variations of frequency as a function of operating voltages is attacked. Work is continuing on this latter phase of the problem. *Theoretical Investigation of Oscillator Circuits*, Norman R. Scott, Electrical Engineering Research Laboratory, University of Illinois, Urbana, Apr. 1, 1950, 20 pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 139944 from Library of Congress, Washington 25, D.C.

Memo from **VALUE ANALYSIS:**

Use "SCOTCH" Brand No. 1 Electrical Paper Tape for this motor coil. Initial cost 1¢; coil must last 10 years' minimum. Annual insulation cost is less than 1/10¢.

Tape passes all corrosion tests.



"SCOTCH" BRAND Paper Tapes—like all "SCOTCH" BRAND Electrical Tapes—are specially formulated for consistently high, electrical grade quality. It's quality you can depend on . . . roll after roll.

All "SCOTCH" BRAND Paper Electrical Tapes have "quick stick" adhesives for time-saving, neat, positive placement for assembly line methods. The thermosetting paper tapes have strong holding power initially; when cured, holding power is almost doubled. Thermosetting also gives maximum resistance to solvents and softening under high heat.

FREE DESCRIPTIVE FOLDER covers electrical qualities and thermosetting characteristics of "SCOTCH" BRAND Paper Electrical Tapes. The 3M Company also manufactures "SCOTCHCAST" BRAND Casting and Dipping Resins. Write for descriptive booklet. Address: 3M Co., 900 Bush Ave., St. Paul 6, Minn., Dept. EAC-99.

REG. U.S. PAT. OFF.
SCOTCH Electrical Tapes
BRAND

"SCOTCH" AND "SCOTCHCAST" ARE REGISTERED TRADEMARKS OF 3M CO., ST. PAUL 6, MINN. EXPORT: 99 PARK AVE., NEW YORK 16. CANADA: LONDON, ONTARIO

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 46 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 Transducerized Tank NT-202
35 watts Capacity: 3/8 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 Transducerized Tank NT-602
60 watts 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 Generator G-1501
Capacity: 5 gallons 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

Hell 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.

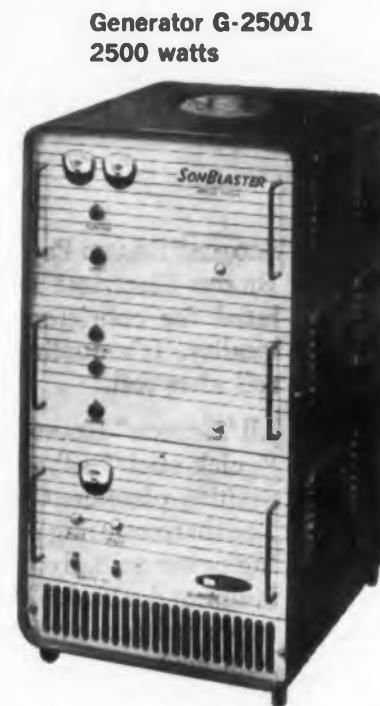
\$130



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.

REPORT BRIEFS

High-Temperature Printed Circuitry, I

The findings of the program on high-temperature printed circuitry are summarized briefly, and the several techniques for circuit fabrication are evaluated in the light of the 200 C temperature specification for this year and the 750 C specification for the coming year. The conductivity of silver enamels has been found to remain high with silver contents as low as 26%. Platinum resistor films were found to have a linear temperature coefficient of resistance from 28 to 500 C, with a change in resistance of +18% over this temperature range. Boron carbide thermistor films are stable in air above 750 C, but crack when temperature cycles between 200 to 300 C. Silicon carbide and zirconium carbide enamel resistors were successfully formed using suitable wetting agents. Irreversible increases in resistance were observed in testing vacuum deposited gold-palladium resistors films to 500 C. Preliminary attempts to form aluminum oxide capacitor dielectric films are discussed. A simple method of attaching lead wires to high temperature printed ceramic circuits using properly formulated enamels is described. These connections function satisfactorily at least up to 750 C. *High-Temperature Printed Circuitry, I. G. H. Young, C. H. T. Wilkins, Mellon Institute of Industrial Research, University of Pittsburgh, Pa., Sept. 1957, 41 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 136579 from Library of Congress, Washington 25, D.C.*

High Temperature Printed Circuitry, II

Enamel resistors based upon molybdenum disilicide (MoSi_2) have been found to have excellent oxidation resistance at elevated temperatures. Vacuum evaporated gold-palladium resistor films from room temperature to 740 C are also under study. Two types of high temperature capacitors made were conducting silver enamel electrodes formed on opposite sides of a thin alumina substrate, and an air dielectric capacitor fabricated by means of enamel bonding techniques. *High Temperature Printed Circuitry, G. H. Young, C. H. T. Wilkins, Mellon Institute of Industrial Research, University of Pittsburgh, Pa., April 1958, 31 pp, Microfilm \$3.00, Photocopy \$6.30. Order PB 135871, Library of Congress, Washington 25, D.C.*

New Approaches to Printed Circuitry

Performance tests on vacuum evaporated chromium resistors and chemically deposited tin oxide resistors have been carried out. Silicon monoxide overcoating is effective in protecting glass-based chromium films to 300 C. Various overcoatings



the narda ultrasonics corporation

625 MAIN STREET, WESTBURY, L. I., N. Y.
Subsidiary of The Narda Microwave Corporation

CIRCLE 47 ON READER-SERVICE CARD

For higher temperature service and protection of ceramic-based components have been tried without success. Quantitative measurements of corona charging characteristics of materials for use in making electrostatic printing masters have been made. *Performing Research On New Approaches to Printed Circuitry*, Haloid Co., Rochester, N.Y., Sept., 1957, 27 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 135502 from Library of Congress, Washington 25, D.C.

Radome Discontinuities

The effects of radome discontinuities on antenna patterns are investigated. Several studies were made on specific rib configurations. From this work it was seen that: (1) a dielectric rib may scatter as much as or more energy than a conducting rib of the same size; (2) metal ribs may exhibit very little scattering when the electric field is perpendicular to the axis of the rib; (3) when a radome framework is composed of conducting elements about five wavelengths or more in length, there is no appreciable difference in the scattered fields whether the ribs are insulated or connected to each other at their ends; (4) the effects of small metal objects with size and arrangement typical of the bolts of a reinforced, plastic, geodesic radome are negligible. *Effects of Radome Discontinuities on Antenna Patterns*. Antenna Laboratory, Ohio State University, Research Foundation, Columbus, Ohio, Aug. 1957, 46 pp, Microfilm \$3.30, Photocopy \$7.80. Order PB 136557 from Library of Congress, Washington 25, D.C.

Maximum Gain From Yagi Antennas

In conventional Yagi design, optimum performance requires separate adjustments in a number of parameters: the array length and the height, diameter and spacing of the directors and reflector. By introducing the notion of a surface wave traveling along the array, it is possible to demonstrate the interrelation between these parameters experimentally. The gain then depends only on the phase velocity of the surface wave (which is a function of the height, diameter, and spacing of the directors) and on the choice of the reflector. Maximum gain for a given array length, for any director spacing less than 0.5λ , can be obtained by suitable variation of the parameters to yield the desired phase velocity. A design procedure that provides maximum gain for a given array length is presented. *A New Method For Obtaining Maximum Gain From Yagi Antennas*, H. W. Ehrenspeck and H. Poehler, Air Force Research Center, Bedford, Mass., Dec. 1958, 24 pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 140142 from Library of Congress, Washington 25, D.C.



THE HUMAN FACTOR in today's technology

Scientists have long been preoccupied with the technological problems of Man and the Machine. The increasingly complex nature of advanced systems has created an urgent need to enhance man's contribution to effective systems performance. The complicated nature of this relationship requires the skills of psychologists, social scientists, mathematicians, and engineers.

At Ramo-Wooldridge, human engineering, personnel selection, individual and system training, display design, and communications are successfully integrated into systems design and development by the technique of large-scale simulation.

Simulated inputs enable scientists to observe a system as it operates in a controlled environment and make possible the collection of data on performance, training, human engineering, maintenance, and logistics and support. Scientists and engineers use this data to assure the design, production, and delivery of a unified system capable of high performance and reliability.

Expanding programs at Ramo-Wooldridge in the broad areas of electronic systems technology, computers, and data processing have created outstanding opportunities for scientists and engineers. For further information concerning these opportunities write to Mr. D. L. Pyke.



RAMO-WOOLDRIDGE

P. O. BOX 90534, AIRPORT STATION • LOS ANGELES 45, CALIFORNIA
a division of *Thompson Ramo Wooldridge Inc.*

Please write direct to advertiser mentioning *ELECTRONIC DESIGN*



... they're both
my babies

... but
what a
difference

Despite their identical appearance, those young innocents are barely fraternal. They *are* destined for fame, but along different Roads of Life.

The one on the left latches magnetically, eats only 50 mw. and works best in a circuit designed expressly with his characteristics in mind. He's also a few months older than his colleague, and has already made solid friends with at least one big military group. They like his particular combination of magnetic latching operation, high sensitivity, and ability to take 30 g's of vibration to 5000 cycles and 100 g shocks both on paper and in the flesh.



The little fellow on the right, on the other hand, offers a ready *replacement* suitable for existing equipment where standard DPDT switching is needed and the signal level is up around 200 mw. As such he's looking forward to making an even wider circle of friends than his companion — especially since he can take just as much vibration and shock and is put together with exactly the same care and high class materials.



Both of these hermetically sealed prodigies are described in their birth certificates which you can get for the asking. If you think the 50 mw., magnetic latching, left-hand one is for you, ask for the *Series 32* specs; if it's the right-hand, "on-off" one you're interested in, specify *Series 33*. Don't try to go by looks — everything's coming in crystal cans these days.

*
Sigma Corporate Image

SIGMA

SIGMA INSTRUMENTS, INC.
91 Pearl Street, So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO. (SINCE 1939)

CIRCLE 49 ON READER-SERVICE CARD



BOOKS

Low-Frequency Amplifiers

Alexander Schure, Editor, John F. Rider
Publisher Inc., 116 W. 14th St., New York
11, N.Y., 79 pp, \$1.80.

The frequency band considered in this book ranges from 20 to 16,000 cps. Specific problems encountered at the very low ranges are treated.

In a rather elementary fashion, the book clarifies the application of vacuum tubes as well as transistors to audio frequency amplifiers. The chapter on transistor amplifiers covers a comparison of transistor characteristics, the establishment of operating points, biasing methods, and stabilization computations.

Other sections deal with principles of amplification, low-frequency voltage amplifiers, single-ended power amplifiers,

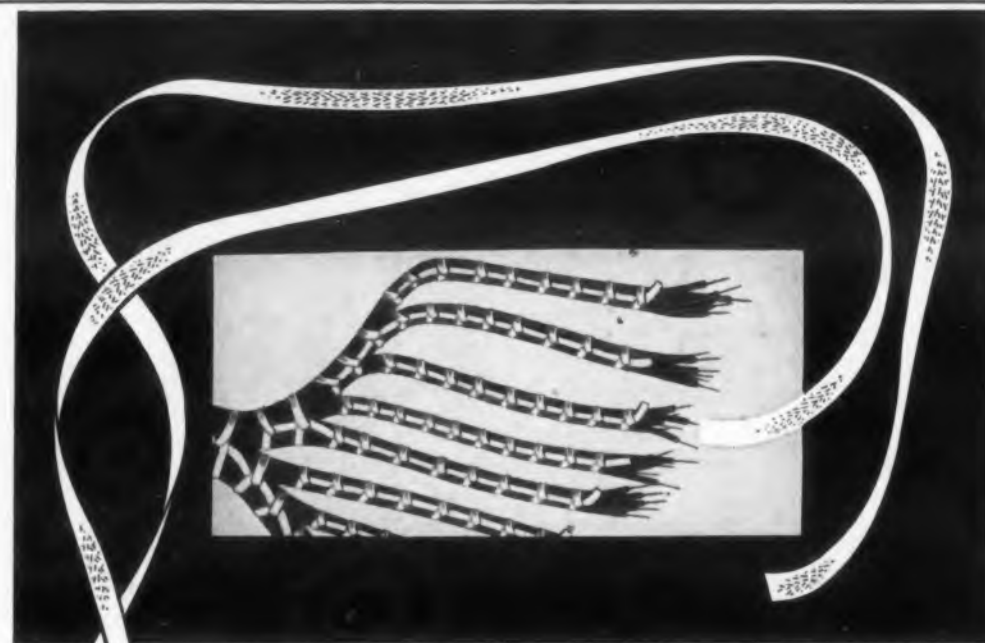
and push-pull power amplifiers. Special emphasis is given to considerations underlying the design of systems, in addition to the solution of design problems

Automation Cybernetics and Society

F. H. George, Philosophical Library, Inc.
15 E. 40th St., New York 16, N.Y., 283 pp,
\$12.00.

The author's aim is to study automation in relation to the advancement of science and society. A study of automation involves cybernetics, the science of communication and control.

Part Two, which presents chapters on communication theory, logic and machines, computers and computations, and servo-systems, should be of special interest to engineers. Parts One and Three are



for every lacing need . . .

BEN-HAR LACING TAPES

BEN-HAR "TEFLON® GLASS"—fibers are Teflon coated before braiding for unique non-slip action. Knots hold. No heat shrinkage. Chemically inert. Flame-proof. Non-absorbent. Color fast. Practically indestructible.

BEN-HAR DACRON®—excellent dimensional stability and heat resistance. Available plain, waxed, or synthetic rubber treated.

BEN-HAR NYLON—meets Gov. Specs. MIL-T-713A. Flat braided nylon available in same finishes as above.

BENTLEY, HARRIS

WRITE FOR SAMPLES AND PRICES

Flexible INSULATIONS

Bentley, Harris Manufacturing Co., 900 Barclay St., Conshohocken 3, Pa.

CIRCLE 50 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

concerned with: "Social Background of Automation" and "Operational Research and Automation," respectively.

Mathematical Programming and Electrical Networks

Jack B. Dennis, *The Technology Press of M.I.T. and John Wiley and Sons, Inc.*, 440 Fourth Ave., New York 16, N.Y., 186 pp, \$4.50.

This is a new approach to mathematical programming based on an analogy with electrical networks. It is shown that any dc electrical network made up of current sources, voltage sources, ideal diodes, or ideal transformers is equivalent to a pair of dual linear programs. This relation is extended to include a correspondence between dc networks and quadratic programming.

A simple algorithm developed for solving diode-source networks, is applicable to network flow problems including the familiar transportation problem. Then, a procedure for algebraically tracing the breakpoint curve of a diode-source-resistor-transformer network is derived. It is used to obtain optimal solutions to gen-

eral linear or quadratic programs.

Finally, it is shown that the direction of steepest descent appropriate to a general programming problem is determined by a quadratic program. A method using this result is suggested.

Basic Data of Plasma Physics

Sanborn C. Brown, *The Technology Press of M.I.T. and John Wiley and Sons, Inc.*, 440 Fourth Ave., New York 16, N.Y., 336 pp, \$6.50.

This volume presents fundamental data of plasma physics. Only that material is covered which is necessary for work in gas discharges, controlled thermo-nuclear devices, and upper atmospheric research (including satellites).

Devices are discussed only as illustrations of the fundamental physics of the motion of charged particles. Background information is given in graphs and tables. The author discusses such topics as elastic and inelastic collisions, diffusion and mobility, electron attachment, glow discharges, and steady-state microwave discharges.

American Beauty...an iron for every Soldering Job

Whatever your soldering problem, American Beauty has the right iron for your particular job. The finest engineering, best materials and on-the-job experience since 1894 is yours with EVERY American Beauty.

There is a right model, correct tip size ($\frac{1}{4}$ " to $1\frac{1}{8}$ ") and proper watt-input (30 to 550 watts) to do any soldering job. Ask about which iron will do your job best. American Beauty electric soldering irons are the highest quality made.

ILLUSTRATED IS
CATALOG NO. 3125
 $\frac{1}{4}$ " TIP SIZE, 60 WATTS

TEMPERATURE REGULATING STANDS
Automatic devices for controlling tip-temperature while iron is at rest—prevent overheating of iron, eliminate frequent re-tinning of tip, while maintaining any desired temperature. Available with heavy-gauge perforated steel guard—protects user's hand.

YOU CAN'T BEAT A SOLDERED CONNECTION

203-B

WRITE FOR 26-PAGE ILLUSTRATED CATALOG CONTAINING FULL INFORMATION ON OUR COMPLETE LINE OF ELECTRIC SOLDERING IRONS—INCLUDING THEIR USE AND CARE.

AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 2, MICHIGAN



CIRCLE 51 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959



Unmatched speed, unequalled sensitivity

EG&G's 2236A TW Oscilloscope is the newest of a family of millimicrosecond instruments. This precision instrument has met the exacting requirements of nuclear weapon tests conducted for the AEC.

The 2236A's excellent record of performance is based on EG&G's sensible approach to oscillography. All features of the 2236A design are matched to give the maximum flexibility to your high-speed, DC to 3000 MC, oscilloscopic problems.

Current applications of the EG&G 2236A include its unprecedented performance in measurement of:

- Decay times of scintillators
- Reverse recovery time of high-speed semiconductor diodes
- Rise and fall times of high-speed switching transistors
- Discontinuities in transmission lines
- As a synchroscope in high-resolution radar systems.

For additional technical data and information, call or write: Application Engineering Group.



EDGERTON, GERMESHAUSEN & GRIER, INC.

160 BROOKLINE AVENUE, BOSTON 15, MASS.

1622 SOUTH "A" STREET, LAS VEGAS, NEV.

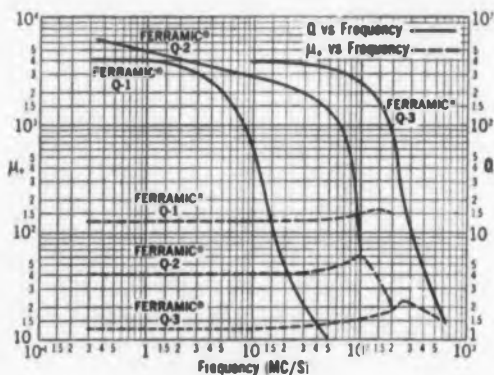
CIRCLE 52 ON READER-SERVICE CARD

Only GENERAL CERAMICS offers a complete line of HIGH FREQUENCY FERRITE CORES

Make G-C your single source for a complete line of H-F ferrites ranging in frequency from 300 kc to 220 mc.

Ferramic® Q-1, Q-2 and Q-3 materials, developed and introduced by G-C, feature exceptionally low losses, temperature stability and high permeability. Whether your ferrite requirement is for the commercial entertainment industry, military, ground or air borne communication equipment or industrial electronic applications, G-C will meet your needs with the broadest line of high frequency ferrite materials and in the shapes you require.

This curve demonstrates the exceptional qualities of G-C's "Q" family of materials — high permeability and low loss.



Q-1 Material

Ideally suited for IF transformers at 455 kc and antenna cores from 500 kc to 1700 kc.

Magnetic properties include: Initial permeability at 1 mc/sec. — 125; Maximum permeability — 400; Saturation flux density — 3300 gauss; residual mag. — 1800 gauss; coercive force — 2.1 oersted; temperature coefficient of initial permeability — .10%/°C max; Curie point — 350°C; vol. resistivity — high; loss factor at 1 mcs/sec. — .000020; loss factor at 5 mcs/sec. — .000050.

Standard Ferramic parts in various sizes and shapes offer a dependable, quick solution to design problems. Custom parts can be produced to your specifications. Contact General Ceramics' engineering advisory service. Our staff is ready to discuss your problems and make recommendations.



Q-2 Material



This material produces excellent results in TV receiver IF applications at 45 mc; and FM radio applications at 10.7 mc.

Magnetic properties include: Initial permeability at 1 mc/sec. — 40; Maximum permeability — 115; Saturation flux density — 2400 gauss; residual mag. — 750 gauss; coercive force — 4.7 oersted; temperature coefficient of initial permeability — 0.10%/°C max; Curie point — 450°C; vol. resistivity — high loss factor at 10.0 mc/sec. — 0.000085; loss factor at 50.0 mc/sec. — 0.000017.



Q-3 Material

The exceptionally high Q, excellent temperature stability and high permeability of Q-3 ideally suits it for applications in the 88 mc–108mc FM band and television RF frequencies from 50 mc–216 mc.

Preliminary specifications include: Initial permeability μ_0 — 14; Maximum permeability μ_{max} — 42; Saturation flux density B_s — 2600 gauss; Residual magnetism B_r — 1470 gauss; Coercive Force — 21 oersted; Q at 100 mc — 250; Q at 150 mc — 150; Q at 200 mc — 70; Resistivity high; Curie point 330°C; Temperature coefficient of μ_0 — .09%/°C max.

A New 16-page FERRITE PARTS CATALOG



is available to engineers by request on company letterhead. It contains complete engineering data on stock parts and materials. When requesting your copy, please address Dept. ED.

General Ceramics Corporation

KEASBEY, NEW JERSEY (Near Perth Amboy) — Telephone: VALley 6-5100
CIRCLE 53 ON READER-SERVICE CARD

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906

NEW LITERATURE

Electron Tubes

54

Four-page brochure "Nuvistor" describes three electron tubes. Electrical and physical data are given on a 1/2 in. high small signal triode, a 1-1/4 in. high beam power tube and a 3/4 in. high small signal tetrode. Plate characteristics and stability curves are given. Radio Corporation of America, Electron Tube Div., Harrison, N.J.

Delay Line Data

55

Advances and refinements in delay line techniques are given in two-page bulletins 201, 202, and 203. Higher storage capacity in smaller units, longer time delays, lines with polarity sensitivity, and servo-operated delay lines are discussed. Included in bulletin 203 are descriptions of general purpose delay line equipment. Delttime, Inc., 608 Fayette Ave., Mamaroneck, N.Y.

Relays

56

This catalog contains five data sheets which describe the firm's line of rotary relays. Mechanical, electrical, and environmental specifications and mounting arrangements are provided. These miniature relays range in contact rating from dry circuits to 10 amp; operating voltages are 6 to 300 v dc. Couch Ordnance, Inc., 3 Arlington St., N. Quincy 71, Mass.

Computer

57

The G-15 digital computer is described in six-page illustrated bulletin AB-059. Included are electrical and physical specifications and short descriptions of computer accessories, including a punched card and tabulator coupler, magnetic tape unit, differential analyzer, and graph plotter. Bendix Aviation Corp., Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

Demodulation Techniques

58

Bulletin "LVDT Application Note 59-14," eight pages, describes demodulation techniques for linear variable differential transformers. Included is a description of a modified circuit incorporating special transformers in which the phase of the reference voltage shifts simultaneously with the signal voltage so that the relative phase angle between the two voltages remains constant. Also illustrated are simple demodulation circuits as well as direction-sensitive and multi-purpose types. Schaevitz Engineering, Pennsauken, N.J.

Flowmeters 63

A complete line of flowmeters from small purge meters to laboratory rotameters and calibrators is described in this eight-page bulletin. The firm's new flowmeters provide a reproducible method of flow measurement for a wide variety of flow ranges for various gases and liquids. Matheson Co., P.O. Box 85, E. Rutherford, N.J.

Plastics 64

Illustrated bulletin 5904, four pages, tells where and why to use plastics. Application, capacity, and tolerances are among the features described. Wilcox Products Co., 3455 Dakota Ave., Minneapolis 16, Minn.

Electrometers 65

This eight-page illustrated bulletin discusses linear, log, differential current, dual linear, and dual log electrometers. General features of the electrometer line and detailed specification data such as current ranges, stability and accuracy ratings, and dimensions are outlined. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Coaxial Choppers 66

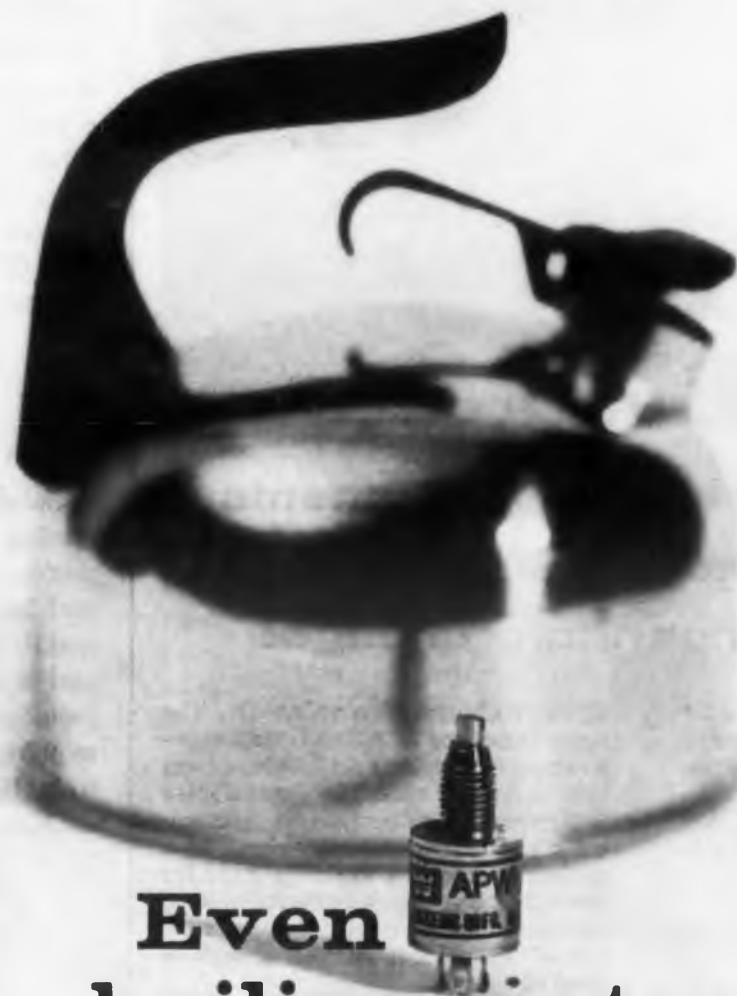
Data sheet F-1522 provides complete electrical and mechanical specifications of the firm's coaxial choppers which cancel the external effects of shock and vibration. Diagrams and applications also appear. James Vibrapowr Co., 4050 N. Rockwell St., Chicago 18, Ill.

Robot Machines 67

Publication GER-1581, an eight-page reprint, explains how numerical control systems for machine tools direct completely automatic production of simple and complex parts in job-lot production. Numerical positioning control and numerical contouring control systems are discussed. The operations and applications of both systems are explained and illustrated. General Electric Co., Schenectady 5, N.Y.

Parts Selector Guide 68

This 36-page, illustrated catalog discusses the latest electronic component service replacements, which have been circuit and test-pattern tested in the original manufacturer's chassis to meet or exceed original specifications. Among the new components described are if coils, power and audio transformers, and filter chokes. Ram Electronics Sales Co., 600 Industrial Ave., Paramus, N.J.



**Even
boiling water
can't affect
the reliability
of this pot!**

Waters APW $\frac{1}{2}$ Sealed Potentiometer is so watertight and so heat resistant that it reliably operates even in boiling water! The APW $\frac{1}{2}$ is completely unaffected by humidity and water vapor, the two common causes of potentiometer failures in aircraft and missiles, where pressure and altitude changes allow equipment "to breathe". Naturally, the watertight construction of the APW $\frac{1}{2}$ also seals out dust and other minute particles which might cause failure. Waters APW $\frac{1}{2}$ Sealed Potentiometer gives the engineer the ultimate in potentiometer reliability. (Waters WPW $\frac{1}{2}$ Sealed Potentiometer features the same construction as the APW $\frac{1}{2}$, but with a servo face.) Write for Bulletin APW-359.



Sealed against water immersion as specified in MIL-E-5272A and other military specifications by means of a double "O" ring shaft seal. The glass-to-metal terminal board is solder-sealed to the case. Available with 125°C or 150°C construction, mechanical rotation stops, special winding angles, values to 100K and tighter linearity tolerances. Can be supplied with optional split bushings and various shaft lengths.



POTENTIOMETERS • SLUG TUNED COIL FORMS • RF COILS • CHOKES • POT HOOK® PANEL MOUNTS • TORQUE WATCH® GAUGES • C'TROL METER/CONTROLLER • INSTRUMENTS
CIRCLE 69 ON READER-SERVICE CARD



New UNION readout instruments withstand shock, vibration and extreme temperature changes

Union Switch & Signal's new READALL* readout instrument replaces complicated systems of lights and relays for reading, storing or transferring all types of information for industrial and military applications. It is not to be confused with conventional indicating devices.

Designed to meet requirements of MIL-E-5422D. The new READALL readout instrument is precision-built and provides instantaneous and continuous operation under conditions of shock, vibration and extreme ranges in temperature. The digital display includes characters in numerical sequence from 0 to 9 plus two blank spaces. $\frac{7}{32}$ -inch characters can be illuminated red or white as desired; when not illuminated, they appear white against a black background.

Reliability. Performance through one million random operations is an inherent feature of the new READALL instrument. Each module is gasket-sealed in its case to exclude moisture and seal out foreign particles. An especially thin enclosed DC motor, containing ball bearings, permits more efficient operation.

Modular Construction. A unique feature of the readout instrument is its modular construction. It can be used individually or in groups to display multiple characters in a single case.

Direct Code Translation. The operation of the READALL readout instrument is based on a positioning system using a four-bit code. The visual display is the result of a direct electro-mechanical conversion of a binary signal to a decimal read-out. There is no need for additional conversion equipment. Separate code and motor circuits permit the use of the readout instrument in low-level circuitry.

Electrical and Visual Data Storage. Once positioned, the information is displayed until a new code is transmitted to the instrument. No power is consumed while the information is retained. This data may be stored or read-out electrically for further transmission or recording.

Operate Time. The operate time varies from 0.1 second to 1.0 second depending on character position.

Weight and Size. Maximum weight including case is seven ounces; without case, four and one-half ounces. Size encased is $5\frac{1}{4}$ inches long, $1\frac{7}{16}$ inches high and $\frac{39}{64}$ inch wide. The new READALL instrument is designed for operation over a temperature range of -54°C to $+71^{\circ}\text{C}$ in humidities up to 100% and altitudes up to 70,000 feet. For more information, write for Bulletin 1019. *Trademark

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 73 ON READER-SERVICE CARD

NEW LITERATURE

Epoxy Resin

74

These catalog sheets illustrate and describe TC-459 epoxy resin. Electrical and physical properties, packaging, and uses are given. This resin seals and reinforces electrical connectors, wiring, cables and other equipment against corrosion, insulation failure and moisture contamination. Electronic Production & Development, Inc., Chemical Div., 501 N. Prairie Ave., Hawthorne, Calif.

Encoders

76

Bulletin 300-5 is a four-page summary of the firm's standard shaft position encoders. Specifications and performance data are provided for C-100, C-200, C-700, C-800, and C-900 series encoders, the CG-200 and CG-700 series internally geared assemblies, and the GB-100 series externally geared assemblies. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Servoalves

75

Catalog 310, eight pages, describes operating principles, design features and performance characteristics of series 31 and 32 flow control servoalves. Dimensional diagrams, cut-away photographs, and a series of performance curves are included. A glossary of servoalve terminology is also given. Moog Servocontrols, Inc., E. Aurora, N.Y.

Measuring Instruments

77

Six-page catalog WK-02 illustrates and describes instruments for electronic, physical, and chemical measurements. Electrical and physical specifications are given for transformer ratio-arm bridges, oscillators, transistor adaptors, milliwattmeters, vibration meters, an electronic micrometer, an attenuator calibrator, and a wide-band attenuator. Wayne Kerr Corp., P.O. Box 801, Philadelphia 5, Pa.



CIRCLE 78 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Electrical Connectors 83

Single-conductor plugs and receptacles available in 50 and 100 amp ratings for use in portable or stationary power and distribution panels, are described in bulletin PR259. The eight-page, illustrated bulletin includes advantages, features, types, and colors in its discussion. The Superior Electric Co., 83 Laurel St., Bristol, Conn.

Combustion Safeguard 84

Used for heating and heat-treating applications, this combustion safeguard control is the subject of bulletin 659. Illustrations and a description of the operation procedures are provided in the four-page bulletin. Protection Controls, Inc., 6000 N. Legett Ave., Chicago 46, Ill.

Filter and Transformer Catalog 85

The general catalog covers over 800 stock items of filters and transformers. It gives specifications and applications. A separate catalog, consisting of specifications and pertinent data for filters and inductors, has been issued. United Transformer Corp., 150 Varick St., New York, N.Y.

Power Supplies 86

This two-page bulletin describes the firm's transistorized power supplies. It gives specifications and selective features for 64 basic models with continuously variable voltage ranges to 300 v and up to 25 amp dc output. Mid-Eastern Electronics, Inc., 32 Commerce St., Springfield, N.J.

TV Replacement Guide 87

Catalog TV-60 lists the firm's complete television replacement line. In addition to recommendations for replacement problems, the book contains a catalog of transformers for television and audio applications. Triad Transformer Corp., 4055 Redwood Ave., Venice, Ca

Miniature Relays 88

Two illustrated bulletins, BR-591 and BR-592, describe models BR-8 and BR-7 miniature relays, which are available in ac and dc models with various header and mounting styles. Performance specifications, dimensions and operating characteristics appear in each two-page bulletin. Babcock Relays, Inc., 1640 Monrovia Ave., Costa Mesa, Calif.

MICRO-MINIATURE

precision wire-wound

RESISTORS

fixed, noninductive

newly developed Kelvin "RELAXED WINDING" techniques practically eliminate resistance drift with age and "shorts" or "opens" due to thermal shock.



PLASTIC ENCAPSULATED SERIES "EP"

The 0.05W micro-miniature type EP-00 is .080" dia. x .325 long, 50K ohms max. resistance. Available with radial and axial lead wires. ALL CONNECTIONS ARE WELDED. High temperature epoxy plastic is used in an exclusive vacuum encapsulation process. Standard resistance tolerances to 0.1% (specials to 0.01%). Environmental temperature range: -65°C to +125°C.



CERAMIC SERIES "CB"

The 0.15W miniature type CB-05 is 1/4" dia. x 1/4" long, 500 K ohms max. resistance. Available with radial and axial lead wires. Standard resistance tolerances to 0.1% (specials to 0.01%). Environmental temperature range: -55°C to +85°C.



send for complete literature

KELVIN

ELECTRIC COMPANY

5907 Noble Avenue, Van Nuys, California

TRiangle 3-3430 • STate 2-6662

CIRCLE 89 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959



He is looking at the conquest of space

The man above is studying the vibration reaction of a Union 6 PDT miniature relay, at the reliability laboratory of Convair-Astronautics, San Diego, Calif.

Result: These Union Switch & Signal relays were chosen by Convair for the guidance of their Atlas missile, launched into orbit December 18, 1958.

Extreme reliability was needed in the Atlas guidance system, to insure precise control of flight. And the Union relay subjected to thorough testing, answered that need.

Part of the 6 PDT relay reliability can be laid to its small size and its clean, simple, rotary design which gives it fewer inherent problems than other relays. In tests at Union Switch & Signal, it has proved its ability to give outstanding performance in critical dry-circuit control applications—was absolutely solid to 2,000 C.P.S. at 15G!

The relay used in the Atlas is just one of a complete line of dependable relays designed by Union Switch & Signal. Write today for complete technical details.

"Pioneers in Push-Button Science"



UNION SWITCH & SIGNAL

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY

PITTSBURGH 18, PENNSYLVANIA

CIRCLE 90 ON READER-SERVICE CARD

Need MULTIPLE CABLES...



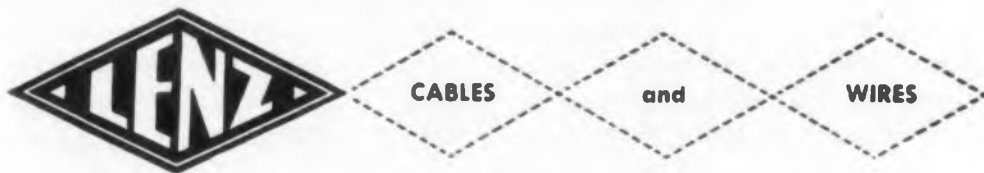
See LENZ, of course!

Whether for Electronic Control Equipment, Public Address or Inter-Com Systems, you'll want a cable that is just right for the job. Whatever your mechanical or electrical requirements, Lenz will meet them.

Organized in 1904, with a half century of wire and cable engineering experience behind us, we can help you select a standard cable from our catalog or supply you with cables built to meet your special requirements.

Send us your specifications! Remember, a Lenz Cable is a Quality Cable!

WRITE TODAY for the LENZ WIRE and CABLE CATALOG, containing detailed illustrations and valuable technical data on cable construction.



LENZ ELECTRIC MANUFACTURING CO.

1753 North Western Avenue

Chicago 47, Illinois

In Business Since 1904

CIRCLE 93 ON READER-SERVICE CARD

NEW LITERATURE

Handling Equipment 94

Materials handling equipment, parts handling equipment, power rectification equipment, mechanical shaft seals, paper jiggers and portable power tools are discussed in catalog 596. Included in the 68 pages are descriptions, data and specifications, in addition to illustrations showing products in operation. Syntron Co., 283 Lexington Ave., Homer City, Pa.

Aluminum Clad Copper Wire 95

Technical booklet, "Aluminum Clad Copper 40 Per Cent," describes a high-conductivity wire developed by the company for high temperature magnet wire and a variety of applications in aircraft, missiles, and high-speed industrial equipment. The four-page booklet contains conductivity ratings, mechanical properties, and weight/length conversion tables for 40 gages of the new high temperature wire. Sylvania Electric Products, Inc., Parts Div., Warren, Pa.

Instrument Cases 96

Four-page bulletin 402G illustrates and describes a complete line of instrument cases. Dimensional diagrams and tables, and physical specifications are also provided. TA Manufacturing Corp., 4607 Alger St., Los Angeles 39, Calif.

Power and Gas Tubes

This 32-page booklet, PG-101D, contains data for 19 new tube types. Concise technical information on the firm's power tubes, rectifier tubes, thyratrons, and ignitrons is provided. Each of the 175 tube types is covered by a thumb-nail text description, charted dimensions, ratings, operating values, and a base or terminal-connection diagram. Photographs of representative tube types in each tube family are shown. *The booklet may be obtained from RCA electron tube distributors, or by sending 30 cents to Commercial Engineering, RCA Electron Tube Div., Dept. ED, Harrison, N.J.*

Average Reading R.F. POWER METERS



GREATLY IMPROVED!

These broad band R.F. Power Meters are of the absorption-type consisting of an oil filled, air cooled, coaxial load resistor and a volt-meter calibrated to read watts. The power meter is suitable for use as a field or laboratory test instrument, is completely shielded and non-radiating, permitting transmitter testing and adjustment without interference. The meter box is easily detached, permitting location of the load resistor at a remote point. In cases where power measurements are not required the load resistor may be used as a dummy load. No correction curve is necessary to cover the frequency range. The spurious response usually associated with directional couplers and capacitive voltage dividers is absent in this purely resistive voltage divider. Since this is a resistive voltage divider which has the same voltage division at DC, 60 cycle AC, and at high radio frequencies, this instrument can be calibrated and its calibration can be checked frequently on 60 cycle supply voltages.

Model	Power Ranges in Watts	Max. Power Dissipation	Price
PM-3	60, 150	150 watts	\$220.00
PM-6	1.5, 6	10 watts	95.00
PM-7	150, 600	600 watts	285.00
PM-8	1.5, 6, 15, 60	100 watts	225.00
PM-9	2.5, 10	10 watts	105.00
PM-10	15, 60	90 watts	145.00
PM-16	150, 600, 1500	1500 watts	375.00
PM-18	1.5, 6, 15, 60, 150, 600	600 watts	485.00
PM-19	1.5, 6, 15, 60, 120	100 watts	250.00

WRITE FOR COMPLETE INFORMATION

ELECTRO IMPULSE Laboratory

208 River Street

Red Bank, New Jersey

Phone: SHadyside 1-0404

CIRCLE 97 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

AC Timing Motors 103

These reversible ac timing motors, suitable for both military and industrial applications, are discussed in bulletin AWH MO-807. Specifications for the motors, along with an illustration, wiring diagram, and outline and mounting dimensions appear in the two-page bulletin. A. W. Haydon Co., Waterbury, Conn.

Bonded Mica Insulation 104

This 16-page catalog describes and illustrates the firm's line of bonded mica insulation. It offers information about properties, tolerances, composition, and four new grades. Forms, sizes, weights, and specifications are covered, in addition to fabricating aids such as how to punch, turn, saw, and drill this material. Continental-Diamond Fibre Corp., Newark, Del.

Modular Control Systems 105

These matched systems, suitable for use in the aircraft, missile, electronic control, and related fields, are covered in bul-

letin PS-5A. Its four pages contain charts and photographs of units in the system which includes transducers, modular contactorless controls, and modular actuators. Airborne Accessories Corp., 1414 Chesnut Ave., Hillside 5, N.J.

Laminated Plastics 106

This 16-page engineering data book lists specifications on laminated plastics and associated products. Tables and charts present typical performance values for grades of laminated sheets, allowable thickness tolerances, design recommendations, and other information on the firm's printed circuits and copper-clad laminates. Northern Plastics Corp., LaCrosse, Wis.

Power Packs 107

Catalog sheet 118 describes a line of solid-state, miniaturized, high amperage power packs. Physical features, electrical and dimensional specifications, and illustrations of the unit are provided. Electronic Research Associates, Inc., 67 Factory Place., Cedar Grove, N.J.

for maximum reliability

KEEP TRANSISTORS COOL

Keep transistors at or below maximum operating temperatures with these new Birtcher Transistor Radiators. Provides the transistor with its own heat sink and a greatly increased radiating surface. Easy to install in new or existing equipment. Modifications to fit hundreds of popularly used transistors.



FOR MOST JETEC 30 TRANSISTORS
(Jetec Outline TO-9)

with **NEW**
BIRTCHER
TRANSISTOR
RADIATORS

B BIRTCHER COOLING AND RETENTION DEVICES ARE NOT SOLD THROUGH DISTRIBUTORS. THEY ARE AVAILABLE ONLY FROM THE BIRTCHER CORPORATION AND THEIR SALES REPRESENTATIVES.

THE BIRTCHER CORPORATION
industrial division

4371 Valley Blvd. Los Angeles 32, California

Sales engineering representatives in principal cities.

FOR CATALOG
and
test data
write:



CIRCLE 108 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

LEFT: STUD 7/16-11/16
CENTER: AXIAL LEAD TOP HAT
RIGHT: STUD INSULATED

COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS
COLUMBUS ELECTRONICS CORPORATION
DOUBLE DIFFUSED SILICON RECTIFIERS



Now ... an extensive line of
high performance, hermetically sealed,
silicon power rectifiers UP TO 35 AMPS.
JEDEC types exceeding MIL specifications.

NEW

SINGLE unit VERY HIGH VOLTAGE silicon rectifiers exhibiting these desirable characteristics ...

HIGH VOLTAGE up to 2000 PIV	LOW FORWARD DROP 1.5 Volts, DC
EXTREMELY LOW LEAKAGE 1 μ A	FORWARD CURRENT up to 20 Amps.

NEW

INSULATED STUD silicon rectifiers offering these quality features ...

- Simplify mounting
- Save assembly parts & costs
- Obtain efficient heat transfer
- Give greater design flexibility

AVAILABLE UP TO 10 AMPS PER UNIT AND UP TO 2000 VOLTS PIV.

WRITE FOR FULL DETAILS

COLUMBUS ELECTRONICS CORP.

1010 SAW MILL RIVER RD., YONKERS, N. Y.
YOnkers 8-1221 • TWX-Yonkers, NY-1369

CIRCLE 109 ON READER-SERVICE CARD

This Book is Influencing the Entire Future of Electronics...



ACT NOW
Supply is
Limited

ONLY
\$11.00

FULL SIZE:
6 1/4 x 9 1/4
Over 3,000
copies sold
on first
printing

MICROMINIATURIZATION

The first and only volume of collected information
on the important new developments and
techniques of microelectronics

Now hard bound for permanent addition to your technical book shelf, MICROMINIATURIZATION contains the complete proceedings of the "Symposium on Microminiaturization of Electronic Assemblies"*. Here is the latest work in the field of microelectronics, 21 papers in all, complete with all of the original text, charts, tables, and illustrations—plus an editorial analysis and commentary by *Electronic Design's* staff. A valuable reference volume and working tool, this is the only collection covering these important new developments in the state of the art. Take advantage of this special pre-publication offer today—simply fill in the order blank below

*Sponsored by the Diamond Ordnance Fuze Laboratories

CONTENTS

Twenty-three chapters. Six sections: Section I *Techniques*; Section II *Semiconductors*; Section III *Components*; Section IV *Circuits*; Section V *Missile Systems*. Up-to-the-minute editing has resulted in the addition of Section VI *Microelectronics in industry*.

ORDER BLANK

Please send () copies of MICROMINIATURIZATION at \$11.00 plus 15c postage. (Postage paid if cash is received with order).

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

() Check Enclosed () Bill Me () Bill My Company

HAYDEN BOOK COMPANY, INC.

830 Third Avenue, New York 22, N.Y. • PLaza 1-5530

NEW LITERATURE

Brush Maintenance 114

Practical tips on brush operation and maintenance on high-current, low-voltage generators used in electrolytic processes are contained in 16-page illustrated booklet CP-3004. Included is a discussion of metal-graphite brushes used in plating generators, together with explanations of contact drop, friction, resistivity, and commutator surfacing. National Carbon Co., 535 Fifth Ave., New York 17, N.Y.

Data Handling Systems 115

A line of precision electronic measuring and data handling systems is presented in eight-page illustrated bulletin G-101. These systems are used to measure weight, strain, force and thrust, flow, pressure, and temperature in the aircraft and missile, steel, automotive, and chemical processing industries. Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

Differential Voltmeter 116

A precision dc-ac differential voltmeter, model 803, is illustrated and described in four-page bulletin 335. A basic block diagram is given, as well as electrical, physical and dimensional specifications. John Fluke Manufacturing Co., Inc., 1111 W. Nickerson St., Seattle 99, Wash.

Multiplier-Divider 117

This two-page data sheet describes the model K5-M multiplier-divider. Electrical, physical, and mechanical specifications are given, as well as applications and a block diagram. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 6, Mass.

Isolated Power Supply 118

Applications and specifications for the firm's model 21 isolated power supply appear in this four-page bulletin. Accuracy, durability, and performance are also described. Moeller Instrument Co., Electronics Div., 132nd St. & 89th Ave., Richmond Hill 18, N.Y.

IN-LINE DIGITAL DISPLAY WITH ONE PLANE PRESENTATION



SERIES 10,000

OUTSTANDING FEATURES

- Reliable, dependable, no moving parts.
- All digits displayed on front surface viewing screen... quickly seen from any angle of viewing.
- All digits uniform in size and intensity... easier and faster to read.
- High-contrast viewing screen insures utmost visual sharpness.
- Digit style of your choice to complement manufacturer's original equipment.
- Colored digits of your choice for special environmental lighting.
- Individual units may be assembled in groups for convenient panel mounting.
- Dimensions: 1-9/16" wide, 2 5/8" high, 5 3/8" long.

NEW! LARGE IN-LINE DISPLAY Series 80,000



\$3300
each
Quantity
prices
available

Offers same outstanding features as Series 10,000 In-Line Display, but approx. four times larger. Easily viewed over 100 feet away!

PRICE PER UNIT

\$18.00

QUANTITY PRICES
ON REQUEST

WRITE TODAY FOR
COMPLETE DETAILED
SPECIFICATIONS

Representatives
in principal cities



INDUSTRIAL ELECTRONIC ENGINEERS, Inc.

Engineers and Manufacturers of
Fully Automatic Systems and Machines

3973 Lankershim Blvd., North Hollywood, Calif.

CIRCLE 119 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Fastenings

This 88-page net price catalog gives prices for each of the thousands of corrosion-resistant fastenings the firm manufactures. Included in the catalog are bolts, nuts, screws, washers and rivets. Write on company letterhead to H. M. Harper Co., Dept. ED, 8200 Lehigh Ave., Morton Grove, Ill.

Precision Wire 120

Four-page bulletin 359 lists and describes various types of precision wire. Resistance thermometer wire, 1000 F insulated wire, semiconductor wire, and high tensile strength magnet wire are among the types included. Secon Metals Corp., 7 Intervale St., White Plains, N.Y.

Aluminum Spheres 121

Data sheet Z-101 describes 99.99% pure aluminum spheres used in forming alloy junctions in silicon semiconductor devices. General description, available sizes, instructions for ordering, and a photograph are included. Accuracy Specialties Co., Inc., 37-11 57th St., Woodside 77, N.Y.

Power Supply 122

Data sheet 336 illustrates and describes precision dc power supply model 301E. This power supply is chopper stabilized, calibrated, and standard-cell referenced. Electrical and mechanical specifications are given. John Fluke Manufacturing Co., Inc., 1111 W. Nickerson St., Seattle 99 Wash.

Rate Gyros 123

Information on three rate gyros that cover practically every application requirement can be found in bulletin RG-101, two pages. Specifications and dimensional diagrams are given, in addition to pictures of the instruments. Humphrey, Inc., 2805 Canon St., San Diego, Calif.

Interference Filters

Electrical and physical specifications and product information on interference devices for electronic equipment are given in this 350-page design and product catalog. Write on company letterhead to Filtron, Inc., Systems Div., Dept. ED, 10023 W. Jefferson Blvd., Culver City, Calif.

GREEN PRINTED CIRCUIT DRILL



A Pneumatic Attachment on The Green Model D2 Pantograph Engraver rapidly drills holes in printed circuits by tracing templates.

- Drill as many as 100 holes per minute, Foot switch actuates air powered operation.
- Drill speeds and feeds have independent adjustments, Feed regulated by air pressure.
- Spindle speeds up to 26,000 rpm. Permits use of carbide drills when required.
- D2-201 air attachment includes spindle air cylinder, regulating valve and pressure gauge, foot switch, filter and oiler, ready to operate when connected to compressor.

The Model D2 Heavy Duty Pantograph Engraver features ratios of 2 to 1 to infinity. Unobstructed on three sides to handle large work. Micrometer adjustment for depth of cut. Vertical range 10" adjusting copy table automatically with pantograph.

GREEN INSTRUMENT COMPANY, INC.

361 Putnam Ave. • Cambridge 39, Mass.

FOR FULL DETAILS. WRITE, WIRE OR CALL

CIRCLE 124 ON READER-SERVICE CARD

when the heat's on, you can rely on DAYSTROM PACIFIC SQUARETRIMS

PERFORMANCE UP TO 200° C.

model 313



model 318



shown full size

HIGH POWER RATINGS 1-watt at 95°C;
0.5-watt at 150°C.

SUBMINIATURE PACKAGE 1/2-inch square, aluminum case.

The Series 313 Squaretrims are the smallest, high-temperature, trimming potentiometers. The Series 318 Squaretrims are identical in performance to the Series 313, but they are adapted to mount base-down to a printed circuit board and remain secure under high vibration and shock loads. Both are available in humidity proof versions. For full environmental specifications, write for Data File ED-653-2.

DAYSTROM PACIFIC

a division of DAYSTROM, INC.
9320 LINCOLN BOULEVARD
LOS ANGELES 45, CALIFORNIA

In Canada: DAYSTROM LTD.
840 Caleconia Rd.
Toronto 10, Ontario

Export: DAYSTROM INTERNATIONAL
100 Empire Street
Newark 12, New Jersey

potentiometers / gyro instruments / airborne systems

CIRCLE 125 ON READER-SERVICE CARD

CML

PRECISION AC POWER SOURCE

Model 1301C & 1302C



ULTRA STABLE AND PRECISE SUPPLY OF AC VOLTAGE

These supplies are ideal for small missile system checkout, gyro testing, etc. Two sizes are available, one at 6 VA output and one at 15 VA output.

The output frequency is precisely controlled by means of a tuning fork. Loading and line voltage changes have negligible effect on output frequency, actually less than 1 PPM over the ambient temperature range of from 0° to 50°C. Three ranges of tuning fork stability are available — ±.05%, .01%, or .001% over the same ambient range.

The amplitude stability of the 1300 series units after a one hour warmup is approximately ±0.1% normal drift with a maximum of ±0.2% for ambient variations of from ±10° to 40°C and ±0.2% for line voltage changes from 110 to 125 volts.

Harmonic content is 0.1% into a load unity power factor at rated output level. The noise and hum level is better than 60 db down.

Regulation of the output voltage is better than 0.2% from no load to rated load of unity power factor. Three output voltages are available and each is adjustable over a small range. The regulation and distortion specifications apply within the range of ±10% of the nominal output voltage only. Outside of this area, both the regulation and the distortion degrade by 100% at the worst condition.

Write for complete specifications and performance data. Available as cabinet mounted unit or for rack mounting.

Size-Rack Mounting Models:

Model 1301 — 5¼" x 19" panel, 10" deep

Model 1302 — 7" x 19" panel, 11" deep

Special models made to meet unusual requirements.

CML

COMMUNICATION MEASUREMENTS LABORATORY, INC.
350 LELAND AVENUE, PLAINFIELD, NEW JERSEY

Tel. PL 4-5502

CIRCLE 133 ON READER-SERVICE CARD

NEW LITERATURE

Modular Enclosure System 134

Technical and engineering data, specifications, drawings, photographs and illustrations of the units and component parts of the modular enclosure system appear in catalog 106, 108 pages. A 16-page condensed version of catalog 106 will answer requests. Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill.

Electronic Parts and Equipment 135

This general catalog devotes over 300 pages to the latest electronic parts and equipment including a complete line of stereo high fidelity components. The firm offers its own line of stereo tuners, amplifiers, preamplifiers, tape recorders, speakers and enclosures. A full presentation of radio and TV parts, transistor kits and miniaturized components, antennas and installation accessories, relays, transformers, and rectifiers appears. Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N.Y.

Silver-Cadmium Batteries 136

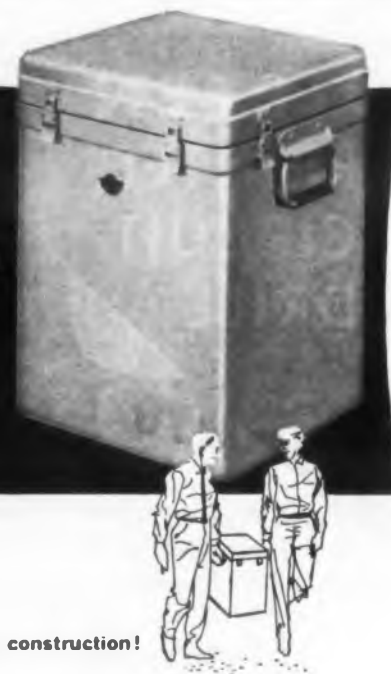
This six-page brochure supplies data on physical and electrical characteristics of long-life silver-cadmium cells, which are smaller in size and weight than ordinary batteries. Graphs compare the performance of these cells with other types. Yardney Electric Corp., 40-50 Leonard St., New York 13, N.Y.

Protective Surface Coatings 137

Thermal, physical, chemical, and electrical characteristics of protective surface coatings for electronics applications appear on this chart. All characteristics can be seen at a glance on one side of the sheet. The chart breaks down the firm's ten types by the AIEE classification as well as 47 other characteristics. On the reverse side of the sheet is a selector table which enables the user to choose the type best suited for his application. Columbia Technical Corp., 61-05 31 Ave., Woodside 77, N.Y.

NOW for the first time!

KING SIZE AMAZING NEW SUBMERSIBLE Standard Aluminum INSTRUMENT CASES



Only TA offers you:

- ★ New extra-deep, submersible design!
- ★ Choice of 120 basic types and sizes!
- ★ Tailored cases at off-the-shelf prices!
- ★ Special shock-mounted reinforced aluminum construction!
- ★ 4-week delivery on prototypes!

TA's new King-Size line includes cases up to 30" high — yet prices are comparable to those of standard-depth containers.

You simply choose from the many standard lid sizes, specify the depth and accessories (latches, handles, pressure relief valves, etc.) and TA does the rest. In fact TA even furnishes you free vellums and templates so you can design your instruments to these standard sizes and save yourself costly tooling charges.



TA Mfg. Corp. 4607 Alger Street • Los Angeles 39, Calif.
(or call CH 5-3748)

Write for TA Engineering Manual 402G. Free — (no obligation).
Get the TA King-Size story today.

TWX 9863 Glendale, Calif. • WUX CAT Los Angeles, Calif.

CIRCLE 138 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Thermistors

This 38-page booklet contains historical background, operating characteristics, electrical specifications, uses and applications, and typical circuitry for the firm's thermistors and varistors. Illustrations, graphs, and dimensional diagrams are included. Send \$1.00 to Victory Engineering Corp., Dept. ED, 519 Springfield Rd., Union, N.J.

Servo Amplifier 143

An electronic servo amplifier and power supply for use in ac instrument servo systems are described in data sheet EE-1005. Electrical and physical specifications and applications of the units are provided, as are a block diagram and illustrations. Seneca Falls Machine Co., Electronics Div., Seneca Falls, N.Y.

Compression Terminals 144

Bulletin SCT-59-101, six pages, describes a series of glass-to-metal compression terminals. Electrical specifications, performance data, installation information, and dimensional diagrams are given,

as well as a two-page terminal selection chart. Electrical Industries, 691 Central Ave., Murray Hill, N.J.

Delay Lines 145

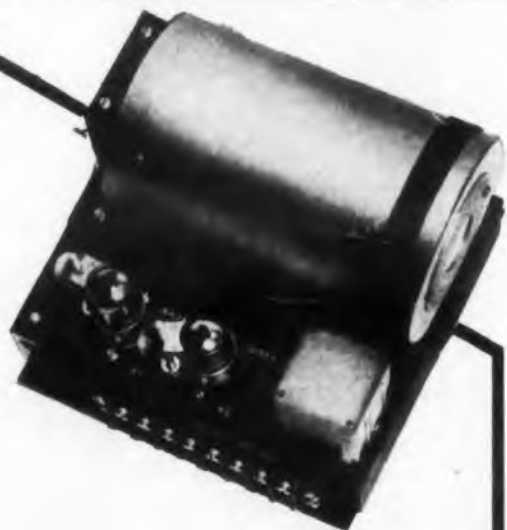
A line of distributed constant delay lines and pulse test equipment is illustrated and described in this short form catalog. Electrical specifications and environmental characteristics are given, as well as physical dimensions and illustrations of the various available case styles. Technitrol Engineering Co., 1952 E. Alleghany Ave., Philadelphia 34, Pa.

Electro-Mechanical Parts 146

Over 20,000 electro-mechanical, developmental, electronic, gearing, and tool components are described in 512-page catalog No. 60. Dimensional diagrams, physical and mechanical specifications, and prices are given in this pocket-sized catalog. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, N.Y.



**new FORK
OSCILLATOR—**
Stability 1 part
in 10,000,000



Improvements in the amplifier circuitry have minimized frequency excursions caused by variables such as temperature, plate supply voltage, tube aging, etc.

Fork employs compact oven developed for this unit.

Fork FK5-A Standard frequencies

(1600, 1800 or 2000 cps). \$350.00.

Also furnished without oven. Write for detailed specifications.

**TIMES FACSIMILE
CORPORATION**

540 West 58th Street, New York 19, N.Y.

CIRCLE 147 ON READER-SERVICE CARD

NUMBER SIX* in a series of candid camera studies planned, frankly, to impress you with the efficient service rendered by—

BURLINGAME ASSOCIATES

SERVING SCIENCE AND INDUSTRY SINCE 1928

510 S. FULTON AVE., MT. VERNON, N. Y. • MOUNT VERNON 4-7530
WASHINGTON, D.C. • WALTHAM, MASS. • UPPER DARBY, PA. • SYRACUSE, N. Y.

