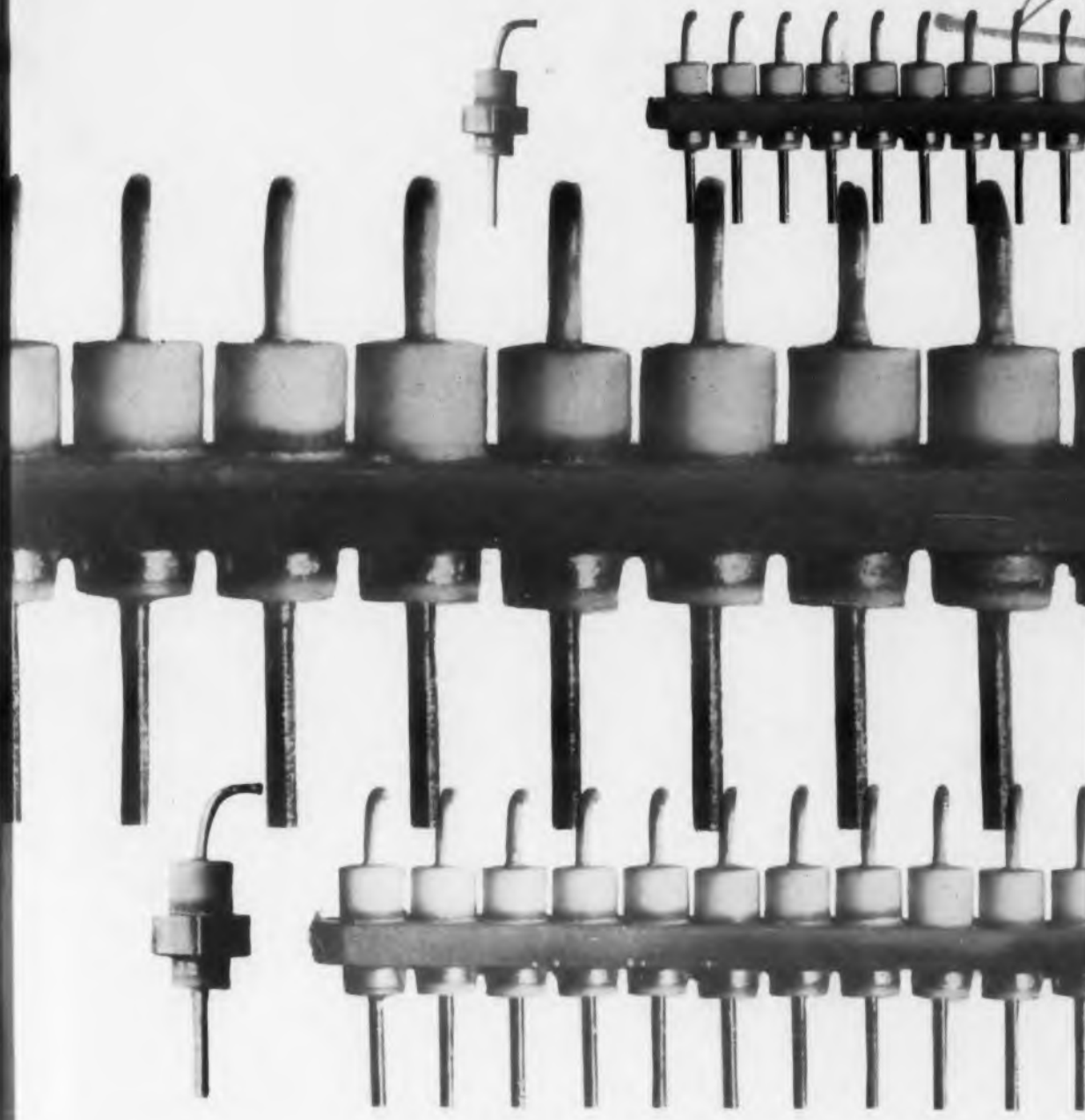


# ELECTRA DE