EASTERN FIELD ENGINEERS FOR:

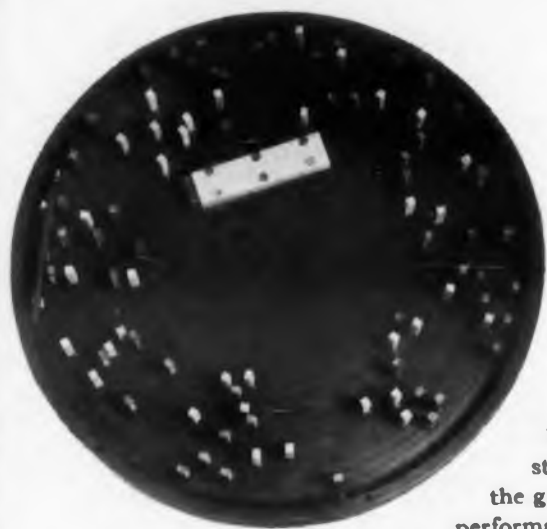
ALLISON LABORATORIES • BRUSH INSTRUMENTS • CARDINAL INSTRUMENTS
• CONVAIR INSTRUMENTS • ELECTRO INSTRUMENTS • ELECTRO-PULSE
• EMPIRE DEVICES PRODUCTS • HOLT INSTRUMENT LABORATORIES
• HUGGINS LABORATORIES • LEVINHAL ELECTRONIC PRODUCTS •
MENLO PARK ENGINEERING • NARDA MICROWAVE • NJE • SYSTRON
WAYNE-KERR LABORATORIES

*Dr. Jackson is learning to read. Although he has had 21 years of formal education, plus 3 degrees, the BA field engineer sitting next to him is showing him how to read a new instrument catalog, filled with unfamiliar nomenclature, specialized parameters and complex performance charts. It happens every day. Takes years for us to train such a top-notch field man. One more reason to "Get the Burlingame Habit".



CIRCLE 148 ON READER-SERVICE CARD

G-E WIRE SONIC DELAY LINES PROVIDE LOWER INSERTION LOSS HIGHER STORAGE RATE



Information storage up to 1.2 mc/s
Delay up to Ten Milliseconds
Adjustable Delay
Small Volume for Length of Delay
Shock and Vibration Resistant
Stable over Wide Temperature Range

Wire Sonic Delay Lines employ a special alloy wire as the delay medium. G.E. uses both piezoelectric and magnetostrictive transducers to provide the greatest possible range of system performance. Piezoelectric transducers assure *minimum insertion loss* for fixed inputs and/or outputs while the magnetostrictive transducers provide intermediate taps, both fixed and adjustable.

For complete development information write to *Defense Industries Sales, Sect. 227-28A*

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION
HEAVY MILITARY ELECTRONICS DEPARTMENT, SYRACUSE, NEW YORK

CIRCLE 155 ON READER-SERVICE CARD

From the manufacturer of the widely used and well known FM-3 Frequency Meter and the later FM-6 Frequency Meter comes the newest addition to a growing family of fine instruments. The newest, the FM-7 provides in a small package all of the essentials for the maintenance of mobile communications systems.

NEW FREQ METER

MEASURES AND GENERATES: 20 mc to 1000 mc
ACCURACY: 0.0001% exceeding FCC requirements 5 times
MODULATION: AM, 30% at 1000 cps; FM, 1 kc at 30 mc
5 kc at 150 mc, or 15 kc at 450 mc max.



MODEL FM-7

As optional equipment the FM-7 may be combined with the new DM-3 Deviation Meter as illustrated. The DM-3 is a new Dual-Range Deviation Meter with 15 kc and 7.5 kc full scales.

WRITE OR CONTACT YOUR GERTSCH REPRESENTATIVE FOR FULL DETAILS

GERTSCH PRODUCTS, Inc.

3211 South La Cienega Boulevard, Los Angeles 16, California
UPhon 02761 • VErmont 92701

Gertsch

CIRCLE 153 ON READER-SERVICE CARD

NEW LITERATURE

Basic Circuits 154

"Basic Circuits", 32 pages, serves as a guide to determine the availability of a circuit and its components. This pocket-sized catalog contains line drawings of slow-operating and slow-releasing circuits, relay locking circuits, pulse generators, pulse stretching, ac rectifier circuits, and rotary switch circuits. Automatic Electric Co., Northlake, Ill.

Shock and Vibration Environments

Entitled, "Electronic Designers' Shock and Vibration Guide for Airborne Application," this 250-page technical report was prepared for use by electronics contractors engaged in work for the Air Research and Development Command. The manual contains theory, vibration studies, electronic component parts and their characteristics, rack and chassis design, damping, equipment for simulating and measuring shock and vibration,

laboratory test procedures, vibration and shock protective devices, and equipment mounting and installation techniques. It is available to Department of Defense contractors. *Armed Services Technical Information Agency, Dept. ED, ASTIA Document No. AD-204095.*

Remote Impulse Counters 156

Remote impulse counters manufactured by Sodeco of Geneva, Switzerland, are illustrated and described in this two-page data sheet. Dimensional diagrams, electrical specifications, operating instructions, and construction data are provided. Landis & Gyr, Inc., 45 W. 45 St., New York 36, N.Y.

Fiberglass Tubing 157

High frequency electronic insulating material is the subject of this two-page bulletin. Electrical and mechanical properties, in addition to such data as size, length and tolerances, are given. Other structures of silicone and urethane fiberglass are also described. Chemfab Corp., 40-30 23 St., Long Island City 1, N.Y.



He's back on the job

because . . .

someone like you gave him a helping hand after his discharge as a mental patient.

Help thousands like him find friends, a job, a home by giving your welcoming hand and your support to the . . .



Mental Health Campaign

Casting Aluminum. 159

This 32-page handbook covers the various casting processes suitable for aluminum. Recommendations on alloy selection are given, plus a discussion of alloying elements and their effects. Design of aluminum castings is explained fully. Tables on core sand mixes, tolerances, weight comparisons, annealing and stress relieving cycles, shrinkage data and machining information are included. Reynolds Metals Co., Box 2346, Richmond 18, Va.

Precision Pulse Generator 160

A 256-step precision pulse generator is discussed in bulletin 3022-9. Suggested uses, principle of operation, features, specifications and performance data are given. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Electronic Tracer 161

Four-page bulletin 1287 describes an electronic tracer which uses simple line sketches to guide oxygen shape-cutting machines. This unit eliminates the need

for expensive metal or plastic templates, photographic negatives, or complicated silhouettes. Linde Co., Div. of Union Carbide Corp., 420 Lexington Ave., New York 17, N.Y.

Capacitors 162

The firm's rectangular tantalum electrolytic capacitors are described in revised bulletin GEA-6766A, four pages. Performance data, outline drawings, tables of sizes and ratings for operation at 85 and 125 C, polar and non-polar applications are given. The bulletin discusses new terminal construction and high-vibration mounting brackets. General Electric Co., Schenectady 5, N.Y.

Indicating Recorders and Recorder-Controllers 163

Catalog 66, four pages, covers the sensitivity, accuracy, control and alarm function, installation, operation, maintenance and applications for indicating recorders and recorder-controllers. Illustrations of the units and instrument dimensions also appear. Thermo Electric Co., Inc., Saddle Brook, N.J.

CHART-PAK precision tapes and die-cut symbols made these conductor paths and terminal pads for a printed circuit layout in 9 minutes 40 seconds!

HOW LONG WOULD IT TAKE YOU TO DRAW THEM?

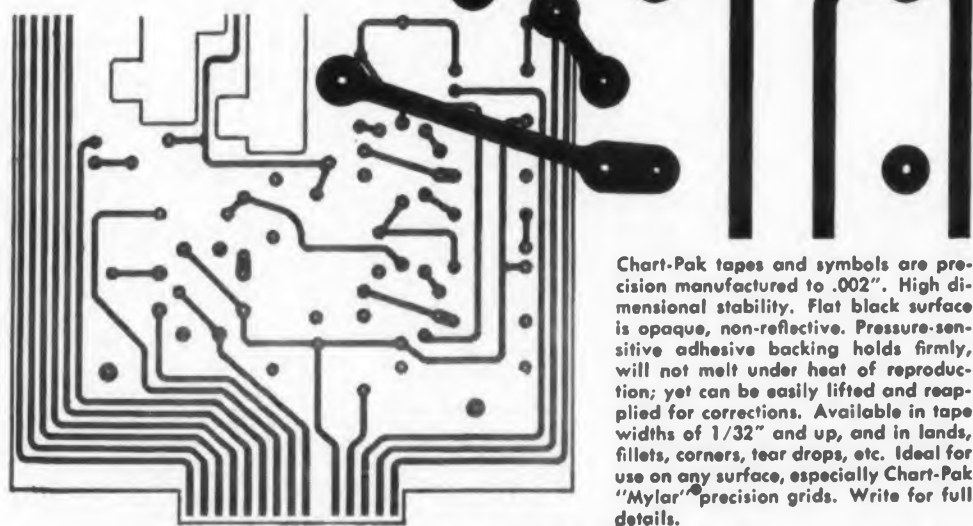


Chart-Pak tapes and symbols are precision manufactured to .002". High dimensional stability. Flat black surface is opaque, non-reflective. Pressure-sensitive adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and reapplied for corrections. Available in tape widths of 1/32" and up, and in lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak "Mylar" precision grids. Write for full details.

**CHART-PAK
Saves time...
Saves money!**



CHART-PAK, INC.

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

149 River Road, Leeds, Mass.

CIRCLE 164 ON READER-SERVICE CARD



New Series of Sprague Cylindrical-Style Radio Interference Filters: top row, l. to r.—4JX14, 5JX94, 1JX115, 20JX15, 50JX20 bottom row—5JX27, 1JX54, 1JX113, 1JX117, 2JX49, 1JX118.

New Series of Small, Light Radio Interference Filters

The new cylindrical-style radio interference filters recently announced by Sprague Electric Company are the smallest and lightest filters of their type available for military and industrial electronic and electrical equipment. Their basic design was pioneered by Sprague in order to achieve maximum miniaturization.

This new series of standard filters, believed to be the largest in the industry, ranges in current rating from 5 milliamperes to 50 amperes to cover the great majority of application needs.

The natural shape of the rolled capacitor section and of the toroidal inductors dictates the cylindrical form. All filters have threaded-neck mountings for use on panels or bulkheads. This assures both the proper isolation between input and output terminals as well as a firm peripheral mounting with minimum impedance to ground.

Listed in Sprague Engineering Bulletin 8100 (available upon request to the Technical Literature Department) are 68 of the more popular low-pass filter designs intended for use as three-terminal networks connected in series with the circuits to be filtered. The excel-

lent interference attenuation characteristics reflect the use of Thrupass® capacitor sections.

Since maximum effectiveness of filtering involves elimination of mutual coupling between input or noise source and output terminals, filters should be mounted where the leads being filtered pass through a shielded chassis or bulkhead. The threaded neck mounting is designed to give a firm metallic contact with the mounting surface over a closed path encircling the filtered line and to eliminate unwanted contact resistance so that the theoretical effectiveness of these units is realized in practice.

Typical insertion loss is determined by measurements made in conformance with Military Standard MIL-STD-220. Minimum curves for specific filters are available upon request.

For assistance in solving unusual interference, rating, or space problems, contact Interference Control Field Service Manager, Sprague Electric Co., at 12870 Panama Street, Los Angeles 66, California; 224 Leo Street, Dayton 4, Ohio; or 347 Marshall Street, North Adams, Massachusetts.

CIRCLE 165 ON READER-SERVICE CARD



THE DRONE FOR THE ANSD-5 SURVEILLANCE SYSTEM

engineers

PROGRESS AT FAIRCHILD ASTRIONICS

One of the most advanced projects Fairchild Astrionics Division is now undertaking is the ANUSD-5 Surveillance System for the U. S. Army. This system consists of a jet-powered drone, supporting launch and recovery vehicles and trailerized data processing equipment. This delta-winged drone carries electronic equipment capable of gathering and transmitting data on enemy positions and movements.

If you are looking for a position with more scope, one that requires imagination as well as ability, then there's a place for you at Fairchild Astrionics. Outstanding career opportunities now available for assignment on ANUSD-5, training devices, airborne electronic systems, as well as on numerous research and development programs applicable to missile system engineering.

RF RECEIVERS AND TRANSMITTERS / DIGITAL COMPUTERS /
COMMAND GUIDANCE / TRANSISTORIZED CIRCUITRY / AC
AUTOPILOT / FILM PROCESSING / OPTICS AND IR SYSTEMS /
TEST EQUIPMENT / DATA TELEMTRY / SYSTEMS & CIRCUIT
DESIGN / GUIDANCE SYSTEMS / PACKAGING / ANALOG COMPUT-
ERS / DISPLAY SYSTEMS / CONTROL CIRCUITRY / SERVO-
MECHANISMS / OPERATIONS ANALYSIS / HYPER AND SUPER
AERO / MISSILE AND AIRFRAME STRUCTURES / FIELD ENGINEERS
/ RADARS / STANDARDS ENGINEERS / DYNAMIC ANALYSIS /
ANTENNAS / SONAR / GROUND SUPPORT EQUIPMENT

Why not give serious thought to becoming part of an engineer-oriented organization whose diversity of activities has created the heaviest volume of work in years, thereby insuring you of the opportunity to advance as rapidly as your ability and creativity warrants.

To arrange a mutually convenient interview, please send your resume, in complete confidence, to: Professional Employment Department


FAIRCHILD

ASTRIONICS DIVISION—WYANDANCH, LONG ISLAND, NEW YORK
A Division of Fairchild Engine and Airplane Corporation.

NEW LITERATURE

Beam Power Tube 174

Seven-page booklet AN-182 discusses the application of the 6EM5 beam power tube in vertical-deflection circuits of television receivers utilizing picture tubes with diagonal deflection angles of 110 deg and operating at ultor voltages of up to 20,000 v. A circuit is given and analyzed. Electrical characteristics of the 6EM5 are also given. Radio Corporation of America, Electron Tube Div., Harrison, N.J.

Power Pentodes 175

Seven-page booklet AN-180 discusses the application of a series of power pentodes designed for use in low-cost audio amplifiers. Electrical and mechanical characteristics are given for the 6EH5, 12EH5, 25EH5 and 50EH5 power pentodes. Included are circuit diagrams of typical applications. Radio Corporation of America, Electron Tube Div., Harrison, N.J.

Rotary Switch 176

Two-page illustrated data sheet S-1 describes multiple rotary switches. It provides complete specifications and design information on four types with a cross reference to the applicable BuShips drawing number. Couch Ordnance, Inc., 3 Arlington St., N. Quincy 71, Mass.

Environmental Testing 177

Four-page catalog illustrates and describes a series of temperature and humidity chambers for environmental testing. These units range from a 2 cu ft portable model up to a 10 cu ft production testing model. Physical and dimensional specifications are given. Harris Refrigeration Co., 308 River St., Cambridge 39, Mass.

Temperature Chambers 178

This illustrated two-page bulletin describes a bench-type temperature test chamber. Electrical, physical, and dimensional specifications are given. Missimers Inc., 3737 San Fernando Rd., Glendale 4, Calif.

Tape Transports 179

"Transistorized Tape Transports and Accessories," 12 pages, describes in detail a line of digital magnetic and perforated tape handlers and record/playback heads and amplifiers. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, N.Y.

Atomic Industry Directory

This 132-page directory provides product and service profiles of more than 200 industrial organizations in the nuclear field. Classifications included are radioactivity gages, laboratory instruments, process instrumentation, nuclear reactors, and control equipment and simulators. Send \$2.50 to Atomic Industrial Forum, Dept. ED, 3 E. 54th St., New York 22, N.Y.

Mercury Relay 184

Four-page illustrated bulletin 410 describes a long-life mercury relay that operates swiftly and silently. Included in the brochure are electrical specifications, photos and diagrams of this relay. Also described is the operating principle of the normally open and normally closed type of mercury relay. Mack Electric Devices, Inc., Wyncote, Pa.

Semiconductors 185

Five illustrated bulletins describe the firm's MS-41 Magnetoresistor, HS151 Halltron, HR-31 Halltron, MC-1 Magnetic Circuit and TA-11 Thermoelectric Junction. Ranging from two to four pages, each brochure gives electrical and physical specifications, examples of applications, and charts showing performance characteristics. Ohio Semiconductors, Inc., 1035 W. Third Ave., Columbus 8, Ohio.

Recording System 186

Illustrated bulletin 350-3, two pages, describes a reactor temperature and pressure recording system. Included are electrical and physical information and a block diagram of the entire system. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Preamplifiers 187

Descriptions of the firm's line of preamplifiers are given in four-page illustrated bulletin 63. Electrical, mechanical and dimensional specifications of the units are provided, as well as graphs of selectivity vs. frequency, dynamic response, and gain vs. frequency. Rixon Electronics, Inc., 2414 Reedie Dr., Silver Springs, Md.

Megohmmeter 188

Illustrated bulletin 2-1.2, two pages, describes the firm's Vibrotest megohmmeter. This instrument offers stable resistance measurements up to 5×10^{12} ohms. Included are electrical and dimensional specifications and a block diagram. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

1959 Transistor Data CHART Revisions

Several changes to our Seventh Annual Transistor Data Chart are tabulated below. Please clip the sheet to the Chart or make the corrections directly on the listing.

TO VERIFY the validity of our Transistor Data Chart listings, we have solicited the help of all contributing manufacturers in advising us of any corrections to be made. The information presented should be added to the original tabulations appearing in the July 22 issue.

Clarification on Sources of Supply

In cases where several manufacturers submitted different data on a particular type, it was difficult to choose the set of data to be published for the type. It was decided that average, rather than extreme limits, should be given.

If, for example, the alpha cutoff frequency for a type was listed as 10 mc, 11 mc, and 12 mc by three manufacturers (A, B, and C), the data of company B using the average (11 mc) figure was given with Manufacturer's B abbreviation listed in the "Mfg." column; the other two companies (A and C) were indicated as alternate sources in the "Remarks" column.

Actually, manufacturer A or C may be the original or "prime" supplier for the particular type. There was no intention of stating or implying that the company listed under the "Mfg." heading was the original registrant for the particular type or produced superior or cheaper units than those companies listed in the "Remarks" column. Readers should be aware of this important fact and check pricing as well as full technical specifications of all listed suppliers before proceeding with their purchasing plans. ■■

Changes To Transistor Data Chart

TYPE NO.	CATEGORY	MANUF.	CORRECTION
2N696	LLS	FA	} Since units are rated at 2w, they should be included in HLS category rather than LLS.
2N697	LLS	FA	
2N1131	LLS	FA	
2N1132	LLS	FA	
XT515	HF	PSI	} Change power rating to 2.8 w, w/c to 0.023 and add to "Power" category. Also include new EIA numbers.
XT516	HF	PSI	
XT517	HF	PSI	
XT518	HF	PSI	
XT519	HF	PSI	
XT520	HF	PSI	
2N117	HF	TI	} Add to "Audio" section and indicate TI as manufacturer.
2N118	HF	TI	
2N119	HF	TI	
2N332-36	HF, LLS	TI	
2N497	HLS		} Add to "Power" category Add TI as manuf.
2N389	HLS		
903	Audio	TR	} Add TR as source. Add TR as source. Add TR as source. Add TR as source. Add TR as source. Add TR as source. Add TR as source. NOTE: Change to "Special" as these are extremely low level devices.
904	Audio	TR	
904A	Audio	TR	
905	Audio	TR	
910	Audio	TR	
2N118	Audio	TR	
2N332-36	LLS	TR	
2N1247	Audio	TR	
2N1248	Audio	TR	
2N1249	Audio	TR	

The WESCON Winners!

Outstanding design earned awards for these products at the WESCON Industrial Design competition

The 18 designs shown here were judged to have best "clarity of function, ease of operation and appropriateness of appearance" of the 140 entries submitted to the first Industrial Design Competition sponsored by the Western Electronic Show and Convention.

A jury of prominent industrial designers awarded certificates of excellence to seven of the winning products and certificates of merit to the rest. All the award winners were displayed in a special exhibit area at the WESCON show, where they attracted much favorable attention.

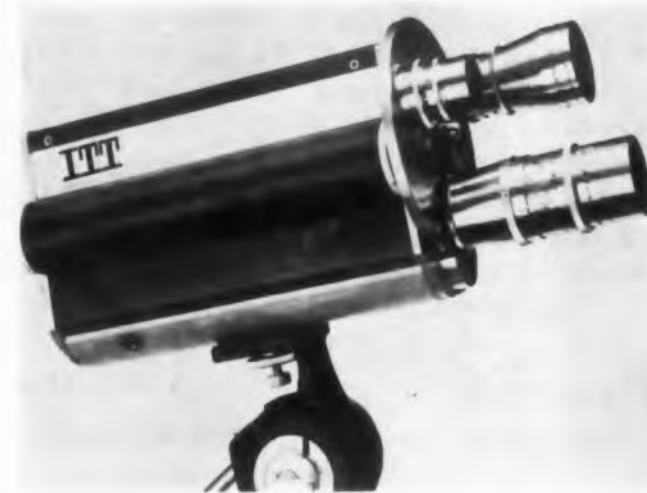
The contest, open to any company exhibiting at WESCON, will be conducted next year also.



Electropack standard cabinetry designed for Santa Anita Engineering Co. by Jim Powell Industrial Designers won an award for excellence.



Power oscillator, designed by Matt Jacobson of Jaycraft Co., won an excellence award for Electronics International Co.



Closed Circuit TV camera with extruded aluminum and vinyl exterior won excellence award for Industrial Products Division of ITT. Designers: James Lee, Channing Gilson and William Brewer.



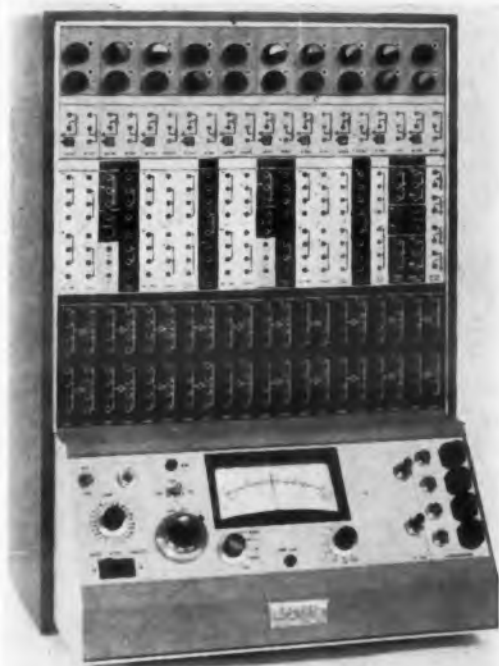
Digital tape handler (left, rear) earned excellence award for Ampex designer F. T. Walsh, who receives merit award from design show director O. H. Brown, right, for airborne tape recorder he designed with G. A. Smith. Another Walsh-designed product, Ampex' FR-400 digital tape recorder, also won an award for merit.



Computer for industrial process control, designed by Zierhut and Associates for Librascope, Inc., won an award for excellence.



Clip-on probe for dc, winner of excellence award, was designed by T. C. Lauhon for Hewlett-Packard Co.



Transistorized analog computer for desk-top use was one of two merit award-winners designed for Electronic Associates, Inc., by James Patmore.



Digiswitch designed by Jim Powell, consultant, and H. D. Wright and Jack Reitzell, designers earned excellence award for Digitran Co.



General-purpose transistorized, digital computer won merit award for Autonetics designer R. E. Davis.



Videotape recorder designed for Ampex by company designers James Hackney and Roger Wilder and Melvin Best Associates won merit award. Ampex won four of the eighteen design awards.

num
trial
man-

Nickelonic News



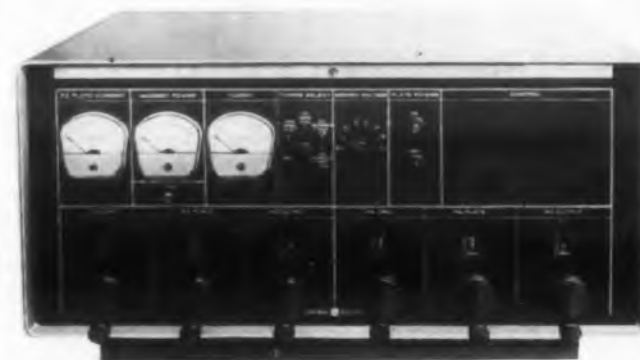
DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



WESCON WINNERS



Portable wattmeter designed by Tor Patterson won a merit award for Voltron Products.



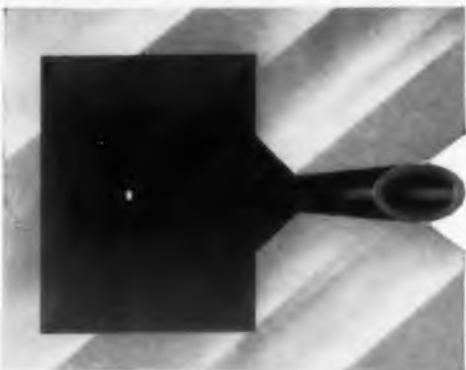
Airborne uhf transmitter, received one of two merit awards won by GE's Light Military Products Department. Designers: Noland Vogt, Robert Robb, and George Beck.



Mating connectors for audio/video received excellence award for Cannon Electric Co. designers Sam Arson and Carlos Beck.

Metal that acts like air wraps half-mile vacuum

UPTON, N. Y. In the huge new 25-Bev Synchrotron at Brookhaven National Laboratory, Inconel "X" age-hardenable nickel-chromium alloy — "a metal that acts like air" — is used to contain a 1/2-mile-long proton beam vacuum cavity.



Tube of low-magnetic Inconel "X" alloy carries Synchrotron's 25-Bev proton beam between magnet jaws. Tube's assembled, in sections, into a circle 1/2 mile around.



Inspecting one of Synchrotron's 240 magnets. This one weighs about 17 tons. Inconel "X" tube fits into narrowest gap between jaws.

Principal reason for the selection of Inconel "X" alloy, reports Brookhaven, was its high electrical resistivity. This resistivity, about 740 ohms per circular mil-foot, results in the avoidance of high eddy currents. In addition, the low magnetic permeability of Inconel "X" alloy, approximately the same as air, has virtually no effect on the strong magnetic field passing through the tube walls to guide the proton beam.

Inconel "X" also benefits vacuum cavity tube in other ways

Its high structural strength permits thin-wall construction—tensile strength after heat treatment, above 130,000 psi. Other physical properties important to this application—the alloy's low vapor pressure, good degassing, freedom from porosity.

Inconel "X" alloy provides good fabricability, too—tube is formed in sections from 0.078-inch sheet, welded and flanged.

Pertinent Literature: Send for 51-B; "Nickel Alloys for Electronic Uses." Circle 564 on Reader-Service Card



Designers insure magnetron reliability with 4 nickel alloys

WALTHAM, MASS: Recently announced by Raytheon Company, the #6177 Magnetron is compactly designed for height finding, other airborne radar uses. Size is small, weight only 1 lb, range is 4261-4300 megacycles at 1 watt.

To insure the magnetron's operating reliability, Raytheon designers use 4 nickel alloys in 13 critical parts. (8 parts are numbered in above photo.) Designers report why:

Electronic Grade "A" Nickel offers outstanding purity in ribbon (1).

Inco "220" Nickel assures proper outgassing in washer ring (2), tube (3), tube shield (4).

Another nickel-chromium alloy retains non-magnetic characteristics in reed (5), and reed coil support (6).

Alnico (nickel-iron alloy) magnets provide stability (7); cupro-nickel pole support provides strength, non-magnetic characteristics (8).

Pertinent Literature: Send for 51-B; "Nickel Alloys for Electronic Uses" (see box, below) and T-15; "Engineering Properties of Nickel." Circle 563 on Reader-Service Card

Newly Revised Booklet—"Nickel Alloys for Electronic Uses"—gives you facts on 17 freely available nickel alloys useful in the electronics industry... facts on typical applications, physical and chemical properties, available mill forms. Ask us for your copy.

Monel speeds sound brazing of resistor caps



Close-up of Monel caps soundly brazed to wire winding and leads of semi-finished resistor. Made by Sage Electronics Corporation, 302 N. Goodman St., Rochester 7, N. Y.

ROCHESTER, N. Y.: Monel* nickel-copper alloy now makes possible, fast, sure brazing of connections in resistors designed for severe service by Sage Electronics Corporation (see photo, left).

In the caps, Monel alloy also gives excellent resistance to corrosion in murderous environments... and provides essential strength for anchoring leads.

Monel boosts durability in other electronic components, too

In one magnetron, for example, Monel alloy provides an output flange and mounting plate with the toughness and strength needed for 6000-hr life. In fastenings, Monel alloy stands up against both corrosion and hard knocks. In backing for contact points, Monel alloy contributes important strength and brazing properties.

Pertinent Literature: Send for 51-B; "Nickel Alloys for Electronic Uses" and T-5—"Engineering Properties of Monel and 'R' Monel."

*Inco trademark
Circle 565 on Reader-Service Card

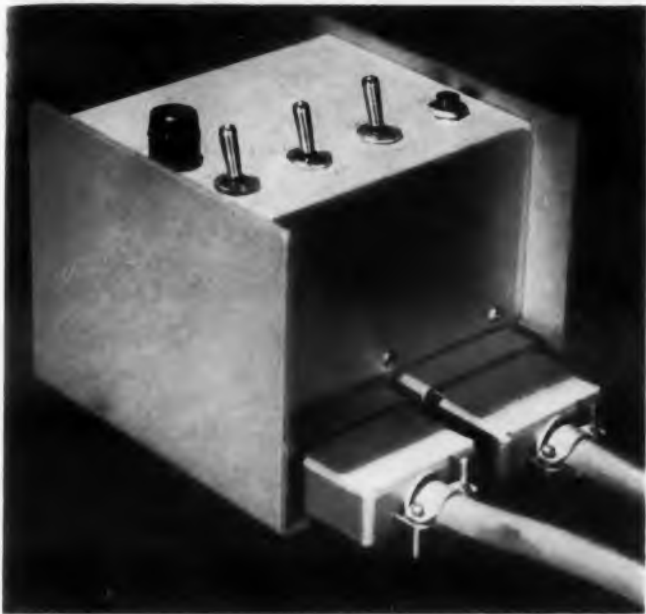
Our specialists can help you solve metal problems. Contact your Inco Alloy Products distributor or:

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.



ALLOY PRODUCTS

CIRCLE 563, 564, 565 ON READER-SERVICE CARD



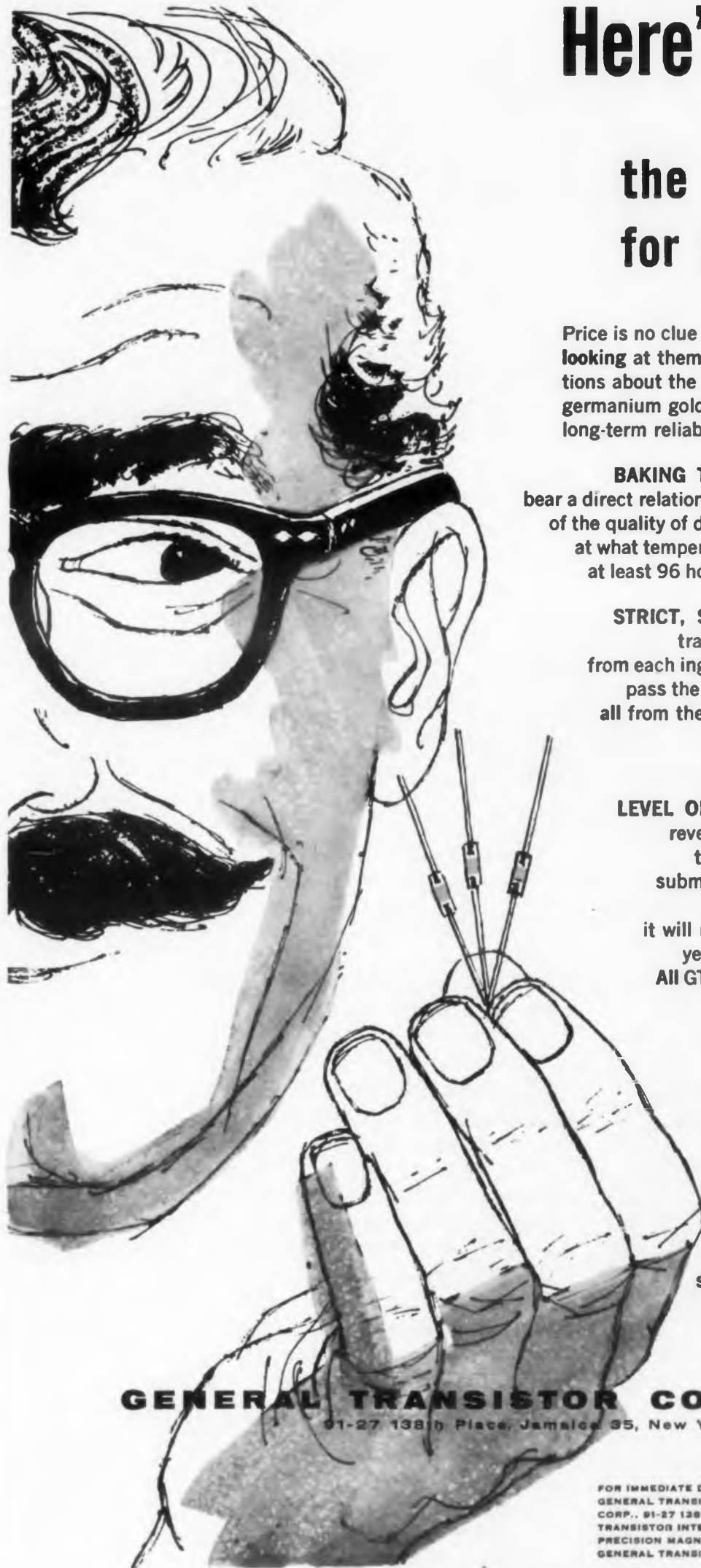
Sixty-cycle pulser designed for Tally Register Corp. by W. C. Vaughn received merit award.



Variplotter, a portable x-y recorder, won a merit award for James Patmore, Electronics Associates, Inc., designer.



Sight amplifier test set won a second merit award for Light Military Products Department of GE. Set was designed by Vogt, Robb and Beck.



Here's how to pick the best **DIODES** for your money

Price is no clue when diodes sell for about the same, and just looking at them tells nothing. But if you ask the right questions about the three key factors in the production of quality germanium gold bonded diodes, you have your clues to more long-term reliability for your money. Here they are:

BAKING TIME AND TEMPERATURE

bear a direct relationship to long-term stability. You get a measure of the quality of diodes by asking: "How long do you bake, and at what temperature?" (All GT diodes are baked at 140°C for at least 96 hours—the highest and longest in the industry!)

STRICT, STATISTICAL, HISTORY LOGGING

traces the progress of every single wafer made from each ingot of germanium. At GT, if a few wafers fail to pass the stringent GT quality tests along the way, then all from the ingot are suspect and can be identified and pulled out. There are no "stowaways" in a shipment of GT quality diodes.

LEVEL OF TESTING STANDARDS

reveals the level of quality. Ask about "everyday" test standards. (In the GT Seal Test, diodes are submerged in a penetrant-dye solution for 24 hours under 75 psi. This test is so sensitive that it will reveal a leak so small it would take over 300 years for 1 cc of gas to diffuse through the case.) All GT quality tests—100% electrical, 100% shock and vibration, and 100% temperature cycling—are at the highest industry level... and as a final mark of quality, the color bands on GT Germanium Gold Bonded Diodes are baked on to stay.

GT is equipped to supply diodes tested to individual customer requirements, such as JAN Qualification Inspection Tests and many others.

To get the full measure of quality in Germanium Gold Bonded Diodes, see your GT representative; or write directly to the company with know-how NOW.

GENERAL TRANSISTOR CORPORATION

91-27 138th Place, Jamaica 35, New York



FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

CIRCLE 190 ON READER-SERVICE CARD

NEW PRODUCTS

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



Silicon Power Rectifier Has 11/16 in. Ceramic Base

The ceramic base silicon power rectifier is available in an 11/16 in. configuration. The ceramic base eliminates the need for insulating hardware and reverse polarity units. The alumina ceramic disc is mounted between the top hat assembly and the hex base, insulating the mounting base from the rectifying junction. The disc has low thermal resistance. The rectifiers are rated up to 20 amp at 150 C case temperature.

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

CIRCLE 191 ON READER-SERVICE CARD

Printed Circuit Trimmer Potentiometer Measures 1/4 x 1/4 x 1-1/4 in.



The Ultrimmer printed circuit trimmer potentiometer measures 1/4 x 1/4 x 1-1/4 in. The resistance element is embedded in alkyd resin to permit the unit to withstand shock vibration. Use of this resin eliminates strain coefficient during temperature cycling. Maximum temperature coefficient is 25 ppm per deg C; the units can be supplied with a high positive temperature coefficient. Humidity and moisture are kept out with a silicon rubber O ring, which also maintains constant turning torque. A clutch arrangement prevents overtravel or jamming of the slider. Ranges run from 200 to 150,000 ohms with zero end resistance and standard tolerance of $\pm 5\%$.

Ultronix, Inc., Dept. ED, 111 E. 20 Ave., San Mateo, Calif.

CIRCLE 192 ON READER-SERVICE CARD



Self-Stepping Crossbar Scanner Operates at Frequencies to 10 mc

Model SC-5F self-stepping scanner is a modified crossbar switch with simplified circuitry which enables it to connect sequentially a six-wire circuit to each of 100 sets of six-wire terminals at up to 50 sets per sec. The unit takes up 27 in. of 19-in. relay rack space and operates reliably over millions of cycles with low cross-talk between adjacent circuits at frequencies up to 10 mc. This scanner is adaptable to thermocouple and strain gage scanning. It has a bridging capacity of 20 μf to ground between conductors. Current carrying capacity is 100 ma non-inductive at 50 v dc for 2×10^7 operations.

James Cunningham Son & Co., Inc., Dept. ED, 101 Litchfield St., Rochester 8, N.Y.

CIRCLE 193 ON READER-SERVICE CARD

Kit Contains All Equipment Needed to Wind Precision Resistors

This kit contains all necessary tools, materials and instructions needed to wind prototype quantities of precision resistors. Included are a bobbin winding machine, resistor wire, bobbins, lugs, tools and miscellaneous supplies. Sufficient materials are furnished to make more than 200 resistors.

Resistron, Dept. ED, 2487 E. Washington St., Pasadena, Calif.

CIRCLE 194 ON READER-SERVICE CARD

Tantalum Capacitors Have Certified Reliability

A written certification of pre-tested reliability is given on these Gold-Cap tantalum capacitors, eliminating the need for further testing by the user. The capacitors are polarized, tantalum electrolytic units capable of operating at full rated voltages in temperatures ranging from -55 to $+85$ C with voltage derating at ambient temperatures from 85 to 125 C. Included in the reliability tests are performance and stability checks at reduced and high temperatures, vibration, salt spray, temperature and immersion cycling, barometric pressure, surge voltage, moisture resistance, terminal strength, shock, and 2000-hr life tests. Results are supplied with each capacitor. The units are rated at 6 to 1000 wvdc max; capacitances are from $2 \mu\text{f}$ at 100 v to $330 \mu\text{f}$ at 6 v.

Fansteel Metallurgical Corp., Dept. ED, North Chicago, Ill.

CIRCLE 195 ON READER-SERVICE CARD

Beam-Deflection Tube Operates to 100 mc

This beam-deflection tube is designed for balanced-modulator, balanced-mixer, and product-detector service in single-sideband equipment. Called the RCA-7360, it is capable of operation up to 100 mc. Advantages include balanced push-pull output with single-ended input, high gain and large output-signal voltages, self-excited operation, 60 db carrier suppression in balanced-modulator service and 40 db oscillator-signal suppression in balanced-mixer service. The tube has two plates and two beam-deflecting electrodes, together with a screen grid, control grid, and cathode. Control-grid-to-plate transconductance is $5500 \mu\text{mho}$, and deflecting-electrode-to-plate transconductance is $1000 \mu\text{mho}$.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 196 ON READER-SERVICE CARD

WHY USE TWO?



WHEN ONE **JFD** LC TUNER WILL DO!



The versatile new JFD LC Tuner combines the characteristics of a precision variable capacitor and a metallized inductor. Its unique miniaturized construction helps effect compact electronic packaging to meet space challenging demands... affords higher reliability, faster assembly, and greater economy in prototype design or production.

A wide selection of 12 LC Tuners (in panel and printed circuit mounting types), each offering a large range of resonating frequencies, meet most circuitry requirements. If our standard line does not meet your needs, our engineering staff will be glad to design LC Tuners that suit your individual circuit specifications.

Model	Self Resonating Frequency Range	Typical LC Tuners Now Available	
		Length Above Panel	Diameter
LC303	450-700 MC	.635	5/16"
LC304	300-500 MC	.845	5/16"
LC306	200-450 MC	1.104	5/16"
LC309	125-200 MC	1.691	5/16"

Write for Bulletin 216 for further facts. Include your current design or performance problems for specific recommendations.

JFD

Pioneers in electronics since 1929

ELECTRONICS CORPORATION

1462 62nd Street, Brooklyn, New York

JFD Canada Ltd.
51 McCormack St.
Toronto, Ontario, Canada

JFD International
15 Moore Street
New York, New York

PHONE DEWEY 1-1000

CIRCLE 197 ON READER-SERVICE CARD

Widest Option in Low-Power Rotary Switches

SECTIONS

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

METAL PARTS AND FINISHES

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

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

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

CONTACTS

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



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

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

TYPE 3—Contacts and rotor blades made of Oak alloy

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

GOLD-PLATED CONTACTS—Type 1 or 2 contacts may be gold-plated .0002" thick. Not to be confused with gold flash.
FOR PRINTED CIRCUITS—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for dip soldering.

ACCESSORIES



AC SNAP SWITCHES—36 models for use on most switch types. All are UL approved.

POTENTIOMETERS—Customers' choice. Mounts on rear of Oak switches. Operates by switch shaft or separate concentric shaft.

ELECTROSTATIC SHIELDS—Used between sections. Sizes and shapes for all switches.

BEARING STRAPS—Added shaft support on long switches. Steel, brass, and phenolic.

MOUNTING BRACES—Prevents frame twist on long switches due to torsion.

SPECIAL SHAFTS—Hollow, dual-concentric, and triple-concentric for many switches.

OAK MFG. CO.

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

SEND FOR THIS GUIDE CHART TO OAK SWITCHES

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



CIRCLE 202 ON READER-SERVICE CARD

NEW PRODUCTS



Tachometer Generator

Output linearity is 0.03%

Type U720-001 size 20 tachometer generator has an output voltage linearity of 0.03% at 0 to 3600 rpm without the need for compensation due to temperature variations. Temperature rise is 12 to 14 deg C and output voltage variation is $\pm 0.1\%$. Output impedance is $1100 + j3800$ ohms and input impedance is 1173 ohms. Required input is 115 v at 400 cps. The unit weighs 29 oz.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 203 ON READER-SERVICE CARD

Relay

Rated at 10 amp

This 10 amp 4pdt relay is available in both ac and dc operation models. Called E 410 H, it meets MIL-R-5757C, MIL-R-25018 and MIL-R-6106C. It weighs 0.4 lb and measures 1.44 x 1.44 x 2.25 in.

Electro-Mechanical Specialties Co., Inc., Dept. ED, Banning, Calif.

CIRCLE 204 ON READER-SERVICE CARD

Secondary Frequency Standard

Frequencies from 10 kc to 1000 mc



Crystal-controlled time-frequency calibrator model 1213-D provides standard frequencies from 10 kc to 1000 mc for equipment calibration and the measurement of unknown frequencies. Short-time stability is 1 part in 10^7 ; timing markers are provided at decade intervals from 0.1 to 100 μ sec. The unit has a touch-button deviator to introduce a small frequency decrease to establish sense in indications near zero-beat. The calibrator is 14-1/2 x 5-3/4 x 7 in. including a model 1203-B unit power supply.

General Radio Co., Dept. ED, West Concord, Mass.

CIRCLE 205 ON READER-SERVICE CARD

Silicon Rectifiers

Temperature range is -65 to $+125$ C



Operating in the temperature range of -65 to $+125$ C, these silicon rectifiers are designed for dc to ac inversion, dc static switching, pulse width modulation, power equipment frequency conversion, and current limiting circuit breaker use. The time required for the rectifier to regain its forward blocking state after forward current conduction is $12 \mu\text{sec}$. The piv ratings are 100, 150, 200, 250, and 300 v. These rectifiers carry continuous average forward currents up to 16 amp and handle reverse recovery currents of 20 amp.

General Electric Co., Semiconductor Products Dept. ED, Liverpool, N.Y.

CIRCLE 206 ON READER-SERVICE CARD



Data Plotting Boards

For dc analog signals

Types MC-3301 and MC-3302 data plotting boards are designed to plot one dc analog signal, or two signals simultaneously, on a 30 x 30 in. surface. Type MC-3301 has a one arm-pen assembly; type MC-3302 has two. Equipped with 400-cps plug-in servo amplifiers and plug-in power supplies, they can receive input from two or four channels of analog input data. Maximum plotting sensitivity is 20 in. per v. The pens plot at 30 in. per sec. The plot in either direction is linear with respect to input voltage to within $\pm 0.05\%$ of full scale. Dynamic accuracy is $\pm 0.05\%$ at speeds to 10 in. per sec. The units are transistorized.

Computer Systems, Inc., Dept. ED, 611 Broadway, New York 12, N.Y.

CIRCLE 207 ON READER-SERVICE CARD

a valuable first edition for circuit engineers

MOTOROLA'S new zener diode handbook

Here's the first manual of its kind—a 126-page guide to the basic theory, design characteristics and applications of zener diodes. These versatile, voltage-limiting components help solve circuit problems. Motorola's handbook tells how—and describes how the properties of these relatively new devices can be utilized in countless creative applications in industry.

This handbook is available from your nearest Motorola Semiconductor Distributor for only \$1. Call or write today for your copy!

THIS FIRST EDITION CONTAINS:
Nearly 150 illustrations, graphs and tables
...plus chapters devoted to:

- Characteristics of Silicon Zener Diodes
- Design Considerations
- Regulated Power Supplies
- Surge Protection
- AC and DC Amplifiers
- Temperature Compensation and Impedance Cancellation
- New Approaches in Zener Diode Applications
- The Motorola Zener Diode Slide Rule Calculator
- Specifications and Testing Methods



MOTOROLA



SPECIAL SLIDE RULE AVAILABLE

For rapid calculations involved in designing circuit configurations with Motorola Zener Diodes, use this special zener slide rule. It handles most design problems in zener applications. Available from your Motorola Semiconductor Distributor for just \$1.



MOTOROLA SEMICONDUCTOR DISTRIBUTORS

ALAMOGORDO	Radio Specialties, 209 Penn Ave.
BIRMINGHAM	Ack Radio Supply Co., 3101 Fourth Ave., So.
BOSTON	Cramer Electronics, Inc., 811 Boylston St.
CAMDEN	General Radio Supply Co., 600 Penn St.
CEDAR RAPIDS	Deeco Inc., 618 First St., N. W.
CHICAGO	Allied Radio Corp., 100 N. Western Ave. Newark Electric Co., 223 W. Madison St.
CLEVELAND	Main Line Cleveland Inc., 1260 E. 38th St.
DENVER	Denver Electronic Supply Co., 1254 Arapahoe St.
DETROIT	Radio Specialties Co., 456 Charlotte Ave.
HOUSTON	Lenert Co., 1420 Hutchins
JAMAICA, N. Y.	Lafayette Radio, 165-08 Liberty Ave.
LOS ANGELES	Kierulff Electronics, 820 W. Olympic Blvd.
MELBOURNE, FLA.	Electronic Supply, 909 Morningside Dr.
MIAMI	Electronic Supply, 61 N. E. 9th St.
NEW YORK	Milgray Electronics, 136 Liberty St. Lafayette Radio, 100 6th Ave.
OAKLAND	Elmar Electronics, 140 11th St.
PHOENIX	Radio Specialties, 917 N. 7th St.
SAN DIEGO	San Delco, 3821 Park Blvd.
WASHINGTON, D. C.	Electronic Industrial Sales, 2345 Sherman Ave., N.W.

FOR TECHNICAL INFORMATION on Motorola zener diodes and for details on recent price reductions, contact your nearest Motorola Semiconductor regional office:

RIDGEFIELD, N. J.	CHICAGO 39, ILL.	HOLLYWOOD 28, CALIF.
540 Bergen Blvd.	5234 W. Diversey Ave.	1741 Ivar Ave.
WHitney 5-7500	Avenue 2-4300	HOLLYWOOD 2-0821
(from New York, WI 7-2980)		

Outside U. S. and Canada: MOTOROLA INTERNATIONAL, S. A.
4545 W. Augusta Blvd., Chicago, Ill.



"DEPENDABLE QUALITY - IN QUANTITY"

MOTOROLA SEMICONDUCTORS

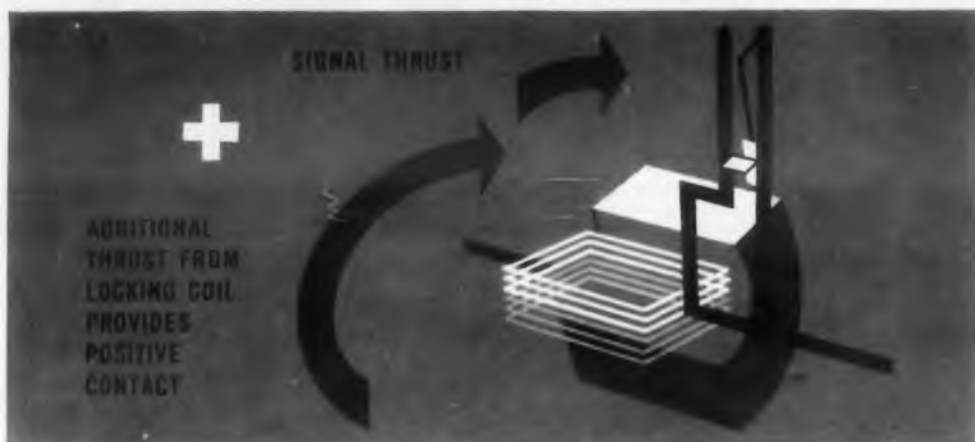
MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

CIRCLE 208 ON READER-SERVICE CARD

FOR DEPENDABLE CONTROL AT LOW COST
USE A.P.I. METER-RELAYS



WITH LOCKED-IN RELIABILITY



Simple, sensitive and accurate . . . the A.P.I. meter-relay is also a rugged-performance instrument that will monitor and control any electrically measurable variable. It will do so with great reliability.

Consider this: the A.P.I. meter-relay is capable of operating for more than 10,000,000 make-break cycles, with perfect contact every time. Because reliability is "locked-in."

How so? A unique locking coil does the trick. It supplements the torque developed by the sensitive D'Arsonval meter movement, drives the indicator and set-point contacts together, creating a firm, sure electrical circuit. And because this action automatically spring loads the contact on the set-point arm, break-contact is clean and decisive, with no teasing or sticking.

Another significant fact about the A.P.I. meter-relay: you can use it with very tiny current or voltage inputs. Full scale sensitivity can be as small as 5 microamperes or 5 millivolts. No signal amplification necessary. Use it with thermocouples, photoelectric cells . . . any sensing element you wish — all you need is some electricity.

Why not explore the design possibilities inherent in the low-cost meter-relay? Catalog 4E gives full data.



ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

S.A. 1870

CIRCLE 209 ON READER-SERVICE CARD

Isolated Outputs from Twin Double-Plate Triode

BY PROVIDING two plates for each triode section of a twin triode receiving tube, two well-isolated outputs can be taken from each stage. Registered as the 12FQ8, the "twin double-plate triode" also offers equipment designers economy in cost and space.

Applications

Currently produced in mass-production quantities by the General Electric Receiving Tube Dept. in Owensboro, Ky., the tube is being used by the Wurlitzer Co. in an electronic organ design featuring special effects.

Tone signals are taken from two separate plates of each frequency generator stage. One output is fed to a standard tone amplifier while the second output is

available for switching to a "percussion effect" circuit. Due to the excellent isolation between outputs, there is virtually no interaction or degradation effects.

While the same results could be obtained from separate tubes, the availability and use of two anodes in each triode section permits a reduction in the total number of tubes required.

Although presently used in musical instrument devices, the 12FQ8 tube can materially reduce the tube quantity in equipment requiring minimum interaction between two outputs from a single input source.

Electrical Ratings

The 12FQ8 is a nine-pin miniature twin triode with each section having two

AVERAGE PLATE CHARACTERISTICS
EACH SECTION

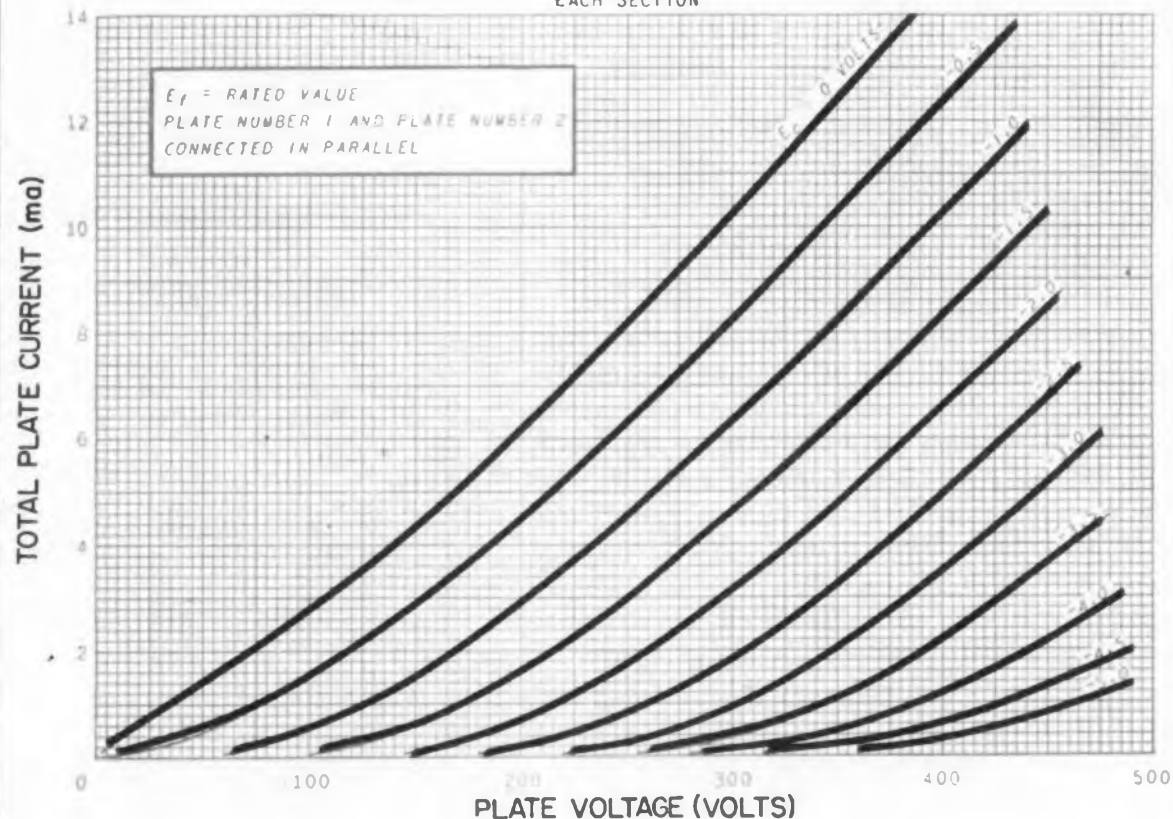
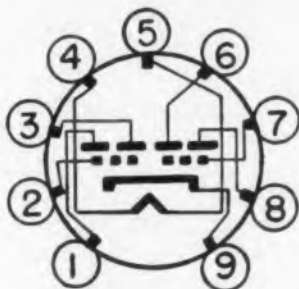


Fig. 1. Average transfer characteristics of each triode section of the 12FQ8.

BASING DIAGRAM

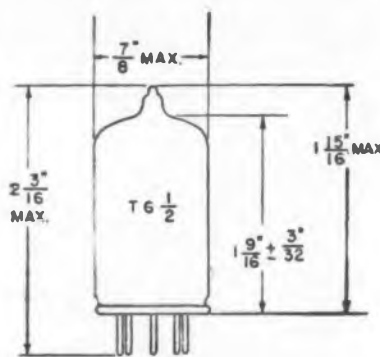


EIA 9KT
(a)

TERMINAL CONNECTIONS

- Pin 1—Plate Number 2 (Section 2)
- Pin 2—Grid (Section 2)
- Pin 3—Plate Number 1 (Section 2)
- Pin 4—Heater
- Pin 5—Heater
- Pin 6—Plate Number 2 (Section 1)
- Pin 7—Grid (Section 1)
- Pin 8—Plate Number 1 (Section 1)
- Pin 9—Cathode

PHYSICAL DIMENSIONS



EIA 6-2
(b)

Fig. 2. (a) Base diagrams for 12FQ8 tube. (b) Physical outline of tube.

plates brought out to separate base pins. Each of the four plates is rated at a maximum of 330 v and 0.5 w dissipation. In typical operation with the plates at 250 v and grids at -1.5 v, the amplification factor of the grids to each plate is 95 and the transconductance is 1250 μ mhos, measured with the other plate of the same section grounded. In this condition, each plate draws 1.5 ma and represents a plate resistance of 76K.

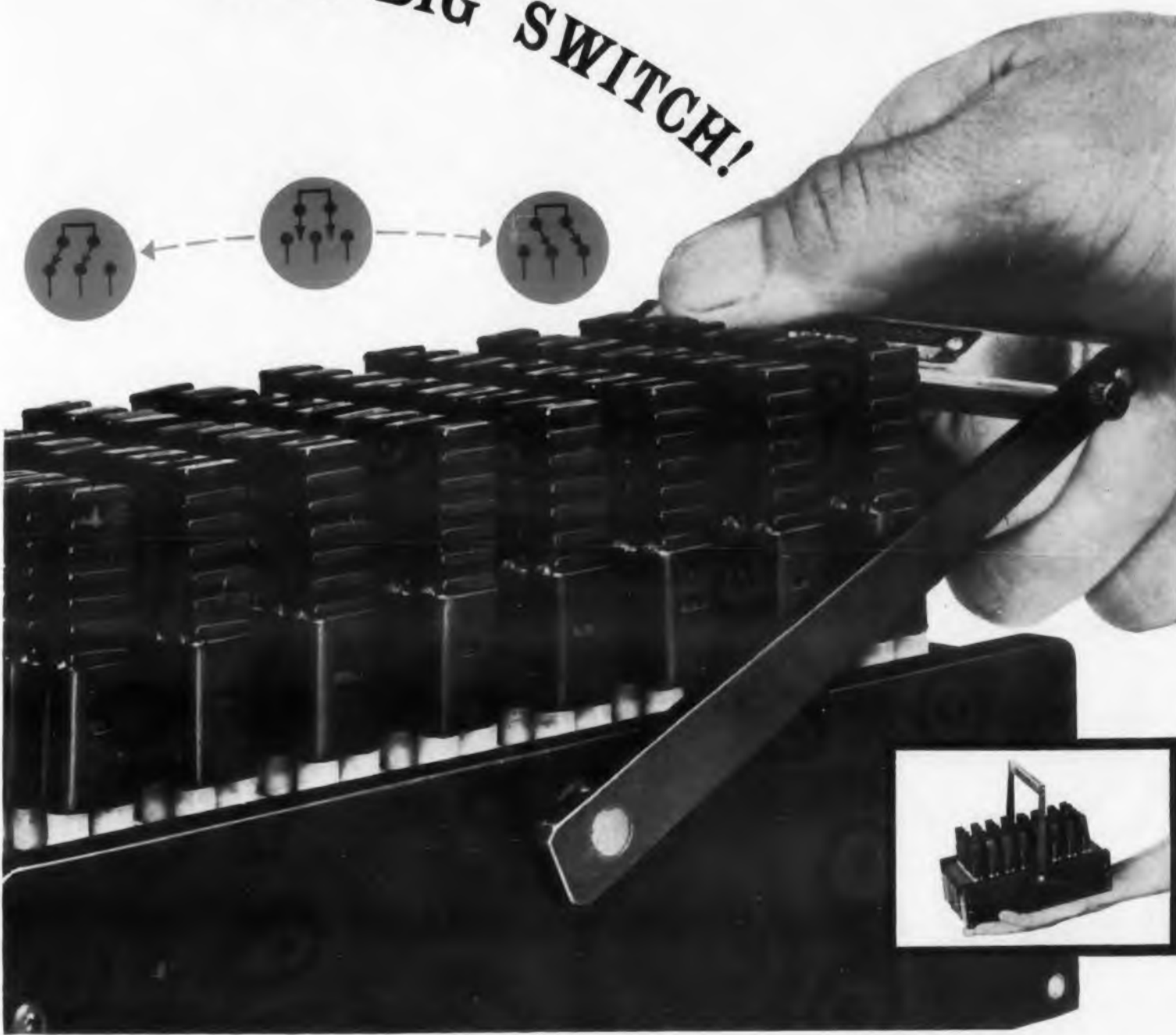
For more information on the 12FQ8, turn to the Reader-Service Card and circle 100.

Just flick your finger. That's all you do to select either of two circuit programs with AMP's new Program Selector Switch—up to 1500 poles, double throw. Compact in size, available in a fully shielded type, this new switch offers you all the reliability you need for any critical dry-circuit application.

The flick of your finger also pre-cleans all contacts for assured conductivity through AMP's patented wiping action. You get uniform pressure on all contacts . . . choice of tin or gold contact finish . . . exclusive contact and spring design plus many other features from AMP's industry-proved Patchcord Programming Systems . . . including A-MP Taper Pins, crimped to your leads and inserted into taper receptacles in the rear of the switch.

And—for flexibility, you can make a combination plug board and double throw switch with all throw positions independently patched.

THE BIG SWITCH!



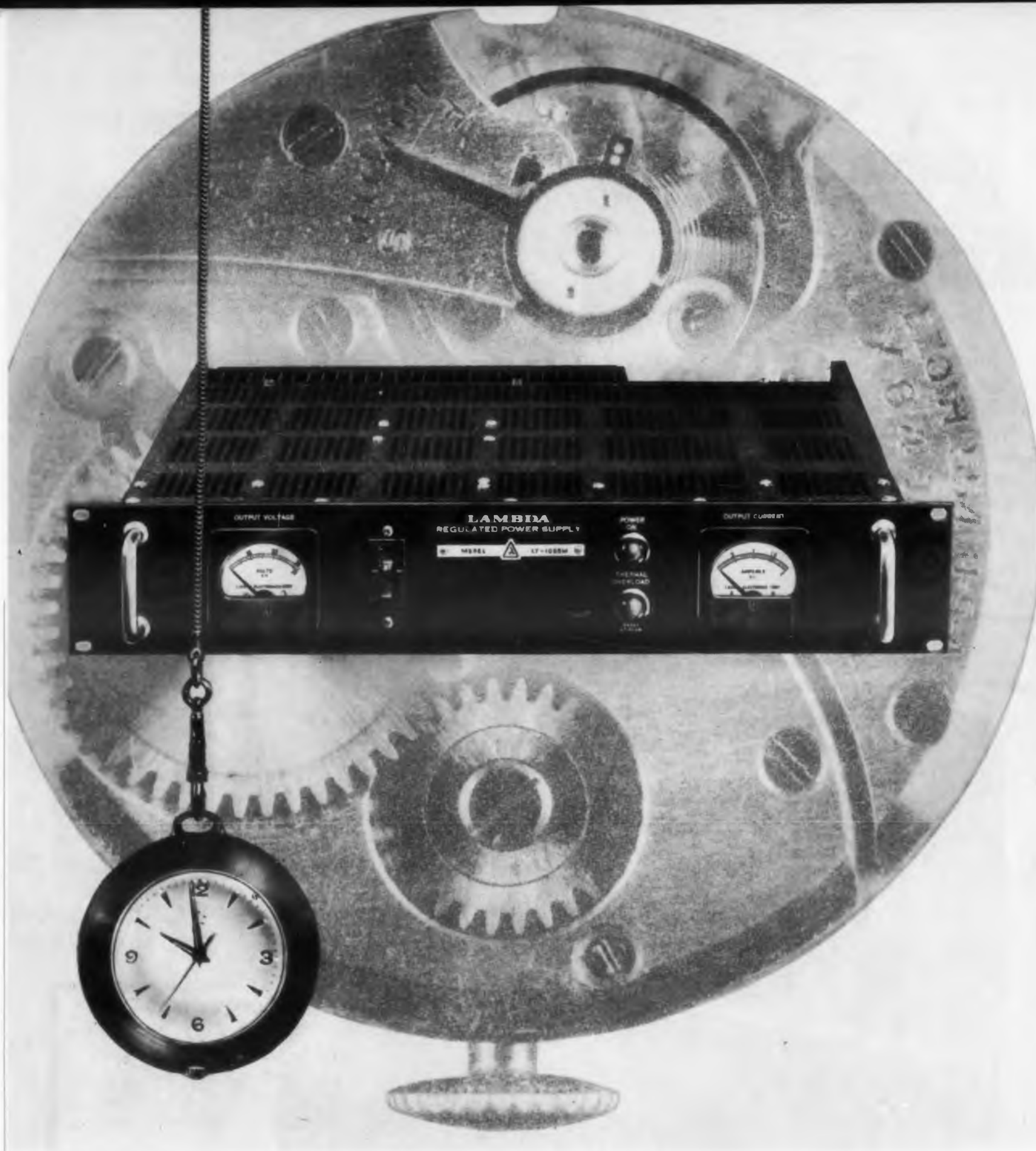
Make the big switch to the A-MP Double Throw Program Selector Switch. Send today for more information.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

CIRCLE 210 ON READER-SERVICE CARD



Guaranteed: around-the-clock performance for five years

Freedom from worry about major maintenance or extensive replacement for *five full years*. That's the guarantee given with every Lambda power supply—the first such guarantee in the electronics industry. It proves the point engineers keep making in preference studies: When operating conditions make dependability a “must,” they specify Lambda...

LAMBDA POWER SUPPLIES

LAMBDA ELECTRONICS CORP., 11-11 131 STREET, COLLEGE POINT 56, N. Y.

Send for
32-page
Catalog



NEW PRODUCTS

Tach Generator

Compact design



Designed for applications where space must be conserved, type 6227-03 tach generator with size 10 motor measures 1.281 in. long and weighs 2.5 oz. The ambient temperature range is -55 to $+100$ C and the rotor inertia is 0.65 g-cm². The motor section has 26 v fixed phase, 35 v center tap control phase, 0.3 oz-in. stall torque, and 6500 rpm no load speed. The generator section has 10 v input and 0.16 v per thousand output. The housing is stainless steel.

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

CIRCLE 211 ON READER-SERVICE CARD

Resistors

Wirewound type



These wirewound resistors have ratings at 25 C of 3, 5, and 10 w. At 200 C their ratings are 1, 1.5, and 3 w respectively. Temperature coefficient is \pm ppm per deg C even at the maximum operating temperature of 275 C. These units meet MIL-R-9449 and the 1000 v V-block test of MIL-R-26C. Standard units have 1% tolerance; tolerances to 0.1% can be ordered. The resistors are wound helically on ceramic cores and have a jacket of silicone-ceramic pressure-molded around the core.

Ohmite Mfg. Co., Dept. ED, 3657 Howard St., Skokie, Ill.

CIRCLE 212 ON READER-SERVICE CARD

◀ CIRCLE 213 ON READER-SERVICE CARD

for immediate
delivery of
**General
Instrument
semiconductors**
at factory prices
call your
stocking distributor

The authorized distributors listed below carry a full stock of all General Instrument semiconductors — and can give you immediate delivery from stock:

**SILICON RECTIFIERS
TRI-AMP RECTIFIERS
SELENIUM RECTIFIERS
SILICON DIODES
GERMANIUM
DIODES**



CALIFORNIA

Valley Electronic Supply Co.
1302 W. Magnolia Blvd., Burbank
Shanks & Wright, Inc.
2045 Kettner Blvd., San Diego
Pacific Wholesale Co.
1850 Mission St., San Francisco

DISTRICT OF COLUMBIA
Silberne Industrial Sales Corp.
3400 Georgia Ave., NW

ILLINOIS

Merquip Company
5904 W. Roosevelt Rd., Chicago

INDIANA

Brown Electronics, Inc.
1032 Broadway, Fort Wayne
Graham Electronics Supply, Inc.
122 S. Senate Ave., Indianapolis

MARYLAND

D & H Distributing Co.
2025 Worcester St., Baltimore

MASSACHUSETTS

The Greene Shaw Co., Inc.
341-347 Watertown St., Newton

NEW YORK

Hudson Radio & TV Corp.
37 W. 65th St., NYC
Sun Radio & Electronics Co., Inc.
650 Sixth Ave., NYC

OHIO

The Mytronic Company
2145 Florence Ave., Cincinnati
Pioneer Electronic Supply Co.
2115 Prospect Ave., Cleveland
Buckeye Electronic Distributors, Inc.
236-246 E. Long St., Columbus

OKLAHOMA

Oil Capitol Electronics
708 S. Sheridan, P.O. Box 5423, Tulsa

PENNSYLVANIA

D & H Distributing Co.
2535 N. 7th St., Harrisburg
Herbach & Rademan, Inc.
1204 Arch St., Philadelphia

WASHINGTON

Seattle Radio Supply Co.
2115 Second Ave., Seattle

WISCONSIN

Radio Parts Co., Inc.
1314 N. 7th St., Milwaukee

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION

AUTOMATIC

**silicon
rectifiers**

all the
available

**JAN
TYPES**

to meet MIL-E-1 specifications

Maximum Values for AUTOMATIC Military Type Silicon Rectifiers

Type No.	Peak Reverse Voltage (VDC)	DC Output Current (MA)			Maximum Reverse Current (MA)	Mounting	MIL-E-1 Technical Spec. Sheet No.
		Av. @ 135° C. Case Temp.	@ 25° C. Ambient	@ 150° C. Ambient			
1N253	100	1000	—	—	0.1*	Stud	1021A
1N254	200	400	—	—	0.1*	Stud	989B
1N255	400	400	—	—	0.15*	Stud	990B
1N256	600	200	—	—	0.25*	Stud	991B
1N538	200	—	750	250	0.350†	Axial Lead	1081A
1N540	400	—	750	250	0.350†	Axial Lead	1085A
1N547	600	—	750	250	0.350†	Axial Lead	1083A

*Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current; case temperature 135° C.

†Averaged over 1 cycle for inductive or resistive load with rectifier operating at full rated current at 150° C. ambients.

Without qualification, these rectifiers are the finest available today, designed and manufactured to meet stringent government requirements and the exceedingly high quality control standards of General Instrument Corporation.

These JAN types are offered in volume quantities for *on time delivery* at prices that reflect General Instrument's years of production experience. Data sheets on these and other AUTOMATIC silicon rectifiers are available upon request.

JAN
Type
1N538

JAN
Type
1N540

JAN
Type
1N547

JAN
Type
1N253

JAN
Type
1N254

JAN
Type
1N255

JAN
Type
1N256



Semiconductor Division

GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION,
AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC.,
AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

GENERAL INSTRUMENT DISTRIBUTORS: Baltimore: D & H Distributing Co. • Chicago: Merquip Co. • Cleveland: Pioneer Electronic Supply • Los Angeles: Valley Electronics Supply Co. • Burbank • Milwaukee: Radio Parts Co., Inc. • New York City: Hudson Radio & Television Corp., Sun Radio & Electronic Co. • Philadelphia: Herbach & Rademan, Inc. • San Diego: Shanks & Wright Inc. • San Francisco: Pacific Wholesale Co. • Seattle: Seattle Radio Supply • Tulsa: Oil Capitol Electronics

CIRCLE 214 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

CIRCLE 215 ON READER-SERVICE CARD

POSITIVE PROTECTION

The new AIRPAX Series 500 Miniature Magnetic Circuit Breaker has an inverse time delay mechanism providing a trip level which is unaffected by ambient or operating temperature. Only slightly larger than an "ON-OFF" switch, it replaces a switch, fuses and overload relays. Hermetically sealed and explosion proof, its operation is unaffected by severe shock and vibration. Available with long or short time delay in 50 volt DC ratings from 50 MA to 10 AMPERES: 120 RMS volts at 60 or 400 CPS with ratings from 1 to 10 AMPERES.

AIRPAX SERIES 500 CIRCUIT BREAKER



CIRCLE 216 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Comparator

Has three ranges



Model 5 voltage comparator has these three ranges: 0 to 10, 0 to 100, and 0 to 1000 v dc. Accuracy is 0.1%, response time is 0.1 sec, and sensitivity is better than 1 mv. Power requirements are 105 to 125 v ac at 60 cps. Applications include automatic system fault identification, automatic voltage calibration, and continuous monitoring of voltage or any electrical or physical variable that may be converted to a dc voltage.

Optimized Devices, Inc., Dept. ED, 864 Franklin Ave., Thornwood, N.Y.

CIRCLE 217 ON READER-SERVICE CARD

Resistance Wire

Diameters from 0.0031 to 0.0005 in.

This low density resistor alloy has a resistivity of 815 ohms per cmf at 20 C. Called 815-R, it is of iron-chromium-aluminum composition and is available precision drawn with diameters from 0.0031 to 0.0005 in. The alloy possesses a low temperature coefficient of resistance which is inherently controlled within limits of ± 0.00001 ohm per ohm per deg C.

Hoskins Mfg. Co., Dept. ED, 4445 Lawton Ave., Detroit 8, Mich.

CIRCLE 218 ON READER-SERVICE CARD

Solid Tantalum Capacitors

Capacitances of 1 to 330 μ f



Operating at a temperature range of -55 to $+125$ C, these solid tantalum capacitors are available with capacitances from 1 to 330 μ f. When measured at 25 C and 120 cps, tolerance is $\pm 20\%$ of rated value. Leakage current at rated voltage and 25 C is below 0.03 μ a per μ f per v. The dissipation factor is under 6%.

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

CIRCLE 219 ON READER-SERVICE CARD

Pulse Generators

Modular Construction



Typical of this series of modular construction programmed pulse generators, type II-507B delivers four different pulse programs to two signal outputs with sync pulses at various pulse repetition frequencies. The units have a preset counter allowing choice of the number of pulses or words per program. The use of transistors and cold-cathode gas tubes keeps power consumption at 8 w.

Iconix, Inc., Dept. ED, 945 Industrial Ave., Palo Alto, Calif.

CIRCLE 220 ON READER-SERVICE CARD

Solder Preforms

For temperatures from 158 to 1800 F

For automatic soldering at temperatures from 158 to 1800 F, these soft solder preforms are available as rings, discs, washers, pellets, castings, balls, spheres, and special shapes. The rings and pellets have a core of acid or rosin flux and are available in wire diameters of 0.003 to 0.735 in. The ball or sphere-shaped preforms are made in a wide range of alloys and have diameters of 0.002 to 0.125 in.

Alloys Unlimited, Inc., Dept. ED, 21-01 43rd Ave., Long Island City, N.Y.

CIRCLE 221 ON READER-SERVICE CARD

Relay Actuator

Has no moving parts



This relay actuator senses the magnetic field created by the current in a wire placed in the hole of the toroid. Actuation can be as low as 4.5 amp, depending on the relay used. The toroid is enclosed in epoxy material. The actuator has no moving parts and eliminates the need for mechanical timers.

L and B Electronics, Dept. ED, 2424 Sixth St., Berkeley, Calif.

CIRCLE 222 ON READER-SERVICE CARD

IN DELAY LINES... ALL ROADS LEAD TO ESC

ESC was the first company devoted exclusively to the design and manufacture of custom built and stock delay lines... for all military and industrial applications. ESC was also the first to provide complete laboratory reports with each delay line prototype... containing submitted electrical requirements, photo-oscillograms (which indicate input and output pulse shape and output rise time), the test equipment used, and an evaluation of the electrical characteristics of the prototype.

Whatever the application, ESC can design and build precisely the delay line you need—easily, efficiently and exactly as specified.

PLEASE WRITE FOR
COMPLETE TECHNICAL DATA



ESC

CORPORATION
534 Bergen Boulevard, Palisades Park, New Jersey



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

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

CIRCLE 223 ON READER-SERVICE CARD

how small do you need them?

tiny switches?

LOOK AT THESE...

moisture proof?
SEE HERE...



basic snap-action switches

FOR AIRCRAFT, MISSILE,
ELECTRONIC AND
INDUSTRIAL APPLICATIONS



- quality engineered designed to meet human factors
- over 60,000 switch and actuator variations available
- adaptations can be made to fit your requirements

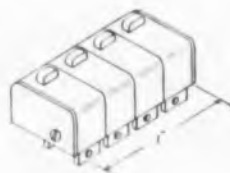
sub-sub-miniature



actual size
T series
SPDT

Only .526" L. x .250" W. x .323" H. No dead break, perfect for super-sensitive uses. High repeatability, only one moving part besides button. Rugged construction withstands extreme shock and vibration.

Amb. Temp. T-3 -65° to +250° F.
T-7 -65° to +350° F.
Elec. 7.5 amps @ 125/250 V.A.C.
Rating: 7.5 amps Res. @ 30 V.D.C.
3 amps Ind. @ 30 V.D.C.



gang in min. space w/close-tolerance mtg.



A3-59/T-3



A5-71/T-3



A5-73/T-3 roller leaf

new designs on the boards, send us your requirements

sub-miniature



actual size
E4-100 series
SPDT

L.W.H. 25/32" x .250" x 23/64"

Elec. 5 amps @ 125/250 V.A.C.
Rating: 4 amps Res. @ 30 V.D.C.
2.5 amps Ind. @ 30 V.D.C.

Operating Force 150 grams max.
Amb. Temp. -65° to +250° F.
E4-107 -65° to +350° F.

Variety of termination and operating characteristics. For switches meeting Military and U.L. approval, write for details.



A3-32/E4-103 maintained



A3-47/E4-103 momentary



A4-14/E4-103



A4-15/E4-103 adj. move. diff.



A4-82/E4-103 removable plastic button



A4-87/E4-103 alternate action



A5-10/E4-103 roller leaf



A9-7/E4-103 rotary

miniature

ENVIRONMENT FREE



actual size
EF-100 series
SPDT

L.W.H. 3/8" x 11/32" x 19/32"

Elec. 5 amps @ 125/250 V.A.C.
Rating: 4 amps Res. @ 30 V.D.C.
2.5 amps Ind. @ 30 V.D.C.

Operating Force 5 to 17 oz.
Amb. Temp. -65° to +180° F.
EF-105 -65° to +350° F.

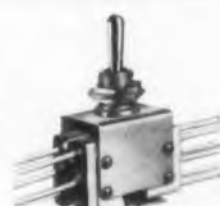
Termination, 12" of 20 ga. wire epoxy resin sealed. Enclosed basic switch conforms to MIL-S-6743, with entire unit meeting MIL-E-5272A.



A3-30/EF-103 maintained



A3-38/EF-103 momentary



A3-51/EF-103 momentary, 3 position (center off)



A4-58/EF-103 roller ball, cam act.



A5-59/EF-103 leaf



A5-103/EF-103 roller leaf



C2-33/EF-103 interlock

LIGHTED PUSH-BUTTON PANEL SWITCHES

The industry's most complete line. Models light up in any of one to four colors, with round or rectangular buttons. All units relampable from front of panel. Make possible revolutionary ASTROMATIC panel concept which simplifies and reduces complex monitoring and control centers to small, efficient, pictorial lighted panels. Write for data on lighted switches or complete ASTROMATIC panels.

ELECTROSNAP CORPORATION

Switch Division

West Lake Street • Chicago 24, Illinois
Telephone VAn Buren 6-3100 • TWX CG-1400

CIRCLE 226 ON READER-SERVICE CARD

NEW PRODUCTS

Wirewound Resistors

Have resistances of 130 to 5000 ohms



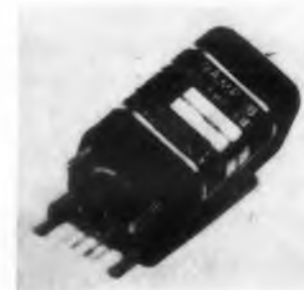
For use in control circuits, computers, and meters, series FM wirewound resistors are available with resistances from 130 to 5000 ohms. The temperature coefficient is 0.002% per deg C for resistors wound with Karma alloy and 0.015% per deg C for resistors wound with Nichrome. Standard tolerance is 1%. The units are equipped with pigtail wire axial leads using No. 20 tinned annealed copper wire. Insulation resistance between body and leads is 900 v min.

Precision, Inc., Dept. ED, 4748 France Ave. N., Minneapolis, Minn.

CIRCLE 224 ON READER-SERVICE CARD

Servo Amplifier

Plug-in type



Designed to receive signals from a synchro control transformer and to operate a servo motor, model 1800-3500 miniature servo amplifier is a hermetically-sealed, plug-in unit. Input impedance is 10,000 ohms, voltage gain is 0.8 v per mv, and power gain is 70 db. The phase shift is adjusted internally to provide 90 deg voltage required by the motor. The carrier frequency is 380 to 420 cps. Output is 20 v at 400 cps when used with a typical servo motor load. Required input is 28 v dc at 150 ma. The unit operates in a temperature range of -55 to +71 C. It measures 1-1/8 x 1-1/8 x 1-55/64 in. and weighs 3 oz.

M. Ten Bosch, Inc., Dept. ED, Pleasantville, N.Y.

CIRCLE 225 ON READER-SERVICE CARD

CIRCLE 226 & 227 ON READER-SERVICE CARD

Power Supplies

Have 20 to 230 v ac output



The series 500 power supplies provide adjustable outputs of 20 to 230 v ac. Output frequencies may be variable, fixed, or in combination; fixed frequency outputs range from 300 cps to 5 kc. Load regulation is 5%. Typical input specifications are: 115 v, 60 cps, single phase, for units with output to 500 va; 230 v, 60 cps, single phase, three wire, for units rated at 750 to 2000 va; and 230, 60 cps, three phase for units with over 2000 va output. The units are designed for use in production testing, ground check-out systems, and other applications.

Matrolog Corp., Dept. ED, 169 N. Halsted St., Pasadena, Calif.

CIRCLE 228 ON READER-SERVICE CARD

Test Chamber

Produces temperatures from -65 to +540 F



Designed for thermal shock and other controlled temperature testing, these chambers have temperature ranges from -65 to +540 F. Temperature uniformity and CO₂ dispersal is achieved by a built-in air circulation system. Temperature chart recorder provides 24 hr record of chamber temperatures. Units are equipped to accommodate through wall connections for test articles.

Electric Hotpack Co., Inc., Dept. ED, 5074 Cottman Ave., Philadelphia 35, Pa.

CIRCLE 229 ON READER-SERVICE CARD



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



Edgewise: Vertical, DC



Wide-View: 2½", 3½", 4½"; AC and DC

These are Simpson panel instruments...



Round: 3", DC



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



Front Adjust Relay: 2½", 3½", 4½"; DC. Rectangular also.

engineered and built to stay accurate...



Elapsed Time: 3½", 60-cycle AC



Fan Shape: 4½", AC or DC



Modernistic: 2½", 3½", 4½", 5½"; AC, DC, RF

available from stock or custom-built

METERS FOR EVERY NEED
Simpson
ELECTRIC COMPANY

5202 W. Kinzie St., Chicago 44, Ill.

Phone: EStbrook 9-1121

In Canada: Bach-Simpson Ltd., London, Ontario

CIRCLE 230 ON READER-SERVICE CARD

Reserved For You

Ward William & Company, Advertising

*over 400 microwave frequency meter or filter designs

With hundreds to choose from, you can select the microwave frequency meter or tunable band pass filter to meet your exact requirement. If the unit you need is not already in stock, it can be produced readily by *modifying* one of the Frequency Standards meters or filters now *available*. This means both minimum lead time and development costs.

Send your technical requirement for a prompt analysis or meet with our staff to discuss your specific problem.

Literature on Standard Products Available on Request

FREQUENCY STANDARDS
 Division of Harvard Industries, Inc. Box 504, Asbury Park, New Jersey
 Phone: PRospect 4-0500 TWX A PK 588

NEW PRODUCTS

Cartridge Lamps Rated at 12.8 v, 1.02 amp



Types 211 and 212 cartridge lamps are rated at 12.8 v, 1.02 amp and have a light output of 15 cp and 6 cp respectively. Each is rated for 100 hr continuous operation, is 1-3/4 in. long, and has a bulb diameter of 0.6 in. Steel end caps are 0.335 in. in diam. They are made for such uses as radio and panel lamps.

Tung-Sol Electric Inc., Dept. ED, 1 Summer Ave., Newark 4, N.J.

CIRCLE 231 ON READER-SERVICE CARD

Oscillators

Cover 1 to 18 kmc



The series 620 microwave oscillators, covering the 1 to 18 kmc frequency range, provide electronic sweep of rf output or extremely stable cw operation. All models have linear frequency sweep coverage over all or part of each band for evaluation of reflection coefficient, gain, attenuation, and other characteristics. Rise and fall response to am is 0.5 μ sec. The units include two adjustable frequency markers.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

CIRCLE 232 ON READER-SERVICE CARD

CIRCLE 233 ON READER-SERVICE CARD

Voltmeter

Measures to 100 kv static charge



Designed to measure static charges, model 250 electrometer voltmeter has full scale ranges of 10 and 30 kv when the detecting head is about 3/8 in. from the charged surface. Up to 100 kv can be measured with the detecting head at a distance of 6 in. The instrument has an accuracy of 5% and provides indication of both positive and negative voltages. It can be used to measure electrostatic charges on plastics, paper, and hydrocarbons.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

CIRCLE 234 ON READER-SERVICE CARD

Toggle Switch

Bat handle travels 50 deg



Designed especially for control panels, this toggle switch permits the bat handle to travel 50 deg. A chrome-plated jam nut fastens the 15/32 in. bushing to the panel. The switch is available with dpdt or 3pdt. Each circuit is rated at 5 amp 125 v ac, 4 amp 30 v dc, and 2.5 amp 30 v dc inductive.

Electrosnap Corp., Dept. ED, 4218 W. Lake St., Chicago 24, Ill.

CIRCLE 235 ON READER-SERVICE CARD

CIRCLE 236 ON READER-SERVICE CARD

BUILT-IN RELIABILITY



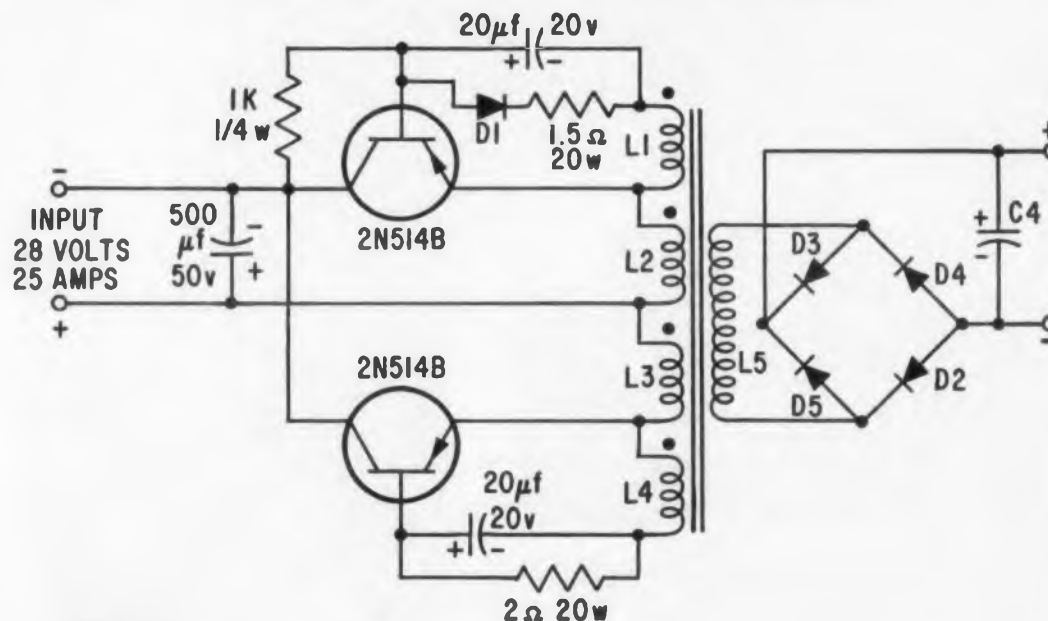
Low R_{cs} (0.05Ω) at high temperatures insured by large ring emitter-base area. Leakage currents minimized by all welded construction . . . no contaminating solders or fluxes used!



High current-carrying capacity and maximum safety against over-heating provided by heavy 90-mil emitter lead.

GERMANIUM TRANSISTOR APPLICATION NOTES

630 WATT DC-TO-DC POWER CONVERTER 90% EFFICIENT



NOTES

L5 may be wound according to the output voltage desired, allowing about 0.639 turns per volt. The wire size should be large enough to allow one circular mil per millampere. The output current and load will then determine D2, D3, D4, D5, and C4.
L2, L3—17 turns each #10 bifilar wound
L1, L2—4 turns each #16

Core-type 50022-2A Magnetics, Inc.

Q1, Q2—2N514B 80 volt 25 amp each mounted on a minimum of 200 sq in. of 1/4" aluminum for operation up to 50°C.
D1—1N1124 mounted on a minimum of 1 sq in. of exposed aluminum 1/16" thick. Operation to 50°C.
Frequency about 1 kc.

REDUCE YOUR COMPONENT COSTS WITH ONE TI POWER TRANSISTOR!

Save on overall costs and *up your circuit reliability* by selecting one *specific* TI germanium power transistor for your high power circuitry job. The need for transistor paralleling is greatly reduced . . . and, in many applications, eliminated . . . with TI's newest high current alloy-junction power transistor series. If you are using two types in parallel for a 25-amp job, save by using *one* TI high current alloy-junction transistor! Ranging from 10 to 25 amps in 40, 60, or 80 volt types, all

units feature guaranteed gain at maximum rated currents and 1.5 volts V_{CE} . For your high current switching applications, all types highlight typical switching times at 25°C of 12.0 usecs (t_{on}) and 7.0 usecs (t_{off}).

Contact your nearest Texas Instruments sales engineer for applications assistance or your nearby TI distributor for off-the-shelf delivery at factory prices. For high reliability, high performance, and a full year product guarantee, you can rely . . . on TI!

maximum ratings at 25°C

	2N511	2N511A	2N511B	2N512	2N512A	2N512B	2N513	2N513A	2N513B	2N514	2N514A	2N514B	units	
V_{CBO}	Collector-to-Base Voltage ($I_C = -5\text{ma}$, $I_E = 0$)	-40	-60	-80	-40	-60	-80	-40	-60	-80	-40	-60	-80	v
V_{CEX}	Collector-to-Emitter Voltage ($V_{BE} = +0.2\text{v}$, $I_C = -5\text{ma}$)	-40	-60	-80	-40	-60	-80	-40	-60	-80	-40	-60	-80	v
V_{EBO}	Emitter-to-Base Voltage ($I_E = -5\text{ma}$, $I_C = 0$)	←-30	←-30	←-30	←-30	←-30	←-30	←-30	←-30	←-30	←-30	←-30	v	
I_C	DC Collector Current	←-10	←-10	←-15	←-15	←-20	←-20	←-25	←-25	←-25	←-25	←-25	a	
I_E	DC Emitter Current	←-10	←-10	←-15	←-15	←-20	←-20	←-25	←-25	←-25	←-25	←-25	a	
I_B	Base Current	←-5	←-5	←-5	←-5	←-5	←-5	←-5	←-5	←-5	←-5	←-5	a	
	Total Dissipation	←-80	←-80	←-80	←-80	←-80	←-80	←-80	←-80	←-80	←-80	←-80	w	
T_J	Junction Temperature	←-95	←-95	←-95	←-95	←-95	←-95	←-95	←-95	←-95	←-95	←-95	°C	

germanium and silicon transistors
silicon diodes and rectifiers
TAN-TICAP solid tantalum capacitors
precision carbon film resistors
sensistor silicon resistors

TEXAS



INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 • DALLAS, TEXAS

INTERNATIONAL RECTIFIER CORPORATION



RECTIFIER NEWS



644 Zener Diode Types Offer Advantages to Every Voltage Regulator Circuit

As compared to other voltage reference elements, the silicon diode regulator has a longer life expectancy because of its mechanical ruggedness. It does not deteriorate under storage nor age during its operating life. Small size and light weight make its use in airborne or portable equipment especially desirable from many standpoints.

International Rectifier Corporation now offers an extensive line of zener types numbering 644 in seven basic styles. From the miniature type rated at 750 milliwatts to the precision 1N430 reference element types, all are manufactured to meet the most rigid military requirements. See how these all-welded, hermetically sealed diodes can improve your circuit design. . . .

CIRCLE READER SERVICE CARD NO. 250

Miniature Voltage Reference Packs Maintain Voltage Regulation to within $\pm 0.01\%$!



REF-PAK MODEL 4RV8
Standard MIL Transformer Case

Designed around the highly stable 1N430 silicon reference element, these miniature reference supplies may be considered to be the solid state equivalent of the standard cell. A high degree of stability is attained by maintaining a precise constant current through the reference element, regardless of temperature or line voltage variations.

Ref-Paks will operate directly from



REF-PAK MODEL RV8-PC
Special Housing for insertion into printed circuit boards.

an unregulated power source . . . maintain voltage regulation to within $\pm 0.01\%$! Output voltages of either 8.4 or 16.8 volts dc are available in 5 distinct types that allow operation from 28 or 115 volt dc, 400 and 60 cycle power supplies. Temperature coefficient of these devices is $\pm 0.001\%/^{\circ}\text{C}$ from -55° to $+100^{\circ}\text{C}$.

For complete details ask for SR-401.

CIRCLE READER SERVICE CARD NO. 252

ZENIAC Provides a Shortcut to the Application of Silicon Zener Diodes

A flip of the Zeniac selector switch quickly tells you the exact diode required in complex breadboard circuitry. This unique innovation — the first semiconductor substitution box in history — has been designed specifically to aid system design groups by saving valuable lab time in the application of zener diodes.

Two units are available, each housing 11 diodes in voltage steps from 3.9 thru 27 volts. Model A Zeniac is rated at 1-watt; Model B is rated at 10-watts. Both are now in stock at your Authorized Distributor. Ask for details on this time saver . . .



CIRCLE READER SERVICE CARD NO. 251

Technical Service Provides XY Plot of Reverse Breakdown Characteristics of Each Diode in all Prototype Orders

To eliminate guesswork and tedious testing on your part, every zener diode sent on prototype orders will be accompanied by a specially plotted XY recording of its exact breakdown voltage point! This permanent record can come in mighty handy when it's time to match diodes or reorder to the same specs. This is just one of the many application engineering services we are prepared to extend to you at all times!

Write to the factory for Bulletin SR-250-A, a four page technical article describing the characteristics of zener diodes, how to select them, and application data with circuit schematics.

FOR SAME DAY SERVICE ON PRODUCT INFORMATION DESCRIBED ABOVE, SEND REQUEST ON YOUR COMPANY'S LETTERHEAD

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 9-6281 • CABLE RECTUBA
BRANCH OFFICES: NEW YORK CITY AREA OFFICE: 132 E. 70th St., TRafalgar 9-3330 • NEW YORK STATE AREA OFFICE: 2366 James St., Syracuse, N.Y., HOward 3-1441 • CHICAGO AREA OFFICE: 205 W. Wacker Dr., FRanklin 2-3888 • NEW ENGLAND AREA OFFICE: 17 Dunster St., Cambridge, Mass., UNiversity 4-6520 • PENNSYLVANIA AREA OFFICE: Suburban Square Bldg., Ardmore, Pa., Midway 9-1428 • MICHIGAN AREA OFFICE: 1799 Coolidge Hwy., Berkley, Mich., LINcoln 9-1144 • IN CANADA: International Rectifier of Canada, Ltd., 1581 Bank St., Ottawa, Ontario, Regent 3-6880

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

NEW PRODUCTS

Oscillator

Frequencies are to 1 mc



For use as a master timing clock for data-handling, this frequency standard stable oscillator has an accuracy of 10 ppm in the range of a few cycles to 1 mc. Warm-up time is 20 min at 25 C ambient temperature. Stability is 0.1 cycle per day over the temperature range of -40 to $+124$ F. The output is 1.5 v rms into 1000 ohms; required input is 17 to 18 v dc regulated. The unit measures 3-1/2 x 3-1/2 x 3 in.

RCA Victor Co., Ltd., Technical Products Marketing Div., Dept. ED, 1050 Lacasse St., Montreal, Que., Canada.

CIRCLE 237 ON READER-SERVICE CARD

Voltmeter

Frequency range is 2 to 200,000 cps



Model 2409 voltmeter measures true rms, peak, and average values of voltages over the frequency range of 2 to 200,000 cps. An accuracy of 0.5 db is obtained for true rms indication of signals with crest factors to 5 and over a 20 db range. The unit may be used as a vtvm or as a calibrated decade amplifier with 60 db gain.

B & K Instruments, Inc., Dept. ED, 3044 W. 106th St., Cleveland 11, Ohio.

CIRCLE 238 ON READER-SERVICE CARD

◀ CIRCLE 250, 251, 252 ON READER-SERVICE CARD

Delay Lines

Operate at -55 to $+125$ C

These miniature, distributed-constant delay lines operate in the temperature range of -55 to $+125$ C. The impedances are 50 to 2500 ohms, delay times are 0.02 to 1 μ sec, and rise times are 0.02 to 0.085 μ sec. Available with standard leads or terminals, the delay lines have barrel lengths of 1-1/8 to 9-3/8 in.

PCA Electronics, Inc., Dept. ED, 16799 Schoenborn St., Sepulveda, Calif.

CIRCLE 239 ON READER-SERVICE CARD

Servo Valve Amplifier

Weights 8 oz



For proportional control of hydraulic transfer valves in missile and aircraft guidance systems, this servo valve amplifier measures 4 in. long x 1-1/2 in. sq, and weighs 8 oz. The output is 8 ma dc push-pull into two 1400-ohm loads; the control signal is 0.5 to 2 v dc into a 300-ohm load.

Vickers Inc., Electric Products Div., Dept. ED, 1815 Locust St., St. Louis 3, Mo.

CIRCLE 240 ON READER-SERVICE CARD

Adhesive

Bonds silicone rubber to metal

Type EX-B579-1 adhesive bonds a wide variety of silicone rubbers to steel, aluminum, brass, copper, and other metals as well as to glass, porous ceramics, cured epoxies, phenolics, and other resins, synthetic fabrics and treated teflon. Bonding occurs during the room-temperature cure of the silicone rubber compounds. This one-part, one-coat adhesive does not stain and is resistant to broad temperature conditions.

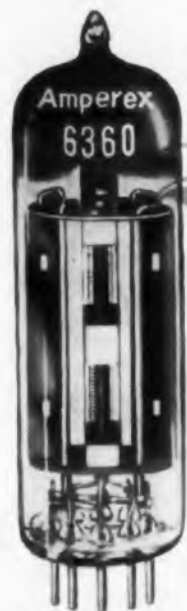
Hughson Chemical Co., Div. of Lord Mfg. Co., Dept. ED, Erie, Pa.

CIRCLE 241 ON READER-SERVICE CARD

CIRCLE 242 ON READER-SERVICE CARD



Amperex 6939
5 watts
total anode
dissipation



Amperex 6360
14 watts
total anode
dissipation



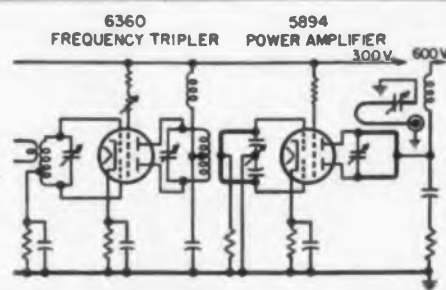
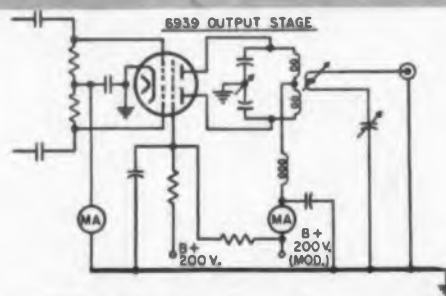
Amperex 6907
20 watts
total anode
dissipation



Amperex 5894
40 watts
total anode
dissipation

Compatibility

an Amperex® concept in tube design



Presenting a Compatible Family of 4 Twin Tetrodes, Specifically Designed to Simplify Circuitry in Mobile VHF/UHF Transmitter Design

These four AMPEREX twin tetrodes, designed from the ground up as a compatible group, complement one another in electrical and mechanical characteristics. The designer of light VHF and UHF transmitting equipment in the 5 to 85-watt category can draw on this group for all of his power amplifier, oscillator, frequency multiplier and modulator requirements, with considerable benefit in design efficiency. He can (1) save entire stages in his transmitter, (2) reduce power consumption requirements and (3) generally optimize transmitter design. The superior performance and reliability of the AMPEREX twin tetrodes, particularly in the 460 Mc band, have made them the most widely accepted small transmitting tubes in the world for amateur, professional, military and airborne applications.

Type	Max. Power Input (watts)	Max. Power Output (watts)
1 6939	14 ICAS 12 CCS	7.5 ICAS 5.8 CCS
2 6360	30 ICAS 22.5 CCS	18.5 ICAS 14.5 CCS
3 6907	112 ICAS 90 CCS	67 CCS
4 5894	150 ICAS 120 CCS	96 ICAS 90 CCS

Ask Amperex

about tubes and useful circuitry for VHF/UHF transmitters

AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, L.I., N.Y.

In Canada: Rogers Electronic Tubes & Components, 116 Vanderhoof Avenue, Toronto

GOOD-ALL CAPACITORS ASSURE

Circuit Stability

in **ELECTRONIC ORGANS**

GOOD-ALL 600UE, one of the types specified by leading manufacturers, excels in capacitance stability with life and has extremely high humidity resistance.

For these same reasons the 600UE has rapidly gained an excellent reputation for use in a wide range of fine instruments including oscilloscopes, professional quality recorders and closed circuit TV chains.

This premium capacitor costs surprisingly little more than conventional paper dielectric types.



SPECIFICATIONS

Construction . . . Mylar* dielectric molded in Epon** epoxy.
Extended foil winding.

Stability with life Less than 1% change after 10,000 hours under full rated conditions.

Insulation Resistance . . . Greater than 60,000 meg. x mfd. at 25°C, but need not exceed 180,000 megohms.

Temperature Range . . . Full rating —55°C to +85°C; to 125°C with 50% derating.

Voltage Ranges . . . 100, 200, 400 and 600 V.D.C.

Capacitance Tolerances . . . Standard tolerances ±20%; also available in ±10% and ±5%.

* DuPont's trade name for their space-saving polyester film.

** Shell's trade name for their epoxy resin plastic molding compound.

Write for detailed specifications.

The 600UE and other popular Good-All Capacitors are now available at
AUTHORIZED DISTRIBUTORS



GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEBRASKA

Some of the well known Electronic and Electric Organ manufacturers who specify Good-All Capacitors.

ALLEN
Allen organs

CONN
CONN ORGAN

LOWREY
LOWREY

WURLITZER

WURLITZER

Good-All is a leading Manufacturer of Tubular, Sub-miniature Electrolytic and Ceramic Disc Capacitors.

NEW PRODUCTS

Sweep Generators Variable Type



These four models of variable sweep generators are continuously adjustable from 0.01 to 100 cps per sec. Model LR-3 has a center frequency range of 4 to 15 mc; model LR-4, 10 to 35 mc; model LR-5, 20 to 75 mc; and model LR-6, 50 to 125 mc. For the first three models, the sweep width is variable from 0.05% to 40% of center frequency. The sweep width of model LR-6 is from 0.05% to 30%. Output is over 0.25 v rms into 50 ohms with better than 5% flatness over the maximum sweep width. Attenuation is from 1 to 120 db, in intervals of 1 db.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 244 ON READER-SERVICE CARD



Ratio Counter Has three banks

Developed for a military radio transmitter, this ratio counter tunes three bandwidths on one dial. The second bank displays a total equal to twice the reading of the first bank and the third bank shows twice the total of the second bank. The counter may be supplied in ratios to fit the customer's specifications. It meets military requirements for environmental testing of airborne instruments. Overall length is about 2-3/4 in., width including gear extension is 1-1/2 in., and depth is 1/2 in.

Veeder-Root Inc., Dept. ED, Hartford 2, Conn.

CIRCLE 245 ON READER-SERVICE CARD

Relay Device

For overtemperature uses



Originally made to protect three-phase ac motors, this relay device has a wide range of ac overtemperature applications. The unit consists of a magnetic relay, two transistor amplifiers, and a diode network for signal separation and a voltage regulated power supply. The thermistor is inserted in the windings of the motor, generator or transformer. Power supply ratings are 110, 208 to 220, 440 or 550 v, 60 cps. Contacts are pilot duty type, 600 v ac max.

Cutler-Hammer Inc., Dept. ED,
538 N. 12th St., Milwaukee, Wis.
CIRCLE 246 ON READER-SERVICE CARD

Potentiometer Recorder

Dual-channel



Type G-22 dual-channel potentiometer recorder has chart speeds from 1/8 in. per hr to 8 in. per min. Full span balancing time is 1 sec and accuracy is 1% of full scale. Two speeds are standard, four speed units can be supplied. The range is adjustable from 0 to 9 mv through 0 to 100 mv. Zero can be set anywhere across the 5-in. chart; both pens traverse the full width of the chart. The unit weighs 35 lb; portable and panel mount units are available.

Varian Associates, Instrument Div., Dept. ED, 611 Hansen Way, Palo Alto, Calif.

CIRCLE 247 ON READER-SERVICE CARD

CIRCLE 248 ON READER-SERVICE CARD

Trimpot® Trio

MODEL 236 MODEL 260 MODEL 200



MODEL 236 HUMIDITY-PROOF TRIMPOT

Completely sealed to meet Mil Specs for humidity, sand, dust and salt spray, this proved wirewound potentiometer dissipates 0.8 watt at 70°C., operates reliably at temperatures up to 135°C. Resistances from 10Ω to 100K. Choice of terminals and mounting types.

MODEL 260 HIGH-TEMP, HIGH-POWER TRIMPOT

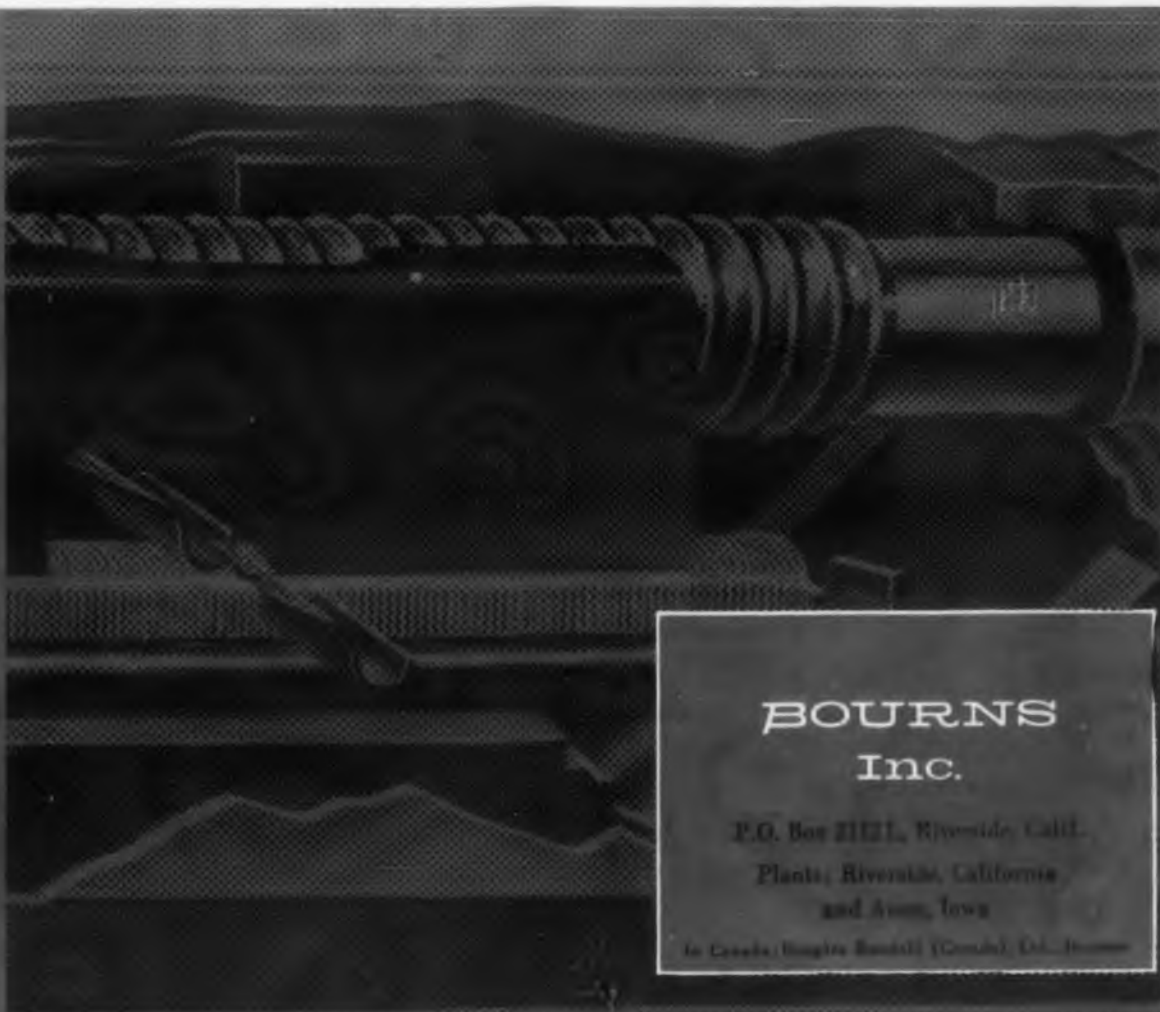
A favorite Mil Spec wirewound unit for hot spots. Use it where you need dependable, continuous operation from -65°C. to +175°C. Dissipates 1.0 watt at 70°C. Resistances from 10Ω to 100K. Choice of terminals and mounting types.

MODEL 200 GENERAL-PURPOSE TRIMPOT

Up-to-the-minute version of the original wirewound Trimpot—used in more military and commercial programs than any other leadscrew-actuated potentiometer. Maximum operating temperature is 105°C. Dissipates 0.25 watt at 70°C. Resistances from 10Ω to 100K. Choice of terminals and mounting types.

The reliability of this well-known Trimpot trio has been proved repeatedly in America's toughest military programs. The Trimpot design has become the standard of the industry since Bourns introduced the leadscrew-actuated potentiometer seven years ago. Screwdriver settings are pinpoint sharp and virtually unaffected by vibration, acceleration and shock. Small size and space-saving shape permit installation of 12 units in one square inch.

For your wirewound or carbon potentiometer applications, Bourns offers you an inventory of 500,000 units—stocked by the factory and franchised electronic distributors across the nation. Besides the Trimpot Trio, there are 20 other basic models—each available in a variety of terminal and mounting types. *Terminals:* insulated stranded leads, solder lugs, printed circuit pins and bare wires. *Mounting types:* Panel, chassis and printed circuit. Write for new summary brochure no. 4.



**BOURNS
Inc.**

P.O. Box 2121, Riverside, Calif.
Plants: Riverside, California
and Avon, Iowa

In Canada: Douglas Boudell (Canada) Ltd., Toronto

New Deutsch "Snap-In" Miniature Connectors
make **RELIABILITY & REALITY**



Here's a snap-in miniature you can trust to do what it's supposed to do. The new Deutsch DS Series of quick-disconnect connectors—with insertable and removable contacts and crimp-type terminations—has been thoroughly tested and *proved* under extreme environmental conditions.

Proven
Check these advantages
against your design requirements



	DS FEATURES	YOUR DESIGN REQUIREMENTS
1 Pins and sockets	Easily insertable and removable	
2 Terminations	Crimp-type	
3 Contact retention	Withstands minimum of 25 lbs. pull	
4 Crimp strength	Greater than the wire itself	
5 Hand tools	Simple, fool-proof crimping, inserting and removal tools	
6 Interfacial seal	Continuous dielectric separation without voids; no bonding, reversion or shrinkage of inserts	
7 Environmental	Meets or exceeds MIL-C-26482 (ASG)	
8 Temperature	-100°F. to 300°F.	
9 Push-pull coupling	Positive ball-lock design; operates in direction of plug travel	
10 Contact size	Immediately available in #20 size; others to follow	
11 Shell size	Immediately available in 3, 7, 12, 19, 27, 37 and 61 contacts	
12 Interchangeability	Mates with existing Deutsch DM5000, DM6500 and DM9000 series	
13 Assembly	Delivered completely assembled except for insertion of contacts	

For complete technical information and test report, contact your Deutsch Representative or write us for Data File C-2



The Deutsch Company
7000 Avalon Boulevard • Los Angeles 3, Calif.

© THE DEUTSCH COMPANY, 1959

CIRCLE 249 ON READER-SERVICE CARD

NEW PRODUCTS

Static Transformer Rectifier

Rated at 200 amp



Type W-1206-1 static transformer rectifier operates continuously at 200 amp with an input voltage of 190 to 210 v, three-phase, and an input frequency of 380 to 420 cps. Output voltage is 25 to 30 v when the output load is 20 to 210 amp. The core operates at flux densities to 20,000 gauss. Maximum no load voltage is 36.7 v dc.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 253 ON READER-SERVICE CARD

Delay Lines

Produce delays to 100 msec

The DL-1000-10,000/25T series of delay lines produce delays from 0 to 100 msec, with negligible deterioration of the shape of the waveform. The 100 msec line consists of four identical 0 to 25 msec tapped delay lines in cascade. Each of these delay lines contains 25 sections of m-derived LC networks utilizing high-Q toroidal inductances and stable capacitors.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N.Y.

CIRCLE 254 ON READER-SERVICE CARD



Strain Gage Recording System

Selection of up to 40 strain gages

This system records in digital form the output of strain gages. Rate of data recording is adjustable from 0.7 to 5 sec per point. The system provides for selection of up to 40 strain gages and may be expanded in modules of 10 points up to a capacity of 100 points or more.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 255 ON READER-SERVICE CARD



FOR A CHECKUP

A year ago, he was only reading about cancer, just as you are now. But cancer was something that happened to the other fellow. No need for *him* to go to a doctor.

Now that he knows better, it is unfortunately too late. He is one of the 75,000 cancer patients who will die needlessly this year because they did not see their doctors in time.

... AND A CHECK

Nor could he see any reason, last year, for backing the fight against cancer with his dollars.

But cancer always strikes close to home—in two of every three families, to be exact. This toll can be reduced by supporting the medical counterattack with a contribution.

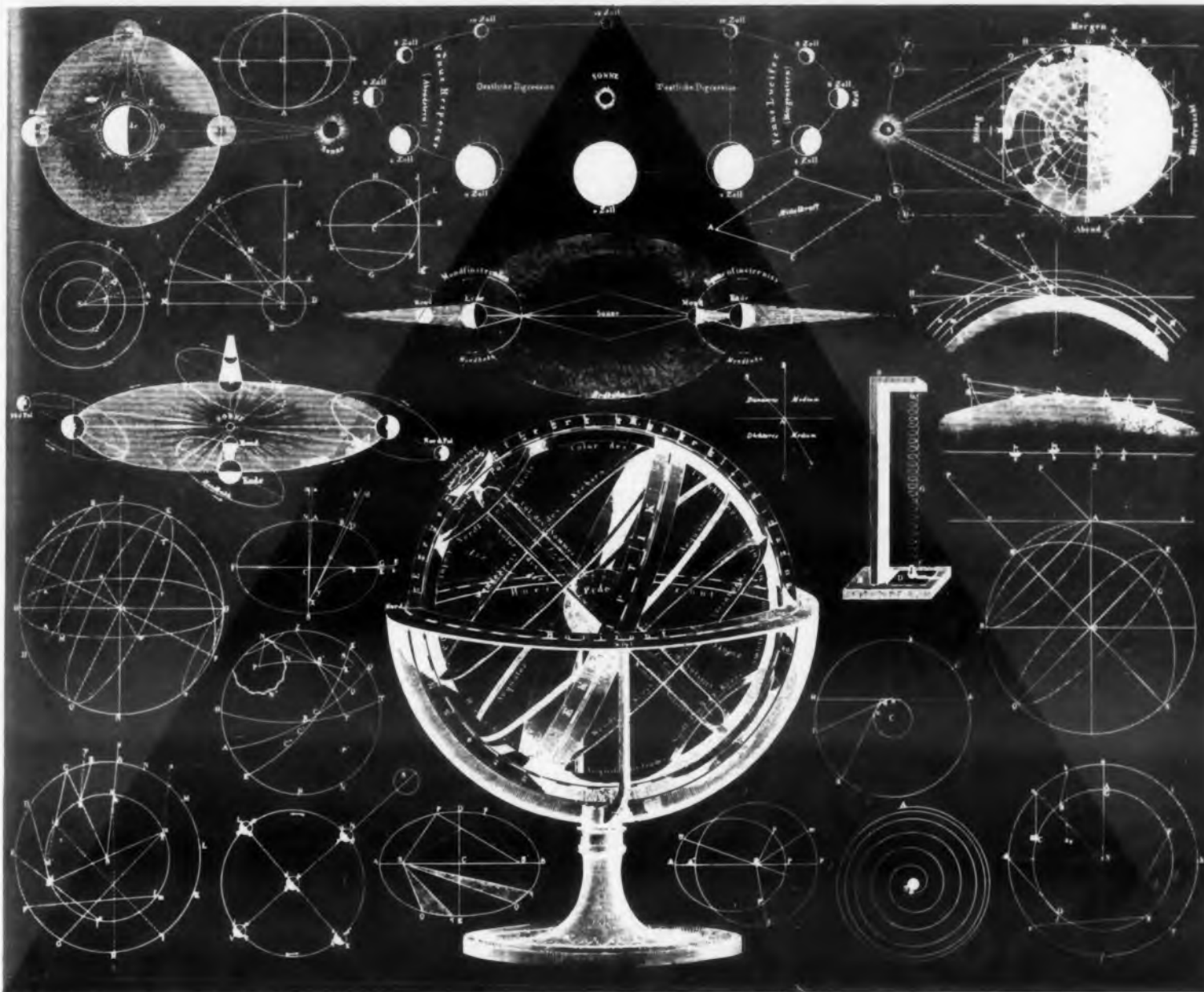
The other fellow? He's always one of us. Some find it out the hard way. What will it take to convince you?