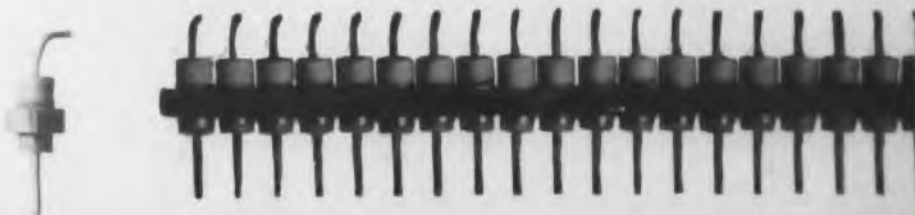
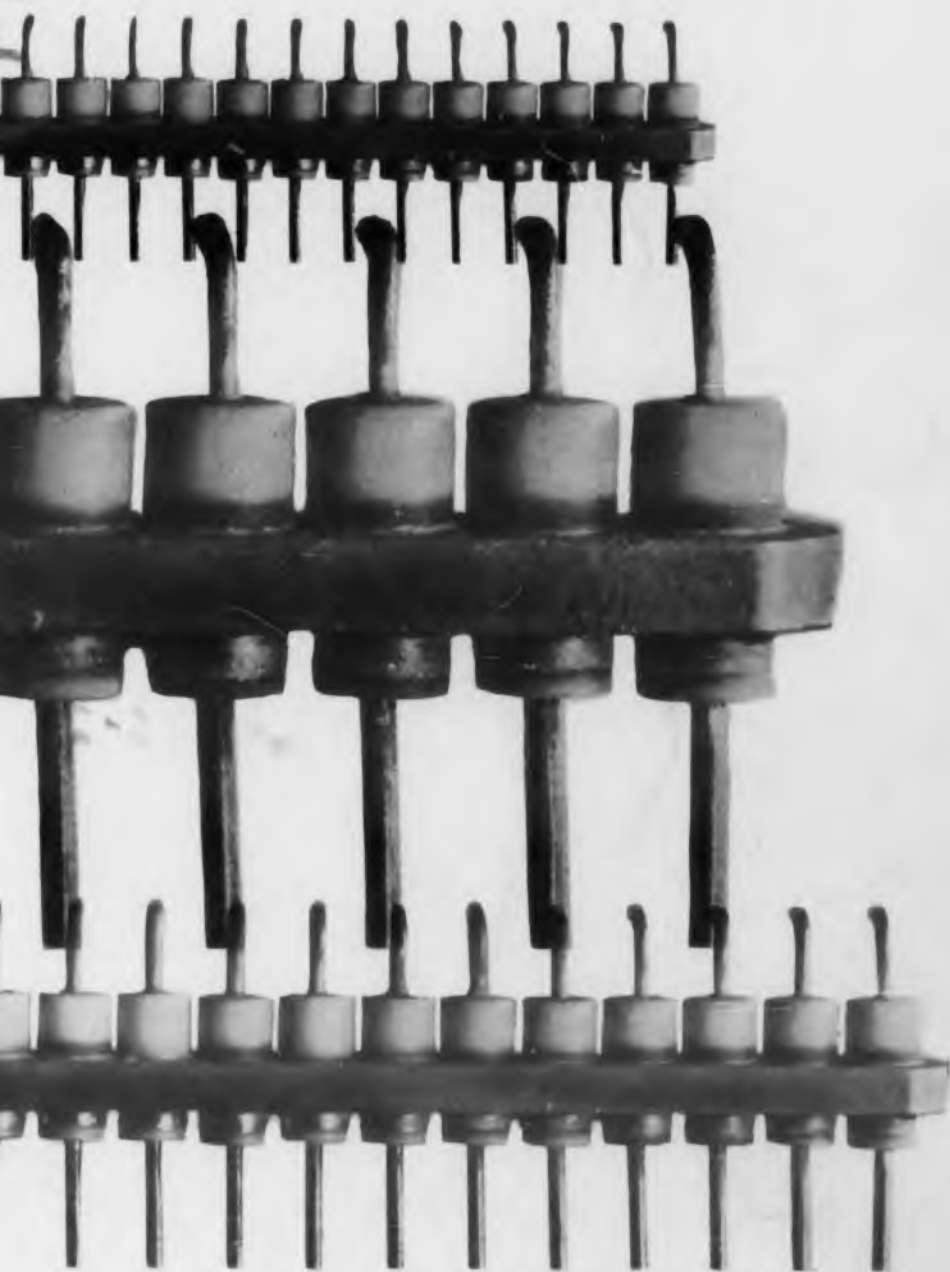
B 614181

OCT 11 198



# SONIC SIGN

66



In sealing, potting and encapsulation—

# EPON<sup>®</sup> RESINS

give excellent electrical, thermal and mechanical properties, plus—

- ✓ excellent dimensional stability
- ✓ high mechanical strength
- ✓ outstanding adhesion to metal, glass, plastics
- ✓ exceptional dielectric properties



Applying Epon resin sealing compound, formulated by Epoxylite Corporation, El Monte, California, to a 400-kva transformer winding at Larsen-Hogue Electric Co., Los Angeles, Calif.



Thoxene Clamp-Coat, an Epon resin cable splicing compound, produces a weatherproof, abrasion-resistant coating with high electrical insulation. Manufactured by Woodmont Products Inc., Huntingdon Valley, Pa.

Although relatively new, the Epon resins have won an important place in electronic and electrical manufacture. Their applications are manifold . . . in printed circuit laminates, transformer and motor sealing compounds, potting compounds for components and subassemblies, protective enamels, adhesives, tool and die materials.

**For potting and encapsulating**—the excellent dimensional stability of Epon resins, which can, for example, withstand solder bath temperatures without ill effect, and their outstanding adhesion to metals and glass assures airtight enclosure of delicate components and vacuum tubes

**As adhesives**—solvent-free Epon resin formulations cure at room temperature with contact pressure alone; form powerful bonds between glass, metal, wood or plastic.

**As sealing compounds**—varnishes and enamels based on Epon resins provide excellent moisture sealing plus outstanding resistance to solvents and chemicals, even at elevated temperatures.

**For laminating**—Epon resins laid up with inert fibrous fillers produce base laminates that have superior dielectric properties and can be sheared, punched, drilled and bath soldered.

Write for information on the use of Epon resins in electrical and electronic applications.

## SHELL CHEMICAL CORPORATION

CHEMICAL SALES DIVISION, 380 Madison Avenue, New York 17, New York

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis  
IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited • Montreal • Toronto • Vancouver



CIRCLE 1 ON READER-SERVICE CARD FOR MORE INFORMATION

Edward E. Grazda ..... Associate  
J. A. Lippke ..... Associate  
E. T. Ebersol, Jr. .... Associate  
L. D. Shergalis ..... Associate  
E. Burger ..... Associate  
S. Dresner ..... Assistant  
D. S. Viebig ..... Assistant  
S. H. Hubelbank ..... Contributing Editor  
J. M. Montstream ..... Contributing Editor  
J. G. Adashko ..... Contributing Editor  
R. D. Thornton ..... Contributing Editor  
G. Schwartz ..... Editorial Assistant  
B. Parrish ..... Editorial Assistant  
A. G. Jones ..... Editorial Assistant  
S. Sussman ..... Art Director  
E. D. Fava ..... Production Manager  
R. M. Walsh ..... Assistant Production Manager  
P. L. Canfield ..... Business Manager  
S. Buffinton ..... Circulation Manager  
L. R. Wendt ..... Reader Service

**Co-Publishers** James S. Mulholland, Jr.  
T. Richard Gascoigne

### Advertising Representatives

**New York:** Owen A. Kean  
Lawrence Conover  
Bryce Gray, Jr.  
Robert W. Gascoigne  
19 East 62nd St.  
New York 21, N. Y.  
TEmpleton 8-1940

**Chicago:** Thomas P. Kavooras  
Berry Conner, Jr.  
Nelson Joliffe  
664 No. Michigan Ave.  
Chicago 11, Ill.  
SUperior 7 8054

**Los Angeles:** Robert E. Ahrensdorf  
Earl W. Wilken  
John Quillman  
1140 Wilshire Blvd.  
Los Angeles 17, Calif.  
MAdison 9-2681

### 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 us the following information on your company's letter head: your name and title; your company's name, address, and main product. Electronic, research, development, project, electrical, and chief engineers are typical qualifying titles. If you have a design responsibility not indicated by your title, describe those responsibilities. Job changes require requalification.

Subscription rate for non-qualified subscribers—\$12.00 for 1 year only.