*Guard your family—
fight cancer with a
checkup and a check.*

Send your check to "Cancer,"
c/o your local post office.

AMERICAN CANCER SOCIETY





Guided tour of the solar system



The new NASA Thor-boosted research rocket, DELTA, now being constructed by Douglas, will set up big signposts for further space explorations. Combining elements already proved in space projects with an advanced radio-inertial guidance system developed by the Bell Telephone Laboratories of Western Electric Company, DELTA will have the versatility and accuracy for a wide variety of satellite, lunar and solar missions. Douglas insistence on reliability will be riding with these 90 foot, three-stage rockets on every shoot. At Douglas we are seeking qualified engineers to join us on this and other equally stimulating projects.

Maxwell Hunter, Asst. Chief Engineer—Space Systems, goes over a proposed lunar trajectory with Arthur E. Raymond, **DOUGLAS** Senior Engineering Vice President of



Back at the earth
terminal...

DOUGLAS AIRCRAFT COMPANY MISSILES AND SPACE SYSTEMS

has immediate openings
in the following fields—

Electrical and Electronics:

- Control System Analysis & Design
- Antenna & Radome Design
- Radar System Analysis and Design
- Instrumentation
- Equipment Installation
- Test Procedures
- Logic Design
- Power System Design

Mechanical Engineering — Analysis and Design of the following:

- Servo Units
- Hydraulic Power Systems
- Air Conditioning Systems
- Missile Launcher Systems
- Propulsion Units and Systems
- Auxiliary Power Supplies

Aeronautical Engineering:

- Aerodynamic Design
- Advanced Aerodynamic Study
- Aerodynamic Heating
- Structural Analysis
- Strength Testing
- Dynamic Analysis of Flutter
and Vibration
- Aeroelasticity
- Design of Complex Structure
- Trajectory Analysis
- Space Mechanics
- Welding
- Metallurgy

Physics and Mathematics:

- Experimental Thermodynamics
- General Advanced Analysis in
all fields
- Computer Application Analysis
- Computer Programming and
Analysis
- Mathematical Analysis

For full information
write to:

Mr. C. C. LaVene
Box 601 E
Douglas Aircraft Company, Inc.
Santa Monica, Calif.

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT
CIRCLE 900 ON CAREER INQUIRY FORM, PAGE 157

CONDUCTIVE PLASTIC PRECISION POTS



10⁸ revolutions at
2000 rpm . . .

... AND NO END IN SIGHT! That's what life expectancy tests of these new conductive plastic precision pots have shown. And checks during testing have shown near-infinite resolution, no measurable change in linearity or noise, and only 5% change in total resistance.

Stock resistance values are 1, 2, 5, 10 and 20K. Values between 100 ohms and 10 megohms supplied on special order.

A COMPLETE LINE OF
wirewound
precision pots

Included in this outstanding line is Model 158: a 4-watt, multi-section pot that passes a rigid noise test at -55°C, and is available in resistances up to 150K ohms. Also included in the complete NEI wirewound line are servo mounting and low torque types. Sizes range from 1/2" to 3" in diameter.



... AND special CONDUCTIVE PLASTIC ELEMENTS . . . including rectilinear elements for slide-wire applications and other precisely built conductive plastic elements for use in fuel gauges, accelerometers, pressure transducers and other instruments.

NEI is the only source to offer precision wirewound AND conductive plastic potentiometers. WRITE TODAY for full information. Spec sheets and the convenient NEI Fact File are yours on request.

**NEW ENGLAND
INSTRUMENT
COMPANY**



350 MAIN STREET, WOONSOCKET, RHODE ISLAND

CIRCLE 274 ON READER-SERVICE CARD

NEW PRODUCTS

Weighting Network

For voice circuits



Type 601A weighting network adapts any high-impedance, vacuum-tube voltmeter to read F1A noise measurements. A 3-ft connecting cord with banana plugs connects the network to a vtm. The meter reading is subtracted from a calibration factor to obtain noise measurements in dba. The set provides an insertion gain of 10 db, and may be used to measure noise as low as 10 dba on a +7 dbm drop level voice circuit. The unit is cased in aluminum and its dimensions are 8 x 3-1/4 x 4-1/4 in. Its shipping weight is about 4 lb.

Lenkurt Electric Co., Dept. ED, San Carlos, Calif.

CIRCLE 275 ON READER-SERVICE CARD

Universal Insulation Tester

Has range of 0 to 2100 v ac and dc



Model 103/105 universal insulation tester has a test voltage range of 0 to 2100 v ac and dc. The maximum short circuit current is 10 ma, the ac compensation range is 0 to 0.005 µf, and the megohm range is 0.1 to 400 meg. The leakage current ranges are to 5000 µa. For production testing, the instrument can be to predetermined limits and rejections are signaled by a buzzer and a lamp signal. For laboratory testing, the ac tests provide data for a complete analysis of insulation: total leakage, resistive leakage, ac resistance, power factor, inherent capacity, and breakdown strength. Required input power is 115 v ac, 60 cps. The unit measures 21-1/2 x 13 x 15 in. and weighs 50 lb.

Slaughter Co., Dept. ED, Piqua, Ohio.

CIRCLE 276 ON READER-SERVICE CARD

marion
advancement
in instrument
design



actual size
Model HCM 7/16

MINIATURE 7/16" INDICATOR

Micro-miniature moving coil, core magnet indicator; 7/16" diameter, 31/32" length. Weight 10 grams; sealed. Available with a pointer or flag display in a wide variety of electrical sensitivities and functions. Data on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, New Hampshire, U.S.A.
Copyright © 1959, Marion

marion
"WHERE ELECTRONICS MEETS THE EYE"
meters
CIRCLE 277 ON READER-SERVICE CARD



E PLURIBUS



Many bits of information to transmit... one optimum antenna. If this is the problem to be solved (as it was in the Titan), Rantec multiplexers can couple two, three, four or six telemetry signals of different frequencies to one antenna system. Insertion loss (only 1.5 db on model above) is minimum, weight is minimum, space is minimum, and isolation (20 db) is maximum.

r a n t e c
corporation

calabasas, california

* UNUM

CIRCLE 278 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

500 W Power Supply

Delivers up to 50 amp

The model P-87A 500 w power supply has current ranges of 0.75, 1.5, 3, 7.5, 15, 30, and 50 amp and 0.5% full scale regulation. An all solid-state unit 19 x 20 x 8-3/4 in., it is designed with silicon semiconductor rectifiers, power transistors, and short-circuit protection. The control unit may be mounted with the equipment or at a remote point, and the emitter current for each pass transistor is independently monitored at a front panel meter.

Foto-Video Labs, Inc., Dept. ED, 36 Commerce Rd., Cedar Grove, N.J.

CIRCLE 279 ON READER-SERVICE CARD

Tape Wound Cores

Have high permeability

Vacuum melted and processed to give high initial and maximum permeability, Super Hymu 80 nickel-iron tape wound cores are designed for use in low level input magnetic amplifiers, wideband toroidal transformers, and radar pulse transformers. They have an initial permeability of over 55,000 tested at 20 gauss, 100 cps. The units are oil damped and sealed in an aluminum case.

G-L Electronics, Inc., Dept. ED, 2921 Admiral Wilson Blvd., Camden 5, N.J.

CIRCLE 280 ON READER-SERVICE CARD

Pulse Transformer

Operates transmitting tube at 100 kv

This pulse transformer operates a transmitting tube at 100 kv with 10 amp filament supply. The case contains a bifilar choke for overload protection. Peak power output is 32 megawatts at 100 kv; step up ratio is 1:5. Primary impedance is 12.5 ohms; pulse duration is 0.5 to 5.5 usec and pulse repetition frequency is up to 2000 pps. The unit measures 14 x 19 x 12 in.

Stavid Engineering, Inc., Dept. ED, Plainfield, N.J.

CIRCLE 281 ON READER-SERVICE CARD

CIRCLE 282 ON READER-SERVICE CARD ➤

CLEVITE SILICON JUNCTION DIODES

ACTUAL SIZE

250 MW Package . . . Fast Switching and General Purpose Types Featuring . . .

- **MECHANICAL RELIABILITY** — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.
- **ELECTRICAL SUPERIORITY** — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.
- **PRODUCT UNIFORMITY** — Tight manufacturing controls.

For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current		Test Volts
			@ 25°C	@ 150°C	
1N457	60 V	20 ma @ 1.0 V	0.025 μ a	5.0 μ a	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μ a	5.0 μ a	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μ a	5.0 μ a	175 V
1N662	90 V	10 ma @ 1.0 V	20 μ a	100 μ a (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μ a	50 μ a (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μ a	30 μ a (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μ a	30 μ a (@ 125° C)	175 V

OTHER CLEVITE DIVISIONS:

Cleveland Graphite Bronze • Brush Instruments
Clevite Electronic Components • Clevite Harris Products
Clevite Ltd. • Clevite Ordnance • Texas Division
Clevite Research Center • Intermetall G.m.b.H.

A DIVISION OF
CLEVITE

CLEVITE TRANSISTOR PRODUCTS

241 CRESCENT ST., WALTHAM 54, MASS.
Twinbrook 4-9330



Silicon Junction Diodes Germanium Diodes Power Transistors Solder Lug Power Transistors

NEW PRODUCTS

Capacitor

Retrace is within 0.02%

This Teflon capacitor has within 0.02% retrace for temperature range of -10 to +85 C. The temperature coefficient is 10 ppm per deg C with less than 0.06% total capacitance change from 25 to 85 C. Insulation resistance is 10^{13} ohms min from 25 to 85 C. The unit withstands vibration of 20 g rms from 5 to 5000 cps for 15 min. It is made for use in guidance computer integrator circuits; other models are available for network compensation.

Component Research Co., Inc.
Dept. ED, 2639 S. La Cienega Blvd.,
Los Angeles 34, Calif.

CIRCLE 283 ON READER-SERVICE CARD

Zener Diodes

Are rated at 10 w

These Zener diodes have a voltage drop essentially independent of current. Junction and storage temperature range is -65 to +175 C. Dc power dissipation at 50 C case temperature is 10 w. Nominal Zener voltages range from 6.8 to 200 v. These units have a standard D0-4 package.

Motorola, Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 284 ON READER-SERVICE CARD

Reference Supply

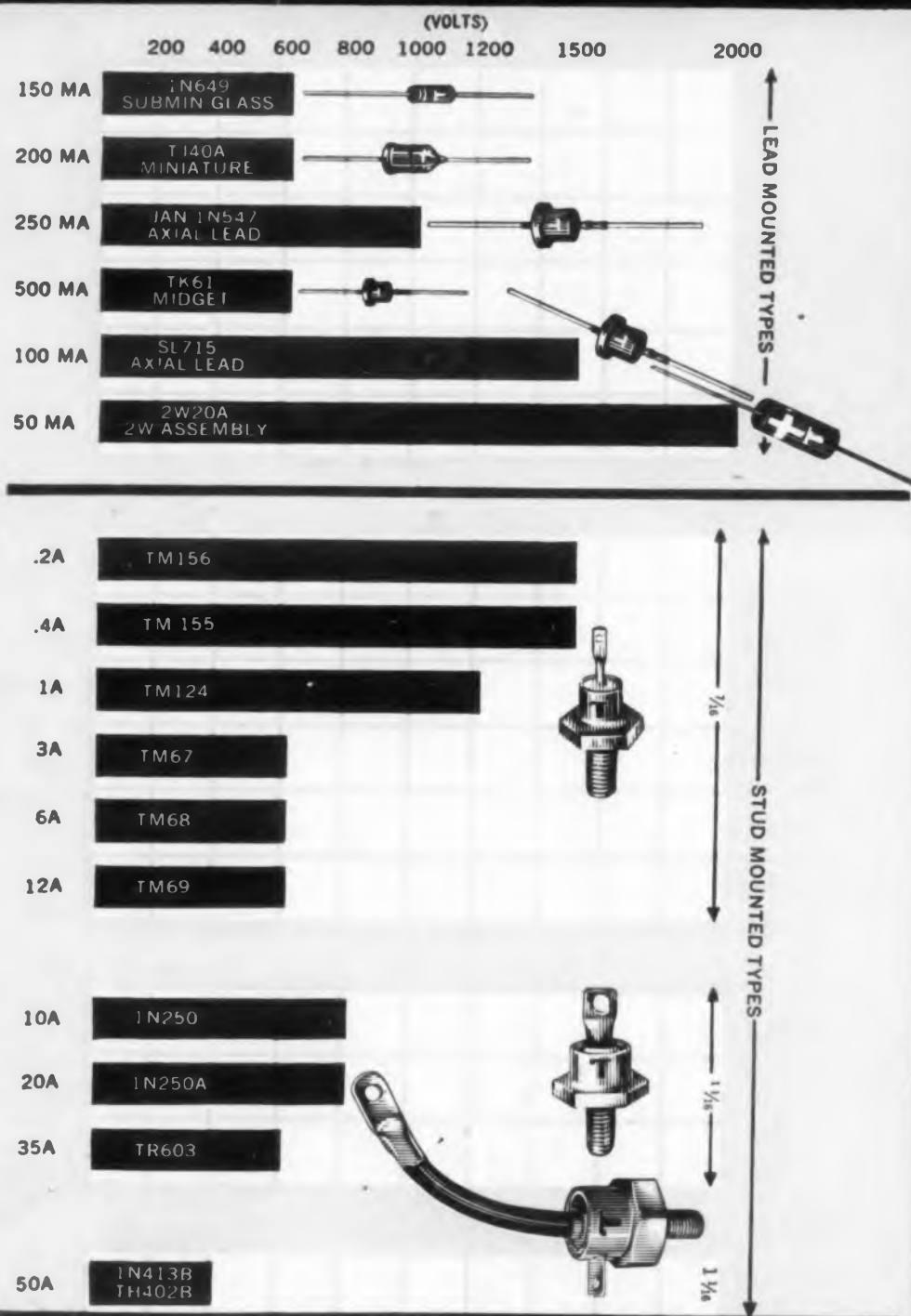
Dual output

Reference supply CVR-610 has two separate outputs, and can deliver 6 or 10 ma by shunting and reconnecting the output posts. This unit replaces standard short-life 1-1/2 v batteries used in bridge-measuring circuits. Output is held to 0.1% over input voltage changes of 90 to 130 v and frequencies of 50 to 60 cps. A transformer within the unit shields the measuring circuit from line noises.

Performance Measurements Co., Dept. ED, 15301 W. McNichols Rd., Detroit 35, Mich.

CIRCLE 285 ON READER-SERVICE CARD

T[®] INDUSTRY'S MOST COMPLETE SILICON RECTIFIER LINE



SILICON CERAMIC BASE RECTIFIERS



Fig. 1



Fig. 2

Ceramic base rectifiers of compact design now eliminate the need for insulating hardware and "reverse polarity" units. These rugged stud-mounted silicon power rectifiers achieve their versatility by virtue of an alumina ceramic disc mounted between the top hat assembly and the hex base. The ceramic disc offers low thermal resistance and high electrical insulation properties. Further, bridge assemblies are now simplified and standardization of components is subsequently advanced.

The ceramic base rectifiers are available in $\frac{1}{8}$ " hex base configuration up to 12 amperes @ 150°C case, and in $\frac{1}{16}$ " hex base configuration up to 20 amperes @ 150°C case.

For example:

Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current @ 150°C Case (amps)	Figure
1N 341/C	400	400	1
1N 250 A/C	200	20	2

For further information write in for bulletin TE-1351R.

Number 12, 13, 14 and 15 in a series of 37 new Transiron Products to be announced before 1960!

... designed to meet ALL your circuit requirements: current, voltage, temperature, size ... now available from Transitron.

A complete description of the lead and stud mounted types, which are summarized below, is in bulletin TE-1351.

We welcome your inquiries concerning special requirements such as high frequency, fast recovery and high voltage applications.

SILICON CONTROLLED RECTIFIER

Handling 10 KW Power



Transitron's Silicon Controlled Rectifier is a PNP High power bistable controlled switching device. It is analogous to a thyatron or ignitron, with far smaller triggering requirements and microsecond switching. The low forward voltage drop permits high current ratings and provides high efficiency with low cooling requirements. The PNP design permits higher voltage ratings and lower saturation resistance than power transistors. This permits the smallest packaging for high power control yet made possible.

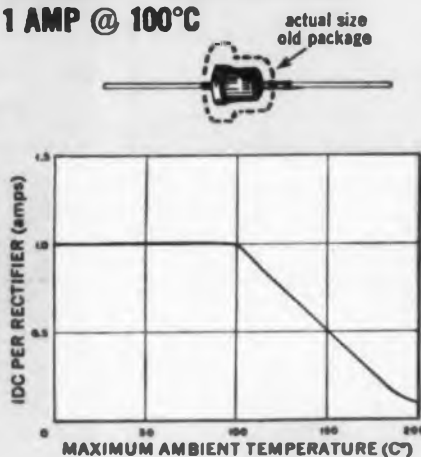
NOW AVAILABLE IN TRANSITRON'S NEW PACKAGE

Type	Minimum Peak Reverse Voltage (Volts)	Minimum Forward Breakdown Voltage (Volts)	Maximum Average Forward Current (amps)	
			at T _{case} = 100°C	at T _{case} = 25°C
TCR102	100	100	10	20
TCR202	200	200	10	20
TCR302	300	300	10	20
TCR402	400	400	10	20

Maximum Storage Temperature Range -65°C to +150°C
Maximum Operating Temperature Range -65°C to +125°C

Send for Bulletin TE-1356A

MIDGET RECTIFIER 1 AMP @ 100°C

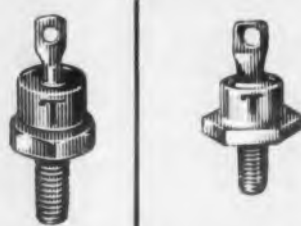


Transitron announces, higher ratings and smaller size in a lifetested lead mounted silicon rectifier. By establishing a high level of designed quality, these rectifiers feature reliable 200°C operation. Remember, the size is SMALLER, the flange is GONE! These units will meet all electrical and environmental requirements of the JAN-1N 547 series.

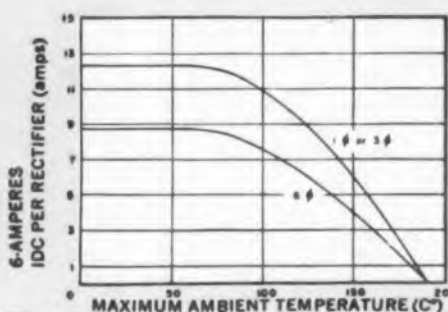
Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current		Maximum Forward Voltage @ 25°C (Volts) (Milliamps)
		@ 200°C (Milliamps)	@ 100°C (Amps)	
TK61	600	100	1.0	1.0 @ 750
TK41	400	100	1.0	1.0 @ 750
TK21	200	100	1.0	1.0 @ 750

Write for bulletin PB-58

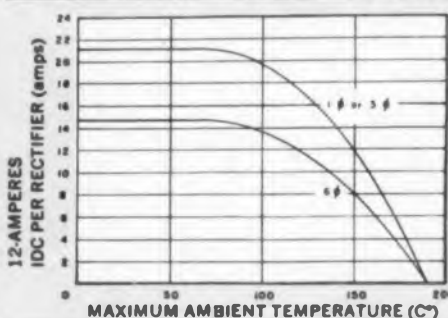
HIGH CURRENT RECTIFIERS



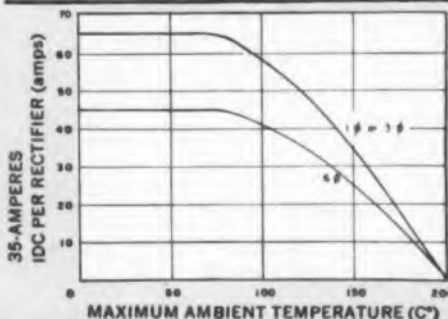
Now, from Transitron, stud-mounted silicon power rectifiers which combine high power handling ability with a minimum of size and weight ... The extremely low forward resistance and thermal impedance of these units allow operation up to 12 amperes @ 150°C case temperature in the 1/8" hex base configuration, and similarly up to 35 amperes @ 150°C case temperature in the 1/4" hex base configuration. Still further, the inherently low leakage currents and high peak inverse voltage ratings allow flexibility in the design of both power supply and magnetic amplifier circuits.



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM58	500	1.1 @ 6	2
TM48	400	1.1 @ 6	2
TM38	300	1.1 @ 6	2
TM28	200	1.1 @ 6	2
TM18	100	1.1 @ 6	2
TM8	50	1.1 @ 6	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TM59	500	1.2 @ 12	2
TM49	400	1.2 @ 12	2
TM39	300	1.2 @ 12	2
TM29	200	1.2 @ 12	2
TM19	100	1.2 @ 12	2
TM9	50	1.2 @ 12	2



Type	Peak Recurrent Inverse Voltage (Volts)	Maximum Forward Voltage @ 25°C (Volts) @ (Amps)	Maximum Average *Inverse Current 150°C (Milliamps)
TR503	500	1.5 @ 100	5
TR403	400	1.5 @ 100	5
TR303	300	1.5 @ 100	5
TR203	200	1.5 @ 100	5
TR153	150	1.5 @ 100	5
TR103	100	1.5 @ 100	5
TR53	50	1.5 @ 100	5

*Averaged over one cycle with rectifier operating at full rated current and voltage into a resistance load.

Compatible Electronic Transmitter

Converts motion to dc signals

Fully transistorized, this compatible electronic transmitter converts motion to dc signals. Its output may be 1 to 5 ma dc into a 0 to 6 K load, 4 to 20 ma dc into a 0 to 1500 ohm load, or 10 to 50 ma dc into a 0 to 600 ohm load. The load may be any value between the limits stated without the addition of external resistance, and printed wiring cards permit changes in the field. The unit operates at ambients from -20 to +150 F.

Fischer & Porter Co., Dept. ED,
142 Jacksonville Rd., Hatboro, Pa.

CIRCLE 286 ON READER-SERVICE CARD

Circuit Equivalent

Has flip-flop characteristics

The silicon Trigistor, a circuit equivalent component, has flip-flop characteristics. It is a pnpn device with the property of triggered turn-off as well as triggered turn-on control at its base. A low-level positive pulse to the base turns it on; a negative pulse turns it off. It is designed for operation in the range of 1 to 8 ma collector current. Applications include memory, counting, timing, gating, and logic functions.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.

CIRCLE 287 ON READER-SERVICE CARD

Electronic Timer

Rated at 15 amp

Model 5231-B electronic timer is rated at 15 amp and operates on 115 v, 60 cps. Single and dual timing ranges are available, including 0.02 to 1 sec, 0.04 to 2 sec, 0.05 to 3 sec, 0.2 to 10 sec, 0.4 to 20 sec, and 0.5 to 30 sec. Maximum ranges available are 60 and 120 sec. Temperature range is from 0 to 100 F. The unit is designed for use in printed circuits and has two heavy contact, 4pdt relays. A modified version is available for 230 v, 50 or 60 cps.

Automatic Timing & Controls, Inc., Dept. ED, King of Prussia, Pa.

CIRCLE 288 ON READER-SERVICE CARD

CIRCLE 289 ON READER-SERVICE CARD

Transitron

electronic corporation • wakefield, massachusetts

Leadership in Semiconductors SEE YOUR LOCAL AUTHORIZED TRANSITRON DISTRIBUTOR FOR QUANTITIES FROM 1-999.



THERMOSTATS

BY *Therm-O-Disc*



TYPE A—Adjustable

- Slow make or break contacts
- For operating temperatures up to 550°F.
- Resistive load—1500 watts at 120 VAC

TYPE HL

- Single pole, single throw or double pole, single throw
- Manual or automatic reset
- Preset, snap action, non-adjustable
- For operating temperatures up to 300°F.
- Resistive load—40 amperes at 125 VAC 25 amperes at 250 VAC



TYPE 11T-11

Best suited for controlling temperatures in air streams
same ratings as TYPE 11T-21



Designed for surface mounting
also available for watertight mounting

- High ratings with minimum size
- Single pole, single throw or single pole, double throw
- Preset, snap action, non-adjustable
- For operating temperatures up to 350°F.
- Blade or screw terminals, exposed or enclosed disc
- Resistive load—6000 watts at 240 VAC 3000 watts at 120 VAC
- Inductive load—10 amps, full load at 120 VAC 5 amps, full load at 240 VAC



TYPE 11T-21

TYPE AF & AL

- For fan motor or limit control
- 3" or 7" sensing element
- Snap action—adjustable
- For operating temperatures up to 300°F.
- Fan or limit rating—1/2 h.p. at 120/240 VAC and 125 volt amperes at 120/240 VAC



TYPE WA

Best suited for controlling temperatures in air streams
same ratings as TYPE WC



TYPE WC

Designed for surface mounting
(with or without mounting bracket)

- Preset, snap action, non-adjustable
- Single pole, single throw
- For operating temperatures up to 350°F.
- Blade or screw terminals, exposed or enclosed disc
- Resistive load—2500 watts at 240 VAC 1650 watts at 120 VAC
- Inductive load—4.4 amps, full load at 120 VAC 2.2 amps, full load at 240 VAC



TYPE 20T

- Refrigeration and air conditioning control
- Hermetically sealed in all-metal case
- Single pole, single throw
- For operating temperatures up to 200°F.
- Resistive load—1000 watts at 120/240 VAC



Detailed information on request

Minimum production order quantity accepted—25



THERM-O-DISC, Incorporated Mansfield, Ohio

CIRCLE 290 ON READER-SERVICE CARD

NEW PRODUCTS

Photoelectric Pulse Generator

Shaft driven



A shaft driven device that delivers electrical pulses at its output terminals, the model 8601 photoelectric generator may be used as a rate generator or as an angle measuring unit. In the first application, the output frequency is read in terms of shaft rpm; in the second, the total angle is determined by totalizing individual pulses. The pulses are generated by a light which passes to a photocell through a rotating disc with alternate opaque and clear sectors. The number of pulses per revolution is thus a function of the number of segments on the disc. The generator can be supplied with photoresistive cell or a photovoltaic cell. The output of the first cell consists of alternations between two levels of internal resistance, while the output of the second is a series of dc voltage pulses. In most cases the output voltage is 0.1 to 0.25 v at 10 K load impedance. There are several standard disc patterns providing up to 500 pulses per revolution.

W. & L. E. Gurley, Dept. ED, 514 Fulton St., Troy, N.Y.

CIRCLE 291 ON READER-SERVICE CARD



Megohmmeter

Hand-crank type

Model 5G1000 series B hand-crank megohmmeter operates at 500 v, has a range of 0 to 1000 meg, and meets both ASTM and Mil specs. Other models in this series have ranges from 0 to 50 through 0 to 2000 meg, at test potentials from 100 to 1000 v. All units have dual range and ohm scales. A generator with a 39-bar armature is used. The driving gear is mounted on needle bearings to reduce cranking torque.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

CIRCLE 292 ON READER-SERVICE CARD

relay
delivery
a
problem?

Not when you buy from globe!

24 hour to ten day delivery on prototype relays

Engineering staff at your disposal Relays designed

and built to meet your specifications

Expanded production facilities for quantity

orders When delivery counts... call globe

Telephone, Telegraph or TWX-it collect

globe electrical mfg. co.

1729-45 west 134 street / gardena, california

FAculty 1-3311 TWX: COMPTON CAL 6092

relays / printed circuits / molded terminals

plastic fabrication / terminal boards

CIRCLE 293 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

NATIONAL CERAMIC COIL FORMS



UNIVERSAL CERAMIC COIL FORMS FOR MILITARY AND COMMERCIAL APPLICATIONS

National Radio, one of the nation's oldest suppliers of quality coils and coil forms, now introduces, for immediate delivery, a new line of ceramic coil forms, engineered to meet the most rigid military and commercial applications.

- Available in 5 standard sizes, with or without terminal collars. Terminal collars accept up to four terminals per collar.
- Internal, pre-set torque spring provides smooth, vibration-proof means of positioning and locking the adjusting cores. Keep coils tuned as set, even under severe vibration and shock.
- Powdered iron cores available in choices of standard and long-core lengths. Color-coded to indicate optimum frequency ranges.
- All material used are in accordance with applicable MIL-Specs.
- Coil forms, collars, and terminals available at your National Parts Distributor. Coil forms supplied with spring washer, rubber gasket, coil base, external tooth, lock washer and brass nut. Cores are also available. Pre-assembled forms to your prints quoted by National Company upon request.

FOR SPECIFICATIONS, PRICES, DELIVERY—
WRITE, PHONE, WIRE,

NATIONAL RADIO CO., INC.
MELROSE 76, MASS.



A wholly owned subsidiary of National Company, Inc.

CIRCLE 294 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Operations Recorder

Monitors digitized or sequential data



Operating upon a change in the incoming signal in analog or digital channels, this operations recorder monitors digitized, sequential, or special forms of analog type data. It has six off-on channels and one analog channel and operates at standard chart speeds. Frequency response is 0 to 600 cps for the analog, 0 to 200 cps for the off-on channels. The unit measures 17 x 17 x 17 in. and has an accuracy of $\pm 2.5\%$ for the analog channel. Its chart is 3-3/4 in. wide.

Hamilton Watch Co., Hathaway Instrument Div., Dept. ED, 5800 E. Jewell Ave., Denver 22, Colo.

CIRCLE 295 ON READER-SERVICE CARD

Paper Capacitors

Miniature

Type P161N miniature paper tubular capacitors have plastic case construction and a solid impregnant. They are available in a wide range of capacitances at voltages of 200, 400, 600, and 1000 wvdc. The operating temperature range is -30 to $+85$ C.

Aerovox Corp., Dept. ED, New Bedford, Mass.

CIRCLE 296 ON READER-SERVICE CARD



Current Source

Has a range of 0.1 μ a to 20 ma

Designed for diode ageing and life testing, model CS-125 modulated constant current source has a range of 0.1 μ a to 2 ma, up to 2250 v dc. With 21 independent supplies housed in one rack, 10,000 5 v Zener diodes can be aged or tested at one time. Input is 115 v $\pm 10\%$, at 60 cps; stabilized output current is 0 to 20 ma. Typical regulation is 0.05% at 1 ma from 0 to 500 v. Accuracy is 1% ± 0.1 μ a and ripple is 0.15% ± 0.1 μ a rms. Made for rack mounting, the unit measures 19 x 10-1/2 x 15 in.

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

CIRCLE 297 ON READER-SERVICE CARD

What's the latest score on cartridges?

<input checked="" type="checkbox"/>	1 ST	ceramic cartridge was invented by Sonotone...
<input checked="" type="checkbox"/>	13	years ago. Today, over...
<input checked="" type="checkbox"/>	65	different manufacturers have specified Sonotone for...
<input checked="" type="checkbox"/>	662	models of high-quality phonographs. Altogether over...
<input checked="" type="checkbox"/>	9,000,000	Sonotone Ceramic Cartridges have been used for original and replacement purposes. ('Nuff said!)

Sonotone CORP.
Electronic Applications Division, Dept. CGG-99

ELMSFORD, NEW YORK

In Canada, contact Atlas Radio Corp., Ltd., Toronto

Leading makers of fine ceramic cartridges, speakers, microphones, electronic tubes.

CIRCLE 298 ON READER-SERVICE CARD



SUBMinax[®] look delicate— but read how tough they are!

SUBMINAX RF connectors are AMPHENOL's sophisticated design solution for RF miniaturization programs. These are subminiature connectors with full size electrical and mechanical capabilities. For example:

Strength: Cable retention force of Subminax assemblies is 20 pounds

Insulation Resistance: 1,000,000 Megohm

Dielectric Withstanding Voltage: 1500 Volts RMS 60 Cycles minimum

The Subminax family is a large one, too. Standard and Field Serviceable designs are available in 50 or 75 Ohm Impedances with Push-On or Screw-On coupling. All popular RF connector constructions are included.

Write for Subminax cataloging and collateral technical data.

AMPHENOL CONNECTOR DIVISION

Amphenol-Borg Electronics Corporation
CHICAGO 50, ILLINOIS

NEW PRODUCTS

Scaler

For digital and analog readout



Designed for digital and analog readout of spectrographic equipment, model ADRS2-5 scaler consists of one scaler for counting and another for data identification. Outputs from both scalers may be used to operate a printer and a recorder. Both scalers provide one digital output coded 1, 2, 2, 4. One scaler has two analog outputs of 0 to 100 v positive and 0 to 10 mv positive for the X-Y recorder. Negative analog outputs can be supplied. The other scaler has one analog output of 0 to 10 mv. The three-decade analog range is up to 10^3 , 10^4 , or 10^5 counts full-scale. Resolution is 5 μ sec to pulse pairs. Power requirements are 2.5 amp at 115 v, 60 cps.

The Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.

CIRCLE 300 ON READER-SERVICE CARD

Transducer Control Unit

Has strain-gage balance and power supply



Type TC-1 transducer control unit combines a current regulated strain-gage power supply with strain-gage balance and calibration circuitry. It requires an input of 95 to 135 v ac; output voltage is 3 to 10 v and output current is continuously adjustable from 5 to 33 ma. The fully transistorized unit is of modular construction and is designed for dc instrumentation. It measures 5-1/4 x 2-1/2 x 8 in. and may be mounted on strip chart recorder panels or in 19 in. racks.

Anadex Instruments, Inc., Dept. ED, 14734 Arminta St., Van Nuys, Calif.

CIRCLE 301 ON READER-SERVICE CARD

◀ CIRCLE 299 ON READER-SERVICE CARD



SUBMinax[®]

subminiature connectors

ARE AVAILABLE FROM

AUTHORIZED

AMPHENOL

DISTRIBUTORS

AT FACTORY PRICES!

DISTRIBUTOR DIVISION

Amphenol-Borg Electronic Corporation
BROADVIEW, ILLINOIS

CIRCLE 302 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

THE MARK OF QUALITY

BARBER
COLMAN

quick solutions
to various
electronic
problems



Ultra-Sensitive Relays

Operating on input powers of 40 to more than 1,000 microwatts, the Barber-Colman Micropositioner polarized relay is ideal as a differential relay in electronic plate circuits, as a null detector in resistance bridge circuits, or as an amplifier in photoelectric circuits. Resonant relays also available from Barber-Colman



Reversible Small Motors

Shaded pole a-c type, up to 1/25 hp . . . adaptable to a variety of control circuits, including transistor and vacuum tube types. Ideal for use with servo mechanisms and other follow-up and positioning units. Available with or without gear-heads. A wide range of gear ratios for gear motors . . . open or enclosed



Small Motors with Blowers

In both a-c and d-c types with cooling fans or blowers for quick, dependable dissipation of heat from tubes, circuit components and other equipment mounted in confined enclosures.

BARBER-COLMAN COMPANY
Dept. U, 1283 Rock Street, Rockford, Illinois

CIRCLE 303 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 30, 1959

Three-Channel Power Amplifier

Aids vibration data recording



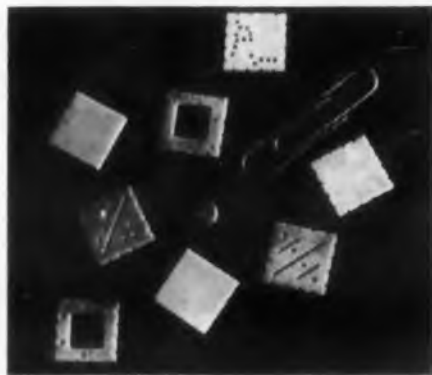
Designed to drive fluid damped high frequency galvanometers from low level signals, the three-channel model 8003 power amplifier aids shock and vibration data recording in systems with crystal accelerometers. Response is flat from 1 cps to 20 kc, covering the entire accelerometer range. Noise is 20 μ v rms; gain, 0.3 to 1000; input impedance, 1600 meg; and output impedance, 1 ohm. Output overload voltage is 10 v peak-to-peak with current up to 200 ma. The unit is accurate and permits the use of standard recording oscillographs. Used with the company's cathode follower probe, it can be used 100 ft or more from the accelerometer.

Columbia Research Labs, Dept. ED, MacDade Blvd. and Bullens Lane, Woodlyn, Pa.

CIRCLE 304 ON READER-SERVICE CARD

Circuit Wafers

For microminiature circuitry



Made from high-alumina ceramic, steatite, glass, or quartz, these microminiature wafers can be supplied in thicknesses down to 10 mils. Tolerances on hole diameters, slots, channels, and edge notches are held to within 0.0002 in. Available in custom and standard design, the units are drilled, ground, and finished to specifications, for end or substrate applications.

Zenith Optical Lab., Dept. ED, 1940 Great Neck Rd., Copiague, N.Y.

CIRCLE 305 ON READER-SERVICE CARD



test . . . test . . . test . . .

If you feel you *must* make your own pots to get exactly what you need, don't overlook quality control along the way! And this can be a messy business, what with special, elaborate techniques to quality-check every production stage! Oh, you'll get involved in maddening bouts with visual comparitors, ratiometers, environmental testing labs — and when you've finished — *and* made a few hundred revisions — you *might* have the quality you want!

So, before you go fly a kite — consider Ace. We've been all through this before, and have what is regarded to be the finest quality control system in the industry. It enables us to keep our final costs down, by rejecting sub-standards at each stage, without waiting for the final inspection. Although it's more work this way, we can offer a higher degree of resolution and linearity at a lower price. So, for precision-at-price, see your ACErep!



Here's 0.3% linearity in a 1/2" pot: the Series 500 ACEPOT®. Single-turn, -55° to 125°C range. As with all Ace components, tested in every stage of its manufacture!

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.

SOMerset 6-5130 TAx SMVL 181 West. Union WUX

Acopot® Acotrim® Acosol® Aceahm® *Reg. Appl. for
CIRCLE 306 ON READER-SERVICE CARD

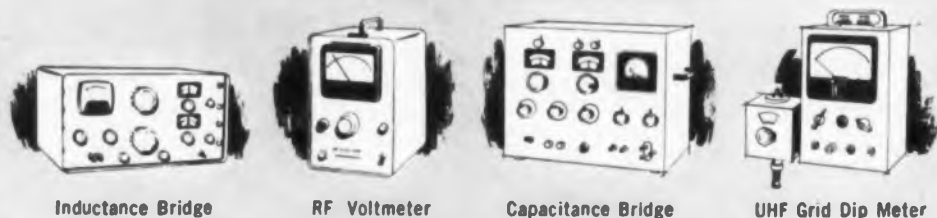


DC NULL DETECTOR

MODEL 56-A PRICE \$395

- HIGH VOLTAGE SENSITIVITY** 10 μv full scale; 0.5 μv smallest division
- HIGH INPUT IMPEDANCE** 10 megohms constant on all ranges
- HIGH POWER SENSITIVITY** 10⁻¹⁷ watt full scale; .05 micro-micro-microwatt smallest division (5 x 10⁻²⁰ watt)
- FAST METER RESPONSE** Approximately 1 second for full scale on most sensitive range

ALSO MANUFACTURERS OF THESE FINE INSTRUMENTS:



Boonton ELECTRONICS Corp.

Morris Plains, N. J. • Phone: Jefferson 9-4210

CIRCLE 307 ON READER-SERVICE CARD

NEW PRODUCTS

RECTIFIER TUBE.—Type 5R4-GYB full-wave vacuum rectifier tube is glass-octal type and is rated for service at altitudes to 40,000 ft. Maximum peak inverse-plate-voltage rating is 3100 v and maximum peak plate-current rating is 715 ma per plate. It is electrically identical with types 5R4-G, 5R4-GY, and 5R4-GYA.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 308 ON READER-SERVICE CARD

DIGITAL MULTIMETER.—Patterned after model 520 dc voltmeter, model 500 digital multimeter also measures ac voltage and resistance. The ac and dc ranges cover 0 to 1200 v, and the resistance range covers 1 ohm to 1 meg. Absolute accuracy is 0.1% for dc, 0.5% for ac, and 0.2% for ohms.

Franklin Electronics Inc., Dept. ED, Bridgeport, Pa.

CIRCLE 309 ON READER-SERVICE CARD

MALFUNCTION DETECTOR.—Type 66, for use in rotating and reciprocating machinery, allows vibration above a preset level to activate an internal switch, which, in turn, activates an alarm or causes machinery shut-down.

Robertshaw-Fulton Controls Co., Dept. ED, 911 E. Broad St., Richmond 19, Va.

CIRCLE 310 ON READER-SERVICE CARD

TACHOMETERS.—This line of transistorized tachometers, designated the 7120 series, measure speed without physical loading and provide overspeed-underspeed control.

Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 311 ON READER-SERVICE CARD

MINIATURE CAPACITORS.—Designed for aircraft, missiles, and radar units, these capacitors have a temperature range of -55 to +125 C. The use of silicones improves heat dissipation and resistance to cold.

San Fernando Electric Mfg. Co., Dept. ED, 1509 First St., San Fernando, Calif.

CIRCLE 312 ON READER-SERVICE CARD

VOLUME CONTROLS.—For the replacement of 500 K and 1 meg volume controls, these units improve bass and treble response by compensating for the Fletcher-Munson effect.

Centralab, Dept. ED, 900 E. Keefe Ave., Milwaukee, Wis.

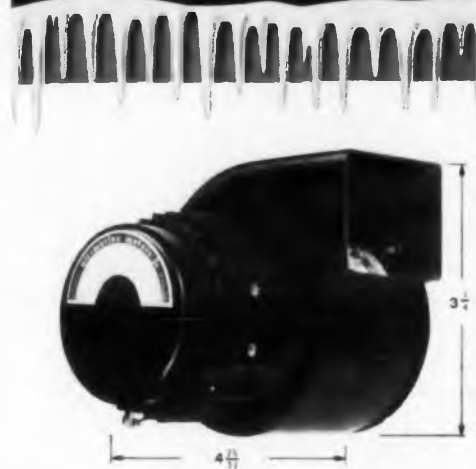
CIRCLE 313 ON READER-SERVICE CARD

MATING JACK AND PLUG.—For breakaway-connector usages, SKT-31 jack is designed to accept PR-10, a 0.04 in. plug. They have solder cups and can be mounted on 0.187 in. centers.

Sealectro Corp., Dept. ED, 139 Hoyt St., Mamaroneck, N.Y.

CIRCLE 314 ON READER-SERVICE CARD

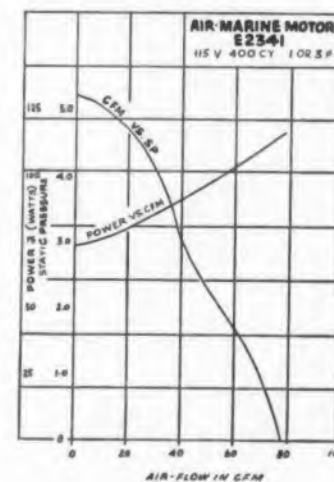
air-marine motors
cool the "hot spots"
of electronics



CENTRIFUGAL BLOWER

1000 hrs. Continuous Operation
at 85°C—115V—400 CPS—1 or 3 ϕ

Model E2341 (shown above) is another in the complete Air-Marine line of blowers, fans and motors designed and built to industrial and military specifications.



Minimum delivery of 50 CFM
against 2" wg

For information about our complete
line see Page 292—I.R.E. Directory.



air-marine
motors, inc.

369 BAYVIEW AVENUE
AMITYVILLE, L. I., N. Y.
2221 BARRY AVENUE
LOS ANGELES, CALIF.

CIRCLE 315 ON READER-SERVICE CARD

Blower

Provides 350 cfm of air



Model BP350-A provides 350 cfm of filtered air at 0 SP. The airflow is directed to the necessary location from either of the back blower outlets. Designed to be mounted in a standard 19 in. panel rack, the blower occupies 8.75 in. panel space and has 9.5 in. total depth.

Amco Engineering Co., Dept. ED, 7333 W. Ainslie St., Chicago 31, Ill.

CIRCLE 316 ON READER-SERVICE CARD

Transistorized Power Supplies

Have automatic protection



Series 36 transistorized, rack mounted power supplies provide a 0 to 36 v variable dc output at 1.5, 2.5, 5, 10, and 15 amp. They are automatically protected against overvoltage, short circuits, current overload, and thermal overload. Remote programming is available in all current ranges.

Trygon Electronics Inc., Dept. ED, Pleasant Ave., Roosevelt, N.Y.

CIRCLE 317 ON READER-SERVICE CARD

Coaxial Cables

Have impedances of 50 and 95 ohms



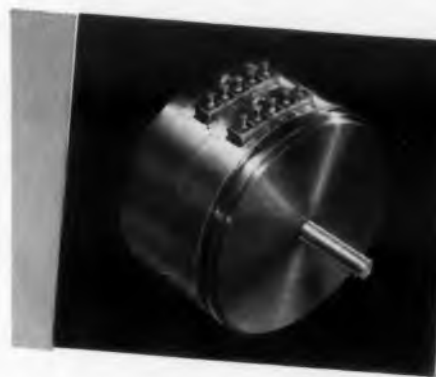
This series of 50- and 95-ohm cable, designated the T-line, has an expanded dielectric which approaches dry-gas-purged rigid or semi-rigid coaxial cable attenuation characteristics. Large solid copper conductors are used. Jacketed with a high molecular weight polyethylene, these cables have an anticipated life of over 20 yr. They are especially suitable for applications which require lighter weight and greater tensile strength.

Times Wire and Cable Co., Inc., Dept. ED, Wallingford, Conn.

CIRCLE 318 ON READER-SERVICE CARD

for
precise
control....

CLAROSTAT PRECISION POTENTIOMETERS



for stringent
environmental
conditions...
VARI/PHASE
series 54

Windings phased to meet application. Available in four sizes from 2- to 10-watts. Resistance range up to 200K ohms, depending upon unit size. Overall diameters from $\frac{7}{8}$ " to 3". "Claroseal" construction available to meet environmental applications.



for
space-saving...
 $\frac{1}{2}$ "
POTENTIOMETER
series 57

Provides more performance in less space. Combines special rotor with Hi-Load winding element for maximum stability and reliability. Nickel-silver body only $\frac{1}{2}$ " in dia. Features new Clarostat positive mechanical internal lead connections. Ranges to 40K ohms. Linearity, $\pm 2\%$ standard; $\pm 1\%$ special.



for
versatility...
"42"
POTENTIOMETER
series 42

Precision potentiometers rated at 3 watts. Available in resistance ranges up to 100K ohms, from 1 ohm. Continuous or limited rotation. High-dielectric phenolic case. Units ganged by means of threaded tie rods. Switches available for actuation at any shaft position.



for super
accuracy in effect
and read-out...
MULTI-TURN
series 55

Potentiometers in 3- to 6-watt ratings. Diameters from .875 to 2". Improved design permits 20% more winding length for same outside diameter, resulting in greater overall resistance and higher resolution. Taps available.



● These items are available from your Industrial Distributor. Write us for technical data.

CLAROSTAT MFG. CO., INC.

DOVER, NEW HAMPSHIRE, U.S.A.

In Canada: CANADIAN MARCONI CO., Ltd., Toronto 17, Ont.

CIRCLE 319 ON READER-SERVICE CARD

BENDIX TRANSISTOR VERSATILITY

POWER SUPPLY • AUDIO AMPLIFIER (CLASS A OR B) • AUDIO OSCILLATOR • POWER SWITCH • TRANSISTOR DRIVER • SERVO CONTROL • RELAY DRIVER • MOTOR CONTROL



CHECKMATE HIGH COSTS AND DESIGN LIMITATIONS

The new Bendix™ "yeoman" driver transistor series is engineered to perform over a wide range of audio frequency applications. The new 2N1176 series will find broad use wherever reliability, versatility and low cost are primary design requirements.

Each of the three "yeoman" models, 2N1176, 2N1176A and 2N1176B, has a different voltage rating, but all are contained in a rugged, welded JEDEC TO-9 package. Dissipation ratings are 300 mW at 25°C and 50 mW at 75°C. Higher voltage rating and high current gain coupled with a more linear current gain curve yield low distortion and efficient switching. Saturation resistance

is very low—typical values are 1 ohm measured at 100 mAdc.

Write today for the new Bendix Semiconductor Catalog for more information on our complete line of power transistors, power rectifiers and driver transistors. SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, N. J.

	MAXIMUM RATINGS				TYPICAL OPERATION	
	Vce Vdc	Ic mAdc	Pc mW	Tj °C	Current Gain hFE at Ic	
2N1176	15	300	300	85	50	10 mAdc
2N1176A	40	300	300	85	50	10
2N1176B	60	300	300	85	50	10

West Coast Sales Office: 117 E. Providencia Avenue, Burbank, California
Midwest Sales Office: 4104 N. Harlem Avenue, Chicago 34, Illinois
New England Sales Office: 4 Lloyd Road, Tewksbury, Massachusetts
Export Sales Office: Bendix International Division, 205 E. 42nd Street, New York 17, New York
Canadian Affiliate: Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ontario, Canada

Red Bank Division



CIRCLE 320 ON READER-SERVICE CARD

NEW PRODUCTS

CONTINUOUS LEVEL CAPACITANCE SYSTEM.—Made to detect, measure, and visually indicate media level changes, this unit has two-step calibration and unrestricted cable length between probe detector and transmitter. Linearity is $\pm 10\%$ of full range.

Robertshaw-Fulton Controls Co., Dept. ED, 911 E. Broad St., Richmond 19, Va.

CIRCLE 321 ON READER-SERVICE CARD

SOCKET MOUNTS.—For use in breadboard circuitry, these socket mounts include 7- and 9-pin miniatures, octals, and other standard tube bases. They may also be obtained for transistors and other multi-lead components. The unit consists of small plastic boards that fit over one or more elastic cores.

Plastic Associates, Dept. ED, 185 Mountain Rd., Laguna Beach, Calif.

CIRCLE 322 ON READER-SERVICE CARD

CERAMIC MIRROR BASE.—Composed of alumina and silica clays, this ceramic mirror base replaces glass mirrors in precision infrared optical systems.

Thompson Ramo Wooldridge, Inc., Dept. ED, P.O. Box 90534, Airport Sta., Los Angeles 45, Calif.

CIRCLE 323 ON READER-SERVICE CARD

DIGITAL COMPUTER.—Designed for laboratory or classroom use, this digital computer, designated SPEC, is modularized and transistorized. It can be converted into a digital differential analyzer.

Computer Control Co., Inc., Dept. ED, 2251 Barry Ave., Los Angeles 64, Calif.

CIRCLE 324 ON READER-SERVICE CARD

SPAGHETTI.—Made from Teflon, this high-temperature, corrosion-resistant spaghetti is available in standard or thin wall form with 0.01 to 0.33 in. hole diameter and 0.004 to 0.02 in. wall thickness.

Pennsylvania Fluorocarbon Co., Inc., Dept. ED, 1115 N. 38th St., Philadelphia 4, Pa.

CIRCLE 325 ON READER-SERVICE CARD

CATHODE REJUVENATOR TESTER.—Model CRT 440 tests and rejuvenates all black and white or color picture tubes at filament voltage from 1 to 12 v, including 110 deg tubes with 2.34, 2.68, 6.3, and 8.4 v filaments.

B & K Manufacturing Co., 3726 N. Southport Ave., Chicago 13, Ill.

CIRCLE 326 ON READER-SERVICE CARD

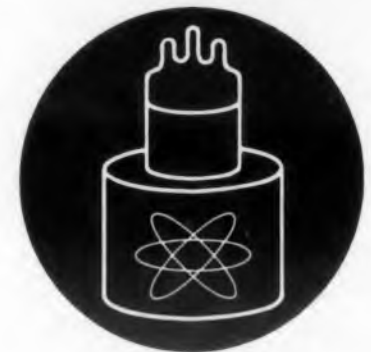
CABLES.—Designed for data transmission applications, the designated Data cable line includes low-capacitance miniaturized coaxial cables, low-loss coaxial cables, and shielded, low-capacitance twisted pairs. Multi-conductor cables are also available.

Times Wire and Cable Co., Dept. ED, Wallingford, Conn.

CIRCLE 327 ON READER-SERVICE CARD



TIED TOGETHER



MB ELECTRONICS is the new name for MB Manufacturing Company.

This recent change in name is simply a long overdue reflection of the company's proper character. It is a reflection of the company's recognized capabilities in the field of electronic design, in the manufacture of audio range, high fidelity, high power amplifiers, in the programming of advanced vibration testing... and in the capabilities of the largest field service force to properly service electronically driven systems and aid on any problem of vibration testing.

As always, you can count on MB to keep you ahead in electronically powered systems of maximum performance capabilities, operating convenience, and test accuracy.

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC.
1058 State Street, New Haven 11, Conn.

Pioneer and leader in the field of vibration

CIRCLE 328 ON READER-SERVICE CARD

Now on tap...

20,000,000 watts
of audio power

from MB
ELECTRONICS!

TWENTY million watts—that's the cumulative output available from MB power supplies now driving vibration test systems in the field.

The figure is more than a measure of the new importance of vibration testing. It's a measure of MB's technical advancement in the field of electronics for vibration, acoustics, and sonar.

And it's a measure of the company's unequalled background of experience in designing electronic power for dynamic forces... in producing *integrated* vibration testing systems including amplifiers of 100KW output and more, and exciters that utilize amplifier power more efficiently... in programming vibration tests to any required specification. This experience is available to you through MB's staff of vibration specialists and the largest force of field service technicians. Avail yourself of their expert recommendations on your vibration test problems.



Pioneer and leader
in the field of vibration

MB ELECTRONICS

A DIVISION OF TEXTRON ELECTRONICS, INC., 1058 State Street, New Haven 11, Conn.

On-Off Indicator

Weights 3.7 g

Of a coil and armature construction, this on-off indicator is resistant to shock and withstands ambients of 350 F. It will operate directly on any voltage up to 120 v ac or dc at frequencies up to 2500 cps. The unit weighs 3.7 g, is easily mounted, and features low power consumption. Either a pointer or an enclosed, hermetically sealed shutter arrangement can be provided as an indicator.

Leetronics, Inc., Dept. ED, 30 Main St., Brooklyn 1, N.Y.

CIRCLE 329 ON READER-SERVICE CARD

Capacitor

Has leakage time constant of 100 yr

This capacitor uses polystyrene dielectric having a dc resistance of more than 10^9 megohm- μ f or a leakage time constant greater than 100 years. Individual 0.1 μ f capacitors charged to 2000 v and disconnected from the power supply are still charged to 1990 v after 2 years. Uncased developmental models with voltage ratings from 1000 to 10,000 v are available.

Radiation Research Corp., Dept. ED, 1114 First Ave., New York 21, N.Y.

CIRCLE 330 ON READER-SERVICE CARD

Static Contactor

Has no moving parts

Made entirely of semiconductors and solid state components, this static contactor has no moving parts. It is switched on by a 10 v step input at 10 ma and turns on or off in 0.5 to 1 cycle. The unit has a long, maintenance-free life and is designed to operate in adverse environments, including explosive atmospheres. The controlled silicon rectifier is used as the main contact to achieve high average power capabilities and good overload characteristics.

Walter Kidde & Co., Inc., Dept. ED, 9 Brighton Rd., Clifton, N.J.

CIRCLE 331 ON READER-SERVICE CARD

← CIRCLE 332 ON READER-SERVICE CARD

NEW PRODUCTS

AMPLIFIER.—Has a gain of 10,000 with delay line clipping, and 20,000 with RC clipping. Model N-300 is used for nuclear applications and may be rack-mounted. It has a rise-time of less than 0.2 μ sec and a gain stability of 0.027% with a 1% line voltage change.

Hamner Electronics Co., Inc., Dept. ED, Princeton, N.J.

CIRCLE 333 ON READER-SERVICE CARD

SOLID STATE RELAY.—Ruggedized, model 530-B has no moving parts, replaces polar relays in teletypewriters and communication systems. Design uses silicon diodes and transistors for switching functions.

Trepac Corporation of America, Dept. ED, 30 W. Hamilton Ave., Englewood, N.J.

CIRCLE 334 ON READER-SERVICE CARD

VINYL ELECTRICAL TAPE.—Used as insulation, it will protect against moisture, surface contamination, corona, and excessive heat. Dielectric strength is 10 kv, and it is flameproof.

Reeves Soundcraft Corp., Dept. ED, Great Pasture Rd., Danbury, Conn.

CIRCLE 335 ON READER-SERVICE CARD

MAGNETIC SHIELDING FOR TOROIDS.—Netic and Co-Netic foils are non-shock sensitive, non-retentive and require no periodic annealing. This lightweight shielding permits high density packaging.

Magnetic Shield Div., Perfection Mica Co., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

CIRCLE 336 ON READER-SERVICE CARD

AC TO DC CONVERTERS.—NLS 125 series operate from 30 cps to 10 kc; voltage range is 0.001 to 999.9 v. Scale multiplier, voltage linearity, and frequency linearity are all accurate to $\pm 0.1\%$.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

CIRCLE 337 ON READER-SERVICE CARD

HIGH-VACUUM SYSTEM.—Develops pressures to 10^{-9} mm Hg within a work chamber 12 in. in diam 18 in. high, equipped with two 2 in. in diam windows, rotary motion and electrical feed-throughs.

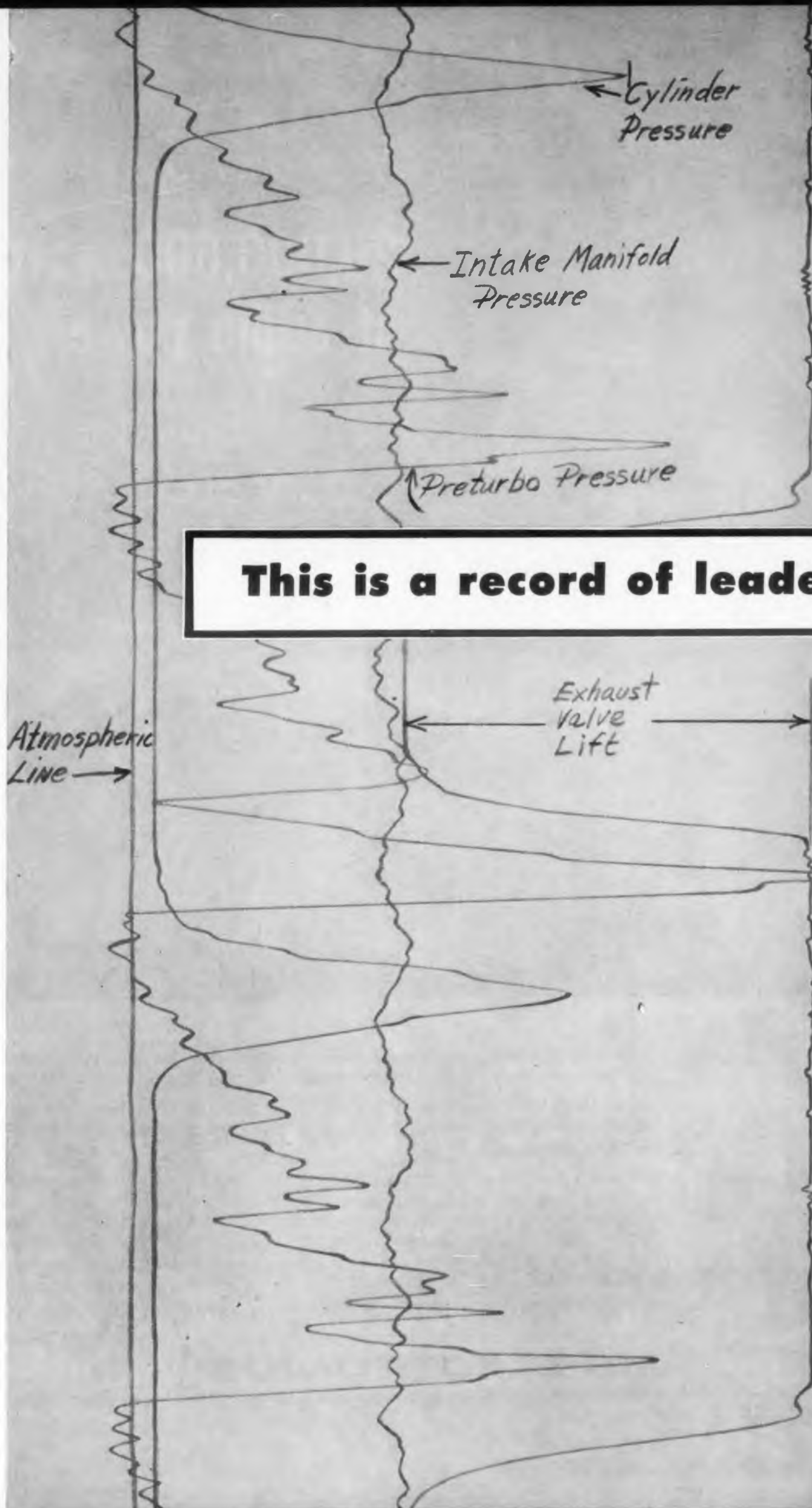
Kinney Manufacturing Div., New York Air Brake Co., Dept. ED, 3529 Washington St., Boston 30, Mass.