Hayden Publishing Company, Inc.  
19 East 62nd Street  
New York 21, New York

# ELECTRONIC DESIGN

## Contents

Vol. 4, No. 19

October 1, 1956

Cover . . . . .	26
Editorial . . . . .	4
Electronic News . . . . .	5
Washington Report . . . . .	10
<b>Features</b>	
Meaning and Prediction of System Reliability, A. Kohlenberg . . . . .	18
Modern Synthesis Network Design From Tables—II, L. Weinberg . . . . .	22
Miniature Ceramic Connectors . . . . .	26
Precision Contact Making Deflection Meter . . . . .	28
Elliptical Delay Line . . . . .	30
Design Techniques Using Conductance Curves, K. A. Pullen, Jr. . . . .	32
Design Tips . . . . .	38
<b>Design Forum</b>	
Pentode Does Two Jobs, L. M. Balter . . . . .	36
Magneto Striction Motor . . . . .	42
<b>Russian Translations</b>	
What The Russians Are Writing . . . . .	96
<b>Abstracts</b>	
New German Tubes . . . . .	98
Making Electronic Chassis Splashproof . . . . .	102
<b>Government Reports</b>	
Crystal Diodes—Forward and Reverse Types . . . . .	100
<b>Departments</b>	
Letters to the Editor . . . . .	12
Meetings . . . . .	14
New Products . . . . .	44
New Literature . . . . .	80
Patents . . . . .	86
Books . . . . .	94
Standards & Specs . . . . .	104
Advertisers' Index . . . . .	106



ELECTRONIC DESIGN is published semi-monthly by Hayden Publishing Company, Inc., 19 E. 62nd Street, New York 21, N. Y., T. Richard Gascoigne, President; James S. Mulholland, Jr., Vice-President & Treasurer and David B. Landis, Secretary. Printed at Hildreth Press, Bristol, Conn. Acceptance under section 34.64 P. L. & R. authorized. Copyrighted 1956 Hayden Publishing Company, Inc. 27,000 Copies this issue.





OCT -4 1956

B 614181

75 INCHES PER SECOND

3 MSEC STARTS AND STOPS



## Model 905 Digital Magnetic Tape Handler

**The Ultimate in Digital Tape Handlers for High-Speed Computers, Electronic Business Machines, Industrial Control and Other EDP Applications.**

**Regardless of cost, many features are exclusive with Potter**

*Speed and ease of operation*—Up to 75"/sec in a variety of dual speed combinations, with 3 msec starts and stops. Tape widths from 1/4" to 1 1/4" are accommodated. Automatic threading, fast rewind, end-of-tape sensing, and front panel or remote control provide unmatched flexibility and ease of operation.

*Standard 19" Rack Mounting*—Hinged front panel provides quick access to mechanical parts and plug-in electronic components. Transparent dust cover protects tape and moving parts without hindering visual observation of tape track.

*Auxiliary Equipment*—A complete line of digital data-handling accessories is available, including record-playback heads (Model 6400) in numerous channel number and tape width combinations. Record-playback amplifiers can be furnished as individual plug-in units (Models 52, 53) or in complete systems (Model 920) for return-to-zero or non-return-to-zero recording. Shift registers, high speed printers and other data-handling components are available separately or in integrated systems for solving specific data-processing problems.

WRITE FOR INFORMATIVE BULLETIN . . . and feel free to consult Potter engineers on your data-handling problems. No obligation, of course.



**POTTER INSTRUMENT COMPANY, INC.**

115 Cutter Mill Road

Great Neck, L I N Y

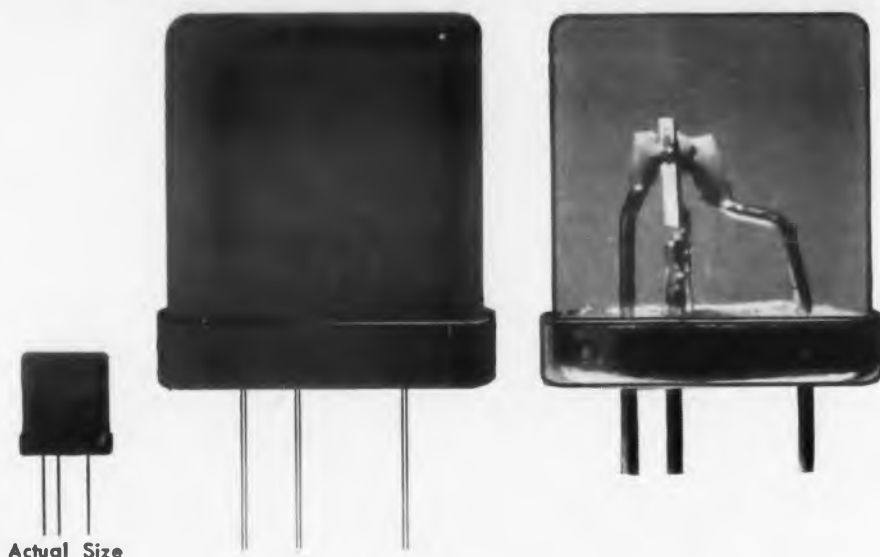
CIRCLE 2 ON READER-SERVICE CARD FOR MORE INFORMATION



# PNP SILICON TRANSISTORS

made with the *FUSION ALLOY* process

have **MAXIMUM RELIABILITY**



The reliability of transistors depends upon both electrical and mechanical properties.

Transistor technology has now solved most electrical problems encountered during life. As a result, greater emphasis must now be placed on the mechanical factors.

Mechanical reliability has always been inherent in the Raytheon *Fusion Alloy* process. Life tests

starting early in 1953 and aggregating over 20,000,000 transistor hours show *less than one "open" per 800,000 hours, and no shorts.*

Raytheon PNP Silicon Transistors, made by the *Fusion Alloy* process, have all this proved reliability in service, plus extraordinarily low cutoff current, low noise factor and the other desirable characteristics shown in the chart.

## RAYTHEON SILICON TRANSISTOR TESTS INCLUDE:

- *Life* — conducted at 135°C and 50 mW dissipation
- *Temperature Cycling* — 116°C (Steam at 10 lbs. gauge) and minus 60°C
- *Temperature Aging* — 100 hours at 160°C
- *Acceleration* — 5000 G centrifuge
- *Shock* — 500 G

RAYTHEON NEW HIGH TEMPERATURE SILICON TRANSISTORS								
Type	Reverse Current at -20v Collector μA (max.)	Emitter μA (max.)	Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity μμf	Alpha Freq Cutoff KC
CK790	0.2	0.2	14	1200	500	30	30	400
CK791	0.2	0.2	24	1400	500	30	30	600
CK793	0.2	0.2	16	1300	500	15	30	500

MAXIMUM JUNCTION TEMPERATURE 150°C.

Temperature Rise (free air) 0.50°C/mW

For superior electrical performance —  
 For superior reliability in service —  
 For superior ability to meet your quantity  
 and delivery needs —

specify RAYTHEON PNP Fusion Alloy TRANSISTORS  
 More In Use Than Any Other Construction Or Make



## SEMICONDUCTOR DIVISION

Silicon and Germanium Diodes and Transistors • Silicon Power Diodes

NEWTON, MASS.: 150 California St. • DEcatur 2-7177  
 NEW YORK: 589 Fifth Ave. • PLaza 9-3900  
 CHICAGO: 9501 Grand Ave., Franklin Park • TUxedo 9-5400  
 LOS ANGELES: 622 S. La Brea Ave. • WEbster 8-2851

CIRCLE 3 ON READER-SERVICE CARD FOR MORE INFORMATION

## Editorial

### Science in Disrepute

The high prestige supposedly enjoyed by members of the engineering and scientific professions seems to be really a dangerous illusion. Science as a career is actually shunned by teenagers according to recent findings made by the Educational Reference Division of Purdue University. Of ten choices as an occupation, atomic scientist ranks at the bottom. The attitude of youth toward science is what is disconcerting. The report revealed that:

Twenty-eight per cent do not believe scientists have time to enjoy life.

Twenty-five per cent think scientists as a group are somewhat "queer."

Fourteen per cent think there is something evil about a scientist.

Nine per cent believe that you cannot be a scientist and be honest.

Twenty-seven per cent think that scientists are willing to sacrifice the welfare of others to further their own interests.