CIRCLE 338 ON READER-SERVICE CARD

FLIP-FLOP MODULE.—Model 110B-NRZ has ten flip-flops which drive double pole transistor switches for bi-directional current signals to magnetic heads. It is a standard 100 series Navcor slide-in module 2-1/4 x 10-3/4 x 7 in.

Navigation Computer Corp., Dept. ED, 1621 Snyder Ave., Philadelphia 45, Pa.

CIRCLE 339 ON READER-SERVICE CARD





The Worthington Corporation used a Honeywell 906 Visicorder to chart the heartbeat of a Worthington Tripower diesel engine. These Tripower (oil fuel, dual fuel, or spark ignition gas) engines have a fourteen inch bore, an eighteen inch stroke, and develop more than 265 h.p. per cylinder at 450 RPM.

The Visicorder used in these tests makes a direct, instantly-readable record of the pressure variations in the exhaust manifold, cylinder, and intake manifold to determine optimum valve

timing and engine configuration. The Visicorder also produces a permanent record of strain gauge measurements taken on the frame and other critical engine parts.

For the manifold and cylinder pressures, strain gauge pressure transducers and a strain gauge amplifier were used. For the valve lift patterns, a linear potentiometer powered with a small battery was connected directly to the Visicorder.

Analysis of these data has led to changes in the Tripower engine for best performance.

in diesel engine research



Ted Dupler (left) and John McAllister, Worthington Engine Research Engineers, measure intake manifold, cylinder, and exhaust manifold pressures and valve stroke on a Tripower with a Honeywell 906 Visicorder.

The Honeywell Visicorder is the pioneer and unquestioned leader in the field of high-frequency, high-sensitivity direct recording oscillography. In research, development and product testing everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

The new Model 906A Visicorder, now available in 8- and 14-channel models, produces longitudinal grid lines simultaneously with the dynamic traces, time lines, and trace identification by means of new accessory units.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin
Minneapolis-Honeywell Regulator Co.,
Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell



Industrial Products Group

CIRCLE 340 ON READER-SERVICE CARD



Digital Plotter

Accepts X-Y data

The model GP-1 digital plotter can be supplied to accept X-Y data in any original format such as binary, decimal, binary coded decimal, or analog. Accuracy is 0.1% of full scale and slewing speed is 50 in. per sec. The chart size is 8.5 x 11 in. and 11 x 16 in. The unit weighs 150 lb and measures 19 x 17 x 22 in. Power requirement is 115 v, 60 cps, at 250 w.

Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford, Conn.

CIRCLE 341 ON READER-SERVICE CARD



Seal

Glass-ceramic

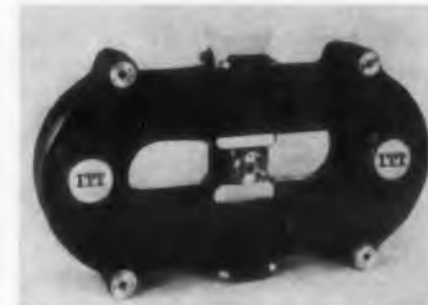
Having a sealing and service temperature of 750 C, this glass-ceramic frit seals aluminosilicate glass to itself, to molybdenum, or to tungsten, and molybdenum to tungsten. Other materials in the expansion range of 40 to 50×10^{-7} can also be sealed. The frit is made principally for the stack mount tube construction, but can also be used in magnetron, klystron, and traveling wave tubes.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 342 ON READER-SERVICE CARD

Magnetron

Has 100 kw peak power



Having a 100 kw peak power output, this magnetron operates in the 35 kmc band. Mean power outputs are 40 and 100 w, depending on the model.

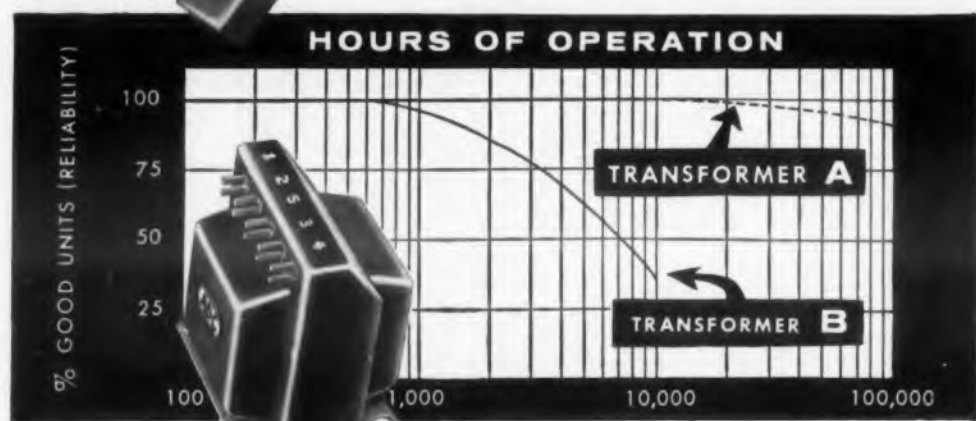
International Telephone and Telegraph Corp., Dept. ED, 67 Broad St., New York 4, N.Y.

CIRCLE 343 ON READER-SERVICE CARD



Long Life RUNS IN THE FAMILY!

Transformer A in the chart will deliver ten times more hours of dependable performance than transformer B. An engineer designing for reliability over a long period will want transformer A.



Transformer A and B are identical in appearance. They can both pass electrical inspection tests. The quality of the materials, workmanship, and design are all hidden from view so that no physical inspection can be made. So how do you tell? Which is A, and which is B?

The best way to tell is to know the manufacturer. If you're not already a customer we'd like to number you among those who *know from experience* that they have transformer reliability *inside*, when it says ADC on the *outside*. Over 15,000 custom transformer designs in nearly 25 years have proven beyond a doubt that long life just plain runs in the ADC family.

**Designing for Reliability?
Look to ADC!**



ADC

AUDIO DEVELOPMENT COMPANY
2835 - 13th Avenue South • Minneapolis 7, Minnesota
TRANSFORMERS • REACTORS • FILTERS • JACKS & PLUGS • JACK PANELS

CIRCLE 344 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Amplifier and Actuator System
Has 200-lb force output



This servo system consists of a clutch type actuator and a transistorized dc servo amplifier which can be supplied separately or as an integral unit. It has a 14-cps natural frequency, a force output of 200 lb, and an output velocity of 3.125 ips. Operating with a 54-db gain, the unit requires less than 35 w. It occupies about 35 cu in. and meets MIL-E-5272B specifications.

Natel Engineering Co., Dept. ED, 15336 Roscoe Blvd., Van Nuys, Calif.

CIRCLE 345 ON READER-SERVICE CARD

Silicon Rectifiers

Are pnpn controlled

These silicon pnpn controlled rectifiers, designated the type-130 series, have applications in power supplies, reversing drives, light dimming devices, surge voltage suppression, and latching relays. A third lead is utilized to control the current passing through the unit. A firing current of 5 ma is required. These units have 50 to 400 v in both piv and breakover voltage. The average rectified forward current is 3 amp at 50 C, 1 amp at 125 C. They will operate to 150 C stud temperature and can tolerate a maximum one-time surge current of 30 amp.

Texas Instruments Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 346 ON READER-SERVICE CARD

Tube Tester

Portable

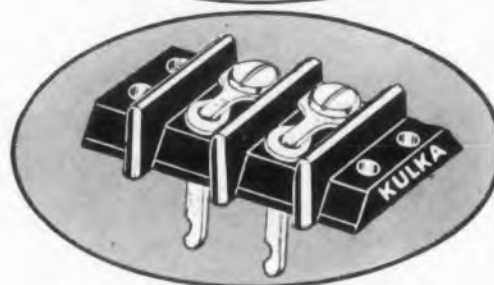
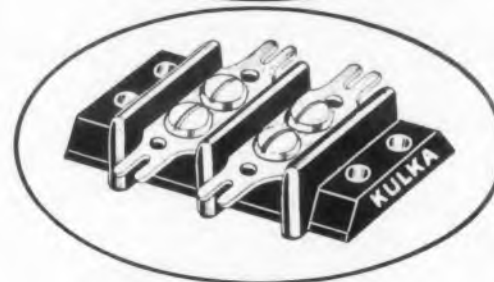
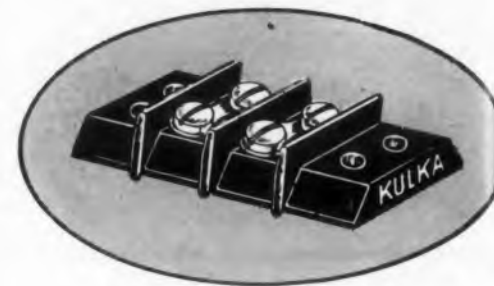
Model 78 grid circuit and tube tester detects grid emission and tube faults; it also checks filament continuity and provides an open element test. Five sockets are furnished, including one 9 pin type. The dimensions of this portable unit are 9 x 10-1/2 x 5 in. and the shipping weight is 6 lb.

Seco Manufacturing Co., Dept. ED, 5015 Penn Ave. S., Minneapolis, Minn.

CIRCLE 347 ON READER-SERVICE CARD

TERMINAL BLOCKS

that CUT
wiring costs



This popular "600" series is typical of Kulka's wide choice of terminal blocks. Note three popular terminal styles. Up to 26 terminals, maximum, in the "600" series. Choice of molded materials. And there are many other Kulka types to choose from.

CATALOG...

Write for the big Kulka Terminal Blocks catalog containing the outstanding selection of types, sizes, terminals, materials.



CIRCLE 348 ON READER-SERVICE CARD

NOISE!

NOISE!

NOISE!

NOISE!

**ANALYZE NOISE WITH
AN ALLISON FILTER**

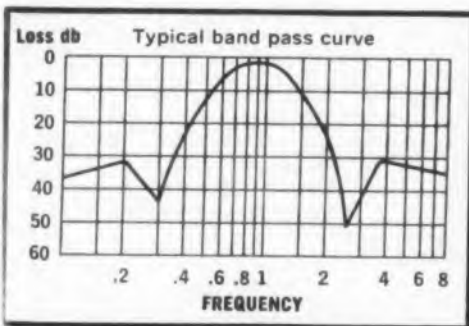


MODEL 420 FILTER

You can evaluate the amount of a noise and its frequency characteristics with an Allison Filter. You can make this evaluation regardless of whether the noise is continuous or intermittent, or whether it has sharp peaks. Allison Filters do not ring on transient noises. This analysis can be very important in testing equipment, preventing hearing loss, and controlling harmful or irritating industrial noises.

420 FILTER SPECIFICATIONS

Continuously variable frequency range from 20 cps to 20,000 cps.
20 db attenuation in first octave.
Passive network — no power supply.
No vacuum tubes.
Dynamic range, 120 db.
Impedance (in and out), 600 ohms.
Plug-in input-output transformers for other impedances.
Maximum input for minimum distortion, 2 volts.
Low loss, approximately 2 db in pass band.
Low pass signals from DC to cutoff frequency.
Minimum band width approximately 1/2 octave.
Size, excluding knobs and handle, 17" long, 5 3/4" deep, 8" high.



Write today for complete literature and prices

Allison Laboratories, Inc.

14191 EAST SKYLINE DRIVE
LA PUENTE, CALIFORNIA

CIRCLE 349 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Keyboard

Has ten digit keys



Having applications in remote numerical transmission and inventory work, this ten-digit keyboard weighs 12 oz and measures 3-3/4 x 1-1/2 x 4-1/4 in. The digit capacity depends on the receiving device which may be a calculator, printer, any solenoid activated business machine, tape punches, or other electronic data recording device. The unit is encased in gold-anodized aluminum.

Victor Adding Machine Co., Dept. ED, 3900 N. Rockwell St., Chicago 18, Ill.

CIRCLE 350 ON READER-SERVICE CARD

Silicon Power Rectifier

Rated at 1 to 15 amp

Style 20 silicon power rectifier is designed for operation at current levels from 1 to 15 amp, single-phase half-wave average. Surge ratings are 90 amp average at 60 cycles (0.1 sec) and 50 amp average at 60 cycles (1.0 sec). Peak inverse voltages range from 50 to 400 v in 50 v steps. Temperature range is from -65 to +175 C. The unit is mounted on a 7/16-in. hexagon stud case. Maximum height is 1-3/16 in.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.

CIRCLE 351 ON READER-SERVICE CARD

RF Filter

For screen room power lines

This low-pass unit filters out interference conducted by power lines entering a screen room. The attenuation of the filter equals or exceeds that of the screen enclosure. The unit is rated at 50 amp, 250 v, 0 to 60 cps. It measures 19-1/2 x 3-5/8 x 3-9/16 in. One filter is used for each incoming wire. Case is heavy-gage steel, hot tin dipped.

International Electronics Mfg. Co., Antran Div., Dept. ED, Second St. Extended, Greenwood Acres, Annapolis, Md.

CIRCLE 352 ON READER-SERVICE CARD

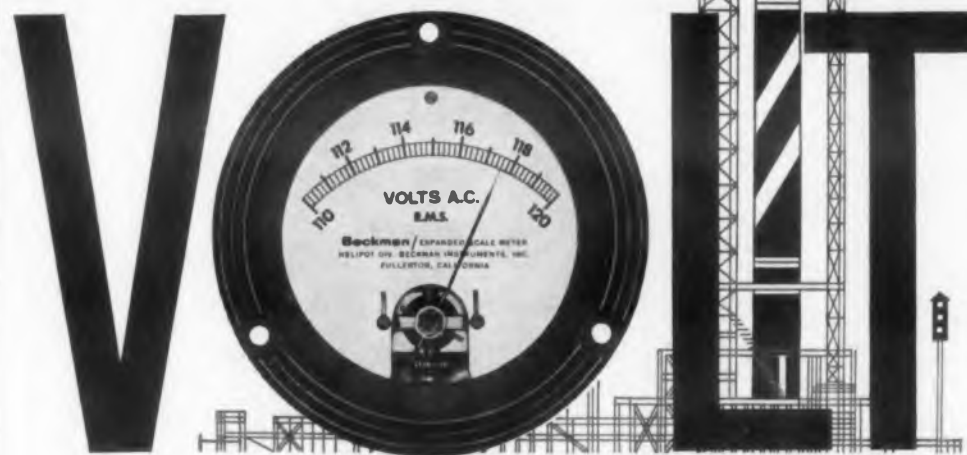
before the bird takes off

During preflight checkout, ground power supplies must be meticulously monitored to avoid limping under-voltage, crippling overvoltage.

How?

BECKMAN Expanded Scale Voltmeters—with accuracy to a fraction... readability to hundredths! That's vital volt-splitting at the moment of "Go—No Go," when operation depends upon precise power input with no room for guesswork. (And no trifling with "average" readings: BECKMAN AC meters give honest, direct rms readings on all wave forms.)

vital



splitting

Helipot offers you hundreds of models... either AC or DC... in diverse shapes, sizes and voltage ranges. (Not to mention voltage monitoring packages, which may include our expanded scale frequency meters and linear scale ammeters, too.) All have uncommon accuracy in common, plus resolution ten times that of conventional meters!

Incredible?

Make us prove it by asking for Data File C404.

Beckman / Helipot

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California
Engineering representatives
in 29 cities

potentiometers • dials • delay lines • expanded scale meters • servomotors • breadboard parts

CIRCLE 353 ON READER-SERVICE CARD

Replace 866 Rectifier Tubes

with **Tarzian**

TYPE S-5130 SILICON RECTIFIERS

10,400 piv 300 ma dc



- ▶ Small Size
- ▶ Long Life
- ▶ Higher Efficiency
- ▶ Greater Circuit Safety
- ▶ Safety Construction
- ▶ Temperature Versatility
- ▶ No Warmup Required

The Tarzian Type S-5130 Silicon Rectifier was designed as a direct replacement for 866 mercury vapor rectifier tubes. The S-5130 is capable of continuous duty operation of 300 ma dc at 10,400 PIV with a resistive-inductive load. Smaller than the 866 tube, the S-5130 requires no filament power or warmup period. The Tarzian type S-5130 conserves space and performs more efficiently than the 866. Shock hazard is minimized by use of an impregnated housing. Capable of operation in temperatures to 100°C, the S-5130 is ideal for use in applications which demand ruggedness, efficiency and ability to withstand temperature variation.

ELECTRICAL CHARACTERISTICS

MAX. RMS INPUT VOLTAGE.....	7400
MAX. INVERSE PEAK VOLTAGE.....	10400
MAX. PEAK CURRENT (MA).....	3000
MAX. DC CURRENT (MA).....	300
CIRCUIT.....	SINGLE PHASE HALF WAVE
DUTY.....	CONTINUOUS
TYPE LOAD.....	RESISTIVE-INDUCTIVE
AMBIENT TEMPERATURE.....	100°C MAXIMUM

NOTE: FOR CAPACITIVE LOAD DERATE DC CURRENT BY 20%, DERATE RMS INPUT VOLTAGE BY 50%

SEND FOR DATA SHEET

SARKES TARZIAN, INC., RECTIFIER DIVISION

DEPT. C-6, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGER 2-7535

EXPORT: AD AURIEMA, INC., NEW YORK CITY

CIRCLE 354 ON READER-SERVICE CARD

NEW PRODUCTS

Circuit Tester

For two- and four-terminal networks



Polyskop type SWOB tester for two- and four-terminal network measurements has a two-channel frequency-response display, a 0.5 to 400 mc frequency range, and a sweep width of ± 0.2 to ± 50 mc. It displays two quantities as a function of frequency in the form of continuous curves. Range of attenuation measurement is 45 db. The unit consists of a sweep signal generator, precision attenuator, electronic switch, and large screen oscilloscope assembled in a compact pull-out cabinet.

Rhode & Schwarz Sales Co., Inc., Dept. ED, 111 Lexington Ave., Passaic, N.J.

CIRCLE 355 ON READER-SERVICE CARD

Germanium Mesa Transistors

For use at fm and TV frequencies

These pnp germanium mesa transistors are used at fm and TV frequencies. The TI-361 has high gain at 200 mc for rf amplifiers and a typical noise figure of 6.5 db at 200 mc. The TI-360 has a typical circuit gain of 15 db in 100-mc rf amplifier applications and a 5.5 db typical noise figure. Both types have an all-glass header and are packaged in a TO-9 case with a fourth lead grounded to the can to minimize circuit radiation. Temperature operating range is -55 to $+85$ C.

Texas Instruments Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 356 ON READER-SERVICE CARD

Warming Box

Temperatures to 400 F

This continuous duty, gravity convection warming box for drying, baking and heating provides controlled heat to 400 F. This unit is available with 800 and 1500 w heating elements. It operates on 120 v, single phase input and measures 18 x 18 x 24-1/2 in.

Trent, Inc., Dept. ED, 201 Leverington Ave., Philadelphia 27, Pa.

CIRCLE 357 ON READER-SERVICE CARD

from **MESA**

NOW! NEW!

Flame
Resistant
Heat
Resistant

DIALL[®] MOLDING COMPOUNDS

*Faster Flame Out than
Any Other Flameproof
Molding Compounds
Heat Resistance
to 500° F*

New Diallyl Phthalates

52-70-70 . . . Short Glass Fiber
52-40-40 . . . Long Glass Fiber
51-60 Asbestos Filled
50-52 Dacron[™] Filled
DU PONT TRADE NAME

New Diallyl Iso-Phthalates

FS-10 Short Glass Fiber
FS-80 Long Glass Fiber
FS-60 Asbestos Filled

*Write TODAY for Data Sheets...
Just Off the Press!
When you Mold Parts Like These...*



Remember DIALL...

Easy to Mold
Easy to Machine
No Post-Mold Shrinkage
Resistant to Solvents
and Corrosives
Unaffected by Moisture
Fungus Proof
Does Not Corrode Metals
All Colors Available

*Please address all inquiries regarding
Diall molding compounds to*

MESA PLASTICS COMPANY...
12270 Nebraska Avenue
Los Angeles 25, California
Dept. 14

DIALL

MESA

CIRCLE 358 ON READER-SERVICE CARD

GE SEALED RELAYS—unmatched for reliability



All the dust in this room could hide under this dot



This is General Electric's "white room," where special, ultra-reliable miniaturized relays are painstakingly adjusted, inspected, and tested. On certain supercritical applications, particularly those involving dry-circuit switching, a tiny speck of dust could cause a sealed relay to malfunction, possibly resulting in failure of an entire electronic system.

To prevent such costly failures, General Electric has installed this special "white room" where elaborate precautions are taken to maintain a dust-free atmosphere for assembly of ultra-reliable sealed relays. Regular checks

insure that dust in the air does not exceed 20,000 particles per cubic foot. Compare this with well over a million particles per cubic foot in the average home or office.

But this dust-free assembly room is only part of General Electric's reliability story. Design leadership, such as produced the Unimite—world's smallest one-amp relay—and advanced manufacturing techniques—including a new inert-arc welding process to eliminate contact-contaminating solder and flux—consistently produce superior relays. Then, General Electric conducts ex-

haustive operational and environmental tests to prove extreme reliability.

Relay applications differ widely in performance requirements. Whatever your application, General Electric can offer sealed relays designed, built and tested to comply with your requirements. Call your G-E Apparatus Sales Engineer today or mail the coupon at right. General Electric Co., Specialty Control Dept., Waynesboro, Va.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 359 ON READER-SERVICE CARD



There's a G-E sealed relay for every circuit need—every reliability requirement

G-E miniature, sub-miniature, micro-miniature and Unimite relays combine small size with unusual reliability under severe temperature, shock and vibration conditions to make them ideal for electronic jobs, both military and commercial. G.E.'s complete line of sealed relays includes these basic types:



MINIATURE: Long-life type; rated 5 amps at 28 volts d-c; in 2- or 4-pole double throw and 6PNO forms. Ideal for ground applications.



SUB-MINIATURE: 2 amps at 28 volts d-c, 115 volts a-c, double-pole double-throw. Excellent thermal life.



MICRO-MINIATURE: Crystal-can type, double-pole and new welded 4-pole units. Rated 2 amps, 28 v d-c or 115 v a-c. Grid-space terminals available.



UNIMITE: The world's smallest 1-amp sealed relay; single-pole type. Isolated contact chamber, high speed 1.5 millisecond operation.

General Electric Co.
Section A792-14
Schenectady 5, N. Y.

Please send me a free copy of the 1959-60 Sealed Relay Catalog.

Name

Address

City State

GENERAL  ELECTRIC

Now!



FIRST AGAIN!

MINIATURE MULTI-TURN PRECISION FILM POTS

FEATURING:

- **VIRTUALLY INFINITE RESOLUTION**
Eliminates servo hunting
- **LONG LIFE AT HIGH SPEEDS**
10,000,000 revolutions—500 rpm

EXCLUSIVE FEATURES:

- **NON-LINEAR OUTPUTS**
No Tapping and Shunting
- **DUAL GANG—SINGLE GANG**
SAME CASE SIZE!
SAME STARTING TORQUE!
SAME INERTIA!
- **ONE PIECE THROUGH SHAFT**
Pot fits anywhere in your gear train
- **ONE PIECE, ALL METAL CASE**
Machined-in, Stay-Put Accuracy

CIC is the largest manufacturer of Precision Film Potentiometers, having pioneered in their development, with a 10-year record of supply to all branches of the Armed Services and throughout industry. Our staff of technical specialists is ready to assist you with your potentiometer needs.

Write for our catalog.

FIRST IN FILM POTS

SINGLE TURN
POTS

SINE-COSINE
POTS

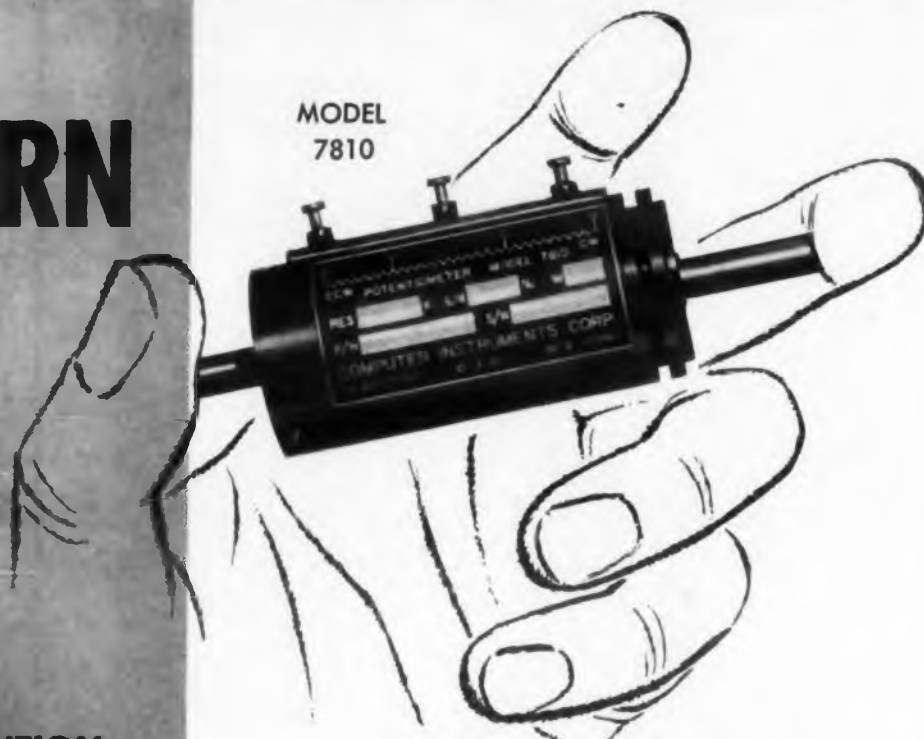
LINEAR MOTION
POTS

PRESSURE
TRANSDUCERS

COMMUTATORS

CIRCLE 360 ON READER-SERVICE CARD

MODEL
7810



This miniature multi-turn precision film pot is not just better than wire-wound types—it brings a new dimension of performance and flexibility to your system. With SuperCon Film pots you can forget about the obsolete concepts of wire resolution, clumsy tapping and shunting to produce non-linear outputs, bulkiness in ganging, and loose-wire, glued-assembly construction. The ball-bearing supported, one-piece through shaft permits you to locate your pot anywhere in the gear train, freeing you to select the optimum ratios with the minimum components, to transmit torque through the pot, to miniaturize even more. SuperCon Film pots have the inherent accuracy and reliability to easily meet your requirements.

92 Madison Avenue, Hempstead, L. I., N. Y.



NEW PRODUCTS

Centrifugal Blower

For electronic equipment



Made for such applications as cooling electronic tubes or ventilating small electronic equipment cabinets, type 89C21 centrifugal blower delivers 106 cfm of air at 0 SP and 20 cfm of air at 1 in. wg-SP. The 1/4 hp shaded pole electric motor operates at 3000 rpm using 115 or 230 v, single phase, 50 or 60 cps. The complete assembly weighs 6 lb; its overall dimensions are about 6 x 6 x 8-1/2 in.

American-Standard, Industrial Div., Dept. ED, Detroit 32, Mich.

CIRCLE 361 ON READER-SERVICE CARD

Target Simulator

Moving video type

Moving video target simulator model RP-175PM provides a complete dynamic test of a long range ballistic missile tracking radar. Up to 90% of the spacing between main bangs is available for target return with this unit. The simulated target may be programmed at ranges up to 500 miles with scales reading 0 to 40, 0 to 250, and 0 to 500 nautical miles. Target velocities up to 30,000 ft per sec and accelerations up to 30 g may be programmed.

Remanco, Inc., Dept. ED, 1630 Euclid, Santa Monica, Calif.

CIRCLE 362 ON READER-SERVICE CARD

Transducer Elements

Piezoelectric ceramic

Made of piezoelectric ceramic, these ultrasonic transducer elements have a resonant frequency of 38 kc. At a temperature of 25 C and a frequency of 1 kc, capacitance is 280 μ f and dissipation factor is 0.6%. The Curie temperature is 138 C. Type 10C21 is furnished with tabs; type 10C21A, without tabs. The standard block measures 2 x 1-7/8 x 1-1/16 in. Various other shapes are available.

Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 363 ON READER-SERVICE CARD



XTVE



TAM



XTL

HAT



TAF



XTLS

Need Tantalum Capacitors?

CHOOSE FROM 15 MALLORY TYPES

Leader in tantalum capacitor technology, Mallory offers the broadest line on the market . . . ranging from micro-miniature Type HAT to the high-capacitance Type XTV. Included are 200° C ratings, pioneered by Mallory, in many case styles and values. Write today for technical data, and for a consultation.

Type	Description	Capacity Range	W. Volts DC Rating at 85°C	Temperature Range	Case Style	Body Length	Body Diameter
HAT	Pellet Anode—Liquid Electrolyte	1-10 mfd.	16-1V.	-20 to +85°C	Metal Case—Axial Leads—Insulated Case	.210" max.	.075" max.
TAS	Pellet Anode—Solid Electrolyte	.33-330 mfd.	35-6V.	-80 to +85°C	Metal Case—Axial Leads	.250" to .750"	.125" to .341"
TAM	Pellet Anode—Solid Electrolyte	6.8-56 mfd.	25-6V.	-55 to +85°C	Dip Coated Resin—Upright Mounting	.175" thick	.313" square
TAF	Foil Anode—Semi-Liquid Electrolyte	.25-440 mfd.	150-3V.	-55 to +85°C	Metal Case—Axial Leads	.688" to 2.750"	.188" to .375"
STNT	Pellet Anode—Liquid Electrolyte	2-40 mfd.	50-3V.	-55 to +85°C	Metal Case—Axial Leads	.350"	.155"
TNT	Pellet Anode—Liquid Electrolyte	4-80 mfd.	50-3V.	-55 to +85°C	Metal Case—Axial Leads	.500"	.155"
TAP	Pellet Anode—Liquid Electrolyte	2-30 mfd.	90-6V.	-55 to +85°C	Metal Case—Axial Leads	.500"	.238"
TAP2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	-55 to +85°C	Metal Case—Axial Leads	.660"	.238"
M2	Pellet Anode—Liquid Electrolyte	11-140 mfd.	90-6V.	-55 to +150°C	Metal Case—Axial Leads	.500"	.290" (Body) .484" (Flange)
XTK	Pellet Anode—Liquid Electrolyte	2-70 mfd.	340-8V.	-55 to +175°C	Metal Case—Axial Leads or Terminal	.438" to 1.313"	.650"
XTM	Pellet Anode—Liquid Electrolyte	4-140 mfd.	340-8V.	-55 to +175°C	Metal Case—Axial Leads or Terminal	.563" to 1.781"	.650"
XTL	Pellet Anode—Liquid Electrolyte	3.5-120 mfd.	630-18V.	-55 to +200°C	Metal Case—Axial Terminal	.500" to 2.595"	.875"
XTH	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	-55 to +200°C	Metal Case—Axial Terminal	.688" to 4.063"	.875"
XTV	Pellet Anode—Liquid Electrolyte	18-1300 mfd.	630-30V.	-55 to +175°C	Metal Case—Axial Terminal	.563" to 2.750"	1.125"
XTO	Pellet Anode—Liquid Electrolyte	7-240 mfd.	630-18V.	-55 to +200°C	Metal Case—Axial Terminal	.563" to 2.750"	1.125"

Mallory Capacitor Company

Indianapolis 6, Indiana

a division of



CIRCLE 364 ON READER-SERVICE CARD

Order Tantalum Capacitors

FROM STOCK

at these

MALLORY

Industrial Distributors

Baltimore, Md.

D & H Distributing Co.

Boston, Mass.

Cramer Electronics, Inc.

DeMambro Radio Supply Co.

Buffalo, N. Y.

Wehle Electric

Sunset Electronics Div.

Camden, N. J.

General Radio Supply Co.

Chicago, Ill.

Allied Radio Corp.

Newark Electric Co.

Dallas, Texas

Engineering Supply Co.

Dayton, Ohio

Allied Supply Co.

Denver, Colo.

Denver Electronics

Glendale, Calif.

R. V. Weatherford Co.

Houston, Texas

Harrison Equipment Co., Inc.

Lenert Company

Los Angeles, Calif.

Kierulff Electronics, Inc.

Minneapolis, Minn.

Northwest Radio &

Electronic Supply Co.

Mountainside, N. J.

Federated Purchaser, Inc.

New York, N. Y.

Harrison Radio Corp.

Harvey Radio Co., Inc.

Hudson Radio & TV Corp.

Lafayette Radio Corp.

Terminal Radio Corp.

Oakland, Calif.

Elmar Electronics, Inc.

Palo Alto, Calif.

Zack Radio Supply Co.

Pasadena, Calif.

Electronic Supply Corp.

Pittsburgh, Pa.

Radio Parts Co.

Tampa, Florida

Thurrow Distributors, Inc.

Tulsa, Okla.

Engineering Supply Co.

Washington, D. C.

Electronic Wholesalers

the identical "guts" — but
your choice of three cases—
three prices with

CHICAGO "sealed-in-steel" TRANSFORMERS

Many of the transformers in the CHICAGO line are available in your choice of three mounting types. Like these three typical units, they are built to the identical electrical specifications and differ only in case, lead termination, and price.

The HERMETICALLY SEALED unit is designed and built in accordance with MIL-T-27A, Grade 4 specifications. It has a premium grade drawn steel case, and is stud mounted. The price of this power transformer (450V. center-tapped AC at 40 MaDC with two filament windings), Part No. PHC-40, is \$12.90.

The identical transformer in S-TYPE construction (Part No. PSC-40) has a steel base cover fitted with a phenolic terminal board. The solder lug terminals are conveniently numbered; unit is flange mounted. The price is \$8.85.

The same electrical performance is available in low-cost C-TYPE construction (Part No. PCC-40). Flange mounted unit has 10 color-coded leads brought out through a fibre board base cover. The price of this "economy model" is only \$5.10.

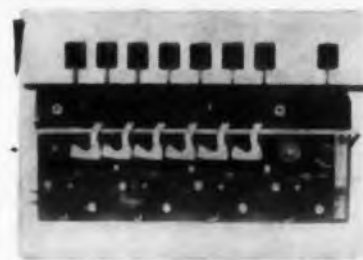
You get this choice only from Chicago Standard. Whether you're interested in meeting military requirements, appearance requirements, mounting requirements, or budget requirements—Chicago Standard can fill your needs. Write for the latest Chicago Standard catalogs for detailed listings of the industry's most complete transformer line.

CHICAGO STANDARD TRANSFORMER CORPORATION
3518 WEST ADDISON STREET • CHICAGO 18, ILLINOIS
CIRCLE 365 ON READER-SERVICE CARD

NEW PRODUCTS

Switches

Have binary-coded output



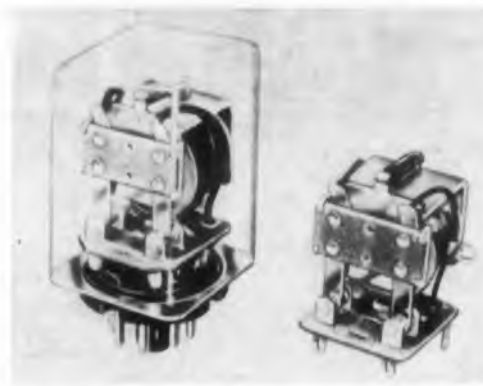
These switches are made for keyboard use and eliminate multiple relay contact arrangements. Model DS-1 has a ten-button decimal bank with 1-2-4-8 binary output contacts. Models OS-1 and OS-2 have eight-button octal banks with 1-2-4 binary output contacts. Model OS-2 has a spdt switch coupled to the zero or clear button. For all models output is through double throw contact arrangements.

Computer Control Co., Inc., Western Div.,
Dept. ED, 2251 Barry Ave., Los Angeles 64, Calif.

CIRCLE 366 ON READER-SERVICE CARD

Relay

Rated at 8 amp



Available in all voltages to 230 v ac and 110 v dc, the model RG relay has 8 amp silver contacts and spdt to 3pdt arrangements. Special alloy contacts may be provided on request. This low cost unit comes in a 1-3/4 oz open model or in a 2-1/2 oz dustproof model that has a clear plastic enclosure with plug-in mounting.

Artisan Electronics Corp., Dept. ED, 171 Ridgedale Ave., Morristown, N.J.

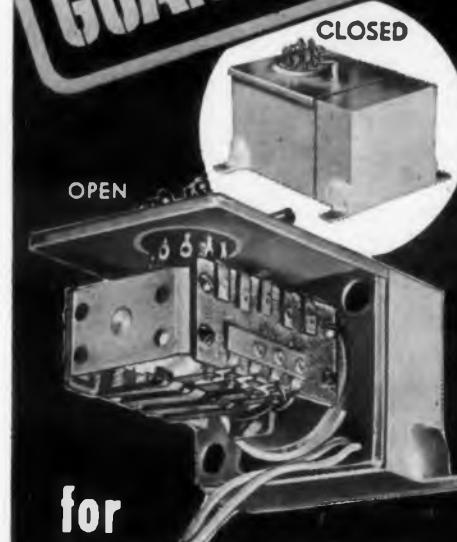
CIRCLE 367 ON READER-SERVICE CARD

Integrator-Computer

Square root type

Type C3A/1 integrator-computer consists of two separately housed assemblies: a computer package and an electro-magnetic six-digit indicator. The indicator measures 1-7/8 x 4-7/16 in. and

GUARANTEED



for
100,000 CYCLES
and
800,000 BREAKS

NEW

miniaturized
solenoid actuated

CAM SWITCH

- ✓ Hermetically sealed
- ✓ Extremely compact, light weight
- ✓ "Reliability engineered" for guaranteed performance
- ✓ Shock & vibration tested in conformance with MIL-E-5272A
- ✓ Operates 24 to 30 volts, DC, at 125°C ambient
- ✓ Rating, 1 amp.
- ✓ Size, 1 1/4" x 1 1/2" x 2 3/4"
- ✓ 7-pole, 18-position shorting with interrupter and homing

Designed to meet standards for guided missile systems, this new Cam Switch is typical of special designs by Tech Labs which can be easily adapted to specific needs. Write for complete data.

TECH
LABORATORIES, INC.

PALISADES PARK,
NEW JERSEY

CIRCLE 368 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959



DIAL-IN TRANSISTOR CIRCUITS with time-saving Transimulator*

- simulates any amplifier stage
- ready-made circuits at your fingertips
- pays for itself in no time

No breadboarding, no soldering. Your transistor circuit designs come to life in a matter of minutes with the Sprague LF-1 Transimulator. The circuit links you need are built right into the instrument. With the Transimulator, you'll be able to obtain a speedy and accurate evaluation of the operating parameters involved in your circuit design... without wasting valuable time with pliers, soldering, or screwdrivers.



only
\$79.50

Step-by-step
manual simplifies
circuit set-ups

SEE THE TRANSIMULATOR IN ACTION!
Write for the name and address of
your nearest authorized Sprague dis-
tributor to Sprague Products Company,
347 Marshall St., North Adams, Mass.

*Trademark

SPRAGUE[®]
THE MARK OF RELIABILITY

CIRCLE 369 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

is located remotely from the computer. The normal counting rate is 20,000 counts per day, but can be from 4000 to 100,000 counts per day. Digital totalization is continuous and accurate from 1 to 100% of the input signal. Installed in parallel with a flow indicator, recorder, and controller, it operates from a common 0 to 0.5 v ac signal and has no effect upon control loop.

Swartout Co., Dept. ED, 18511 Euclid Ave.,
Cleveland 12, Ohio.

CIRCLE 370 ON READER-SERVICE CARD

Oscillator

Covers 10 cps to 5 mc



Model GO-20F oscillator covers 10 cps to 5 mc in these six ranges: 10 to 100 cps, 100 to 1000 cps, 1 to 10 kc, 10 to 100 cps, 100 to 1000 kc and 1 to 5 mc. The output impedance is 50 ohms and the output voltage is 2 v rms max. Distortion is less than 2%. Frequency stability is 1% after warm-up and amplitude stability is 2%. The attenuator covers 50 db in 10 db steps; continuous variable fill-in control is provided. This model has a vtvm output monitor. Power requirement is 115 v, 60 cps, at about 40 w. The unit is available in rack panel mounting measuring 8.75 x 19 x 13 in., or cabinet mounting, 9.5 x 24 x 15 in.

Gerber Scientific Instrument Co., Dept. ED,
89 Spruce St., Hartford 1, Conn.

CIRCLE 371 ON READER-SERVICE CARD

Precision Potentiometers

Have concentric shafts

Two types of concentric-shaft precision potentiometers are available: type APC 1-1/8, having a 1-1/8 in. diam, offers a resistance range of 25 ohms to 350 K; type APC 7/8, having a 7/8 in. diam, offers a resistance range of 10 ohms to 250 K. For both types, standard resistance tolerance is $\pm 5\%$; when specified, $\pm 1\%$ may be obtained. Standard independent linearity is $\pm 2\%$ for APC 1-1/8 and $\pm 3\%$ for APC 7/8; $\pm 0.25\%$ may be obtained. Both types have a temperature range of -55 to $+125$ C.

Waters Manufacturing, Inc., Dept. ED, Way-
land, Mass.

CIRCLE 372 ON READER-SERVICE CARD

the world's
most expensive

inch
of
recording tape

There's no question about it—if there were a dropout in this inch of tape it could cost you plenty. That's why our customers invariably demand perfection from our EP Audiotape—the *extra precision* magnetic recording tape for computers, automation, telemetry and seismography.

Audio Devices' battery of Automatic Certifiers is one of the unique means used to make sure EP Audiotape always meets customers specifications. The Automatic Certifier records and plays back every inch of the EP Audiotape under test. These tests can be so demanding that if the tape fails to reproduce just *one* test pulse out of the 40 million put on a single reel, the entire reel is rejected. There are no *if's*, *and's*, or *but's*.

This is just one of many special quality-control operations. From raw material to hermetically sealed containers, every reel of EP Audiotape gets individual attention.

For more information write for free Bulletin T112A. Write Dept. TD, Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y.

TYPE **EP audiotape** TRADE MARK

AUDIO DEVICES, INC.

444 Madison Ave., N. Y. 22, N. Y.

In Hollywood: 840 N. Fairfax Ave.

In Chicago: 5428 Milwaukee Ave.

Export Dept.: 13 East 40th St., N. Y., 16

Rectifier Division: 620 E. Dyer Rd., Santa Ana, Calif.

CIRCLE 373 ON READER-SERVICE CARD

NEW PRODUCTS

Silicon Transistors

Rated at 50 w at 25 C

Types 2N1060 and 2N1070 silicon transistors are rated at 50 w at 25 C and have an operating temperature range of -65 to $+175$ C. Maximum collector current is 4 amp for both types. Maximum saturation for the 2N1070 is 0.67 ohms at 1.5 amp collector current. The transistors are diffused junction, npn type. Typical applications are: relay replacements and controls, solenoid actuators, power converters, power switches, high level dc amplifiers, class A or B power amplifiers, and power supply regulators.

Silicon Transistor Corp., Dept. ED, Carle Place, N.Y.

CIRCLE 374 ON READER-SERVICE CARD

High Vacuum Gage Control

Combines two gages



Designed for measuring pressures of 5 millimicrons to 1000 microns Hg, model DG 2-2T high vacuum gage control combines a thermocouple gage and a Philips type cold-cathode discharge gage. The thermocouple unit measures pressure response between 1 and 1000 microns from either of two thermocouple gage tubes. The Philips type cold cathode unit is sensitive to pressures from 5 millimicrons to 10 microns. Dimensions are 19.2 x 5.25 x 3.75 in. and shipping weight is less than 15 lb. This model is suitable for table or rack mounting and requires a 110 v ac supply.

Veeco Vacuum Corp., Dept. ED, 86 Denton Ave., New Hyde Park, L.I., N.Y.

CIRCLE 375 ON READER-SERVICE CARD

Printer Relay

Transistorized

Type 237, model 1, printer relay is used as a coupling device between a dc teleprinter signal loop and the printer selector magnet. It isolates the reactance of the printer selector magnet, presenting a resistive termination to the signal loop. The relay may be used with either polar or neutral keyed signals.

Northern Radio Co., Inc., Dept. ED, 147 W. 22nd St., New York 11, N.Y.

CIRCLE 376 ON READER-SERVICE CARD

General Electric Semiconductor News

Prices cut another 20% on

Mass production of SCR's is now a reality. The experience, skill and manufacturing knowhow of General Electric's SCR production line is your assurance of dependable quality-controlled SCR's—an assurance unmatched by any other manufacturer.



WHAT THE SCR DOES

The SCR is a miniature semiconductor device that blocks positive forward voltage in its "off" or non-conducting state. However, by applying a small signal to the gate terminal it switches rapidly to a conducting state and acts like a single junction silicon rectifier. It is completely static, arcless and fast. It is almost 100% efficient. It contains no mechanisms subject to wear. As a result, the SCR can switch and control power either faster, more safely, less expensively or more reliably than the many devices it replaces: circuit breaker, relay, thyatron, magnetic amplifier, rotating amplifier and many others. Among the many hundreds of circuit designs are these:

Superior d-c motor operation from an a-c source. Eliminates motor generator sets, tubes or magnetic amplifiers to provide controlled d-c. Replaces mechanical speed and direction changers.

Superior a-c generation from a variable d-c source. First really practical method of using static inverters with ratings of several kilowatts.

Simpler conversion to high frequency. SCR converters are small and efficient. Extends use of high frequency power where desirable, as in fluorescent lighting systems.

Pulse modulators. Compact, yet rugged replacement for hydrogen thyratrons in radar and beacon modulators.

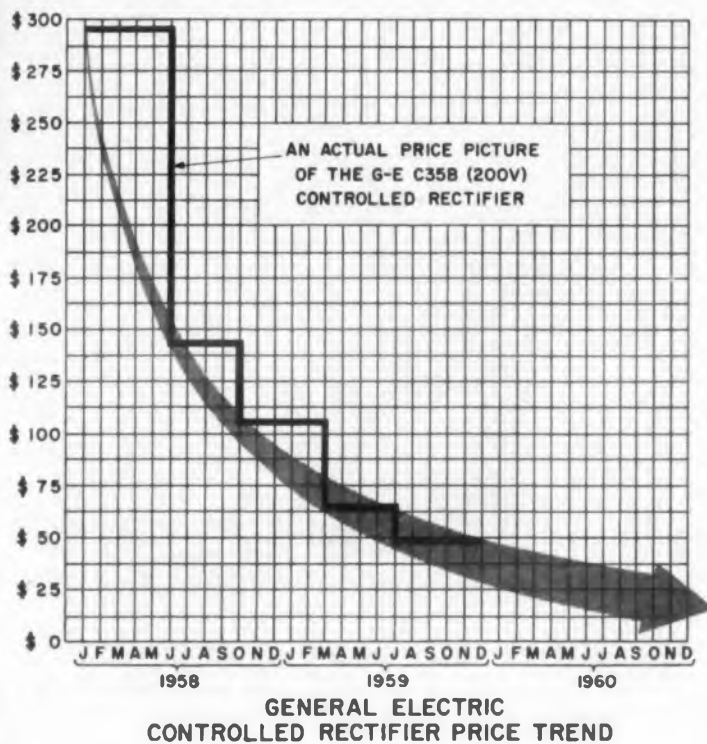
D-c regulation. Control large blocks of voltage with small losses by pulse width modulation. Eliminate bulky rheostats and adjustable d-c generators.

Other applications: Battery charging regulator, transient voltage protection, dynamic braking, constant current supply, static switching, regulated power supply, d-c to d-c conversion, temperature control.

silicon controlled rectifier

*First test data revealed, new circuits developed,
customer designs move into manufacturing stage*

Prices again have been reduced an average of twenty percent on General Electric's Silicon Controlled Rectifier, providing greater values to users. These new prices have been made possible through expanding production and lower manufacturing costs.



TESTS AND FIELD REPORTS PROVE RELIABILITY

Reliability of General Electric SCR's has been steadily improved over two years of manufacturing experience. Typical test results point to the reliability achieved to date.

MAXIMUM ALLOWABLE RATINGS (Resistive or Inductive Load)

Continuous Peak Inverse Voltage (PIV)
Transient Peak Inverse Voltage (Non-Recurrent < 5 millise.)
RMS Voltage (V_{RMS}), Sinusoidal
Average Forward Current (I_F)
Peak One Cycle Surge Current (I_{surge})
Peak Gate Power
Average Gate Power
Peak Gate Current (I_G)
Peak Gate Voltage (V_G) (forward)
Storage Temperature
Operating Temperature

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Continuous Peak Inverse Voltage (PIV)	25	50	100	150	200	250	300	400 volts
Transient Peak Inverse Voltage (Non-Recurrent < 5 millise.)	35	75	150	225	300	350	400	500 volts
RMS Voltage (V _{RMS}), Sinusoidal	17.5	35	70	105	140	175	210	280 volts
Average Forward Current (I _F)	Up to 16 amperes							
Peak One Cycle Surge Current (I _{surge})	150 amperes							
Peak Gate Power	5 watts							
Average Gate Power	0.5 watts							
Peak Gate Current (I _G)	2 amperes							
Peak Gate Voltage (V _G) (forward)	10 volts							
Storage Temperature	-65°C to +150°C							
Operating Temperature	-65°C to +125°C							

CHARACTERISTICS (At Maximum Ratings)
Minimum Forward Breakover Voltage (V_{BO})
Maximum Reverse (I_R) or Forward (I_S) Leakage Current (Full Cycle Average)
Maximum Forward Voltage (V_{F AVG})
Maximum Gate Current To Fire (I_{GF})
Maximum Gate Voltage To Fire (V_{GF})
Typical Gate Current To Fire (I_{GF})

	C35U	C35F	C35A	C35G	C35B	C35H	C35C	C35D
Minimum Forward Breakover Voltage (V _{BO})	25	50	100	150	200	250	300	400 volts
Maximum Reverse (I _R) or Forward (I _S) Leakage Current (Full Cycle Average)	6.5	6.5	6.5	6.5	6.0	5.5	5.0	4.0 ma
Maximum Forward Voltage (V _{F AVG})	0.86 volts (Full Cycle Average)							
Maximum Gate Current To Fire (I _{GF})	25 ma							
Maximum Gate Voltage To Fire (V _{GF})	3 volts							
Typical Gate Current To Fire (I _{GF})	10 ma at +1.5 volts (Gate to Cathode Voltage)							

C-35 Series—lower cost series with ratings similar to above, but for use up to 100°C maximum, with forward current ratings up to 10 amperes.
ZJ-50 Series—a high-current series now in development, and available on a prototype-sample basis.

GENERAL ELECTRIC

Semiconductor Products Department
CIRCLE 377 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Backward Wave Oscillator

Voltage range is 400 to 1800 v

Model HO 22 backward wave oscillator is focused in a periodic permanent magnet structure and has a tuning voltage range of 400 to 1800 v. Frequency is 8.5 to 12 kmc with a minimum power output of 10 dbm, and 8.2 to 12.4 kmc with 5 dbm. Measuring 11-1/2 x 2-1/2 in. and weighing 3.5 lb, this unit replaces solenoid and power supply. No cooling is required.

Huggins Laboratories, Dept. ED, 999 E. Arques Ave., Sunnyvale, Calif.

CIRCLE 378 ON READER-SERVICE CARD

Tritium Monitor

Measures radioactivity



Model 34 tritium monitor measures and records radioactivity in the air and sounds an alarm when the safe limit is exceeded. It detects 10⁻¹² curies of tritium per ml of air. Four ranges are provided: 10⁻¹¹, 10⁻¹², 10⁻¹³, and 10⁻¹⁴ amp full scale. Ion chamber volume is 850 ml; readings are self-consistent to 2% of full scale between all ranges. The monitor requires 100 w of power with 117 v, 50 to 60 cps source. The instrument consists of two units, a control unit, pictured here, and a sampling unit. Both measure 19 x 11 x 13 in.

Applied Physics Corp., Dept. ED, 2724 S. Peck Rd., Monrovia, Calif.

CIRCLE 379 ON READER-SERVICE CARD

Controlled Temperature Bath

For 12-cell bank

Model 66 controlled temperature bath is designed to maintain a bank of 12 standard cells at a constant temperature. The standard cells are immersed in a tank of neutral oil which has a constant temperature of 35 ± 0.01 C. A thermostat regulator detects any temperature deviation and turns the heater on or off as required. Operating at 115 v cps ac, 300 w, the unit weighs 30 lb without oil, measures 13-1/4 x 14 x 18 in., and has a tank capacity of 5 gal.

Weston Instruments Div., Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

CIRCLE 380 ON READER-SERVICE CARD

stitching together a giant radome



Radome designed and built by Long Sault Woodcraft Limited, St. Andrews East, Quebec, for the United States Air Force RADC.



Looking upward from the inside of the world's largest stressed skin sandwich radome built of translucent fiberglass panels, securely joined by hundreds of DUAL-LOCK fasteners.

Radar antennae along the upper perimeter of North America's defense system are enclosed by protective domes which stop ice, snow, and gales up to 150 mph.

This precisely engineered pattern of fiberglass panels is erected quickly and surely, under the most adverse field conditions, using recessed Simmons DUAL-LOCK fasteners.

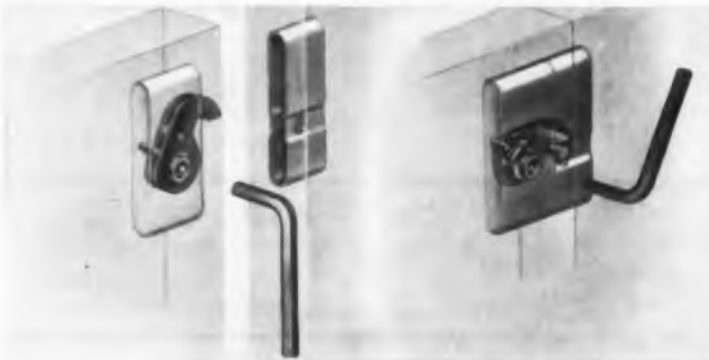
DUAL-LOCK is ideally adapted to panel fastening for military shelters, demountable shipping containers, aircraft cowlings and guided missiles.

Features:

- High load characteristics. The standard No. 1 DUAL-LOCK withstands 2500-lb. tension, and with modifications, tension loads of 7000 lbs. and over.
- Double-acting take-up provides great closing pressure, with minimum pressure on operating tool.

- Positive-locking. Trigger action insures fully open and fully closed positions.
- Vibration-proof and impact-proof. Will not accidentally unlock or loosen.

Write for catalog #1257. Complete specifications, drawings, details of DUAL-LOCK and other Simmons Fasteners with unlimited money-saving applications.



SIMMONS FASTENER CORPORATION

1763 North Broadway, Albany 1, New York

See our 8-page catalog in Sweet's Product Design File

QUICK-LOCK • SPRING-LOCK • DUAL-LOCK • ROTO-LOCK • LINK-LOCK • HINGE-LOCK

CIRCLE 381 ON READER-SERVICE CARD

NEW PRODUCTS

Converters

Analog-digital type

These analog-digital converters operate at temperatures from -80 to $+350^{\circ}\text{F}$, and can withstand 5 to 500 cps vibration at ± 10 g. These shaft position-to-digital units are available for a wide range of applications including latitude, longitude, azimuth or conventional angular shaft displacement conversion. Typical units provide for non-ambiguous conversion up to 2^{15} in a unit diameter less than 1.5 in. and a length of 1-15/16 in.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 382 ON READER-SERVICE CARD

Vacuum Gage

Range of 0.001 to 1 mm of mercury



Used for continuous measurements of gas pressures in a vacuum system, this thermocouple vacuum gage is self-regulating, and has a pressure range of 0.001 to 1 mm of mercury. The gage tube is installed in the vacuum system with a special connector which can be inserted in either glass or metal. The instrument operates from 115 v, 60 cps ac current. It measures 5-1/2 x 6-1/4 x 4-1/2 in., and weighs 5 lb.

Central Scientific Co., Dept. ED, 1700 Irving Park Rd., Chicago, Ill.

CIRCLE 383 ON READER-SERVICE CARD

Gray-to-Binary Translator

Has data storage

Type TR-702 gray-to-binary translator is a fully transistorized unit with data storage. It is packaged in an enclosure measuring 4-1/4 x 6-3/4 x 6-1/4 in. Four of these units will fit into a standard 19 x 8-3/4 in. panel. A companion power supply model PS-701 has a regulated 20 v output plus a bias output and is capable of operating three translators simultaneously.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 384 ON READER-SERVICE CARD

Dosimeter

For X and gamma rays



The sensitive element in this X and gamma-ray dosimeter is radiophoto-luminescent glass which emits luminescent light under near-ultraviolet radiation after exposure to X or gamma radiation. Called DT-60/PD, it weighs one ounce, and is worn about the neck as a pendant. It records exposure to radiation cumulatively from 10 to 600 roentgens. The companion radiac computer-indicator CP-263/PD operates on five 1-1/2 v, size D batteries. This portable unit can handle about 200 readings an hour. It weighs 12 lb, and measures 7-1/4 x 9-1/2 x 6 in.

Specialty Electronics Development Corp., Dept. ED, Syosset, N.Y.

CIRCLE 385 ON READER-SERVICE CARD

Tube Drivers

Self-contained



The series TND tube drivers are self-contained units with complete housing, Nixie tubes, up to ten transistor drive circuits, and mounting hardware. Signals required are 4 v for the on condition and 0 v for the off condition; both are referenced to the common terminal. Power supply requirements for standard units are 180 v and 2 to 4 ma. Units with built-in power supplies may also be ordered. Input is normally through ten input lines. Designed for panel mounting, the unit measures 1-1/4 in. sq and is 2-3/8 to 3-1/2 in. long.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 386 ON READER-SERVICE CARD

Arnold Builds World's Largest Permanent Magnet...Used in Atomic Research

Vital Statistics on the Big Magnet

Here's how the world's champion permanent magnet weighed in: 1720 pounds of Alnico V in the assembly . . . a keeper weighing 225 pounds . . . a total shipping weight of a little over 2 tons.

Overall dimensions of the magnet assembly, as illustrated at right, were 52 1/2" x 36" x 10", with a gap length of 16.5". The gap volume was 1584 cu. inches, and the density at the center of the gap was 1100 gauss.

Approximately 500,000 ampere turns were required to magnetize the big unit, which was shipped magnetized and keepered. It was designed for use in auxiliary equipment serving a breeder reactor for the Argonne National Laboratory, operated by the University of Chicago for the U.S. Atomic Energy Commission. Actual service is in an electro-magnetic pump for pumping fluid metals.

Vital Suggestion for Your Requirements

The facilities and wealth of experience that produced this world's largest permanent magnet are ready to bring you advantages, too.

Arnold permanent magnets are available in all types of Alnico and other magnet materials, from large castings like the Argonne unit to very small sintered parts weighing less than a gram. Many sizes and types of Alnico magnets are carried in stock for immediate delivery.

Special assemblies—such as rotors, traveling wave tube and magnetron magnets, etc.—may be supplied jacketed to facilitate mounting and give added protection to the magnet. Arnold also can supply large magnet assemblies for mass spectrometer and other measuring applications, where a high degree of stability and uniformity of field is required.

● Ask for a copy of Bulletin GC-106C, for more information on Arnold permanent magnets and other products, (tape cores, powder cores, etc.) Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

ADDRESS DEPT. ED-991



Top: the world's largest permanent magnet, built by Arnold for Argonne Labs, was designed to supply a field of 1100 gauss in a gap of 16 1/2 inches. Bottom: a typical group of the permanent magnet assemblies that Arnold supplies for rotors, traveling wave tube, wave guide and magnetron magnets, mass spectrometer and other measuring applications, etc.



ARNOLD

SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES
Find them FAST in the YELLOW PAGES

CIRCLE 387 ON READER-SERVICE CARD

NEW PRODUCTS

Tube Furnaces

Heat to 1500 C



Model VL tube furnace heat to 1500 C max, with close temperature control and uniformly heated work zone. Heating time from room temperature to 1000 C is about 25 min; 1300 C is reached in 45 min or less; and 1500 C is reached in about 90 min. Furnaces can be supplied with operating temperatures of 1500 to 1000 C and lower. This model is available in three sizes with standard tube bores up to 3.5 in. It has heating chambers 18 in. long.

The Sentry Co., Dept. ED, Foxboro, Mass.

CIRCLE 388 ON READER-SERVICE CARD



Data Processing System

Prints up to seven channels

Model GDPS 821-N data processing system is designed to sample analog voltage information, digitize, and print up to seven channels. Sampling, digital conversion, and printing are at 3 channels per sec. Nixie lamp banks are used for visual output. The minimum input impedance is 2 meg. The unit has a range of 0 to 999 and is adaptable to yield punched paper tape or IBM cards. Its accuracy is ± 1 digit. Measuring 21 x 19 x 16 in., the standard model is for rack mounting. A console model is also available.

The Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford, Conn.

CIRCLE 389 ON READER-SERVICE CARD

Sola reduces prices on $\pm 1\%$ static-magnetic



**Sola Sinusoidal type
Constant Voltage Transformers
for universal application,
now moderately priced**

Housed unit with mounting plate typical of structures employed in 60va to 1kva ratings.

An important advance in the field of voltage regulation is the development of a new line of Sola Standard Constant Voltage Transformers with sinusoidal output. New design enables us to price them about the same as previous models not having sine-wave output. Now you can have the advantages of $\pm 1\%$ static-magnetic voltage regulation in new applications requiring harmonic-free input where previously the cost was a deterrent.

These new units provide output voltage regulation of $\pm 1\%$ for line voltage variations as great as $\pm 15\%$. They regulate automatically and continuously. Fast response time averages 1.5 cycles or less. Output has less than 3% total rms har-

monic content, and formulae based on sinusoidal wave shape may be used in designing related load circuitry.

Design and production innovations make these new units substantially smaller and lighter than previous models. They are relatively compact compared to other equipment for comparable ac voltage regulation. They are easy to select and order—the buyer merely selects the stock unit whose output capacity equals or exceeds the desired equipment input. Sola Standard Sinusoidal CV Transformers are available in nine stock output ratings from 60va to 7500va. Custom designs to meet specialized requirements are available in production quantities.

Write for full information . . .



With electrical control systems and components continuing to increase in number and complexity, and imposing more rigid reliability requirements, these new Sola Constant Voltage Transformers provide many advantages and virtually unlimited application. They are the result of over four years of development, design, and production engineering in the Sola laboratories and plant.

These developments mean superior voltage regulation, giving you a bonus in equipment reliability and performance at no increase in cost.

For full information, please write for technical literature on Sola Constant Voltage Transformers. We will mail it promptly, or if you wish, we will have a representative call on you.

Static-magnetic voltage regulators

Sola Normal-Harmonic type Constant Voltage Transformers now specifically designed and priced for component use

End-bell unit with separate capacitor typical of structures engineered for component use.

Re-design of Sola "Normal-Harmonic" type static-magnetic voltage regulators has resulted in a significant reduction in their size and weight. Prices on many of these units have been reduced. Now it's possible for you to improve equipment performance by using them in many new fields at less cost than ever before. Re-design has in no way sacrificed the performance of these units—they provide all the outstanding benefits which have made them the standard of the industry for more than fifteen years.

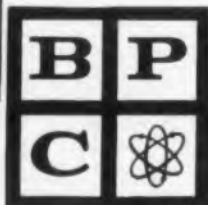
Sola Normal-Harmonic type voltage regulators provide $\pm 1\%$ output voltage

with line voltage variations as great as $\pm 15\%$. This group has an average of 14% total rms harmonic content in its output voltages and is suited to equipment not extremely sensitive to voltage wave shape.

Sola Normal-Harmonic type voltage regulators are available in nineteen stock ratings from 15va to 10kva, including those mechanical designs specially engineered for use as built-in components. With many of the most popular ratings now reduced in price, these Sola Constant Voltage Transformers provide one of the most economical means of close voltage regulation in a broad range of applications.

SO LA

A DIVISION OF



BASIC PRODUCTS CORPORATION

Sola Manufactures: Constant Voltage Transformers, Regulated DC Power Supplies, Constant Wattage Mercury Lamp Transformers and Fluorescent Lamp Ballasts

SO LA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois

Sales Offices in all principal cities

IN CANADA, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ontario

CIRCLE 390 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Frequency Decades

Two types available



This precision calibration line of frequency decades includes two models. Schomandl ND-5 provides discrete frequencies between 50 cps and 31 mc at intervals of 100 cps. Maximum reading error is 1 or 0.1 cps, depending upon the associated decade. Reference frequency is obtained from 100 kc with a stability of better than 2×10^{-8} over 24 hr. Schomandl FD-3 microwave decade provides frequency and full reference accuracy between 300 and 10,000 mc, with a tuning error of ± 300 cps. This unit may be used in harmonic operation to beyond 30,000 mc with the same accuracy.

Electronic Applications, Inc., Dept. ED, 194 Richmond Hill Ave., Stamford, Conn.

CIRCLE 391 ON READER-SERVICE CARD

Battery Voltage Regulator

Magnetic amplifier type



This transistorized, magnetic amplifier type battery voltage regulator maintains outputs constant to $\pm 2\%$, even with a battery supply voltage drop of 20 to 30%. The unit has 85 to 90% efficiency and operates in a temperature range of -20 to $+165$ F. It weighs about 4 lb and meets the requirements of MIL-E-5272A, MIL-I-6181, and others. Possible applications are with ground check-out equipment.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

CIRCLE 392 ON READER-SERVICE CARD

BENDIX-PACIFIC NEEDS SYSTEMS
AND CIRCUIT DESIGNERS FOR

advanced submarine detection systems

Unusual Creative Opportunities for

- Electronic engineers with a well rounded background to participate in a unique research and development program
- Qualified mechanical design engineers including structural thermo-dynamicists in this challenging new field.

SEND RESUME OF YOUR QUALIFICATIONS TO MR. WALKER



CIRCLE 901 ON CAREER INQUIRY FORM PAGE 157

NEW PRODUCTS

Shock and Vibration Isolators

For use at temperatures to 500 F



Designed to provide shock and vibration protection in aircraft and missiles, these shock and vibration isolators can be used at temperatures to 500 F. The units consist of two load carrying springs mounted in opposite positions, with a built-in damper assembly to restrict resonant build-up. Requirements of MIL-E-5272A are met.

MB Electronics, Dept. ED, 20 Fitch St., New Haven 11, Conn.

CIRCLE 395 ON READER-SERVICE CARD

Precision Potentiometers

Maximum resistance ranges from 45 to 200 K



Series GC precision potentiometers have a maximum resistance of 45 to 200 K per 360 deg, and a maximum resolution of 0.015 to 0.059%. Standard linearities are 0.08 to 0.2%; best linearities available are 0.03 to 0.15%. Operating temperature range is -55 to +120 C, torque is 0.05 to 0.5 oz-in., and noise level is 100 ohms at 4 rpm. Typical of this series, model GC 30 has a standard electrical angle of 350 ± 1 deg, maximum continuity angle of 375 deg, and a dielectric strength of 1500 v rms at 60 cps. The entire series meets environmental qualifications of MIL-E-5272A. Mounting is standard servo-type; other types can be furnished as specified.

Guidance Controls, Dept. ED, 119 Duffy Ave., Hicksville, N.Y.

CIRCLE 396 ON READER-SERVICE CARD

There's a New DIAL HEAD AGASTAT®



for every time/delay/relay application

Here's what you get with every Agastat time/delay/relay

- Easy adjustment
- Repeatable accuracy
- Instantaneous recycling
- Unaffected by voltage variations
- Low power consumption

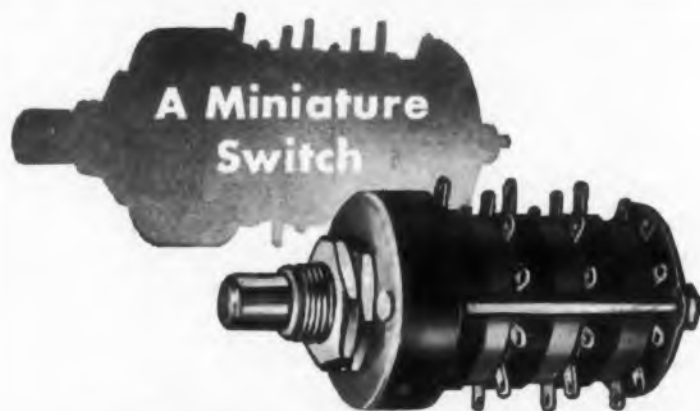
GET THE WHOLE STORY—write today for Bulletin No. SR-10 and find out how Agastat can help you to solve your time delay problems. Write to Dept. A35-924

AGA ELASTIC STOP NUT CORPORATION OF AMERICA

1027 Newark Avenue, Elizabeth, N. J.

Gasaccumulator Co., (Canada) Ltd., 12 Gower Street, Toronto 16, Ontario

CIRCLE 393 ON READER-SERVICE CARD



...with Positive Detent Action

Grayhill
Series
24

This fully enclosed one inch diameter miniature tap switch, designed for high reliability in military and commercial applications, provides accurate indexing by precision detent mechanism.

One to 10 decks, 2 to 10 shorting or non-shorting positions per deck. 36° indexing. Break 1 amp. 115 V. AC, or carry 5 amps. Has passed many military environmental tests including explosion test per MIL-E-5272A

Procedure 1.

Write for Complete Specifications



Phone: Fleetwood 4-1040
565 Hillgrove Ave., LaGrange, Ill.

“PIONEERS IN MINIATURIZATION”

CIRCLE 394 ON READER-SERVICE CARD

Geared Encoder Assembly

Resolves 1 million shaft positions



Built with three shaft position encoders and two gear boxes, the model CG-704 assembly can resolve 1 million shaft positions. The encoder on the input shaft provides 1000 positions of the least significant digit per 360 deg rotation. It is then geared 100 to 1 to a 100-position encoder which is in turn geared to a 10-position encoder. The unit is 5 in. long without the shaft and has a diameter of 3 in. It weighs under 2 lb and operates accurately at temperatures from 32 to 150 F and under 8 g, 2000 cps vibration.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 397 ON READER-SERVICE CARD

Transistor Checker

Collector currents of 5 to 50 ma



Model 100 transistor checker provides a go-no/go test at a collector current of 5 to 50 ma or more. Transistors which can be tested include small signal, drift types, medium power types, and power types. It also provides a check for opens, shorts, and gain, and will identify and check pnp and npn models. A 1.5 v dc battery is contained in the unit. A glow lamp indicator shows test results. Dimensions are 3-1/4 x 6-1/4 x 2-1/4 in. and shipping weight is 1-1/2 lb.

Seco Manufacturing Co., Dept. ED, 5015 Penn Ave. S., Minneapolis, Minn.

CIRCLE 398 ON READER-SERVICE CARD

TADANAC BRAND HIGH PURITY METALS

for SEMICONDUCTOR and other uses

ANTIMONY suitable for intermetallic compounds — with zinc and tellurium each less than 0.01 ppm.
BISMUTH total impurity content of less than 1 ppm.
CADMIUM total impurity content of less than 1 ppm.
INDIUM no single impurity in excess of 0.1 ppm also other grades with a wide range of preform shapes and sizes.

LEAD total impurity content of less than 1 ppm.
SILVER total impurity content of less than 1 ppm.
TIN no single impurity in excess of 1 ppm.
ZINC total impurity content of less than 2 ppm.
INDIUM ANTIMONIDE highest commercial purity



Write for our new brochure on TADANAC Brand High Purity Metals.

INQUIRIES ARE INVITED regarding preforming these metals to your specification.

COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED

Metal Sales Division: 215 St. James Street W., Montreal 1, Quebec, Canada — Phone AVenue 8-3103

CIRCLE 399 ON READER-SERVICE CARD

how small is small?

how high is high?

SPECIFY
Balco
SUB-MINIATURE
CAPACITORS

FOR CONTINUOUS HIGH TEMPERATURE OPERATION TO 250° C WITHOUT DERATING!

EXCEPTIONAL FEATURES EXCLUSIVE WITH **Balco**

- No reliability deterioration at 250° C and 140% rated voltage.
- Insulation resistance greater than 10¹⁴ ohms.
- Temperature coefficients of approximately 100 PPM, 50 PPM and less.
- Dissipation factor less than .05%.
- Minimum (lowest dielectric) absorption .01%.
- Exceeds MIL shock and vibration requirements.
- Low capacitance tolerances to .1%.
- Transistor sizes.

New, Comprehensive Color Catalog Complete With All Technical Data Now Available On Request.

Balco CAPACITORS
50 EDISON PLACE • NEWARK, NEW JERSEY
Telephone: Mitchell 3-5200

CIRCLE 400 ON READER-SERVICE CARD

FREE!
From ALPHA METALS

New Tips on Soldering

This handy ALPHA soldering guide contains valuable technical data. Included are:

- Prevention of silver scavenging
 - Effects of rare metals in soldering
 - Effective soldering of joints requiring high creep strength
- Get your copy ... Act now!

In Chicago, Ill.
ALPHA-LOY CORP.

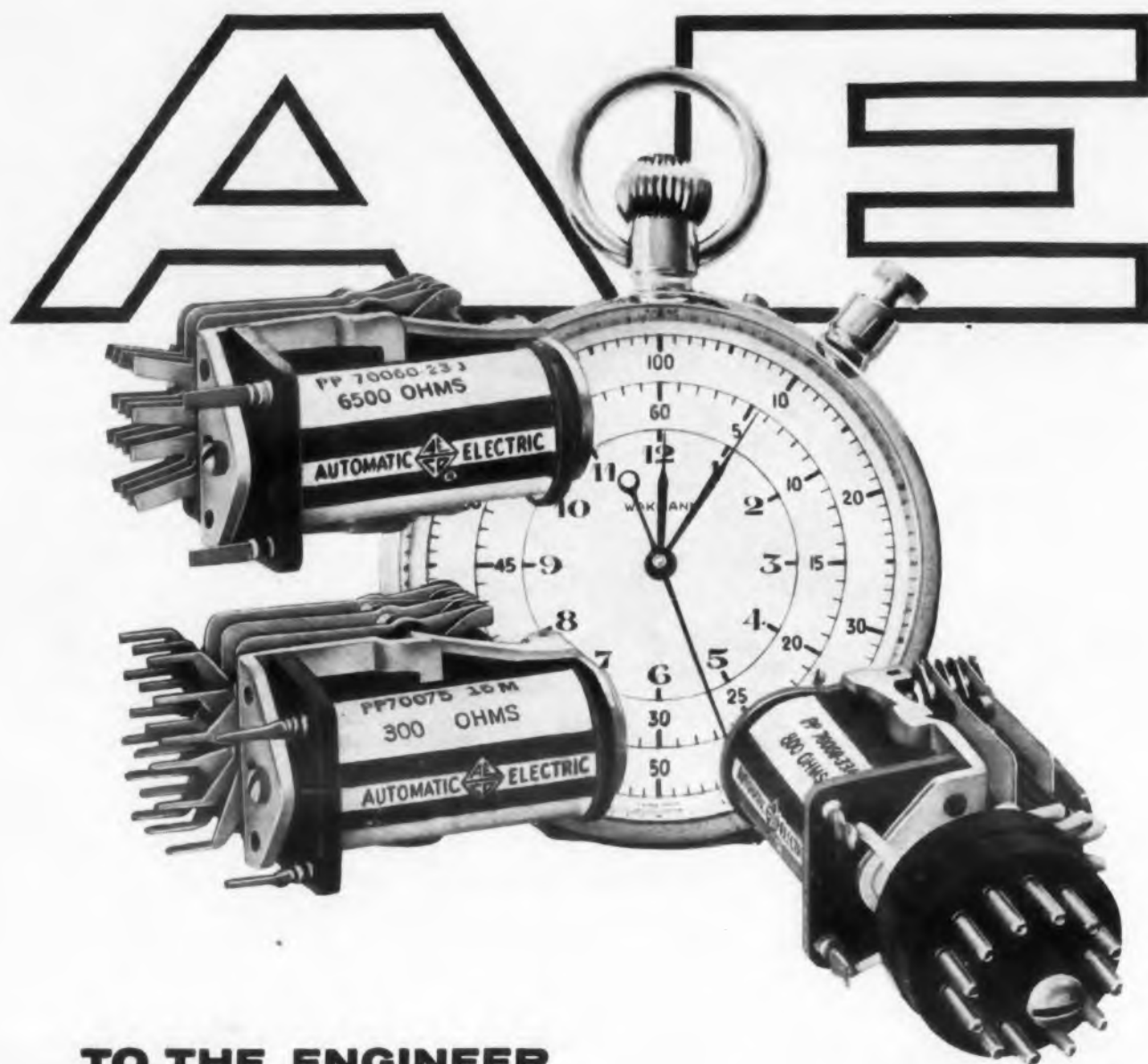
2260 S. Lumber St.

Other ALPHA products:
Solder Preforms,
Wide Range of Fluxes,
High Purity Metals.

ALPHA METALS, INC., 58C Water St., Jersey City 4, N.J.
Send me free your New Tips on Soldering.

Name _____ Title _____
Company _____
Address _____
City _____ Zone _____ State _____

CIRCLE 401 ON READER-SERVICE CARD



TO THE ENGINEER looking for a quick connection

Engineers out to cut costs at no expense of reliability can count on dramatic savings in assembly and wiring time by designing around AE Class E relays with quick-connect terminals.

Series EQPC is designed for direct insertion into printed circuits. Series EQTT, with Taper-Tab terminals, provides firm, high-conductivity connections without soldering.

AE also supplies Class E relays prewired for plug-in — with standard 8- to 20-prong octal plugs. Where additional relay protection is essential, the plug-in types are available in hermetically sealed containers or with

dust-tight housings and hold-down brackets.

The AE Class E relay is a miniaturized version of the premium-quality Class B, with many of its best features. Perfect contact reliability exceeding 200 million operations is common.

AE is also equipped to supply wired and assembled, custom-built control units, or to help you develop complete systems.

Want details? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1702-E on *Relays for Industry*, and the new 32-page booklet on *Basic Circuits*.



AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

CIRCLE 402 ON READER-SERVICE CARD



NEW PRODUCTS

Power Supplies

For microwave tr tubes



Offering keep-alive power for microwave tr switch tubes in radar systems and production test installations, Mini-Keep power supplies can be mounted to a chassis, bulkhead, or waveguide section next to the tube assembly. Their low output impedance permits the use of any series resistor called for under tr tube specifications. One unit, the model K-800, has an output voltage of -1 kv dc, an output current of $200 \mu\text{a}$, and a peak-to-peak ripple of 5%. Its input is 115 v rms at 60 or 400 cps and its volume is about 8 cu in.

Burmac Electronics Co., Inc., Dept. ED, 142 S. Long Beach Rd., Rockville Center, N.Y.

CIRCLE 403 ON READER-SERVICE CARD

Automatic Nyquist Diagram Plotters

Have 1 deg phase angle accuracy



Series 100 automatic Nyquist diagram plotters are self-contained transfer function analyzers for designing and testing ac and dc servo systems. With 1% amplitude accuracy and 1 deg phase angle accuracy, they complete a 10 in. diam graph in 5 min, or, if the response below 1 cps is not required, in 90 sec. Model 103 of the series covers the 0.5 to 250 cps range, while other models extend the low range to 0.025 cps.

British Industries Corp., Dept. ED, 80 Shore Rd., Port Washington, N.Y.

CIRCLE 404 ON READER-SERVICE CARD

Dual Connectors

Shielded or unshielded

Made for use with binding posts mounted on 3/4 in. centers, these dual connectors are available shielded or unshielded. Gold-plated conducting metal parts, color-coded thumbnuts, and recessed twin banana plugs are furnished with both types. The shielded model has a chrome-plated metal case. For use where shielding is unnecessary, the nylon plastic type provides for connection by stud hole clamping, looping and clamping, or by spade lug or clip-lead.

The Superior Electric Co., Dept. ED, Bristol, Conn.

CIRCLE 405 ON READER-SERVICE CARD

Integrating Capacitor

Tolerance of $\pm 0.25\%$



These precision integrating capacitors are available only in matched pairs with tolerances to $\pm 0.25\%$. Operating temperature is -35 to $+100$ C; insulation resistance is greater than 6×10^{12} μf at 100 C. Absorption is less than 0.05%; temperature coefficient maximum is 150 ppm per deg C.

Dearborn Electronic Labs., Dept. ED, 1421 N. Wells St., Chicago 10, Ill.

CIRCLE 406 ON READER-SERVICE CARD

Pressure Transducer

0 to 5000 psi

Model CS-5 pressure transducer changes resistance from 0 to 5000 psi and can be read on any ohmmeter that will read from infinity to 2.6 meg. This unit operates on either ac or dc; the sensitivity and resolution may be controlled by changing the applied voltage. Deflection at full load is less than 0.005 in. The resistance at no load is infinity; at 80 F and 5000 lb, resistance is 2.6 meg. This low-cost instrument will sense oil leakage of 1 lb in 5000. It is 3/4 in. in diam and 5/16 in. thick.

Clark Electronic Labs., Dept. ED, Palm Springs, Calif.

CIRCLE 407 ON READER-SERVICE CARD

reads easily, at a glance...



This new General Electric Type KT time meter measures operating time of any electrical equipment, speeds routine checking with "at-a-glance" readability. Big numbers are more than twice the size of ordinary meter digits. New low cost, too—in square, round, portable and sealed models. Totally enclosed construction means extra years of dependable operation. Increased operating temperature range (minus 67F to plus 150F) extends meter life, reduces maintenance. What's more, a **new sixth digit**—standard on all G-E models—offers more accurate range of measurement at **no extra cost!** Pass on these important benefits to your customers with time meters from the complete KT line. Also, specify G.E.'s Type TSA interval or process timers for dependable service on your automatic time-control applications. New BIG LOOK panel meters are available, too! For the full story on any of these instruments, contact your nearby G-E Apparatus Sales Office; or, write to Section 593-306, General Electric Co., Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Limited, 940 Lansdowne Avenue, Toronto 4, Ontario.

Other General Electric Instruments for Original Equipment Manufacturers—Switchboard instruments; inking, inkless, switchboard and portable recorders; testing instruments; speed-measuring systems.

INSTRUMENT DEPARTMENT

GENERAL  ELECTRIC

CIRCLE 408 ON READER-SERVICE CARD

HOW **SICKLES** SOLVED

the impossible!

DELAY LINE FOR A MISSILE

2½ times smaller than standard
...and a ratio of better than 60!

Everyone stubbed his toe on this project, until Sickles engineers used their skill. Needed for an important missile development, the delay line had to meet all the extreme environmental conditions inherent in space flight and occupy 30% less space than usual.

Because Sickles has no "standard" line, nor any pre-conceived notions, we developed some special tricks. With the customer's cooperation our engineers concentrated on the important requirements and attained a high degree of precision in all electrical parameters. The result is an unorthodox — but highly successful — multiple section lumped constant line with a delay to rise time ratio of better than 60 to 1. And it fits neatly into a space most engineers thought unfeasible.

Sickles' specialized skills and vast production capacity plus experience and creative imagination can help solve your delay line problem too. May we have a qualified representative discuss it with you? For information, write to Section 60.

F. W. SICKLES DIVISION
/General Instrument Corporation
Leaders in electronic coil winding
and assembly since 1921



165 Front Street (P. O. Box 330) Chicopee, Mass.
Other plants in Joliet, Ill. and Waterloo, Ont., Canada

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION,
AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR COMPANY, INC.
AND MICAMOLD ELECTRONICS MANUFACTURING CORPORATION (SUBSIDIARIES)

CIRCLE 409 ON READER-SERVICE CARD

NEW PRODUCTS

Pulse and Marker Generator

Continuously variable



The Vari-Marker is a combined pulse and pip marker generator for use with the company's Vari-Sweep oscillator. Equipped with a direct reading frequency dial calibrated to within $\pm 1\%$, it generates a pip that is continuously variable from 1.6 to 442 mc in eight overlapping bands. A ten-position switch can select up to 30 pulse-type, crystal-controlled markers placed three to a band at specified frequencies in the above range. A high level, automatic gain-controlled cw signal covering the same range is also available.

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

CIRCLE 410 ON READER-SERVICE CARD



Oscillator

Calibrates fm discriminators

For calibration of fm discriminators used in data processing systems, model 350 oscillator can be programmed to generate up to 11 different frequencies in any required sequence. Accuracy is within 0.01% from 100 cps to 100 kc. Any one of three operating modes may be selected by means of switches. In full automatic operation, the oscillator steps through the complete program. In the automatic-manual mode, stepping to the next frequency occurs when a push button is depressed. In the manual mode, adjustment is made by positioning six decimal switches.

Digital Instrument Labs., Dept. ED, 152 S. Atlantic Blvd., Los Angeles 22, Calif.

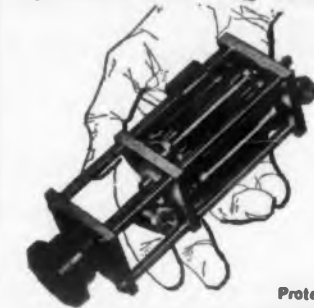
CIRCLE 411 ON READER-SERVICE CARD

STODDART

COAXIAL ATTENUATORS AND TERMINATIONS

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.

2, 6 and 10-position
TURRET ATTENUATORS
with simple "PULL-TURN-PUSH"
operation, small and rugged.



Protected under
Stoddart Patents

ATTENUATOR PADS



Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS
VSWR: Less than 1.2 to 3000 mc.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ± 0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

COAXIAL TERMINATIONS



Small-stable-50 or 70 ohms
½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.
1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items.
Send for complete literature.

STODDART
AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif.
Hollywood 4-9292

CIRCLE 412 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959



a good way to measure 0.00003 ohm

The Keithley 502 Milliohmmeter offers speed, ease, and accuracy in the measurement of low resistances. Typical uses are corrosion tests, checking resistivity of metals, semi-conductors, printed circuits, switch and relay contacts.

Battery operation, a ruggedized meter, and protective cover make the 502 ideal for field tests of squibs, carbon bridges and other explosive devices. Features include:

- 13 overlapping ranges from 0.001 ohm to 1000 ohms full scale.
- accuracy within 3% of full scale; a four-terminal measuring system eliminates errors due to clip and lead resistance.
- 2 microwatts maximum dissipation across sample.
- no calibration or zero adjustments.
- instantaneous indication of resistance without zero drift or errors due to thermal EMF's.
- lightweight and portable. Furnished with protective cover and set of four test leads.

Details about the Model 502 Milliohmmeter are available in Keithley Engineering Notes, Vol. 6 No. 3. Write for your copy today.

**KEITHLEY
INSTRUMENTS, INC.**

12415 Euclid Ave., Cleveland 6, Ohio

CIRCLE 413 ON READER-SERVICE CARD

Thyratron

Has 12 megawatts peak power

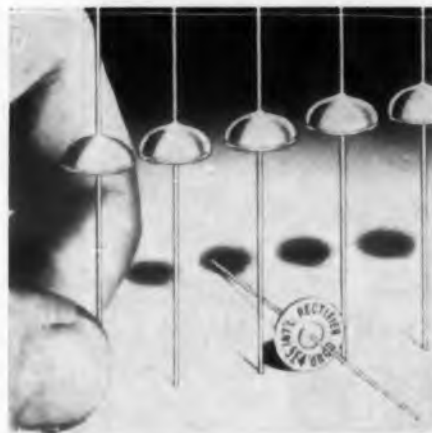
Designed for application in moving target indicator radar systems, type 5948A hydrogen thyratron is rated at 12 megawatts peak power, 25 kv peak voltage, and 1000 amp peak current. Only a three-minute warm-up is needed to reach maximum operating efficiency. Jitter is less than 5 msec.

International Telephone and Telegraph Corp., Dept. ED, 67 Broad Street, New York 4, N.Y.

CIRCLE 414 ON READER-SERVICE CARD

Silicon Diodes

Rated at 400 piv, 200 to 500 ma



Low cost units for commercial equipment, these silicon diodes are rated at 400 piv and 200 to 500 ma. They operate at ambients to 70 C and case temperatures to 100 C. Included in the line are types 2E4 and 5E4 rated at 200 and 350 ma, respectively. All units are multisealed with successive layers of humidity resistant, insulating resins and sealants.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 415 ON READER-SERVICE CARD

Synchro Positioner

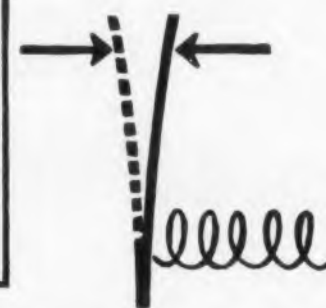
Has 360 deg range

This synchro positioner has a range of 360 deg and an angular accuracy of 20 sec at the coupling output. Positioning is at 5 deg intervals by means of a detent mechanism. Positioning at other angles is by means of a continuous, fine-angle device. Adapters are available in sizes 8 to 37. Made for angular positioning of synchros, gimbal-mounted components, and other rotating devices, the unit conforms to MIL-S-20708A.

Theta Instrument Corp., Dept. ED, 48 Pine St., E. Paterson, N.J.

CIRCLE 416 ON READER-SERVICE CARD

Design Economies with Vibrating Reeds



TIMING OR WARNING ALARMS



Vibration on case or housing creates buzz alarm for appliances, such as automatic washers, dryers, ranges, etc.

TOY SOUND EFFECTS



Remotely controlled train whistles and engine noises generated by repetitive electrical or mechanical pulses.

VIBRATION GENERATOR



Mechanical tapper tests for microphonics of tubes or other components.

LIGHT CHOPPER



Interrupts a beam of light at frequencies of 20 to 120 cps to provide a pulsating photoelectric output proportional to the light intensity.

PULSE POWER GENERATOR



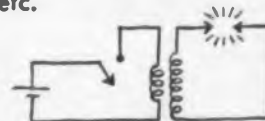
Typical application is for life testing devices such as relays which must be cycled rapidly. Cost is much lower than a geared motor with cam actuated switch performing a like function.

FREQUENCY SENSITIVE RELAY



Used with frequency generators as low cost remote controls for garage doors, television, etc.

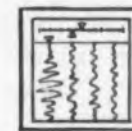
IGNITION DEVICES



Used as independent breaker points for car and aircraft heaters, jet engines, and other ignition jobs.

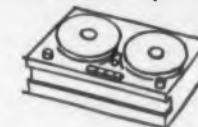
ECONOMICAL CHOPPERS

Available with power interrupting capability, low-noise and low-resistance variations.



Provides 100 cps from DC power source. Driving circuit isolated from chopper contacts. Now being used in medical and aircraft equipment. Frequency doubler chopper operates at 120 cps when driven by a 60 cps supply. Low cost 60 cps chopper for commercial use. Polarized, will follow a 60 cps source.

FREQUENCY GENERATOR



Typical uses include: 20 cps bell ringers; 60 cps timing motors for jobs such as operating taxi meters (eliminates ticking); 60 cps constant frequency unit ($\pm 1/2$ cps over a voltage range of 4 to 1) for precision timers, clocks, tape recorders, meters, etc. The latter is an exclusive, Oak patented design.

TEST EQUIPMENT



Used in instruments to check for "holidays" in insulation on pipe lines, measure insulation resistance, and test ignition systems and timing of cars.

HIGH POWER CONVERTER



In addition to units for all standard power ranges, Oak supplies a special high power vibrator (patented) which allows any number of vibrators to be operated simultaneously at the same frequency. Using this system, four vibrators have handled as much as 500 watts on an intermittent duty cycle.

There are many ingenious ways to use vibrating reeds, which can lower costs through simplified design.

If you've got an idea you'd like to develop, Oak's engineering specialists will be glad to help you work it out. Contact them today.

Oak also supplies a complete line of conventional vibrators, custom-built for any application.

OAK MFG. CO.



1260 Clybourn Ave., Dept. D
Chicago 10, Illinois
Phone: MOhawk 4-2222

Specialized Applications with Vibrating Reeds

CIRCLE 417 ON READER-SERVICE CARD



350°C. ST resistors Highest wattage to volume ratio in metallic oxide field. 2½, 5, and 10 W at 25°C., derating to 350°C. Achieves its specs through new resistance film and insulation coating developed at Corning. 2% and 5% tolerances.



High temperature capacitor New high temperature dielectric. Up to 10,000 uuf, DCWV of 300 V at 300°C. Q better than 500 at 300°C. Especially suitable for missiles and aircraft. Highly resistant to nuclear radiation.



Micro miniature capacitors 1 to 10,000 uuf. DC working voltage is 300 V over -55 to +125°C. range. Suitable for micro miniature work, lumped constant delay lines, missiles, nuclear equipment, and similar high reliability systems.



Epoxy coated resistors Exceptional moisture resistance. 1.5% max. resistance change after military moisture tests. Beats demands of MIL-R-10509C, Char. B. Tin oxide film fused to glass. ¼, ½, 1 W. 10 ohms to 1 megohm at 70°C., derating to 150°C.



FOTOCERAM,® an unusual new printed circuit board We've resoldered more than fifty times on this board without damage to circuit runs or through-plate holes. No adhesives needed to bond copper to board. Bond strength between Fotoceram and metal is 15 to 20 lbs., when 1" strip is pulled perpendicular to board. Takes over 60 g vibration shock. All electrical properties equally outstanding.



Fusion-sealed resistors For *ultra* specs. Glass-enclosed, tin oxide resistance element. Impervious to moisture because of fusion seal. 10 ohms to 360 K at 70°C., derating to 160°C. Well in excess of MIL-R-10509C, Char. B.

Write for data sheets for complete specs on these components. Address: Corning Glass Works, 540 High Street, Bradford, Pa. Or sales offices in New York, Chicago, Los Angeles.

ALL NEW



CORNING ELECTRONIC COMPONENTS

CIRCLE 418 ON READER-SERVICE CARD

NEW PRODUCTS

Multiplexer

High speed

Model TMX-841-S multiplexer allows a maximum of 20 input channels to be sampled at any rate to 10 kc; sampling rates as high as 44 kc may be obtained. The full scale input voltage range is 0 to ± 10 v peak. Noise is less than 2 mv up to 30 C with 50 K source impedance. Input impedance is load plus 70 ± 10 ohms. Output internal impedance is source impedance plus 70 ± 10 ohms. Unity gain is within a tolerance of $\pm 0.05\%$. This model can be provided to handle 2 to 40 channels utilizing a single power supply; more than 40 channels can also be provided. The unit is solid state, measures 5-1/4 x 19 in. for standard relay rack mounting, and weighs 25 lb.

Epsco, Inc., Dept. ED, 275 Massachusetts Ave., Cambridge, Mass.

CIRCLE 419 ON READER-SERVICE CARD

Time Code Generator

Produces eight timing signals



Model 1021 time code generator produces timing signals during the recording of test data on magnetic tape. It consists of a crystal-controlled oscillator and seven decades of frequency division. The instrument produces eight separate timing signals of from 0.01 to 100,000 cps. Use of a variable pulse width to code each timing signal permits mixing of signals to identify elapsed test time; mixed output range is 100 to 0.01 cps on a single channel.

Computer-Measurement Co., Dept. ED, 12970 Bradley Ave., Sylmar, Calif.

CIRCLE 420 ON READER-SERVICE CARD

Silicon Transistors

Seven types available

These seven npn silicon transistors permit complementary circuitry to 100 mc and have low collector capacitance. Type 2N1199 is used in high-speed saturated switching circuits at frequencies to 5 mc. The frequency at which beta equals unity is 125 mc. Maximum temperature is 150 C. Types 2N1267, 2N1268, and 2N1269 have

beta ranges of 6 to 18, 11 to 36, and 28 to 90. Intended for 4.3 mc amplifier applications, they have a typical power gain of 25 db. Typical units oscillate at 90 mc. Types 2N1270, 2N1271, and 2N1272 have the same beta ranges and are for 12.5 mc amplifier applications. Minimum power gain is 20 db. Typical units oscillate at 200 mc.

Philco Corp., Lansdale Tube Co. Div., Dept. ED, Lansdale, Pa.

CIRCLE 421 ON READER-SERVICE CARD

AC Voltmeter

Portable, transistorized type



Battery operated, model 403A ac voltmeter has a frequency range of 1 cps to 1 mc. Transistorized, it weighs less than 5 lb, and measures ac voltages from 1 mv to 300 v full scale with an accuracy of $\pm 3\%$ for 5 cps to 500 kc, and $\pm 5\%$ for 1 to 5 cps and 500 kc to 1 mc. The instrument has 12 voltage ranges and also reads db from -72 to +52 db. This portable unit has a 400-hr battery life; battery voltage is checked by a front panel switch. Noise is less than 50 μ v.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.

CIRCLE 422 ON READER-SERVICE CARD

Time Indicators

For 115 v 60 cps supplies

Series 23200 miniature hermetically sealed time indicators are made for operation on 115 v 60 cps supplies. Two dial type models are offered: one reading to 2500 hr in 5 hr increments and one reading to 10,000 hr in 10 hr increments. A digital model providing a maximum reading of 9999.9 hr is also available. The voltage range is 105 to 125 v and the frequency range is 57 to 63 cps. The timers will not be damaged with frequency variations of 45 to 75 cps at the maximum rated voltage. The instruments are filled with a dry nitrogen atmosphere and are enclosed in a 1-1/4 in. diam housing. The standard mounting flange has two ears which permit installation in a 1-1/4 in. square; a square flange is also available for mounting in a 1-3/4 in. square panel area.

A. W. Haydon Co., Dept. ED, Waterbury, Conn.

CIRCLE 423 ON READER-SERVICE CARD

Electro Instruments Model A12 D.C. Amplifier

FULLY TWO YEARS AHEAD of the FIELD!

Totally transistorized—dissipates only 7 watts.
Long term drift less than 2 microvolts.
.01% linearity and stability.
100 megohms input impedance—40 milliohms output impedance.
1 db DC to 10 KC.
Noise less than 10 microvolts wideband.
Single ended or differential input.
Operates to specifications from 0° to 50° C.
Self-contained power supply—operates on any line frequency from 50-400 cps.
Mil-type chopper gives unmatched reliability for the life of the instrument.
7" x 19" panel accommodates 8 instruments.

Plug-in attenuators of the A12 provide convenience, flexibility and economy. Special variations, gain settings, etc., can be tailored to your system at no extra cost.



The only wideband DC amplifier to meet rugged military environmental tests for altitude, temperature, shock, humidity and electro interference.

Electro Instruments, Inc.

3540 AERO COURT
SAN DIEGO 11, CALIF.

CIRCLE 424 ON READER-SERVICE CARD

SUPRAMICA® 560 ceramoplastic

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



gives this MICRO SWITCH assembly total dimensional stability!

A DIVISION OF MINNEAPOLIS-HONEYWELL

This subminiature assembly—no bigger than your thumbnail—is a high-temperature switch, precision-made for the MICRO SWITCH Division of Minneapolis-Honeywell, and designed for use in missiles, aircraft and other electronic "hot spots." Precision-molded of SUPRAMICA 560 ceramoplastic, the switch base has *total dimensional stability* at temperatures up to +750°F in this application, and up to +932°F in many others. It has also been used in extreme *low* temperature applications as found in missile launching environments.

Reports MICRO SWITCH: "Selection was founded on the characteristics of SUPRAMICA'S moldability, and dimensional stability and control. These are of utmost importance in the production and application of the 6SM switch."

"It allows us to mold terminal inserts into the switch base, parallels the expansion characteristics of the stainless steel terminal inserts, and eliminates dimensional variations during a production run. This promotes extended switch life and helps MICRO SWITCH maintain the quality and reliability for which our products are known."

SUPRAMICA 560 is one of a unique family of precision-molded and machinable ceramoplastics and glass-bonded mica insulation materials. Whatever insulation characteristics you require, there is a Mycalex Corporation of America material to meet your need—for example, SUPRAMICA 620 machinable ceramoplastic offers a maximum operating temperature of +1550°F. Write today for specific information.

General Offices and Plant: 121-G Clifton Blvd., Clifton, N. J.
Executive Offices: 30 Rockefeller Plaza, New York 20, N. Y.

WORLD'S LARGEST MANUFACTURER OF GLASS-BONDED MICA AND CERAMOPLASTIC PRODUCTS
CIRCLE 425 ON READER-SERVICE CARD

NEW PRODUCTS



Amplifier

Automatic gain
adjusting type

This automatic gain adjusting amplifier may be used on any voice circuit to maintain a constant voice level over a 40-db input level range. Reacting to syllabic speech, the unit does not clip excess-volume speech, but shifts the entire range to 0 vu to avoid distortion. The input range can be attenuated to a maximum loss of 20 db in 4-db increments. Output volume is 0 vu \pm 4 vu; frequency range is 300 to 3000 cps. The unit operates on 48 v and occupies 3-1/2 in. in a standard 19-in. rack.

Lenkurt Electric Co., Dept. ED, San Carlos, Calif.

CIRCLE 426 ON READER-SERVICE CARD

Miniature Capacitors

Rated at 5 amp



Developed for use in radio interference reduction in communication and radar equipment, these capacitors are rated at 5 amp. Voltage ratings available are 100 to 600 v dc, capacitance is 0.001 to 1 μ f, and sizes are 3/4 to 2-3/8 in. Type 102P has an operating temperature of -55 to +85 C; type 103P, -55 to +125 C. The capacitors are all hermetically encased and have glass-to-metal solder-seal terminals. Tab or lead type terminals can be furnished. Requirements of MIL-C-11693 are met.

Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 427 ON READER-SERVICE CARD

Voltage Monitors

Solid State

These voltage monitors, model L102, are solid state sensors followed by amplification to either close or open relays. They have a range of 5 to 40 v dc and a response time of 100 msec. Repeatability of trip is within 0.1% of voltage setting. The output relay rating is 2 amp resistive load, and the trip point changes less than \pm 3% over a

THE FIRST SYNTHAMICA SYNTHETIC MICA
SINCE 1919 MYCALEX THE INSULATOR
THE FIRST SUPRAMICA CERAMOPLASTIC
MYCALEX
CORPORATION OF AMERICA

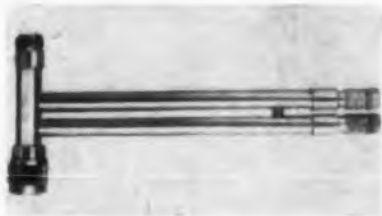
temperature range of -20 to $+54$ C. Typical applications are for voltage comparators in incoming inspection, voltage indicators for automatic checkout, and voltage detection in ground power systems. Three types are available.

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

CIRCLE 428 ON READER-SERVICE CARD

Coaxial Stub Tuners

From 200 to 10,000 mc



These broadband coaxial stub tuners cover the frequency ranges from 200 to 1000 mc and from 1000 to 10,000 mc. They consist of a length of $3/8$ in. concentric line with one, two or three short-circuited variable-length stubs at right angles to the main line. These stubs are axially separated by $1/2$ or 3 in., depending on the frequency range; each stub is a sliding tube with tempered beryllium contact springs. Six types of tuners are available; input and output connectors are type N male and female.

Empire Devices Products Corp., Dept. ED, Amsterdam, N.Y.

CIRCLE 429 ON READER-SERVICE CARD



Limit Switch

No moving parts

The Amplet magnetic limit switch has no moving parts; it acts on proximity of its two sensing elements. The device consists of a probe, which is mounted on a stationary part of the machine being controlled; a magnetic trigger, which is mounted on a moving part of the machine; and a power amplifier. The response time is less than 1 msec. Power amplifier units are available normally off or normally on. Power input is 7 w, 115 v, 60 cps; output signal is 50 μ a in the off condition and 5 w, 24 v dc in the on condition.

Consolidated Controls Corp., Dept. ED, Bethel, Conn.

CIRCLE 430 ON READER-SERVICE CARD

Let KNAPIC
grow your
SILICON
CRYSTALS
for you!



Crystals are gas or vacuum grown by a modified Czochralski technique.



SILICON AND GERMANIUM MONOCRYSTALS

For Semiconductor,
Solar Cell and
Infrared Devices

Major manufacturers of semiconductor devices have found that Knapic Electro-Physics, Inc. can provide production quantities of highest quality silicon and germanium monocrystals far quicker, more economically, and to much tighter specifications than they can produce themselves. Knapic Electro-Physics has specialized in the custom growing of silicon and germanium monocrystals. We have extensive experience in the growing of new materials to specification. Why not let us grow your crystals too?

Knapic monocrystalline silicon and germanium is available in evaluation and production quantities in all five of the following general grade categories—Zener, solar cell, transistor, diode and rectifier, and high voltage rectifier.

SPECIFICATIONS—Check These Advantages

- Extremely low dislocation densities.
- Tight horizontal and vertical resistivity tolerances. Resistivities available in controlled ranges .005 to 1000 ohm cm., N and P type.
- Diameters from .10" to 2". Wt. to 250 grams per crystal. Individual crystal lengths to 10".
- Low Oxygen content 1×10^{17} per cc., 1×10^{16} for special Knapic small diameter material.
- Doping subject to customer specification, usually boron for P type, phosphorus for N type.
- Lifetimes: 1 to 15 ohm cm.—over 50 microseconds; 15 to 100 ohm cm.—over 100 microseconds; 100 to 1000 ohm cm.—over 300 microseconds. Special Knapic small diameter material over 1000 microseconds.

Specification Sheets Available

Infrared Domes and Lenses

**LARGE DIAMETER
SILICON LENSES
AND CUT DOMES
FOR INFRARED USE.**

Individual silicon ingots for lens use and hollow cut domes to 8" diameter are now available in production and evaluation quantities. Diameters up to 19" will be available in the near future. Transmission characteristics—minimum 52%, coated 97% in ranges between 1 to 15 microns.

Quotations will be prepared on request for production orders, for semiconductor materials not falling within the listed categories, or for those requiring additional experimental work.



Dislocation density, Knapic silicon monocrystals. Crystal diameter $1/10"$ to $3/8"$ —None; $3/8"$ to $3/4"$ —less than 10 per sq. cm.; $3/4"$ to $1-1/4"$ —less than 100 per sq. cm.; $1-1/2"$ to 2" less than 1000 per sq. cm.

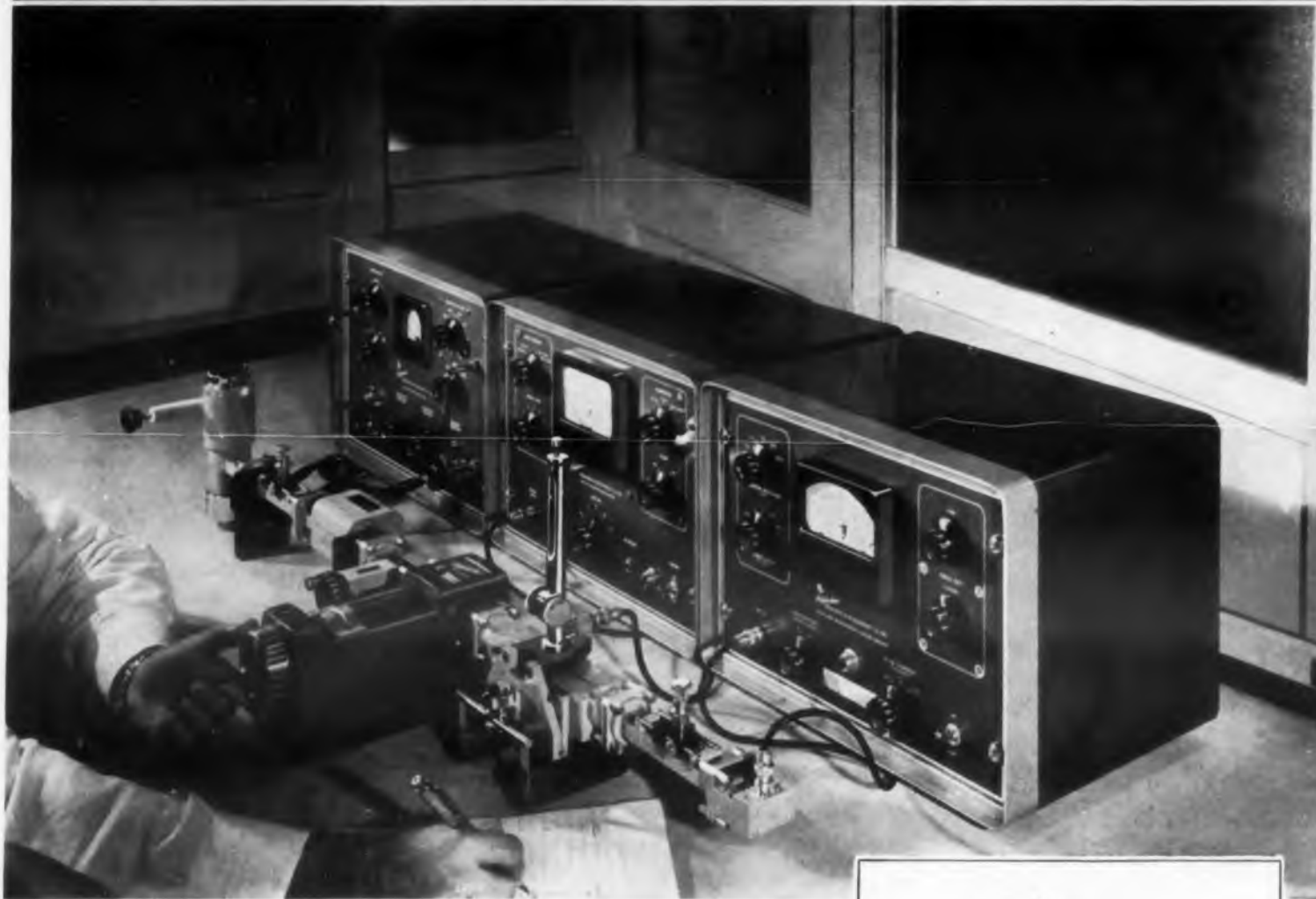


Knapic Electro-Physics, Inc.

936-938 Industrial Avenue, Palo Alto, California Phone: DAvenport 1-5544

CIRCLE 431 ON READER-SERVICE CARD

HOW TO MEASURE POWER



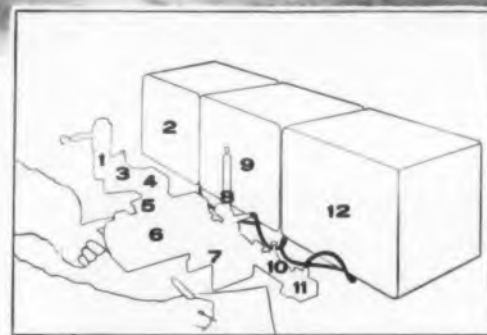
This microwave bench set-up is for the measurement of power by the Self-Balancing Bolometer Bridge method. Other systems, including PRD's more accurate Calorimetric Instrumentation could have been shown, but the Bridge represents the most universally used technique.

The operating procedure is quite simple. First adjust the PRD 650-B Universal Power Bridge for the thermistor or bolometer available. Next tune and match the transmission line for a minimum VSWR indicated on the PRD 277-A Standing Wave Amplifier. Then record the reading of the PRD 650-B Self-Balancing Bridge (directly in milliwatts) and you're ready for your next microwave measurement.

Easy, isn't it? Even more important it's accurate. The PRD 650-B Bridge has guaranteed accuracy of $\pm 5\%$ full scale. The use of the PRD 303-A Slide Screw Tuner eliminates the slightest mismatch of the 643 Thermistor Mount. The importance of fine matching can best be shown by example: a mismatch VSWR of only 1.2 would result in a power error of 1%.

The precision and ease of operation of all the products shown in this example are typical of each of over 300 microwave test instruments currently produced by PRD, the company that's FIRST IN MICROWAVES... our cable address is MICROWAVE, New York, U.S.A.

For technical details and specifications covering products shown write:



TEST INSTRUMENTS USED
IN THIS X-BAND POWER BENCH

- 1-703 Shielded Tube Mount, catalog page F-8
- 2-809 Klystron Power Supply, catalog page F-10
- 3-303-A Slide Screw Tuner, catalog page B-14
- 4-1203 Isolator, catalog page A-21
- 5-159-A Level Set Attenuator, catalog page A-17
- 6-535 Frequency Meter, catalog page D-12
- 7-203-D Slotted Section, catalog page B-11
- 8-250-A Broadband Probe, catalog page B-12
- 9-277-A Standing Wave Amplifier, catalog page E-7
- 10-303-A Slide Screw Tuner, catalog page B-14
- 11-643 Broadband Thermistor Mount, catalog page E-9
- 12-650-B Universal Power Bridge, catalog page E-13

MICROWAVE ENGINEERS-SCIENTISTS

Positions offering stimulating challenges with unlimited potential are now open at PRD. Please address all inquiries to Mr. A. E. Spruck, PRD, 202 Tillary Street, Brooklyn 1, New York.



Polytechnic Research and Development Co., Inc.

202 Tillary Street, Brooklyn 1, New York. Telephone: ULster 2-6800

West Coast Office: 2639 So. La Cienega Blvd., Los Angeles 34, California. Telephone: TEras 0-1940

Special problems in attenuation and other related measurements? Contact our Applications Engineering Department.

CIRCLE 432 ON READER-SERVICE CARD

NEW PRODUCTS

Comb Filters

For operation at 100 to 3000 cps

These 16-parallel-element filters operate in the range of 100 to 3000 cps and have a 180 cps interval between each of the center frequencies. The center frequency for the first filter element begins at 200 cps. Equal input and output impedances are obtained. One of the models has a frequency response of 135 cps at 3 db bandwidth, 180 cps at 8 db bandwidth, and crossovers at 8 db. Insertion loss is $8 \pm 1/2$ db at the passband center frequency. The other model has a frequency response of 60 cps at 3 db bandwidth, 135 cps at 8 db bandwidth, and crossovers of 10 to 18 db. Insertion loss is $11 \pm 1/2$ db at the passband center frequency. The range of operating level for both filter models is -60 to $+15$ dbm. Units adaptable to any frequency range, including microwave, are also available.

Rixon Electronics, Inc., Dept. ED, 2414 Reedie Dr., Silver Spring, Md.

CIRCLE 433 ON READER-SERVICE CARD

Ultrasonic Delay Line

For use as target simulator



Designed for application as a target simulator for doppler radar calibration and other uses where variable data storage capacity is required, this variable ultrasonic delay line has continuous variation from 100 to 300 μ sec. Simulated target velocity is 20,000 ft per sec max. The center frequency is up to 40 mc and the bandwidth is 45% of center frequency. Static attenuation is 50 db into 100 ohms; rise time is 0.1 μ sec or better. Variation is servo-controlled. Requirements of MIL-T-5422 and MIL-T-945 are met.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., W. Hartford 10, Conn.

CIRCLE 434 ON READER-SERVICE CARD

Displacement Gyro

For control and telemetering purposes



This cageable free gyroscope provides accurate angular intelligence for control and telemetering purposes. Caging and uncaging functions are performed electrically with indicating switches signaling the caged or fully uncaged position of the instrument. A motor driven caging device or a solenoid operated caging mechanism can be supplied. It withstands up to 60 g shock along the gimbal axis and up to 10 g vibration. Temperature is -58 to $+185$ F. The basic unit measures $5\text{-}7/8$ in. long and is $3\text{-}9/16$ in. in diam.

Telecomputing Corp., Whittaker Gyro Div., Dept. ED, 16217 Lindbergh St., Van Nuys, Calif.

CIRCLE 435 ON READER-SERVICE CARD

Molded Choke Coils

Miniature

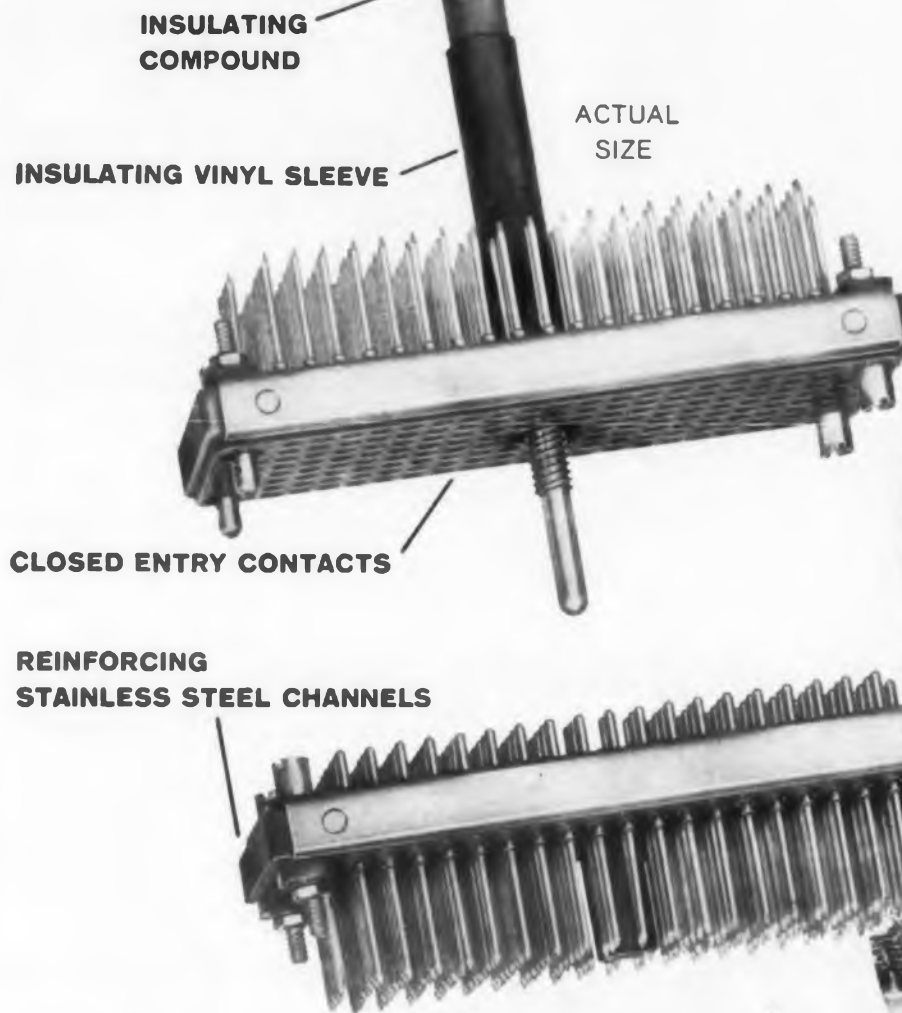


Molded choke coils in the Ring Ding series combine high Q and low distributed capacity with a marked reduction in size. The 1000 μh model is 0.14 cu in., or 0.645 cu in. less than a standard model of the same value. Hermetically sealed through molded encapsulation, the coils are available in current ratings from 100 to 150 ma and in values up to 10,000 μh . They contain no ferrite materials and operate at temperatures to 125 C.

Delevan Electronics Corp., Dept. ED, 77 Olean Rd., East Aurora, N.Y.

CIRCLE 436 ON READER-SERVICE CARD

new!... from Continental Connector



152 CONTACT

CENTER SCREWLOCK CONNECTOR
WITH PROVEN RELIABILITY

MINIATURE POWER CONNECTORS FOR HEAVY DUTY APPLICATIONS

Again Continental Connector meets the challenge for reliability and high precision in critical electronic equipment with these new center screwlock plug and socket connectors. They are designed for heavy duty applications requiring high dielectric and mechanical strength, partially achieved by the use of a body material molded from glass filled Diallyl Phthalate (MIL-M-19833, Type GDI-30, green). The double lead thread action center screwlock and stainless steel channels are extra features that contribute to the rugged construction and performance-proven reliability.

CLOSED ENTRY CONTACTS provide increased reliability and maintain a low millivolt drop under constant and uniform insertion pressure. Positive polarization is assured with reversed male and female guide pins and guide sockets. In addition to the wire wrap termination illustrated, solderless taper pin or solder cup terminals can also be supplied.

ILLUSTRATION SHOWS WIRE WRAP TERMINALS WITH ONE, TWO AND THREE WIRE CONNECTIONS

also available with
104, 78 or 34 contacts

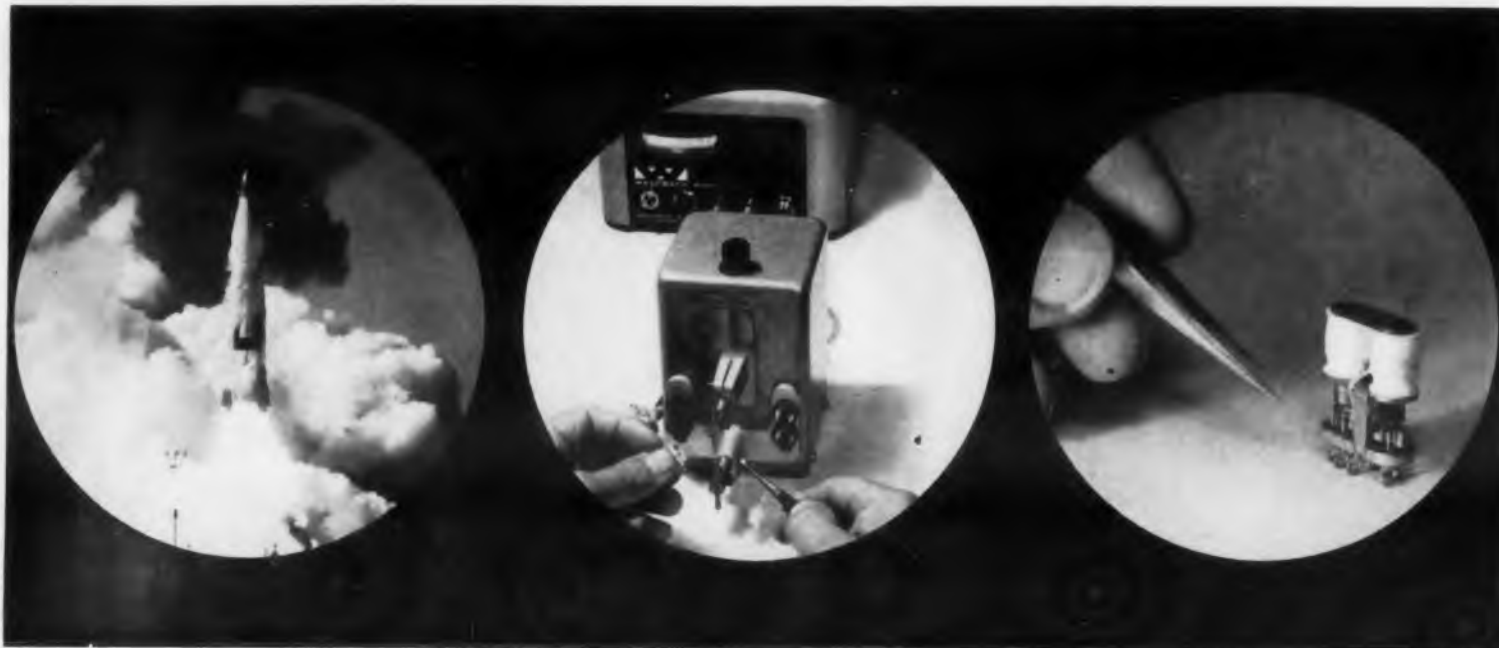


ENLARGED VIEW
CLOSED ENTRY CONTACT

For complete specifications on Continental Connector's new Series 1900, write to Electronic Sales Division, DeJUR-AMSCO CORPORATION, 45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y. (Exclusive Sales Agents)

MANUFACTURED BY CONTINENTAL CONNECTOR CORPORATION, AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS

CIRCLE 437 ON READER-SERVICE CARD



RELIABILITY STARTS WITH THE WELD IN SUBMINIATURE RELAYS Each tiny, hermetically sealed relay—controlling several circuits in an intricate missile assembly—requires precise spotwelds of brass and silver to nickel-plated steel, of tinned copper to copper, 18 welds within a 1" disc. Glass-to-metal seals must not be over-heated, working space is extremely limited. **FILTORS, INC.**, found the answer in Weldmatic . . . the most *reliable* spot-welding equipment you can buy. With Weldmatic, pressure and heat are precisely controllable and exactly uniform from weld to weld. **SEND TODAY** for our free 20-page brochure on spot-welding techniques and applications.

WELDMATIC

370 NORTH HALSTEAD AVENUE, PASADENA, CALIFORNIA



CIRCLE 438 ON READER-SERVICE CARD

DIVISION OF UNITEK CORPORATION

FREE!

416-Page Catalog



PIC MASTER CATALOG #20
Lists over 10,000
PRECISION INSTRUMENT PARTS
and ASSOCIATED COMPONENTS
Available From STOCK!

Completely illustrated, with detailed drawings, specifications and prices.

GEARS • SHAFTS • COLLARS • CLUTCHES • BEARINGS • COUPLINGS • DIFFERENTIALS • SPEED REDUCERS and many other Precision Engineered Parts & Components.

Send for your copy of this new, enlarged catalog, today.

PIC DESIGN CORP.
Subsidiary of **BENRUS WATCH COMPANY, Inc.**
477 Atlantic Ave., East Rockaway, L.I., N.Y.

CIRCLE 439 ON READER-SERVICE CARD

One of a series

Say Engineer, When You Mean Engineer

Somehow it's become popular to speak of science and technology—popular, that is, with everyone but engineers.

Engineers are in a partnership with scientists in this great industrial nation of ours—designing its products, constructing its communications, and even producing its missiles.

The U. S. is reaping fruits of a highly developed technology—a vast body of engineering and scientific know-how. And the fellows with that know-how are scientists and engineers.

So when you speak of these fellows—or write of them—call them what they call themselves. Call them engineers.



Engineers Joint Council
29 West 39th St., N. Y. 18, N. Y.

For information, call Pennsylvania 6-9220

NEW PRODUCTS

Antenna

Circularly polarized



Designed to cover the range of 300 to 520 mc, this circularly polarized antenna has a beam width of 55 deg at the low end and 29 deg at 520 mc. It has a circularity of ± 1.3 db over the frequency band, and better than ± 0.6 db over most of the range. Vswr from 360 to 520 mc is under 1.5. The gain of the antenna ranges from 11.5 to 15.0 db. Developed for telemetry applications, this six-turn helical antenna can be used for data reception from orbital bodies.

Technical Appliance Corp., Dept. ED, Sherburne, N.Y.

CIRCLE 441 ON READER-SERVICE CARD

Ceramic Capacitors

Fit within 1/10 in. modular spacing

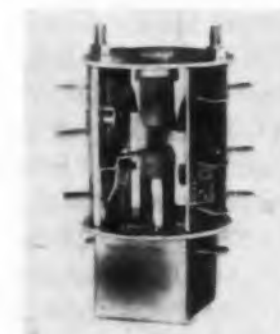
The Narrow-Caps series of subminiature ceramic capacitors are 0.095 in. wide to fit within 1/10 in. modular spacing. Capacitance values are 100, 250, 500, 750, and 1000 μf . Tolerance is $\pm 20\%$. Body length of the first four sizes is 0.250 in. max; the length of the 1000 μf unit is 0.30 in. max. Temperature range is -60 to $+125$ C; power factor is less than 2.5%.

Mucon Corp., Dept. ED, 9 St. Francis St., Newark 5, N.J.

CIRCLE 442 ON READER-SERVICE CARD

Snap Switch Relay

Solenoid operated



This multi-pole solenoid operated snap switch relay is available in contact arrangements up to

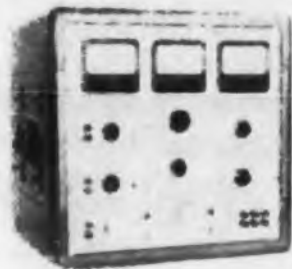
opdt. Called SS 101, it is used to control several circuits handling inductive loads. Each contact is rated at 10 amp, 125 v ac, or 5 amp, 250 v ac. Quick-connect or solder terminals are available on both switches and coil. This unit can be furnished for either top or bottom mounting and will operate in any position. It is 3-1/4 in. long and 1-7/8 in. in diam.

Warco Industries, Inc., Dept. ED, 6625 Delmar Blvd., St. Louis, Mo.

CIRCLE 443 ON READER-SERVICE CARD

Servo Analyzer

For transfer function characteristics



Model 203 servo analyzer, designed for either direct reading or automatic plotting of transfer function characteristics, has a frequency range of 0.5 to 50 cps with 2% accuracies. Phase angle is $\pm 180 \pm 2$ deg. Accuracy and amplitude ratio is read over a ± 40 db range with ± 0.5 db accuracy. The basic carrier frequency is 400 cps and operating signals are either ac or dc. Bode plots, Nyquist diagrams and Nichols' charts may be recorded directly by using the appropriate plotters. Testing is go/no-go type.

Metrolog Corp., Dept. ED, 169 Halstead St., Pasadena, Calif.

CIRCLE 444 ON READER-SERVICE CARD

Multiplexer

Magnetic

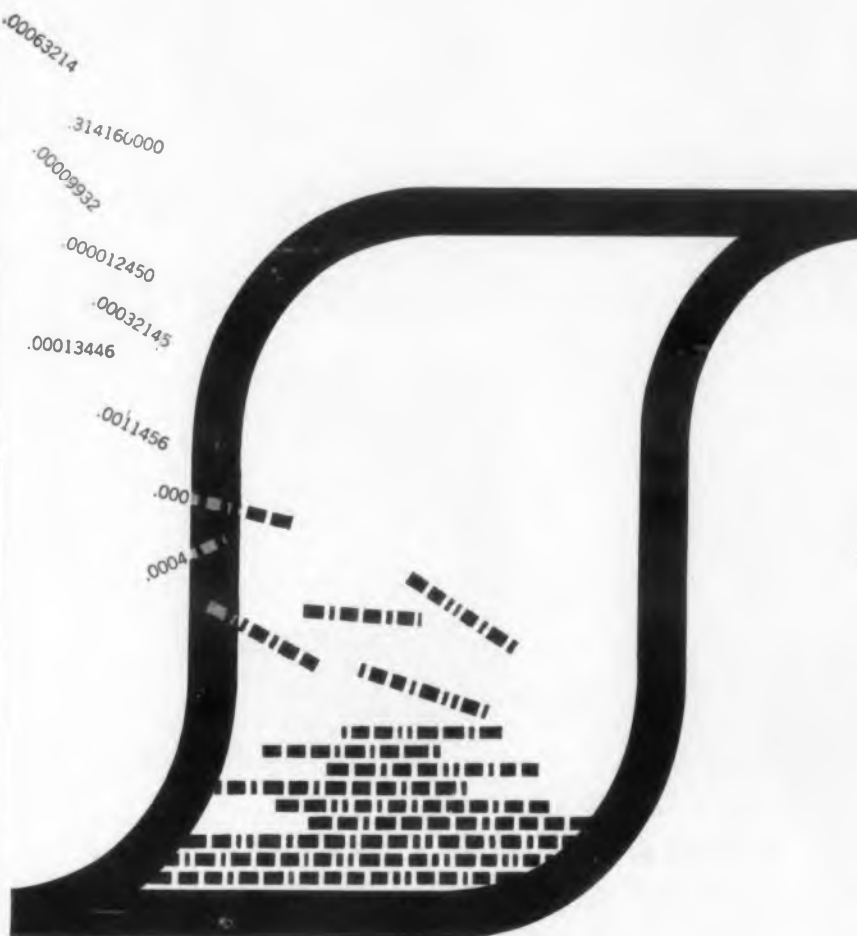
This magnetic multiplexer, designated Magneplexer, samples voltages of thermocouples, strain gages, and other low level sensors without the use of external preamplifiers. Flexible programming permits scanning groups of sensors at different rates within a single system. Some sensors might be scanned 4096 times per sec while others are being measured once each second in a synchronized pattern. A typical magamp requires 50 μ a input current to give full scale output voltage. Input resistance is 40 ohms, input noise level is 0.1 μ a, and basic linearity of the system is better than 0.05%. The standard model is built in modular form and housed in a cabinet which fits into a standard 19 in. rack. The cabinet contains a control module and four matrix modules handling 64 channels each.

San Diego Scientific Corp., Dept. ED, 3434 Midway Dr., San Diego 10, Calif.

CIRCLE 445 ON READER-SERVICE CARD

TAPING CRITICAL INFORMATION?

"SCOTCH" Brand high potency oxides
let you pack more bits per inch!

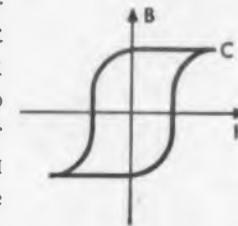


Every day SCOTCH Brand High Resolution Tapes are getting the nod for more instrumentation jobs. The reason? Performance. In taping high frequency data, the sharper resolution lets you pack more pulses to the inch—a greater density of information to each foot of tape.

At the root of this advance are the high potency oxides used in the magnetic coating. The higher magnetic retentivity of these oxides—about a third more than standard—offers distinct advantages. It permits the use of a thinner magnetic coating which may be combined with a thinner polyester base. Naturally, this means a more flexible tape—one that conforms for more intimate tape-to-head contact, automatically improving resolution in the taping of high frequencies.

Even so, you don't have to sacrifice output in low frequencies. For in addition to the marked increase in sensitivity to short wave lengths, SCOTCH Brand High Resolution Tapes show some increase in sensitivity even to long wave lengths.

These more flexible tapes cut drop-outs, too. With better tape-to-head contact, there's less chance that a stray bit of dust can sneak between tape and head to cause a drop-out. The superior magnetic properties of SCOTCH Brand High Resolution Tape No. 159 show up in oscilloscope tests—producing a good squared-up hysteresis curve like that shown at the right, and symbolically illustrated at the left.



Whatever your application—data acquisition, reduction or control programming—you can count on SCOTCH Brand technology to create tapes of higher uniformity and reliability for error-free performance.

SCOTCH Brand High Output Tape No. 128 provides the sensitivity for good output in low frequencies, even under extremes of ambient temperature. SCOTCH Brand Sandwich Tapes No. 188 and 189 offer extremely long life and reduced head wear in digital work and many AM, FM and PDM applications. Finally, for top performance at low cost per foot, SCOTCH Brand Instrumentation Tapes No. 108 and 109 remain the standard for the industry.

Where there's no margin for error, there's no tape like SCOTCH Brand. For more details, mail reader inquiry card or write Magnetic Products Div., Dept. MBQ-99, 3M Co., St. Paul 6, Minn.

© 1959 3M Co.

"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.



SCOTCH BRAND MAGNETIC TAPE

FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
... WHERE RESEARCH IS THE KEY TO TOMORROW



CIRCLE 446 ON READER-SERVICE CARD



Tenney push-button environments



... any size, any shape, anytime!

No matter what environmental test chamber you need, this much is certain: Tenney either has it in stock or can adapt one of its proven prototypes. From chambers that could house a family of four, down to refrigerator size (and everything in between), you're sure to find the modern, push-button unit you need.

Altitude, temperature, humidity, explosion, sand, dust, fog—just about every punch nature can

throw—can be simulated, either alone or in combination. And you get accurate simulation, complete control and precise measurements every time.

For a complete catalog, describing the entire line, write today to Tenney—the world's largest, most experienced creator of environmental test equipment.

Ask about Tenney's research and development, engineering consultation and design services.



Tenney
ENGINEERING, INC.

1090 SPRINGFIELD ROAD, UNION, N. J. • PLANTS: UNION, N. J. AND BALTIMORE, MD.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

CIRCLE 516 ON READER-SERVICE CARD



NEW PRODUCTS

Cleaning Systems

Three types available

Type D-601 one-gallon capacity vapor degreaser suspends parts to be cleaned in the condensing vapors of pure distilled solvent. Type G-10001 ultrasonic generator and type NT-10001 1 kw, 35 gal capacity tank have barium titanate transducer elements to generate uniform ultrasonic vibrations. Type DVC-3000 ultrasonic vapor degreaser has a 300 w cleaning chamber, distillate reservoir, power spray rinse, and filter recirculation system with all stainless steel plumbing. The immersion sump has a six-gallon capacity.

Narda Ultrasonics Corp., Dept. ED, 625 Main St., Westbury, L.I., N.Y.

CIRCLE 517 ON READER-SERVICE CARD

Microwave Step Attenuators

Are remotely operated

These 6 or 12 position automatic microwave step attenuators are powered by a motor-operated driving mechanism. Actuation of a rotary switch or push buttons causes the mechanism to produce the rotary and linear movements required to insert the desired attenuation value. They are available with attenuation values from 0.1 to 60 db and handle 1 or 4 w rf power. Frequency range is from dc to 4 kmc. These units operate from a 28 v dc.

Empire Devices Product Corp., Dept. ED, Amsterdam, N.Y.

CIRCLE 518 ON READER-SERVICE CARD

Oscillogram Scanner

Scans up to four records

Model S-25 oscillogram scanner permits the independent or simultaneous scanning of up to four records. It consists of a 90 x 30 in.-tabletop with guide rails for each channel. A control panel permits the operator to drive any one or all rolls, separately or jointly, in either direction. A back-lighted viewing screen is provided in the center of the table. Input power is 110 v, 60 cps, 250 w. Record width is 0 to 6 in. with standard 1/2-in. spaced perforations; maximum roll diameter is 3 in.

Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford 1, Conn.

CIRCLE 519 ON READER-SERVICE CARD

Ultrasonic Cleaner

Multi-purpose

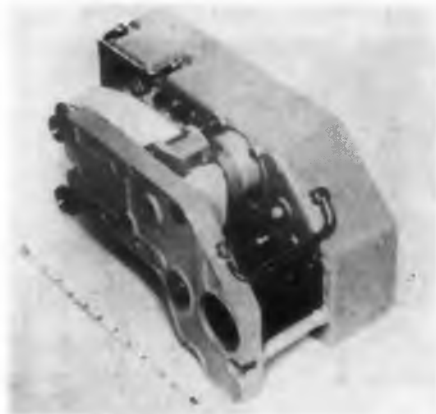
The series 400 SonBlaster ultrasonically agitates the contents of two 400 ml glass beakers, making it possible to wash and rinse parts simultaneously, or use two different solutions at the same time. Units include an ultrasonic generator model G-401, a transducerized ultrasonic tank model NT-401, and two beakers. Items to be cleaned may be placed in separate beakers or directly in the tank.

Narda Ultrasonics Corp., Dept. ED, 624 Main St., Westbury, N.Y.

CIRCLE 453 ON READER-SERVICE CARD

Transistorized Digital Printer

Puts out 10 lines per sec



Completely transistorized and designed for integration into preflight checkout systems, the model 3303 printer is 8-1/2 x 8 x 15-7/8 in. and weighs 34 lb. It is built to MIL-E-16400 and has print-out rates in excess of 10 lines per sec. Its custom designed format offers a choice of character or symbol types and any number of columns up to 20. Storage and programming are supplied in a separate housing that may be integrated with the printer on a RETMA standard structure for rack mounting.

Potter Instrument Co., Inc., Dept. ED, Sunnyside Blvd., Plainview, N.Y.

CIRCLE 454 ON READER-SERVICE CARD

Noise Sources

L-Band to V-Band

These waveguide and coaxial miniature gas tube noise sources cover the L-Band to V-Band frequencies. Designed for installation in branch circuits, series T44-A two-terminal waveguide elements, designed for use as series elements in the receiver circuit, provide noise signals of 10 to 13 db.

Tucor, Inc., Dept. ED, 18 Marshall St., S. Norwalk, Conn.

CIRCLE 455 ON READER-SERVICE CARD

Experience—the added alloy in **A-L Stainless, Electrical and Tool Steels**



GUARANTEED PERMEABILITY... and at higher values than old average values in AL-4750

AL-4750 nickel-iron strip now has higher permeability values than ever before . . . and the new, higher values are guaranteed. For example, using the standard flux density test, at 40 induction gaussses, AL-4750 now has 57% higher permeability than in the past. And permeability values are guaranteed.

This guaranteed permeability means greater consistency and better predictability for magnetic core performance . . . permits careful, high performance design.

The improvement in AL-4750 didn't just happen. It is the result of Allegheny's electrical alloy research and production program in nickel-bearing steels. A similar improvement has been made in AL Moly Permalloy.

WSW 7200

And research is continuing on silicon steels including AL's famous Silectron (grain oriented silicon steel), as well as on other magnetic alloys.

Another service of Allegheny Ludlum includes complete facilities for the fabrication and heat treatment of laminations. Years of experience in AL's lamination department means that Allegheny Ludlum has encountered and solved most problems common to core materials. This practical know-how is available to all. Call us for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. ED-211.

ALLEGHENY LUDLUM
STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17

Export distribution, Laminations: AD. AURIEMA, NYC 4

CIRCLE 456 ON READER-SERVICE CARD



YOU WILL GET VIBRATION FAILURES



Even under severe vibration ranging from 10 to 2000 cycles per second, the leads, welds and seals of TANSITOR tantalum capacitors are not loosened or damaged.

CIRCLE 457 ON READER-SERVICE CARD

with TANSITOR TANTALUM CAPACITORS

Although all Tansitor capacitors tested to date have withstood the MIL-C-3965 vibration test, it is possible that one might fail sometime. Our replacement rate last year for all causes, however, was only 0.001%. Isn't that the kind of reliability you want in your tantalum capacitors for shipboard or airborne electronic equipment?

TANSITOR FOIL CAPACITORS PROVIDE

- -55 to +125 C operating range at 150 volts or less in wide range of capacities
- Leak-tight, vibration-proof
- Non-corrosive electrolyte
- Etched or plain, polar or non-polar
- Long shelf life at -65 C

DESIGNING TANTALUM CAPACITORS that give you the most capacitance in the least space is our only business. Try us for overnight deliveries on all MIL-C-3965/2A/3B ratings, any vibration level. Write or 'phone for complete data to TANSITOR ELECTRONICS, Inc., West Road, Bennington, Vermont. Tel. 5473

TANSITOR

ELECTRONICS INCORPORATED

Where Reliability Comes First

Tantalum Capacitors

NEW PRODUCTS

Magnetic Clutch

Size 8

The size 8 OR precision magnetic clutch has a total torque output of 20 in.-oz at 3.5 w and zero backlash. It weighs 2.4 oz and has a response time of 8 msec. It is available in reverse or direct acting types in any combination of brake and/or clutch actions. This unit can be supplied for voltage applications of 6 to 115 v dc, and meets MIL-E-5272B specs.

Orbit Instrument Corp., Dept. ED, 131 Eileen Way, Syosset, N.Y.

CIRCLE 460 ON READER-SERVICE CARD

Bandpass Cavity Filters

Adjustable over 20% range



Series TCF bandpass cavity filters are available with 200 to 2400 mc center frequencies which may be tuned over a $\pm 20\%$ range. Impedance may be specified at 50, 75, or 93 ohms, or as required. Insertion loss is within 1 db and ripple is less than 0.5 db in the bandpass area. The weight of the assemblies is 32 oz for two-cavity units with 14 oz extra for each additional cavity. BNC or N type connectors are standard, and power rating is 100 w. Selectivity depends on the number of cavities specified.

Telonic Engineering Corp., Dept. ED, Laguna Beach, Calif.

CIRCLE 461 ON READER-SERVICE CARD

Oscillogram Amplitude Tabulator

Range of 0 to 9999 counts

The oscillogram amplitude tabulator is an automatic data reduction instrument composed of two parts: a stationary unit consisting of a printing counter and the necessary servos, and a hand-held rectangular frame. Called the GOAT, this instrument reads oscillogram and strip chart amplitudes up to 6-1/2 in. and prints this information on an adding machine tape. A sequential count for each reading is also recorded. The counter range is from 0 to 9999; time line print is 0 to 99.

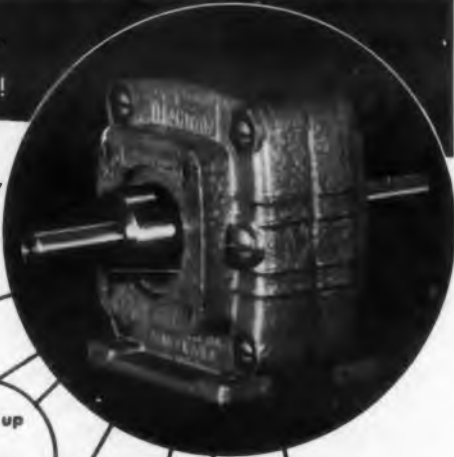
Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford 1, Conn.

CIRCLE 462 ON READER-SERVICE CARD

Metron BANTAM SPEED REDUCERS

- Complete!
- Compact!
- Adaptable!

The New Bantam combines power capacity and toughness with small size.



Save design, production, and assembly costs by using ready-to-go Bantams as package components in your product.

Write for Data Sheet 10 and 11 for details

Metron INSTRUMENT COMPANY
460 Lincoln St. • Denver 3, Colorado

CIRCLE 458 ON READER-SERVICE CARD

small...but **mighty**

COMAR'S SUB-MINIATURE TYPE SM



Less than an inch long Weighs less than 1/2 oz.

big relay performance in crystal can size

A high precision, efficient sub-miniature relay. Constructed to withstand severe vibration, heavy shock and temperature extremes. For control systems, missiles, computers, aircraft and similar applications requiring miniature size and dependable performance.

VISIT BOOTH 217 AT THE WESCON SHOW

COMAR ELECTRIC COMPANY
3349 ADDISON STREET
CHICAGO 18, ILLINOIS

FIAY • SOLENO S • C ILS • SWITCHES • HERMITIC EAL G

CIRCLE 459 ON READER-SERVICE CARD

Data Reduction System

Analog to digital

This analog-to-digital data reduction system is designed to read any type of oscillogram record. Modules include a scanner, a reading head, and a basic control console. The R-2 scanner reads and scans oscillograms up to 16 in. wide; the record speed can be varied from 0 to 200 ft per min. This system is compatible with reading heads R-2-EP, R-2-EM, and R-2-E-X,Y. The R-2-E-X,Y can be moved from left to right to compensate for any shift in the base reference line. The values of X or Y may be determined by intersecting two cross-hairs at a given point on the trace. The basic control console consists of a digital voltmeter with an accuracy of 0.01%. It measures the proportional voltages of either the X-Y or frequency potentiometers and displays the value in a projection lamp bank.

Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford 1, Conn.

CIRCLE 463 ON READER-SERVICE CARD

Pulse Power Calibrator

Frequency range of 925 to 1225 mc

The PCS-1 pulse power calibrator measures the instantaneous power in pulsed radio frequency energy. It measures peak pulse power by comparing the signal amplitude to that of an internally generated 1 mw rf signal. The production unit PCS-1A covers the frequency range of 925 to 1225 mc.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

CIRCLE 464 ON READER-SERVICE CARD

Microwave Sweep Generator

Has constant output to within $\pm 1/2$ db

Power output of model 6002A microwave sweep generator is adjustable from 10 mw to 1 w and is constant to within $\pm 1/2$ db over the entire frequency band. It provides either electronically swept or precise continuous wave, rf power from 2 to 5 kmc. The unit includes a backward wave oscillator, a 10 w traveling wave amplifier, a microwave leveler, and a power supply. Single or recurrent sweep rates are suitable either for oscilloscope or recorder display. Relay contacts are included for single sweep controls of the chart recorder. An internal 800 to 1200 cps square wave generator may be selected to amplitude modulate rf output. Another model is available for 1 to 2 kmc operation.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

CIRCLE 465 ON READER-SERVICE CARD

CAN "MATCHED" SERVO COMPONENTS



IMPROVE SYSTEM PERFORMANCE?

They certainly can! And if performance in your servo system is important, you owe it to yourself to check out the advantages "matched" servo components by Ketay can give you.

For example, Ketay's 105D2V Resolver (designated by the Bureau of Ordnance as Mark 4 Mod 1) trimmed to the TREA 4-100-2 Amplifier gives you a bonus of high performance and interchangeability:

1. The system will be trimmed to $\pm 0.02\%$ transformation ratio, with a phase shift tolerance of $\pm 1'$.
2. The amplifier will hold linearity to $\pm 0.02\%$ from -55° to $+100^\circ\text{C}$.
3. The receiver will achieve $.05\%$ conformity to the sine wave, and $\pm 3'$ interaxis error.

Similar benefits in matched performance can be obtained with system combinations using Ketay synchro transmitters, transformers, receivers, differentials, transistorized servo amplifiers, and servo motors.

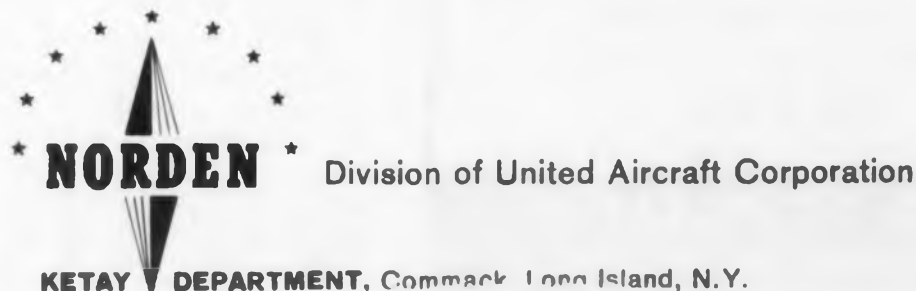
But performance is not all you gain. When all or most of your components are from Ketay, broadest technical assistance is assured, and service and spares problems are simplified.

Ketay engineers are working on many advanced environmental and accuracy problems in developing prototype systems. Why not call or write for help in solving your servo component problems?

Ketay matched components:

SYNCHROS
RESOLVERS
POTENTIOMETERS
SERVO MOTORS
TACHOMETERS
SERVO AMPLIFIERS
GYROSCOPES

Catalogues available



KETAY DEPARTMENT, Commack, Long Island, N.Y.

CIRCLE 466 ON READER-SERVICE CARD

A GUIDE TO PREFORM SOLDERING

FREE! NEW 8 PAGE GUIDE

Complete information on solder preforms, their selection and use. Technical diagrams. Send for your copy today.

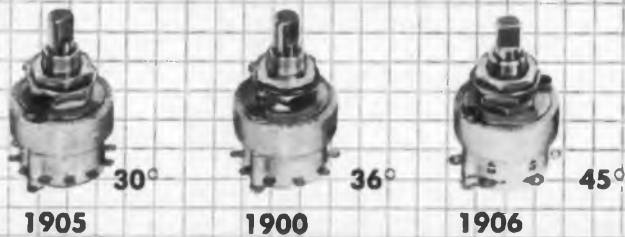
21-01 43rd AVENUE, LONG ISLAND CITY 1, N.Y.



CIRCLE 467 ON READER-SERVICE CARD

ROTARY SELECTOR SWITCHES

SUBMINIATURE SERIES



TOTALLY ENCLOSED
QUALIFIED TO MIL-S-6807A

... 1" DIAMETER ...

- 12 POSITIONS — 30° INDEX
- 10 POSITIONS — 36° INDEX
- 8 POSITIONS — 45° INDEX
- 1 TO 16 WAFERS
- 3/8 - 32 SINGLE HOLE MOUNT
- CARRY 10 AMP CONTINUOUS

... MAKE & BREAK ...

5 AMPS 115 V.A.C. — 3 AMPS 28 V.D.C.

JANCO CORPORATION

3111 WINONA, BURBANK, CALIF.

CIRCLE 468 ON READER-SERVICE CARD

NEW PRODUCTS

Linear Actuator

Stroke is 31 in.

Model D-1870 linear actuator has a 31 in. stroke. Normal load is 300 lb at a travel rate of 3.5 in. per sec. The electrical load sensing mechanism permits the actuator to sense, shut off, and hold a predetermined load of 500 to 800 lb. An electromagnetic clutch brake provides irreversibility within the design load range to 1000 lb with no current. Any of the three major sub-assemblies, the motor and clutch brake assembly with integral thermal protector, the junction box with electrical components or the gearbox and jackscrew, can be removed without disassembling the entire actuator. The radio noise filter meets MIL-I-6181B. The actuator operates at 28 v dc.

Hoover Electric Co., Dept. ED, 2100 S. Stoner Ave., Los Angeles 25, Calif.

CIRCLE 469 ON READER-SERVICE CARD

Silicon Diode

Has 4 μ sec recovery time

The miniature model MA-4223 silicon junction diode is designed for use in computer circuits which require low capacity and fast recovery time components. When switched from the forward bias with 10 ma current flowing to a reverse bias of -5 v, its complete recovery time is 4 μ sec maximum. Forward current is 50 ma dc; peak surge current is 100 ma dc; reverse voltage is 30 v dc; and power dissipation is 100 mw. The glass packaged units operate from -65 to $+100$ C and have axial wire leads.

Microwave Associates, Inc., Dept. ED, South Ave., Burlington, Mass.

CIRCLE 470 ON READER-SERVICE CARD

Flexible Copper-Clad Laminate

For printed circuits and cables

Made of 1-oz, electro-deposited copper foil bonded to polyester film 0.002 of 0.005 in. thick, CuFlex Lamicoid is a highly flexible laminate for flexible printed circuits, cables, and harnesses. It permits complicated, space-consuming circuits to be coiled in corners and printed cables or harnesses to be wrapped around fixed components. The laminate is 99.5% pure and designed for 130 C operation. In continuous rolls, it can be supplied in widths from 1/4 to 36 in.

Mica Insulator Co., Div. of Minnesota Mining & Mfg. Co., Dept. ED, 797 Broadway, Schenectady 1, N.Y.

CIRCLE 471 ON READER-SERVICE CARD

for the first time!
COMPLETE, SKIN-TIGHT, ONE-PIECE VINYL INSULATION FOR FULL-SIZE ALLIGATOR CLIPS

**SNUG AND TOUGH
AS AN ALLIGATOR SKIN!**

**Mueller's New No. 72 Insulator
for 70-Series Alligator Clips...**

(Sold separately. Red, Black, and four special colors.)

THIS IS TRUE "ALLIGATION"!

**FOR LOWER COST THAN ANY OTHER
COMPLETELY INSULATED ALLIGATOR!**



FREE SAMPLE... insulator and clip... on request.

Mueller Electric Co. 1580H East 31st Street
Cleveland 14, Ohio

CIRCLE 472 ON READER-SERVICE CARD

**immediate shipment
on 295 Bodine
stock motors!**

Design Engineers...

295 standard types of Bodine reducer and non-reducer motors are available at once ... from stock. Reducer torque ratings up to 219 in. lbs.

FREE ENGINEERING BULLETIN...

Stock models, specifications and ratings are included in 12-page engineering bulletin.

Distributors in major industrial centers

Bodine also offers 3500 standard built-to-order motors
Bodine Electric Co., 2506 W. Bradley Pl., Chicago 18

BODINE

fractional/horsepower



MOTORS

...the power behind the leading products

CIRCLE 473 ON READER-SERVICE CARD
ELECTRONIC DESIGN • September 30, 1959

Clock Counter

Normal operating speed is 0.1 rpm

Type X-950 clock counter provides indications in minutes and hours for elapsed time readout applications and has a normal operating speed of 0.1 rpm at the input shaft. It has continuous and reversible operation from 0 to 2359 hours. The minute drum is graduated in increments of 0.2 min for fine readings. The counter operates at speeds to 300 rpm for zeroing purposes. The temperature range is from -30 to +71 C; at -30 C input torque is 0.75 oz-in. The characters are white, 0.25 in. high; the frame and drums are black anodized aluminum alloy.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Rd., Fort Wayne, Ind.

CIRCLE 502 ON READER-SERVICE CARD

Electric Cartridge Heaters

Operate at 750 F

These electric cartridge heaters operate at 750 F max, 60 w per sq in., and are equipped with brass sheaths. Sizes range from 2-1/2 to 12 in. in length and from 1/2 to 1-19/64 in. in diam. The units are rated from 200 to 2800 w.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 503 ON READER-SERVICE CARD

Rotary Switch

Takes 1/2 in. panel space

Taking only 1/2 in. panel space, this printed circuit type rotary switch can be removed and replaced without unsoldering, or disassembling. For 10 position type TS-175, dimensions are 3/8 x 1-3/4 in. and for 20 position type TS-225, dimensions are 3/8 x 2-1/4 in. Other types can be furnished for specific requirements. A modular bank of 25 switches can contain up to 500 separate switching circuits.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.

CIRCLE 505 ON READER-SERVICE CARD

CIRCLE 506 ON READER-SERVICE CARD ▶

crystal growing with Trancoa silicon . . .

single,
single
all
the way

POLYCRYSTALLINE SILICON SPECIFICATIONS

Grade	Resistivity P-Type	Max. Resistivity Ratio for 10% & 60% Points	Max. Boron Content (ppb)
IA	500	3:1	0.5
I	100	3:1	1.0
II	50	3:1	2.0
III	25	3:1	7.0
IV	2.5	3:1	-

Consistently clean Trancoa Silicon eliminates the twins, polys, and dropped charges that can result from dirty material. This will give you a larger yield of single crystal per pound of silicon . . . saving material, saving machine time, saving labor.

We prove the cleanliness of our Silicon at Trancoa by growing test crystals with only 3/16th of an inch

between crucible and crystal . . . and they are single, single all the way! You can be confident of achieving uniform results within a lot and from one lot to another by growing crystals with Trancoa Silicon.


See table for the five grades available. Complete information is contained in "Trancoa Methods for Evaluating Silicon". Write today for a copy.

Trancoa
chemical corporation

312-326 Ash Street, Reading, Massachusetts
Tel. REading 2-3900



SYNTHETIC SAPPHIRE FOR HELIX SUPPORTS



The bifilar helix and electron gun structure of this backward wave oscillator tube are supported by sapphire rods. The tube was developed and built at the Electronics Research Laboratory, Stanford University, and operates from 500 to 1000 megacycles at 100 watts.

Single crystal synthetic sapphire rods are being used as support members for TWT helices and electron gun structures.

Sapphire offers flexural strength at elevated temperatures, excellent dielectric properties, small-diameter rigidity, strength at elevated temperatures, low-loss characteristics, zero porosity, and economy.

In addition to rods, single crystal sapphire is available in the form of windows and domes for microwave and infra-red systems. Special sapphire shapes for custom applications can be obtained.

Other single crystals, such as ruby and doped titania for maser amplifiers are available. LINDE also supplies single crystal yttrium iron garnet, for solid-state devices.

For further data, write to Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Linde Company, Division of Union Carbide Canada Limited. Address Department **ED-93**

Linde
TRADE MARK

**UNION
CARBIDE**

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

NEW PRODUCTS

Rectifier Assemblies

Use printed circuits

This series of printed circuit silicon rectifier assemblies are available for single- and three-phase power supply applications, in half-wave doubler, center tap and bridge circuits. The rectifiers are hermetically sealed and will operate up to temperatures of 150 C. Basic ratings are up to 3 amp dc, 800 v in a single-phase assembly, and 4.5 amp dc in three-phase assemblies. Higher voltages and currents may be obtained by putting the rectifiers in parallel or series.

International Telephone and Telegraph Corp., Components Div., Dept. ED, Clifton, N.J.

CIRCLE 508 ON READER-SERVICE CARD

Thermocouple Tubing

Ceramic

This ceramic thermocouple tubing is available in sizes down to 0.03 OD. The alumina body shows a boron content of less than 9 ppm; cadmium, less than 10 ppm; and hafnium, less than 80 ppm. Various types and shapes are available, including single and multi-bore.

Saxonburg Ceramics, Inc., Dept. ED, Saxonburg, Pa.

CIRCLE 509 ON READER-SERVICE CARD

Relay

Has 2 mw sensitivity

Designed for low power input circuits where available current is at a premium, the series 300 Microamp relay has a 2 mw sensitivity. It is field adjustable to handle currents up to 3 amp at reduced sensitivity and may be applied in high speed keying, remote control, or battery operated devices. It has a plastic dust cover and mounts on two 0.196 in. clearance holes on 2-1/8 x 2-1/8 centers.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn 22, N.Y.

CIRCLE 510 ON READER-SERVICE CARD

◀ CIRCLE 511 ON READER-SERVICE CARD

Time Delay Relays

Transistorized

Designed for use in printed circuits, each of these four transistorized time delay relay weighs 2 oz and measures 1.25 in. Time delays range between 0.05 sec and 90 sec; an increase in size will allow time delays to 950 sec. Accuracy is between $\pm 5\%$ and $\pm 20\%$. Operating voltages are 18 to 50 v dc. Maximum power required is 50 ma, insulation resistance is 1000 meg, and life is 100,000 operations at rated contact load. The temperature range of the units is -55 to $+71$ C. Types 50-089 and 50-093 have straight pin terminations; types 50-087 and 50-091 employ hook pins in a glass hermetic header. The contacts for each type are rated at 2 amp.

Hydro-Aire Co., Electronics Div., Dept. ED, 3000 Winona Ave., Burbank, Calif.

CIRCLE 512 ON READER-SERVICE CARD

Static Inverter

Supplies 100 va

Model W1298-2 static inverter supplies 100 va of 3 phase ac power at 115 v per phase. The output frequency is 400 ± 2 cps, with a maximum distortion of 5% at any load. Efficiency of the inverter is more than 70% with a phase balance of 120 ± 5 deg. Designed to be cooled by radiation, it is capable of operating at altitudes in excess of 100,000 ft without special cooling considerations. The inverter weighs 8 lb and measures $7\frac{3}{4} \times 4\frac{1}{2} \times 4\frac{1}{2}$ in. MIL-1-7032 specifications are met.

Electrosolids Corp., Dept. ED, 13745 Saticoy St., Panorama City, Calif.

CIRCLE 513 ON READER-SERVICE CARD

Pressure Switch

Has only one moving part

Having only one moving part, model 655 pressure switch can be used to perform electrical control functions at required altitudes or pressure, to detect loss of pressure in hermetically sealed electronic equipment or in aircraft cabin pressure and oxygen demand systems. The temperature range is -65 to $+150$ C and the pressure range setting is 2 to 14.7 psia. The proof pressure is 0 to 35 psia; higher pressure may be ordered. Consistent performance is maintained at 0.2 amp, maximum at 28 v. The switch has two metal contacts in an evacuated hermetically sealed chamber; a thermo-setting plastic housing is used. It weighs 2.2 oz without bracket and 2.7 oz with bracket.

Bendix Aviation Corp., Friez Instrument Div., Dept. ED, Baltimore, Md.

CIRCLE 514 ON READER-SERVICE CARD

E engineering SUPERIORITY

builds
SUPERIOR RELIABILITY
into . . .

El-Menco Dur-Mica CAPACITORS

QUALITY MATERIALS • PRODUCTION INTEGRITY • "BUILT-IN" RELIABILITY A FACT!
UNSURPASSED PERFORMANCE PROVED IN EXHAUSTIVE LIFE TESTS!

El Menco's advanced engineering vision . . . its rigid adherence to use of the finest grade materials . . . its complete and exhaustive "Debugging" Tests . . . make El Menco Dur Micas the unchallenged leaders in capacitor reliability.

Only the highest-quality materials, only the finest India Ruby Mica films, pretested to have the highest insulation resistance, greatest dielectric strength, lowest dissipation factor, are used.

El Menco's dominance in reliability has been proved beyond a doubt through "OPERATION DEBUGGING"—the removal of early failures by subjecting mica capacitors to a short life test at elevated voltage and temperature . . . DM30, 10,000 MMF, "Debugged" El Menco Dur-Mica Capacitors, subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied turned in a computed record reliability performance of APPROX. 0.6% CUMULATIVE FAILURES OR ONLY 1 FAILURE PER 43 MILLION UNIT-HOURS!

El Menco Dur-Mica Capacitors have proved their powerful performance under accelerated conditions of $1\frac{1}{2}$ times rated voltage at ambient temperatures of 125°C and 150°C —proving longest life, greatest stability, finest performance.

DM15, DM16, DM19, DM20, DM30, DM40, DM42, DM43—perfect for extreme miniaturization; ideal for new miniaturized designs and printed wiring circuits. New "hairpin" parallel leads insure easy applications. El Menco Dur-Micas meet and exceed all humidity, temperature and life requirements, including military specs.

Write for
FREE sample
and catalog
on your
firm's letterhead.



FROM GIANT COMPUTERS TO TINY TRANSISTOR RECEIVERS TO COMMUNICATION EQUIPMENT ON LAND, SEA AND IN THE AIR . . . EL MENCO DUR MICAS DO THE JOB BEST!

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

- 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

CIRCLE 515 ON READER-SERVICE CARD

new MINIATURE SWITCHING COMMUTATORS



Now, from Airflyte Electronics, comes light-weight, miniature switching commutators featuring low noise, low torque, long life and angular accuracy of 10 minutes of arc. Available either motor driven or hand detented, they meet MIL Specs. 5400 and 5272.

Ideal for programing, data processing, selecting, telemetering, high-speed sampling, analog-digital conversion, sync. drives, multi-pole and multi-throw switches and sinusoidal switches.

Write for Catalog #AE-16.
Airflyte ELECTRONICS COMPANY
535 Avenue A, Bayonne, New Jersey

CIRCLE 447 ON READER-SERVICE CARD

specify... G-E KSR* TANTALYTIC* CAPACITORS

for computer, missile, radar, and airborne electronic equipment.

- Provide high microfarad ratings in cases of nominal size and weight without loss of quality or reliability.

- Offer voltage ratings to 150 volts d-c from -55C to +85C; to 100 volts for 125C operation.

- Are up to 50% lighter, 30% smaller compared with lower microfarad units rated for 125C.

SPECIFYING INFORMATION on G.E.'s complete Tantalitic line is available from your nearest Apparatus Sales Office, or write for GEA-6766A, to General Electric, Section 449-11, Schenectady 5, N. Y.

*Registered Trademark of General Electric Co.

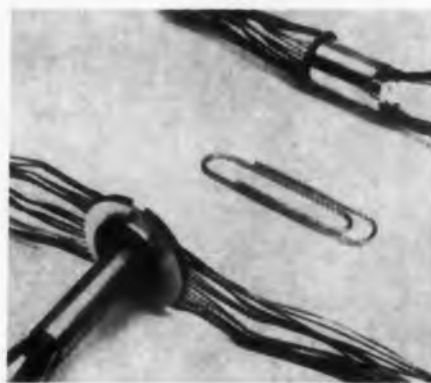
GENERAL ELECTRIC

CIRCLE 448 ON READER-SERVICE CARD

NEW PRODUCTS

Miniature Slip Ring Assemblies

Handle 12 to 100 circuits



Available in miniature and subminiature sizes, these cartridge-type slip ring assemblies operate from -65 to +350 F and comply with MIL-E-5400C. Noise levels are kept below 50 μ v. The miniature units, under 2 in. long with 0.499 to 0.75 diam, are rated 1 to 3 amp and handle 12 to 100 circuits. The subminiature units, under 1 in. long with 0.249 to 0.499 diam, are rated 0.5 to 2 amp and handle 12 to 50 circuits. Rotors of both series are double bearing mounted.

Slip Ring Company of America, Dept. ED, 13000 S. Avalon Blvd., Los Angeles 61, Calif.

CIRCLE 449 ON READER-SERVICE CARD

Modular Control System

Transistorized

Consisting of a transistorized preamplifier, power amplifier, and module case, this modular control system has no moving contacts or relays. Circuitry for the preamplifier and the power amplifier is mounted in a compact chassis which can be slid in or out of the standardized module case by means of a connect-disconnect plug. Three input channels enable the preamplifier to be used in a control system having an input command, and rate and feedback loops. Power amplifiers drive ac and dc servo motors at up to 200 w. The pre-amplifier has a chassis operating temperature range of -55 to +71 C with an option to 120 C. Gain for 1 input is 200; for 2 inputs, 125; and for 3 inputs, 100. Power output is about 50 mv. The power amplifier operates in the same temperature range and has 25 w continuous power output or 50 w peak for lower load resistance. Gain is 11.

Airborne Accessories Corp., Dept. ED, 1414 Chestnut Ave., Hillside 5, N.J.

CIRCLE 450 ON READER-SERVICE CARD

New ESNA CLINCH NUT HANDBOOK



Here's a brand new design manual giving full information on ESNA's line of self-locking clinch type Elastic Stop® nuts. The manual covers such points as:

Applications
Design Features
New Flush mounting Types
Insertion methods
Correct part selection
Plus: Materials, finishes and complete dimensional data

SEND TODAY for your copy.

Write Dept. S19-957, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, New Jersey.

This new flush mounting, miniature ESNA Clinch nut is easily installed by a simple flaring operation—becomes a permanent fastener.



actual size



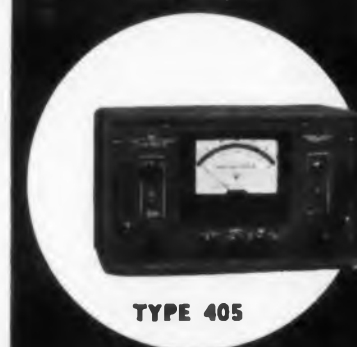
ELASTIC STOP NUT CORPORATION OF AMERICA

CIRCLE 451 ON READER-SERVICE CARD

PHASE METERS

1 CPS to 500 Megacycles
0.05 Degree Accuracy
20 Microvolt Sensitivity
Full Scale Sensitivity of 1 Degree

TYPE 205A1-2: 100 kc to 15 mc, 0.05° accuracy, direct reading in μ s, 0.01 volt sensitivity.



TYPE 405

TYPE 405 SERIES: Direct reading in degrees, no adjustment, 0.3 volt to 70 volts, 0.25° accuracy.

405 - 8 cps to 100 kc.
405L - 1 cps to 20 kc.
405H - 8 cps to 500 kc.

TYPE 202: Sensitivity 1° full scale or 0.04 volt rms; 20 cps to 150 kc; 0.02° or 2% accuracy; 100 kc to 500 mc with probe, accuracy $\pm 3\%$.

TYPE 205B: 15 mc to 500 mc, 0.05° or 1% accuracy, sensitivity 20 microvolts with external receiver, direct reading in μ s.

AD-YU ELECTRONICS LAB., Inc.
FORMERLY ADVANCE
249 259 TERMUNE AVENUE
PASSAIC, NEW JERSEY



CIRCLE 452 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

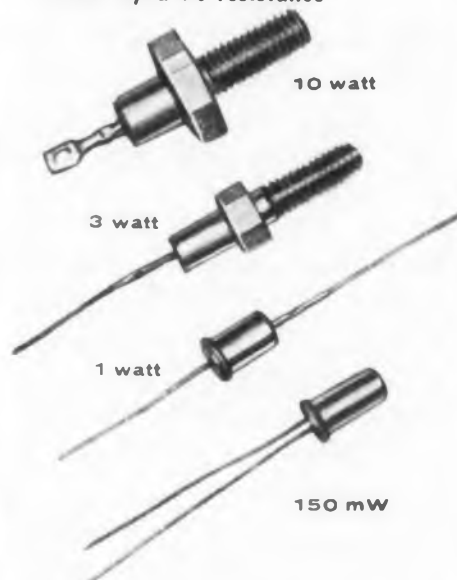
ANNOUNCING...

A
COMPLETE
FAMILY
OF

SILICON REGULATORS 10 TO 200 VOLTS

FEATURES:

- High reliability
- Hermetically sealed welded case
- Small size
- Low dynamic resistance



Rectifiers of all types available
We invite your inquiry

A AMERICAN
SEMICONDUCTOR CORPORATION
1418 W. Cortez
Chicago 22, Illinois

CIRCLE 474 ON READER-SERVICE CARD

ELECTRONIC DESIGN • September 30, 1959

Corona Test Set

Output is 0 to 10 kv rms

Model CT10-0.2 corona test set has a continuously adjustable output of 0 to 10 kv rms at 0.25 kva. The unit includes a three-scale kilovoltmeter at output terminals and a three-position scope sensitivity switch. It has zero start provision on powerstat output control. It measures 22 x 16 x 15 in. and weighs 60 lb. This unit may be used on transformers, bushings, terminals, and short lengths of cable. It may also be used for dielectric breakdown tests without disconnecting the sample being tested for corona. It conforms to military specifications.

Peschel Electronics, Inc., Dept. ED, Towners, Patterson, N.Y.

CIRCLE 475 ON READER-SERVICE CARD

Operational Amplifier

Chopper stabilized

Model D6 chopper stabilized, medium gain, wide-band dc amplifier is designed to simplify dc and ac signals and to provide power to drive direct-writing oscillographs. It has ten fixed gain settings from 1 to 1000, continuously variable gain control, and an input impedance of 100 K. Positive and negative overload indicators are included. Impedance matching of loads as low as 20 ohms with output of 100 ma is provided with model D7 high current amplifier. Model D6 is available in single amplifier units or in modules of six and eight amplifiers for standard rack mounting.

Photron Instrument Co., Dept. ED, 6516 Detroit Ave., Cleveland 2, Ohio.

CIRCLE 476 ON READER-SERVICE CARD

Square Root Circuit

Has accuracies of $\pm 1\%$

These square root diode circuits have accuracies of at least $\pm 1\%$ of output with an input voltage of 1 to 100 v. The frequency response is from dc to 30 kc, 3 db point. Input impedance is greater than 100 K and load impedance is 1 meg or greater. A bias voltage of 12 v dc with current drain of under 10 ma is required. These circuits have applications in control and instrument systems for such purposes as extracting square roots or logarithms. When used in the correct feedback circuit of dc amplifiers, they perform inverse functions.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Rd., Nashville 10, Tenn.

CIRCLE 477 ON READER-SERVICE CARD

Now! A higher reliability factor in printed circuits



ALTORI

a new and distinctively different
finish on TAYLOR copper-clad
laminates that accepts all
acid resists uniformly



Something new and distinctively different has been added to TAYLOR copper-clad laminates — a finish that accepts all types of acid resists uniformly. High fidelity in printed circuit reproduction is assured. Circuits can be of consistently higher quality and reliability, no matter how critical the design. For complete details about TAYLOR copper-clad laminates and samples, write TAYLOR FIBRE CO., Norristown 48, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

CIRCLE 478 ON READER-SERVICE CARD

lifelong association with quality

Lavoie test instruments are known and relied upon right around the world. Superlative design, consistent reliability and the industry's prime order of accuracy are the ingredients which continue to stamp all quality instruments bearing the Lavoie name.

Here are four representative units, each of which invites your trial and the beginning . . . or continuation . . . of a lifelong, rewarding association with the Lavoie standard of quality.



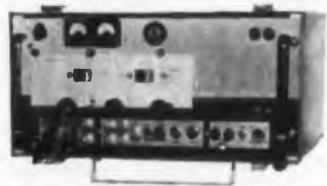
LA-302 ROBOTESTER

Provides the immediate profits of the automated approach to volume testing as well as for unique individualized test programs. High-speed sampling, go/no-go indication, with digital readout of fault isolation.



LA-20W SPECTRUM ANALYZER

Features 1 to 44 Kmc range in one instrument, selection of square law, linear or log detection, 10-KC resolution at 3 db points, regulated filament and plate supplies. Unit illustrated is only one of a full line of spectrum analyzers.



LA-70A FREQUENCY METER

Frequency measurements from 20 mc to 3000 mc with .0001% accuracy. Oven-controlled crystal oscillators, direct dial reading and light in weight for ease in portability. Ideally qualified to accommodate stringent FCC communications requirements.



LA-90 FREQUENCY STANDARD

New design approach to crystal oven thermal regulation permits frequency stability of 1 part per 10⁶ per day at low cost, in small package. Oven temperature stability of 0.01%. Output frequency (basic LA-90 unit): 1 mc, 5 mc, 100 kc, 10 kc, 1 kc.

Technical literature describing these units in detail is available on request. Detailed technical data may also be supplied on a selection of Pulse Generators, WWV Receivers and Crystal Ovens and a diversified line of quality test equipment for laboratory and plant.

Lavoie Laboratories, Inc.

MORGANVILLE, NEW JERSEY

CIRCLE 479 ON READER-SERVICE CARD

NEW PRODUCTS

Indicator Lamp

Draws under 50 ma at 1.3 v

This microminiature incandescent indicator lamp operates directly from the output of a transistor. It operates at less than 1.5 v and draws less than 50 ma. This lamp is 0.110 in. long and 0.050 in. in diam, with two platinum leads extending from one end. Applications include computers and military electronic devices where size and low current are important.

Minitron Components Corp., Dept. ED, 67 Illinois Ave., Paterson, N.J.

CIRCLE 480 ON READER-SERVICE CARD

Recorder

Has up to eight channels

This instrument is used to record any electrical variables on up to eight channels. The oscillogram is transported on a belt along the top of the read-out table allowing the operator a full and undisturbed view of almost three feet of record. A time stamp prints the year, month, day, hour, minute, and tenths of a minute at preset intervals. The oscillogram width is up to 12 in.; its speed is from 1 to 50 mm per sec.

Gerber Scientific Instrument Co., Dept. ED, 89 Spruce St., Hartford 1, Conn.

CIRCLE 481 ON READER-SERVICE CARD

Silicon Rectifiers

High power

The series N, S, and M high power silicon rectifiers have basic ratings of 150 amp, up to 600 piv; 250 amp, up to 600 piv; and 400 amp, up to 400 piv, respectively. These ratings apply at a case temperature of 150 C. The units have low forward drop, and low reverse leakage. Uniformity is assured through the use of advanced diffusion processes, and high reliability results from conformity to stringent military and industrial specifications.

International Telephone and Telegraph Corp., Dept. ED, Clifton, N.J.

CIRCLE 482 ON READER-SERVICE CARD

Precision Potentiometer

Has a 1/2 in. diam

These precision potentiometers have 1/2 in. diam. Called the RP35 series, they have stainless steel pressure-sealed cases and stainless steel pushrods. Designed for missile actuator applications, they are available in strokes up to 8 in., with resistance values from 500 to 20,000 ohms per in. The units are able to withstand temperatures from -65 to 400 F.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego, Calif.

CIRCLE 483 ON READER-SERVICE CARD

NEW USES for

STRAITS TIN

A modern metal for
science and industry

A giant 55-gal. tin can is being successfully used to pack and ship fruit and vegetable concentrates. It might even replace the conventional No. 10 size tin can which has for so long supplied the food remanufacturing market. Lining is of electrolytic tin plating. A special centrifugal spray process permits application of enamel over the tin-plate.

Corrosive attack under severe atmospheric conditions is a serious problem now solved by two tin alloy coatings. A 75 tin-25 zinc coating has been used with considerable success on hydraulic brake parts and landing gear equipment. 25 tin-75 cadmium coated on reciprocating engine parts overcomes low corrosion resistance of normal steels.

Organotin compounds, such as dibutyl tin dilaurate, are added as stabilizers to vinyl plastic sheet to make it heat- and light-resistant when used as windows.

A tin-plate printing machine handling 4-color work is reported by a British firm. It will inexpensively print full-color labels directly onto all sizes of cans up to one gallon in a single operation. The labels will withstand great extremes of temperature.



Write today for more data on these items or for a free subscription to **TIN NEWS**—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau

Dept. 12D, 1028 Connecticut Ave., Washington 6, D.C.

CIRCLE 484 ON READER-SERVICE CARD

NUW

**TI MOLDED PRECISION
FILM RESISTORS**



**EXCEED
NEW
MIL-R-10509C!**

**IMMEDIATELY AVAILABLE
OFF-THE-SHELF FROM**

LAFAYETTE RADIO



Your Authorized
TI Distributor

You are assured dependability and stability in your precision circuitry when you order Texas Instruments molded precision film resistors — they meet and exceed the new, more stringent requirements of characteristic B of Mil-R-10509C.

For new design and current production, order TI precision molded resistors from Lafayette Radio, your authorized TI distributor.

AVAILABLE FROM STOCK NOW!

- 1/8-w RN60B
- 1/4-w RN65B
- 1/2-w RN70B

Order TI resistors, or any of TI's complete line of semiconductors and components, in the following quantities at factory prices:

Carbon film resistors, 1-999; *sensistor* silicon resistors, 1-499; *tan-TI-cap* tantalum capacitors, 1-99; silicon and germanium transistors, silicon diodes and rectifiers, 1-999.



Lafayette Radio
Dept. TI-C

BOSTON 10, Mass.
110 Federal St.
HU 2-7850

JAMAICA 33, N. Y.
165-08 Liberty Ave.
AX 1-7000

PLAINFIELD, New Jersey
139 W. 2nd St.
PL 6-4718

NEWARK 2, New Jersey
24 Central Ave.
MA 2-1661

NEW YORK 13, N. Y.
100 6th Ave.
WO 6-5300

Electrical Heat Control

Handles 300 to 3000 w

This electrical heat control, designated Hott-Watt, is available in a range of 10 capacities from 300 to 1500 w for 110 v circuits and in 10 capacities from 600 to 3000 w for 220 v circuits. Full load flows through the circuit at all times, is shut off completely at a fixed temperature level and stops immediately with a drop of 0.5 deg F. No external probe or thermo sensing device is required. The unit includes fuse protection pilot indicating light, and is cabinet mounted.

Industrial Steam Equipment Co., Div. of Industrial Shoe Machinery Corp., Dept. ED, 5 Gaston St., Roxbury 21, Mass.

CIRCLE 486 ON READER-SERVICE CARD

Complex Wave Analyzer

Resolves harmonics from 0.5 cps to 15 kc

Model 1053 wave analyzer reduces, in real time, a complex electrical wave to the information necessary to produce a time series of power plots. This unit is capable of resolving harmonics from 0.5 cps to 15 kc. Internal timing is provided, but if the system is used with a recorder, the unit can be synchronized with external sync pulse. The input attenuator amplifier varies the input sensitivity from 1 mv to 100 v peak-to-peak.

Briggs Associates, Inc., Dept. ED, 10 DeKalb St., Norristown, Pa.

CIRCLE 487 ON READER-SERVICE CARD

Input Conditioning Module

For data acquisition systems

This transducer input conditioning module for data acquisition systems is used with any type of resistance transducer containing one, two, or four active arms. Called model 6-200B, it provides the means to calibrate out the effects of long input cables. It can be used with four- to eight-wire input cabling systems. Balance potentiometers are fitted for servo gun balancing; when used with servo gun and amplifier, a null of $\pm 10 \mu v$ may be obtained.

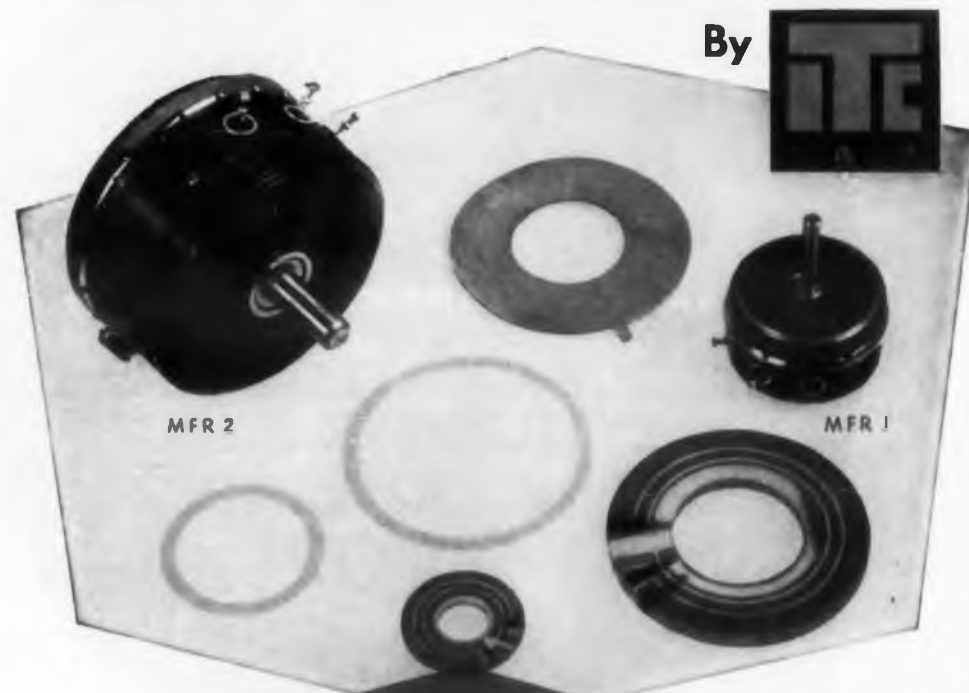
B & F Instruments, Inc., Dept. ED, 3644 N. Lawrence St., Philadelphia 40, Pa.

CIRCLE 488 ON READER-SERVICE CARD

CIRCLE 485 ON READER-SERVICE CARD

**NEW PRECISION VARIABLE
RESISTOR with no sliding wiper**

By



**These Rotary Metallic Film
Potentiometers
are the perfection of years of
research and development**

*Super
reliability
is inherent
through
unique
manufacturing
techniques*

FEATURES:

- Complete Hermetic Seal
- Infinite Resolution
- High Temperature Operation
- Long Life
- Low Torque
- Exceptionally High Accuracy
- Extremely Low Noise

**NEW
CATALOG**

*of the most
complete line of
potentiometers
— available upon
request*



A patented compression contact eliminates the wear or friction caused by usual wiper contacts. A precious metal capsule contact provides dependable long life operation. The deposited metal film resistance element is encased and hermetically sealed. The ultimate in craftsmanship is employed in the manufacture to produce a potentiometer unparalleled for performance. This new concept of design makes possible super reliability under the most severe environmental conditions such as those encountered in airborne, missile and satellite applications.

TECHNOLOGY INSTRUMENT CORP.

569 Main St.
Acton, Mass.
COLonial 3-7711

P. O. Box 3941
No. Hollywood, Calif.
POplar 5-8620

CIRCLE 489 ON READER-SERVICE CARD



Model 1064/2 **\$650**

MARCONI MARKET RESEARCH...

... produced this FM Signal Generator for the MOBILE RADIO Industry. It covers RF, IF and AF, has excellent stability, quick warm-up and calibrated Δ frequency control. This inexpensive field instrument has Lab. Standard performance.

CARRIER FREQUENCY: 30 to 50Mc, 118 to 185Mc, 450 to 470Mc
 Xtal CONTROLLED IF: 290Kc to 16Mc
 FM DEVIATION: 3.5 and 10Kc or to order
 Δ FREQUENCY: Calibrated to 100kc
 RF OUTPUT: 0.025 to 10,000 μ V; high output 100mV
 STABILITY: 0.002% per 10 minutes

All Marconi Instruments can now be leased.



CIRCLE 490 ON READER-SERVICE CARD



NEW... DIRECT-READING TRANSISTOR TEST SET MEASURES

- β in ranges of 0 to 30/100/300
- h_{11} } 0.5 to 20 K at 1 KC
- h_{1e} }
- I_{co} 0 to 50 microamperes
- I_e 0 to 3/10/30 milliamperes

Quickly and accurately the new Metronix Model 545-B Transistor Test Set measures all the essential parameters of transistor performance and gives a direct presentation of the test data.

This versatile instrument can be operated either on its own 5.2-volt collector voltage supply or on any externally supplied potential up to 50 volts DC... can accommodate a wide test frequency range of from 200 cps to 50 kc... has an output jack to permit oscilloscope display of AC collector waveforms. And it's fully protected against meter overload.

Price \$225.00, f.o.b. factory.

Call or write for Specification Sheet No. 545-B

Metronix INC



A SUBSIDIARY OF
ASSEMBLY PRODUCTS, INC.
 Chesterland 17, Ohio



S.A. 2088

CIRCLE 491 ON READER-SERVICE CARD

NEW PRODUCTS

**Power Supply
 Transistorized**

This 1000 w power supply is transistorized and has a continuously variable output of 0 to 600 v dc. The input is 115 v ac at 60 cps. For load variations from zero to full load and input line variations of $\pm 10\%$, the output regulation is within 0.01%. Ripple is less than 3 mv rms. Maximum drift is 0.1 v over an 8-hr operating period. Made for use in ground support and checkout equipment, the unit has standard rack-console type construction.

Aerolab Development Co., Semiconductor Systems Div., Dept. ED, 330 W. Holly St., Pasadena, Calif.

CIRCLE 492 ON READER-SERVICE CARD

Amplifier

Input impedance is 1600 meg

Designed for use with crystal type transducers, type 6000 amplifier has an input impedance of 1600 meg and an output impedance of 150 ohms. Frequency response is 1 cps to 1 mc, output voltage is 60 v peak-to-peak and output current is 2 ma peak-to-peak. The rms noise level when referred to the shorted input is 40 μ v. Power requirements are 115 v, 60 cps. The unit measures 7 x 9-1/4 x 13 in.

Columbia Research Laboratories, Dept. ED, MacDade Blvd., & Bullens Lane, Woodlyn, Pa.

CIRCLE 493 ON READER-SERVICE CARD

Cavity Filter

Available from 400 to 2000 mc

Model 410 cavity filter is available for any frequency in the 400 to 2000 mc range. It is tunable over a limited range of 3 to 10% depending on center frequency. Response curve and bandwidth are about the same for any pass frequency. Power is 20 to 50 w, according to pass frequency; insertion loss is 1 db. The unit has a 3 db bandwidth over 8 mc and a 30 db bandwidth over 60 mc. It is airtight and will withstand shock, vibration, and temperature extremes. It measures 3 x 3 x 5-1/2 in. and weighs 28 oz.

Adams-Russell Co., Inc., Dept. ED, 200 Sixth St., Cambridge 42, Mass.

CIRCLE 494 ON READER-SERVICE CARD

**THIS CARD
 IS AN ADDED
 SECRETARY**



Like a good secretary, *Electronic Design's* reader service card works quickly and efficiently to obtain the information you request. Cards now bear AIR MAIL pre-paid postage for western areas, but even more important, your requests are forwarded to advertisers within ONE DAY OF RECEIPT. Special pre-typed labels also help to cut down the time required to get the data you want in the mail and on its way back to you.

Another Improved Reader Service
 ... Only Available in

ELECTRONIC DESIGN
 a HAYDEN publication
 New York • Chicago • Los Angeles
 London

Special Purpose Wire

titanium

phosphor bronze

BERYLLIUM
COPPER
Silvercote

ALUMINUM

ni-clad-ti

NICKEL CLAD NOT PLATED TITANIUM WIRE

FOR
CERAMIC-TO-METAL
BRAZING

OTHER NON-FERROUS

Consider WIRE and the importance of its function in your product. Whether a highly engineered application or a simple stapling purpose, your choice of the proper alloy or composition, temper and type of wire could mean success or failure during crucial test.

round • flat — square ■ half-round ▲

Precision gauges from 1/8 to .002. Close tolerances held.

SPRING WIRE — WIRE FOR INSTRUMENTS

ELECTRONICS — STRAND FOR WIRE ROPE AND

BRAIDED APPLICATIONS — MANDREL WIRE

WIRE FOR FORMS — RIVETS

STAPLING

Send for descriptive folder.

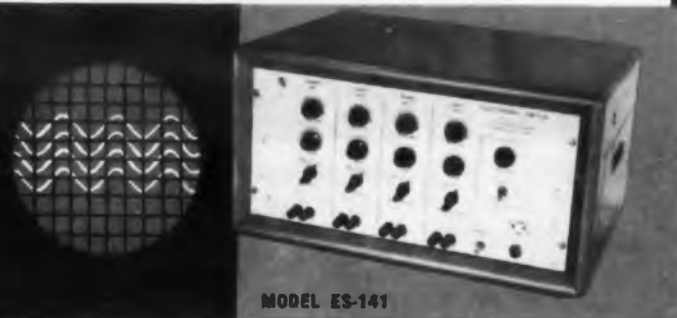
LITTLE FALLS ALLOYS

INCORPORATED
186 Caldwell Avenue • Paterson 1, N. J.



CIRCLE 495 ON READER-SERVICE CARD

DISPLAY 4 WAVE FORMS SIMULTANEOUSLY ON A SINGLE CHANNEL OSCILLOSCOPE



MODEL ES-141

NEWTON MULTI-CHANNEL ELECTRONIC SWITCH

The NEWTON ELECTRONIC SWITCH (Model ES-141) accepts 4 independent signals and sequentially connects them to a single output in a four way display on a single channel oscilloscope. Variations of the basic unit can be made to provide for simultaneous display of any number of positions — the number limited only by total sampling time available.

Compact, light-weight transistorized model for air-borne applications.

FOR COMPLETE INFORMATION,
WRITE TODAY FOR DATA SHEET



ANOTHER ACHIEVEMENT IN
OPERATIONAL DIGITAL BY NEWTON

Transistorized model
10 times smaller
than Model E S-141



MANCHESTER, CONNECTICUT

CIRCLE 496 ON READER-SERVICE CARD

Potentiometers

Linearity is about $\pm 0.2\%$

These cylindrical rectilinear potentiometers have about $\pm 0.2\%$ independent linearity and high resolution. Shock, acceleration, and vibration resistance are over 50 g without opening or discontinuity. Models 3091, 3090, 3080, 3258, 3257, 3254, and 3255 are available with single or dual elements and stroke from 2.5 to 10.

Markite Products Corp., Dept. ED, 155 Waverly Place, New York 14, N.Y.

CIRCLE 497 ON READER-SERVICE CARD

Hybrid Garnet

Microwave type

Type M-062 hybrid garnet has microwave applications over a frequency spectrum of 4000 meg to several hundred megacycles. The line width is 30 oersteds at X band, the saturation moment is 670 gauss, and the Curie temperature is 180 C. It has the usual loss factor required of microwave ferrites. Standard sizes are 6 x 1 x 0.5 in., 6 x 0.5 x 0.45 in., and 6 x 0.5 x 0.25 in.

Motorola Inc., Solid State Electronics Dept., Dept. ED, 3102 N. 56th St., Scottsdale, Ariz.

CIRCLE 498 ON READER-SERVICE CARD

High Voltage Test Sets

Have both ac and dc output

The KS series of high voltage test sets have both ac and dc output with separate kv meters for dc and ac, and a common ac-dc current meter. Other features include simple control circuitry with main switch, pilot-light and hi-speed circuit breaker, continuously adjustable output, and current meter in ground lead. The meters are 4-1/2 sq in. Model KS2-50 is available with 0 to 2 kv at 50 ma and model KS50-40 with 0 to 50 kv at 40 ma, with 2 kva max capacity.

Peschel Electronics, Inc., Dept. ED, Patterson, N.Y.

CIRCLE 499 ON READER-SERVICE CARD

Dual Centrifuge

Rotary type

Model DC-3 dual rotary centrifuge generates sinusoidal accelerations at frequencies from 0 to 20 cps. The unit consists of a small satellite table mounted on a large turntable; the angular velocity of the turntable is zero while it orbits around the main spindle. The radial displacement of the satellite table relative to the main spindle is 0 to 12 in. The range of steady accelerations is 0 to 500 g. Rated load of the satellite table is 2-1/2 lb and rated load of the main turntable is 5 lb at each of 2 stations.

Schaevits Machine Works, Dept. ED, Pennsauken, N.J.

CIRCLE 500 ON READER-SERVICE CARD

Applied Research inc.

WIDEBAND RF AMPLIFIERS 40 to 1500 mcps

Low noise figure • Low power drain
Minimum size and weight • High gain



TYPE HFW AMPLIFIERS are now available for operation in the 600-1500 mcps range, with bandwidths of 100 to more than 400 mcps in the upper ranges. These augment the extant Applied Research amplifiers, which provide for operation in the 40-600 mcps region.

ARI Amplifiers are used as part of receiving systems in antenna preamplifiers, multicouplers, and high frequency IF amplifiers, where faithful reproduction of signals and amplification over a wide band of frequencies are required. The low noise characteristics of these equipments result in a dynamic range of greater than 60 db.

TYPICAL PERFORMANCE CHARACTERISTICS

Model	HFW-5070-3	HFW-77100-3
Frequency range	500-775 mcps	775-1000 mcps
Gain	Greater than 30 db	Greater than 30 db
Noise figure	6 to 8.5 db	8.0 to 9.5 db
Peak to valley ratio	Less than 1 db	Less than 1 db
Zin — Zout	50 ohms	50 ohms
VSWR Input	Less than 1.5	Less than 1.5
VSWR Output	Less than 1.75	Less than 1.75
Anode drain	200V at 60 ma	200V at 60 ma
Filament drain	6.3V at 2.1 amps.	6.3V at 2.1 amps.

Write for further information

Applied Research inc.

76 South Bayles Avenue, Port Washington, N. Y.

CIRCLE 501 ON READER-SERVICE CARD

The ABC Of Teaching Engineering

Not every expert engineer is an expert instructor. And here is why —

When he isn't working as a project engineer (Bulova Watch Co.), spending time in Paramus, N.J., with his family (wife, three boys) or pursuing one of his hobbies (amateur radio station W2WYM photography, writing, gardening, house construction), Joseph Leeb may be found practicing what he preaches in this article. He teaches radio and television repair in the Paramus Evening Adult School.

Nor is this his first venture into teaching. During World War II he instructed in electronics in the War Industries Training Program. Besides an EE degree from Polytechnic Institute of Brooklyn he holds a diploma from the Vocational Teachers Training College, University of the State of New York.

At Bulova's plant in Jackson Heights, N.Y., Mr. Leeb designs equipment for testing electronic components, trains personnel in the use of production test equipment and sets up inspection requirements for quality control.

A BRILLIANT ENGINEER was assigned by a company to teach a course in servomechanisms. The choice seemed to be a natural: not only had the specialist attained an outstanding record, but word of his achievement had spread to his co-workers in the plant. He commanded respect. Company officials were pleased when nearly a hundred junior engineers registered for the course.

Excellent facilities were provided for the classroom, including an amplifier for the instructor's flawless diction. As classes progressed, however, it became apparent that something was radically wrong. Some students found the instructor's concepts hard to understand. Others understood, but not without difficulty: they had to consult reference books and other outside sources to keep abreast of the lessons. Some merely found the

company expert boring. Students dropped out.

Toward the end of the course, the instructor announced that he would give a written examination at the following session of the class. Only seven students showed up for the test. Five left after reading the questions, and only one of the two who took the test handed in his paper.

The instructor was chagrined, the company embarrassed. But the lesson would be clear to any educator: outstanding engineers—or specialists in any non-educational field—do not necessarily make outstanding teachers. Some persons have great stores of knowledge but cannot convey it clearly to anyone else. Others with limited knowledge and a knack for filling in the gaps can teach and inspire their fellow men. The critical determinant is not knowledge of the subject alone but knowledge also of teaching.



Joseph Leeb swings into action as a teacher.

What A Good Teacher Does

The capable instructor knows the established principles of learning and applies them in the classroom. Among his methods, he:

- Establishes clear goals that he intends to reach through his instruction.
- Molds teaching methods to facilitate achievement of these goals.
- Motivates the students so they are receptive to learning.
- Presents the subject clearly, a step at a time.
- Helps the students link new material to what is already familiar.
- Gives extra help to students who are having trouble learning.
- Repeats assignments to enable students to acquire skills through habit.
- Keeps tabs on the progress of his students and reviews material that they have not fully grasped.

Rules for Good Teaching

There are simple general rules for good teaching of engineering. They can be stated as follows:

Determine the level at which the instructing is to be done. Is it intended for the mathematically inclined engineer or physicist, for the practical man, or for the sales engineer? Even with a homogeneous group, the instructor will do well to probe the background of his students with a series of carefully chosen general questions. The responses will prove invaluable for establishing a common ground for the ensuing lessons. The educator's technical term for this introductory maneuver is Determining the Apperceptive Mass.

Before presenting the subject, prepare the student's mind by linking the new material to something he already knows. For example, if the lesson is on servo motors, it would be wise to begin with a brief review of electric motor operation. This step is called, logically, Preparation.

Unfold the subject step by step, beginning with the simple and working toward the complex. Maintain smooth continuity between steps. Information should be elicited from the students with skillful oral questions; it helps, too, to have the responses written on the blackboard by one of the students rather than by the instructor. Class participation is a wonderful stimulant to learning in this stage, called Presentation.

List applications of the newly imparted facts. Tell how servo motors are used in industry, if

TRANSISTOR MEN

Your future advancement lies in Delco Radio's Semiconductor Program in the fields of germanium and silicon transistors, silicon rectifiers, and solar cells.

In expanding its semiconductor line, Delco Radio offers unusual opportunities in research engineering and production. We are vitally interested in hiring men with experience in the following areas:

● SEMICONDUCTOR DEVICE DEVELOPMENT

We need men with experience in the techniques of semiconductor device development including alloying and diffusion.

We need a man with experience in the chemistry of semiconductor devices.

We need a man with experience in semiconductor materials to lead a program on metallurgical research of new semiconductor materials.

We need a man with experience in semiconductor device encapsulation.

● PROCESS ENGINEERING

We need several men for production set-up and trouble shooting.

● EQUIPMENT DEVELOPMENT

We need men to develop automatic and semi-automatic fabrication equipment.

PROGRESS = OPPORTUNITIES

Delco Radio has long been the World Leader in the production of auto radios and is becoming a leader in the semiconductor field. The semiconductor applications which we see are staggering. We're anxious to get more experienced personnel, and responsible positions are open to those who qualify.

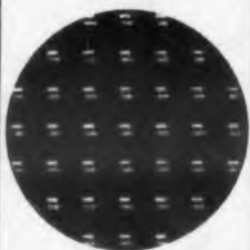
If you're interested in becoming a member of our GM team, send your resume today to the attention of Mr. Carl Longshore, Supervisor Salaried Employment.

DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

CIRCLE 903 ON CAREER INQUIRY FORM



CAREER
OPPORTUNITIES
AT TI



DEVICE DEVELOPMENT ENGINEER

26,000 TI transistors will be produced from the thin slices of germanium crystal seen in the container above being inserted into a diffusion furnace. In circle at left, precisely separated on single slice (magnified 10 times) are 37 of more than 1,000 transistor hearts per slice.

your future: a challenging opportunity with an industry leader

Now take advantage of maximum professional growth at Texas Instruments by participating in development of the most advanced semiconductor-component devices. Working with the newest facilities, take part in:

- **DEVICE DEVELOPMENT** Development of new devices by studies in solid-state diffusion, alloying of metals and semiconductors, vacuum deposition of metals, surface chemistry, and solid state physical measurements.
- **SURFACE STUDIES** Surface reactions and surface energy phenomena on silicon and germanium.
- **ADVANCED COMPONENT DESIGN** Development of new components by studies of deposition of thin films, electrolytic studies such as anodic oxidation rates and film structures.
- **NUCLEAR RADIATION** experiments on semiconductor materials and devices.

With TI... receive liberal company-paid benefits, including profit sharing (*last year 15% of base salary*)... enjoy premium living in a moderate climate with excellent neighborhoods, schools and shopping facilities... work in a plant selected as one of the 10 outstanding U. S. industrial buildings of 1958.

Interviews will be held in your area soon. If you have an Electrical Engineering, Physical Chemistry or Physics degree and experience in semiconductor or related development areas, please send a resume to:

C. A. Besio, Dept. 201-ED

TEXAS  **INSTRUMENTS**
INCORPORATED
SEMICONDUCTOR - COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

For
immediate
Eastern
appointment,
contact
H. C. Laur
Dept. 201-E-ED
1141 E. Jersey St.
Elizabeth, N. J.

DESIGNING YOUR FUTURE

Key Principles of Learning

Psychologists and educators recognize that learning is accomplished easiest when certain established principles are utilized. Here are some major ones:

- We tend to learn best by doing.
- We learn faster when the experience gives us satisfaction.
- We learn one thing at a time.
- We relate new concepts to those we already know.
- We are stimulated through the senses—hearing, sight, touch, taste, smell.
- We learn when we are mentally and emotionally ready to learn.
- We learn thoroughly when we understand what we learn.
- We differ in the speed with which we assimilate new ideas.

that is the subject. This portion of the lesson is called Application.

Test the students to gauge the success of the teaching. An engineer who designs and builds a piece of equipment can be sure of its success only after testing it. Likewise the instructor must examine students on the salient points of the lesson. This is the Testing phase.

A Summary, written on the blackboard, completes the lesson. And an assignment for the following meeting of the class will furnish a link to restart the educative cycle.

Six Ways to Fail

Getting back to the brilliant engineer who conducted a course in servomechanisms, we now can say that he failed as a teacher because:

1. He made no attempt to determine the background of the students in relation to the course.
2. He did not define the basic terms of the subject.
3. He presented the subject on too high a plane for most students.
4. He proceeded at too fast a pace, demonstrating formulas on the blackboard and erasing them before the students could copy them.
5. He gave too few applications of the principles he presented.
6. He did not solicit answers to questions as he went along. ■ ■

After completing, mail career form to *ELECTRONIC DESIGN*, 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below.

20

(Please print with a soft pencil or type.)

Name _____ Telephone _____

Home Address _____ City _____ Zone _____ State _____

Date of Birth _____ Place of Birth _____ Citizenship _____

Position Desired _____

Educational History

College	Dates	Degree	Major	Honors

Recent Special Training _____

Employment History

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924
925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

Advancement Your Goal? Use New Form To Speed Action

ELECTRONIC DESIGN's new Career Inquiry Service form is designed to help engineers advertise themselves. This new service speeds applicants to the jobs they seek. It is the first such service offered in the electronics field and is receiving high praise from personnel managers.

To present your qualifications immediately to the personnel managers of companies that interest you, simply fill in the attached standardized short resume.

Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will act as your private secretary and type neat, duplicate copies of your standardized resume and send them to all companies you may select . . . *the same day the resume is received.* (*ELECTRONIC DESIGN* will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

The standardized resume will permit personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you directly. In the past much time has been lost through personnel-manager requests for resumes from applicants who proved ineligible.

Mail Career Inquiry Service form to Reader Service, *ELECTRONIC DESIGN*, 830 Third Ave., New York 22, N. Y.

ENGINEERS...PHYSICISTS

NEW opportunities at Motorola in Chicago

give yourself and your family
all the big city advantages at a
relaxed midwest pace, while you
ADVANCE YOUR CAREER

Outstanding career opportunities are waiting at the many Motorola research and development laboratories in the Chicago area. This is your opportunity to advance your career with a swiftly expanding company, working in the most modern and well instrumented laboratories . . . with liberal employee benefits, including an attractive profit sharing plan and association with men of the highest technical competence.

You'll like living in one of the beautiful suburbs of the playground of the midwest, where there are endless social, cultural, and educational activities to choose from the year-round. Exciting life or quiet life—Chicago offers either.



MILITARY POSITIONS OPEN

- Radar transmitters and receivers
- Radar circuit design
- Antenna design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using klystron, traveling wave tube and backward wave oscillator
- Display and storage devices

CIVILIAN POSITIONS OPEN

2-WAY RADIO COMMUNICATIONS

- VHF & UHF Receiver • Transmitter design & development • Power supply
- Systems Engineering • Selective Signaling • Transistor Applications • Crystal Engineering • Sales Engineers

PORTABLE COMMUNICATIONS

- Design of VHF & UHF FM Communications in portable or subminiature development.

MICROWAVE FIELD ENGINEERS

Write to:

Mr. L. B. Wrenn Dept. B
MOTOROLA, INC.
4501 Augusta Blvd., Chicago 51, Ill.



ALSO . . . there are excellent opportunities in
PHOENIX, ARIZONA • RIVERSIDE, CALIFORNIA



MOTOROLA

CIRCLE 905 ON CAREER INQUIRY FORM



Grow with a "Growth Organization" in the field of semiconductor devices

The Rectifier-Capacitor Division of Fansteel offers responsible assignments in these areas:

RESEARCH AND DEVELOPMENT—Physicists,
Chemists, Metallurgists

DESIGN AND PROCESS ENGINEERING—Electronic,
Electrical, Chemical

SALES ENGINEERING—Electronic and/or Electrical

EXPERIENCED OR GRADUATES. Whether you have specialized experience—or are a recent graduate pondering your first all important move—find out about a career with Fansteel, pioneers, developers and producers of semiconductor devices. These include selenium and silicon rectifiers and tantalum capacitors which Fansteel introduced to industry in 1949.

If you're inquisitive and like to dig deep for answers to electronic problems dealing with rockets and missiles, aircraft, automobiles and appliances—if you want exciting challenges in your everyday work—if you'd like the advantages of learning through the exchanging of ideas with other experienced professionals—if your plans include sound, long term views on position and stature—then, you'll like being associated with Fansteel.

SECURITY & PROGRESS. Fansteel offers the security but you alone will determine how fast you advance. Relocation (on us) to Chicago's beautiful North Shore area means suburban living at its best.

IMMEDIATE OPENINGS. Fansteel's rapidly moving expansion program has opened many new staff positions. If you'd like to have a part in history-making space age advancements, contact Fansteel.

... Send resume, in confidence,
to Personnel Officer for Professional Employees, Fansteel Metallurgical Corporation, North Chicago, Illinois.



X598A

CIRCLE 906 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • September 30, 1959

Expanding the Frontiers
of Space Technology in

QUALITY ASSURANCE

Quality assurance at Lockheed parallels in importance and augments the research and development, projects and manufacturing organizations. Quality assurance engineers establish audit points, determine functional test gear, write procedures and perform related tests.

These activities, supported by laboratories, data analysis, establishment of standards, and issuance of reports, all insure that Lockheed products meet or surpass contractual requirements. Economy and quality are maintained at every stage to produce the best products at the least cost. As systems manager for such major projects as the DISCOVERER Satellite; Navy POLARIS FBM; Army KINGFISHER; and Air Force Q-5 and X-7, quality assurance at Lockheed Missiles and Space Division has an important place in the nation's defense.

ENGINEERS AND SCIENTISTS

If you are experienced in quality assurance, reliability, or related work, you are invited to share in the future of a company that has an outstanding record of achievement and make an important individual contribution to your nation's progress in the race for space. Write: Research and Development Staff, Dept. I-2-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

Lockheed

MISSILES AND SPACE
DIVISION

Systems Manager for the
Navy POLARIS FBM;
DISCOVERER, SENTRY
and MIDAS; Army KINGFISHER;
Air Force Q-5 and X-7

SUNNYVALE, PALO ALTO, VAN NUYS,
SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO • HAWAII

YOUR CAREER NEWS, NOTES, NOTIONS

The rugged individualist, a vanishing breed in much of America, is losing further ground as a leader in business organizations, according to a Stanford University psychologist. The psychologist's views, presented in a paper at WESCON in San Francisco, may offer a plausible explanation for the "they" concept of leadership in industry. (Ask any employe why he is performing a task the way he is, and he will say "they" want it done that way. But few employes have been able to discover who "they" are.)

"The trend of management has been to remove as many of its decisions as possible from the area of hunch and intuition to that of rational calculation," the psychologist, Alex Bavelas, reported. "More and more, organizations are choosing to depend less on the peculiar abilities of rare individuals, and to depend instead on the orderly processes of research and analysis. The occasions and opportunities for 'personal' leadership in the old sense still exist, but they are becoming increasingly rare and circumscribed."

That is not to say that the role of personal leadership has been abolished, Mr. Bavelas concedes. But he believes the new emphasis has "significantly redefined it."

"Under normal conditions of operation," he says, "leadership in the modern organization consists not so much in the making of decisions *personally* as it does of maintaining the operational effectiveness of the decision-making systems which comprise the management of the organization.

"The picture of the 'leader' who keeps his own council and in the nick of time pulls the rabbit out of the hat is out of date. The popular stereotype now is the thoughtful executive discussing 'in committee' the information supplied by a staff of experts. In fact, it may be that the brilliant innovator, in the role of manager, is rapidly becoming as much an organizational embarrassment as he is an asset."

Trait studies of leaders, based on physical, intellectual and social characteristics, show that such persons tend to be brighter, better adjusted psychologically and inclined to display better judgment, the psychologist notes. In social be-

(Continued on page 162)



RCA

CREATES A GOLDEN OPPORTUNITY FOR SCIENTISTS ENGINEERS

Inquiries are invited for key openings at RCA's new, ultra-modern Semiconductor and Materials headquarters in suburban Somerville, New Jersey (just 35 miles from New York City), from individuals with degrees in . . .

PHYSICS • ELECTRICAL ENGINEERING • PHYSICAL CHEMISTRY
INORGANIC CHEMISTRY • METALLURGY

RCA-Somerville is headquarters for major research and development work on:

SEMICONDUCTORS

Silicon Rectifiers • High Power Transistors • Diodes

MATERIALS

Intermetallics • Thermoelectrics • Semiconducting
Oxide Films

MICROMODULES

Subminiature Circuit Design • Component Development

PHONE OR WRITE: MR. J. B. DALY, RAndolph 2-3200



RADIO CORPORATION OF AMERICA
SEMICONDUCTOR AND MATERIALS DIVISION, SOMERVILLE, NEW JERSEY





ELECTRONIC ENGINEERS STAVID

offers all 3 most important position considerations

CAREER OPPORTUNITIES based on solid, long-term growth...
TOP EARNINGS fully commensurate with experience...
CHALLENGING ASSIGNMENTS made possible by project diversification.

■ RADAR SYSTEMS DESIGN ENGINEERS

Experience in design, development & analysis of airborne systems including fire control, reconnaissance, navigation, bombing, etc. Sub-system experience in radar & computers desirable.

■ RECEIVER ENGINEERS

Capable of designing transistorized IF strips, frequency multipliers and oscillators, video detectors and switching circuitry.

■ DESIGN ENGINEERS

BSME with 5 years experience in design, development & modification of a military electro-mechanical device for trainers & simulators. Previous experience in layouts, fabrication & model-making highly desirable.

■ TEST ENGINEERS

BSEE with experience in testing of military electro-mechanical & airborne electronic training devices. Should be familiar with electronic counters, environmental testing & electronic circuit design.

■ SENIOR MATHEMATICIANS

Experience in mathematical analysis. Working familiarity with circuit theory, information theory, game theory and stochastic process techniques. Experience in radar military weapons or missile systems highly desirable.

■ ENVIRONMENTAL TEST ENGINEERS

Extensive experience in design of military electronic equipment with emphasis in environmental testing. Should be familiar with operation of temperature & humidity chambers, altitude chambers, vibration machines (low & high frequency), radio noise & interference equipment & airborne & ship-board shock machines.

■ SYSTEMS DESIGN ENGINEERS

Broad experience desired in weapons systems. Creative and analytical abilities required in missile guidance systems, radar I R, inertial devices, computers, counter-measures, etc.

■ CIRCUIT DESIGN ENGINEERS

3 to 5 years experience in design, modification and testing of pulse & gating circuits, video displays, digital circuitry, digital storage, digital communications, tape recordings & process equipment. Project concerns, research, installation, testing, development & modification of experimental data process equipment.

■ ELECTRONIC PACKAGING ENGINEERS

Electronic packaging experience on transistorized circuitry. Printed circuit background necessary, knowledge of design requirements for shock & vibration protection desired.

■ LOGIC CIRCUITRY DESIGNERS

BSEE Math or Physics degree required, 2-3 years experience in programming and/or logic circuitry design of digital computers.

■ CABLE TRANSMISSION ENGINEERS

Minimum of 5 years experience in cable transmission. Background should include familiarity with: Transmission Equations, Measurements and Statistics.

■ TECHNICAL WRITERS

Positions require experience in writing operation, maintenance and instruction material for complex airborne military electronics system. Training aids and instruction experience highly desirable. Familiarity with military equipment through actual technician training necessary.

STAVID's facilities in Plainfield, New Jersey, at the foothills of the Watchung Mountains, are near excellent schools, modern shopping facilities and ample housing accommodations. With New York City just 45 minutes away, and the New Jersey shore within one hour's drive, the Plainfield area provides an ideal environment for work, recreation and comfortable suburban living.

DURING NATIONAL ELECTRONIC CONFERENCE

CHICAGO, ILLINOIS OCTOBER 12-14th

STAVID representatives will interview in Chicago.

To arrange appointment on Conference dates, Call:

MR. J. R. CLOVIS, FRANKLIN 2-2100

or, for complete details, please send resume in confidence to

J. R. CLOVIS, Personnel Department "IR"

STAVID Engineering, Inc.

U.S. HIGHWAY 22, PLAINFIELD, NEW JERSEY PLAINFIELD 7-1600

Imaginative Electronics...



CIRCLE 909 ON CAREER INQUIRY FORM

THIS IS NOT AN ORDINARY RECRUITING ADVERTISEMENT

We are not a large company.

We are not engaged in "mass-hiring".

We design and produce ultra-precise instruments, networks, and components that are truly at the limit of the state of the electronic art. They have no real competition.

We have been in business for five years. Our growth has been steady, our financial condition is healthy, and our reputation in the field is secure.

We are ready to expand our engineering and production departments by adding one excellent engineer to each.

We would be happy to review your resume and arrange for an interview, if you have had a good technical education...honor graduates preferred. This is no place for beginners.

We are prepared to pay well, in both money and respect, for the services of two truly competent people.



JULIE RESEARCH LABORATORIES, INC.
 556 WEST 168TH STREET, NEW YORK 32, N. Y.
 LOrraine 8-8700

CIRCLE 910 ON CAREER INQUIRY FORM



A "communications engineer" at ELECTRONIC DESIGN resembles, in part, a communications engineer in the electronic industry. The half that is similar is the engineer—but the other half stands for communicating, clearly and cogently, in print. In fact, cross-communicating practical techniques, ideas for design, new developments, from the working electronic design engineer to the working electronic design engineer.

Our "communications engineers" get out in the field and find out what's going on—then convert technical doings to how-to-do-it articles.

If you have the working combination—use the Career Inquiry Service form to let our Editor know you are interested.

HAYDEN PUBLISHING CO., INC.
 830 THIRD AVENUE,
 NEW YORK 22, N. Y.

CIRCLE 914 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • September 30, 1959

HELP US
KEEP THE
THINGS
WORTH
KEEPING



Photograph by Harold Halma

A boy keeps days like these all his life. Some day he'll trundle his own sons in a barrow too—remembering the jolly, peaceful man-to-man times spent with his father.

So many precious things like this depend on peace. And peace depends upon so many things. For instance: peace costs money.

Money for strength to keep the peace. Money for science and education to help make peace lasting. And money saved by individuals to keep our economy sound.

Every U.S. Savings Bond you buy helps provide money for our country's Peace Power—the power that helps us keep the things worth keeping.

HELP STRENGTHEN
AMERICA'S PEACE POWER
BUY U. S.
SAVINGS
BONDS



The U.S. Government does not pay for this advertising.
The Treasury Department thanks The Advertising Council and this magazine for their patriotic donation.



**MICRO
MINIATURIZATION
FOR
DIGITAL
COMPUTERS**

*12 resistors, 4 capacitors, 4 diodes and 4 transistors...
all are contained in the complete flip-flop circuit illustrated above.*

At the Hughes Research & Development Laboratories, dramatic reduction in component size is symbolic of the advances in the digital computer art...advances which are preparing the digital computer for its role as a system control in space.

In addition to developing new digital circuits and components, Hughes engineers are delving into other digital computer space mission tasks such as navigation guidance and control, communications processing and display, vehicle control, mission programming.

An intensive Hughes program in digital computer systems has created openings for

creative engineers and physicists with degrees from accredited engineering universities in the following fields:

CIRCUIT and COMPONENT DEVELOPMENT: Digital Computer Analysis, Microcircuitry and Cryogenics, Solid State Physics, Magnetic Storage Devices.

SYSTEMS ENGINEERING: Closed-loop Digital Control, Digital Sensing and Conversion, Radar and Communications Information Processing, Inertial Navigation.

The salary structure for these personnel reflect the exceptional backgrounds required and the unusual challenge of the projects.

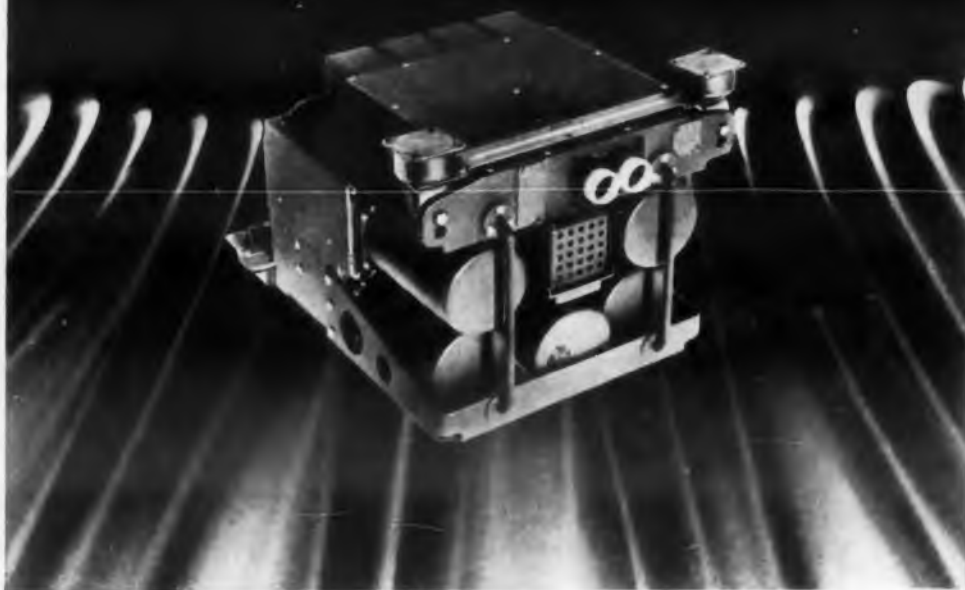
Inquire by writing directly to:
Dr. Allen Puckett, Director
Systems Development Laboratories

HUGHES

© 1969, H. A. C.

Hughes Aircraft Co.,
Culver City 64, California
CIRCLE 911 ON CAREER INQUIRY FORM

GROW WITH AIRESEARCH IN ELECTRONICS



• AiResearch Central Air Data Computer for North American's A3J, Navy's first weapon system, provides information dealing with bombing, navigation, engine inlet control, radar, automatic flight control and cockpit instrumentation.

Expansion in electronics and electromechanical activity is creating excellent openings at all levels for qualified engineers. Diversified programs include Central Air Data systems on the Air Force B-70 and F-108, North American A3J and McDonnell F-4H, as well as other commercial and military aircraft and missile projects.

Openings in the following areas:

- **FLIGHT SYSTEMS RESEARCH** General problems in motivation and navigation in air and space; required background in astronomy, physics, engineering.
- **DATA SYSTEMS RESEARCH** Experience with physical measuring devices using electromagnetic, atomic, thermionic and mechanical approaches.
- **CONTROLS ANALYSIS** Work in preliminary design stage involves servomechanisms analysis and analog computer techniques.
- **FLIGHT DATA COMPONENTS** Analysis proposal, design and development work in the following specialties: circuit analysis, servo theory, transducers, transistors, airborne instrument and analog development of high and low temperature problems.
- **ELECTROMAGNETIC DEVELOPMENT** Work with magnetic amplifiers requires knowledge of electromagnetic theory, materials and design methods.
- **INSTRUMENT DESIGN** Electromechanical design of force-balance instruments, pressure measuring devices, precision gear trains and servo-driven positioning devices. Experience in electrical and electromagnetic transducers desirable.
- **AIRBORNE INSTRUMENTATION ANALYSIS AND DESIGN** Work involves solving problems in accuracy, response and environmental effects.

Send resume to:
Mr. G. D. Bradley



AiResearch Manufacturing Division

9851 SO. SEPULVEDA BLVD., LOS ANGELES 45, CALIFORNIA

CIRCLE 912 ON CAREER INQUIRY FORM

CAREER NEWS

(Continued from page 159)

havior, leaders have been found to "interact" more highly than non-leaders. They tend to give more information, ask for more information and take the initiative in summing up or interpreting a situation, Mr. Bavelas says.

But these personal traits of leadership, he cautions, are tempered by the environment:

"The degree to which an individual exhibits leadership depends not only on his characteristics but also on the characteristics of the situation in which he finds himself."

Thus:

"A man who shows all the signs of leadership when he acts as the officer of a well-structured, authoritarian organization, may give no indication of leadership ability in a more fluid 'democratic' situation.

"A man may become immediately influential in a situation requiring deliberation and planning, but show little evidence of leadership if the situation demands immediate action with no opportunity for weighing alternatives or thinking things out.

"A man may function effectively and comfortably in a group whose climate is friendly and cooperative, but retreat and become ineffective if he perceives the atmosphere as hostile."

Thus company environment can foster or hinder personal leadership.

• • •

The trend toward calculated, well-organized decisions, based on research and analysis, is reasonable on the surface, Mr. Bavelas admits. Efficiency has become a byword in industry and has contributed to technological advances. But the trend "conceals two serious dangers," the psychologist warns:

"First, we may be systematically giving up the opportunity of utilizing the highest expressions of personal leadership in favor of managerial arrangements which, although safer and far more reliable, can yield at best only a high level of mediocrity.

"And, second, having committed ourselves to a system which thrives on the ordinary, we may, in the interests of maintaining and improving its efficiency, tend to shun the extraordinary.

"It is no accident that daring and innovation wane as an organization grows large and successful. On different levels, this appears to have been the history of men, of industries, of nations and even of societies and cultures." ■ ■

OPERATIONS ANALYST

You are invited to investigate unusual career opportunities with excellent futures in the science and engineering Laboratories of IBM. You will find this to be a unique opportunity to contribute original thinking to several important projects.

Our Laboratories are engaged in research and development of advanced electronic digital computers and control systems for the exotic-fueled B-70 strategic bomber, being designed to operate at altitudes above 70,000 feet and at speeds of more than 2,000 miles per hour. We have, in addition, projects in progress on future strategic air weapons, including global satellites, offensive bombardment space vehicles, and missiles.

Should have the ability to simulate tactics involving advanced weapons systems concepts, and derive methods for evaluation of operational effectiveness of alternate design concepts. An M.S. in Mathematics, or Physics with a thorough background in mathematics, and at least two years' experience in applying advanced mathematical techniques to weapons systems evaluation is desired. A knowledge of probability theory and linear programming techniques is also desired.

Salary commensurate with experience. Advancement based on merit. Employee benefits are among the best in industry today.

Please write, including resume, to:

Mr. R. L. Lang, Dept. 55515
IBM Corporation
Owego, New York

IBM®

INTERNATIONAL BUSINESS
MACHINES CORPORATION

CIRCLE 913 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • September 30, 1959

ADVERTISERS' INDEX

September 30, 1959

Advertiser	Page
AGA Div. of Elastic Stop Nut Corp.	126
AMP, Inc.	83
Ace Electronics Associates	105
Ad-Yu Electronics Laboratory, Inc.	148
Air Marine Motors, Inc.	106
Airflyte Electronics Co.	148
Airpax Products Co.	86
Allegheny Ludlum Steel Corp.	141
Allison Laboratories, Inc.	113
Alloys Unlimited, Inc.	144
Alpha Metals, Inc.	127
American Electrical Heater Co.	59
American Semi Conductor Corp.	149
Amperex Electronic Corp.	93
Amphenol Borg Electronics Corp.	104
Applied Research, Inc.	153
Arco Electronics Inc.	11
Arnold Engineering Co., The	123
Assembly Products, Inc.	82
Audio Development Co.	112
Audio Devices, Inc.	119
Automatic Electric Co.	128
Balco Research Laboratories	127
Barber-Colman Co.	105
Belden Mfg. Company	35
Bendix Aviation Corp., Pacific Div.	126
Bendix Aviation Corp., Red Bank Div., Transistors	108
Bentley-Harris Mfg. Co.	58
Bircher Corporation	65
Bodine Electric Co.	144
Boonton Radio Corp.	106
Bourns Laboratories, Inc.	95
Bristol Co.	50
Bulova Watch Co.	8
Burlingame Associates	69
CBS Electronics Co., Inc.	8
Canoga Corp.	23
Carborundum Co., The	51
Centralab, Div. of Glove-Union, Inc.	27
Chart-Pak, Inc.	71
Chassis-Trak, Inc.	49
Chicago Standard Transformer Corp.	118
Clarostat Manufacturing Company	107
Clevite Electronic Components	99
Clifton Precision Products Co., Inc.	Cover II
Columbus Electronics Corp.	65
Comar Electric Company	142
Communication Measurements Laboratory, Inc.	68
Computer Instruments Corp.	116
Computer-Measurements Co.	53
Consolidated Mining & Smelting Co.	127
Corning Glass Works	132
Daystrom Pacific Corp., Potentiometer Div.	67
Dean & Benson Research	47
DeJur Amsco Corp.	137
Delco Radio, Div. of General Motors Corp.	155
Deutsch Company, The	96
Douglas Aircraft	97
Dow Corning Corp.	18, 19
ESC Corporation	87
Edgerton, Germeshausen & Griener, Inc.	59
Elastic Stop Nut Corp.	148
Elco Corp.	42
Electro Impulse Laboratory	64
Electro Instruments	133
Electro-Motive Mfg. Co.	147
Electrosnap Corp.	88

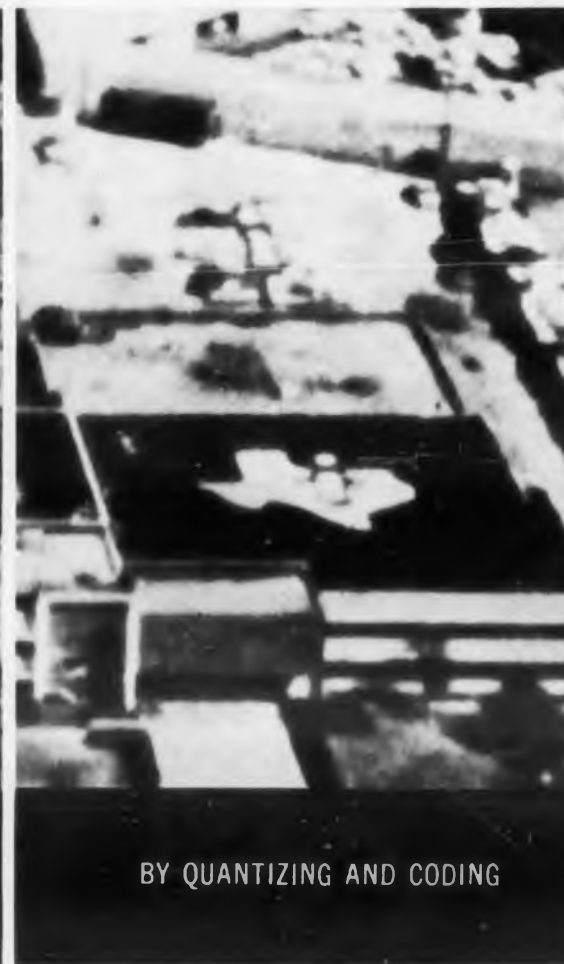
IDEA



ORIGINAL PHOTO



TRANSMITTED: BY AMPLITUDE MODULATION



BY QUANTIZING AND CODING

Quantizing Photographs—electronic surveillance pictures are a source of information, but the usefulness of such information when transmitted over long distances depends upon the faithfulness of the data link. Amplitude modulation, as the data-link approach, cannot be relied upon as signals are oftentimes attenuated to almost useless levels.

Quantizing photographs and then using a coded transmitting scheme such as pulse code modulation improves reproduction and surveillance usefulness at the receiving end of the digital transmission link.

RESULT: faithful transmission and reception over greater distances.

design, manufacturing and quality control engineers — 3-10 years experience

careers and ideas at TI

Ideas come where they are encouraged, and at TI's Apparatus Division engineers work in a permissive atmosphere, one which produces creativity as a *natural* result. Both the modern air-conditioned work facilities and the pattern of life in the progressive city of Dallas encourage a man to his most efficient productivity and rewarding accomplishments.

Your experience in one of the following technologies may find immediate application in our Electronic Surveillance, Antisubmarine Warfare, Heavy Surface Radar, or Missile Systems programs.

radar • sonar • infrared • magnetic anomaly detection • passive detectors • servos • navigational systems • special-purpose computers • timers • programmers • microwave • telemetering • data link • optics • video mappers • visual displays • intercom

Our stable growth requires a steady influx of men qualified in these technologies. To learn more about us and how we can fit into your career plan, write for a copy of "We can tell you this much about Apparatus division" to: **J. R. Pinkston, Department 101 Apparatus Division**

current career openings

EE's & PHYSICISTS: missile guidance, control systems design and analysis, radar (ground and airborne), antenna and microwave components, servo-mechanisms, telemetry, digital circuits, sonar, infrared design, and flight test.

ME's: antenna, mechanisms, miniaturization, thermodynamics, refrigeration, insulation, packaging, and structures design.

INDUSTRIAL ENGINEERS: cost estimating, quality control, and quality assurance studies.

MANUFACTURING ENGINEERS: tooling design and production planning and supervision. (Degrees in EE or ME.)

PROFESSIONAL
PLACEMENT

APPARATUS
DIVISION

TEXAS  INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE • DALLAS 9, TEXAS

CIRCLE 915 ON CAREER INQUIRY FORM

Advertiser	Page
Epsco, Inc.	46
Fairchild Astrionics	72
Fairchild Semiconductor Corp.	29
Falstrom Co.	48
Fansteel Metallurgical Corp.	158
Frequency Standards	90
Garrett Corp.	162
General Ceramics Corp.	60
General Electric Co., Instrument Dept. ...	129
General Electric Co., Defense Electronics Div.	70
General Electric Co., Silicone Products Dept.	41
General Electric Co., Semiconductor Products Dept.	120-121
General Electric Co., Specialty Control Dept.	115
General Electric Co., Tantalytic Capacitors	148
General Instrument Corp.	85
General Radio Co.	52
General Transistor Corp.	77
Gertsch Products, Inc.	70
Globe Industries, Inc.	102
Good-All Electric Mfg. Co.	94
Grant Pulley & Hardware Corp.	48-49
Grayhill, Inc.	128
Green Instrument Co., Inc.	67
Haydon, A. W. Co., Inc.	49
Heiland Div. of Minneapolis Honeywell	110-111
Helipot Div. of Beckman Instruments ..	113
Hewlett-Packard Company	164, Cover III
House Advertisements ..	66, 70, 138, 152, 160
Hughes Aircraft Co.	5, 7, 9, 161
Industrial Electronic Engineers	66
International Business Machines Corp. ...	162
International Nickel Co., Inc.	78
International Rectifier Corp.	92
J F D Mfg. Co.	79
Junco	144
Jerrold Electronics Corp.	46
Julic Research Laboratories, Inc.	47, 160
Keithley Instrument Co.	131
Kellogg Switchboard & Supply Co.	1
Kelvin Electric Co.	63
Kester Solder Co.	62
Knapic Electro-Physics, Inc.	135
Kulka Electric Corp.	112
Lafayette Radio	151
Lambda Electronics Corp.	84
LaVoie Laboratories	150
Lenz Electric Mfg. Co.	64
Linde Co.	146
Little Falls Alloys, Inc.	153
Lockheed Aircraft Corp., Missile Systems Div.	159
M B Mfg. Co.	108, 109
Malayan Tin Bureau	150
Mallory, P. R. Co.	117
Marconi Instrument Co.	152
Marion Electrical Instruments	98
Mesa Plastics	114
Metron Instrument Co.	142
Metronix, Inc., a Subsidiary of Assembly Products, Inc.	152
Mincom Div. Minnesota Mining & Mfg. Co.	33
Minnesota Mining & Mfg. Co., Magnetic Products Div.	139
Minnesota Mining & Mfg. Co., Electrical Tapes	55

BROAD

with these convenient, precision



NEW AMPLIFIER!

**Just clamp on probe and
read current instantly!**

**hp 154A Voltage/Current
Dual Channel Amplifier**

SPECIFICATIONS

(When plugged into -hp- 150A/AR Oscilloscope)

CURRENT CHANNEL

Band Pass: 50 cps to 8 MC.
Sensitivity: 10 calibrated ranges, 1 to 1,000 ma/cm, 1, 2, 5, 10 sequence. Accuracy $\pm 5\%$. Vernier between steps (extends 1,000 ma/cm range to at least 2,500 ma/cm).

Max ac Current: 10 amperes rms 20 KC and above. Below 20 KC core saturation reduces current capability proportional to frequency.

Max dc Current: Direct current to $\frac{1}{2}$ amp has no appreciable effect.

Input Impedance: Approx. 0.01 ohm shunted by 0.8 uH.

VOLTAGE CHANNEL

Band Pass: dc coupled: dc to 10 MC, 0.035 μ sec rise time.
ac coupled: 2 cps to 10 MC, 0.035 μ sec rise time.

Sensitivity: 9 calibrated ranges, 0.05 to 20 v/cm; 1, 2, 5, 10 sequence. Accuracy $\pm 5\%$. Vernier between steps.

Input Impedance: 1 megohm (nominal), 30 uF shunt.

GENERAL

Vertical Presentation: (1) Either voltage or current signal continuously or (2) voltage and current signals sampled at 100 KC or on alternate traces.

Vertical Position: Each channel individually adjustable.

Price: \$430.00 (Includes current probe).

The new hp 154A's exclusive "clamp-around" probe permits fast, direct measurement of current from 50 cps to 8 MC, 1 ma to 15 amperes (peak-to-peak) without breaking into the circuit, loading, or voltage drop due to resistor insertion. Here is a time-saving convenience feature of real significance in the investigation of transistors, logic circuits and other measurements where current information is of prime importance.

In addition, the 154A — actually two instruments in one — makes possible swift, simple and direct comparison between voltage and current waveforms. In this comparison service, one section of the 154A reads current while the other reads voltage in a manner identical with other hp voltage indicating instruments. Comparison is achieved by electronic channel switching — through alternate sweeps or 100 KC chopping. Either of the 154A's dual channels may also be used individually.



now offers better-than-ever service