In the rating of occupations, chemists and engineers fared much better than scientists. Apparently this anomaly might be traced to students' opinions of intelligence or "brain-power." For example, the study showed that thirty-five per cent believe that it is necessary to be a genius to become a good scientist. Forty-five per cent feel that their own personal school background is too poor to permit them to choose science as a career.

It is obvious it is time for our profession to react to the melodramatist's type-casting of a scientist as mad or even as mildly eccentric. Evidence of psychologists show highly intelligent people to be far better adjusted than the average man. If the values of scientists and engineers differ from those held by less well trained majorities, they must not be sacrificed but vigorously advocated as worthy ideals. Enquiry and research must go on and the process and methods of science must be demonstrated as the most hopeful way for better life for more and more people.

Encouraging is the recent action of the Instrument Society of America. Fearful that lack of technically trained people would bring "automation to a halt" in the words of RCA vice-president Engstrom, members of the ISA are setting up a foundation for instrumentation educational research. One of the foundation's purposes is to attract more people into science.

One area that needs attention is the status of science in high school. Take one example—the startling number of general science teachers who cover electricity on the blackboard only because they are afraid of shock when working with apparatus. We might be losing as high as twenty-five per cent of our high school students to science because of the lack of a stimulating spark!

# Electronic News

For more information on developments described in "Electronic News", write directly to the address given in the individual item.



## 400 Mile Range Shipborne Radar

The most powerful shipborne radar set ever put into service has been installed on the US Navy cruiser Northampton.

Delivering over 10 million watts at peak power, the radar magnetron, "Big Maggie," was developed by Westinghouse Electric Corp., Pittsburgh. The tube, which weighs 60 pounds, has a permanent magnet which weighs 300 pounds. A new alloy cathode is employed which withstands temperatures up to 3100 F. Water and mild forced-air cooling is employed for the sealed magnetron oscillator. The magnetron power supply permits peak power pulses of 23 megawatts at 60 kv.

## TV Helps Supervise Dam Construction

Massive dams being built by the Power Authority of the State of New York as part of the St. Lawrence Seaway development are enlisting TV as an aid in supervision. At both the 2350 ft Long Sault and 3230 Barnhart Island dams, two General Precision Lab. cameras are in use. At each dam, one camera is stationary and surveys the entire site; the other, telephoto lens equipped, scans a 120 degree arc. TV signals are transmitted by Raytheon microwave relays to the resident engineer's office where a few minutes observation of the TV monitors saves several hours travel to the work sites.

## New Naval Airborne Search Radar

A Navy contract for approximately one million dollars for pilot production of new-type airborne early warning search radar systems has been awarded to GE, Light Military Electronic Equipment Dept., Utica, New York.

The radars, having increased range and improved performance, will be used in aircraft and blimps to extend early warning radar coverage for North America.

While using the same size antenna, the new radar is an improved replacement for the AN/APS-20E.

## Electronics Industry Growth

Dr. W. R. G. Baker, president of RETMA and GE VP, Syracuse, predicts that a major portion of the electronics business 10 years hence will come from products not now in production. Electronics, 4th largest American industry, now employs 75 per cent of its more than 1-3/4 million employees on jobs which didn't even exist 10 years ago."

He indicates that to "... assume its responsibilities toward society ... industry must: See that new products are not put on the market until the product is ready for market, and vice versa; Never fail to fulfill responsibilities for research, development, production and delivery of military products; Work unceasingly to provide a fair return on investments; Take a genuine interest in employee welfare by providing good pay, pleasant working conditions and steady jobs; Recognize that industry and the community have interrelated responsibilities which must be met if both are to prosper; Help provide for our increasing technology by assisting the field of education wherever possible; Assure efficient use of one of our great natural resources, the radio spectrum, by thoroughly studying the problem of whether uhf can be made reasonably comparable to vhf TV service."

## Private Reactor Begins Operation

Nation's first private nuclear reactor for industrial research has gone into operation at Armour Research Foundation.

The instrument will enable industry for the first time to conduct studies without security restrictions and military competition.

Housed in a new \$1,250,000 Physics and Electrical Engineering Research Building being constructed by Armour Research Foundation near 35th and State Sts. on Chicago's near south side, the reactor was built for ARF by Atomics International, a division of North American Aviation Inc.

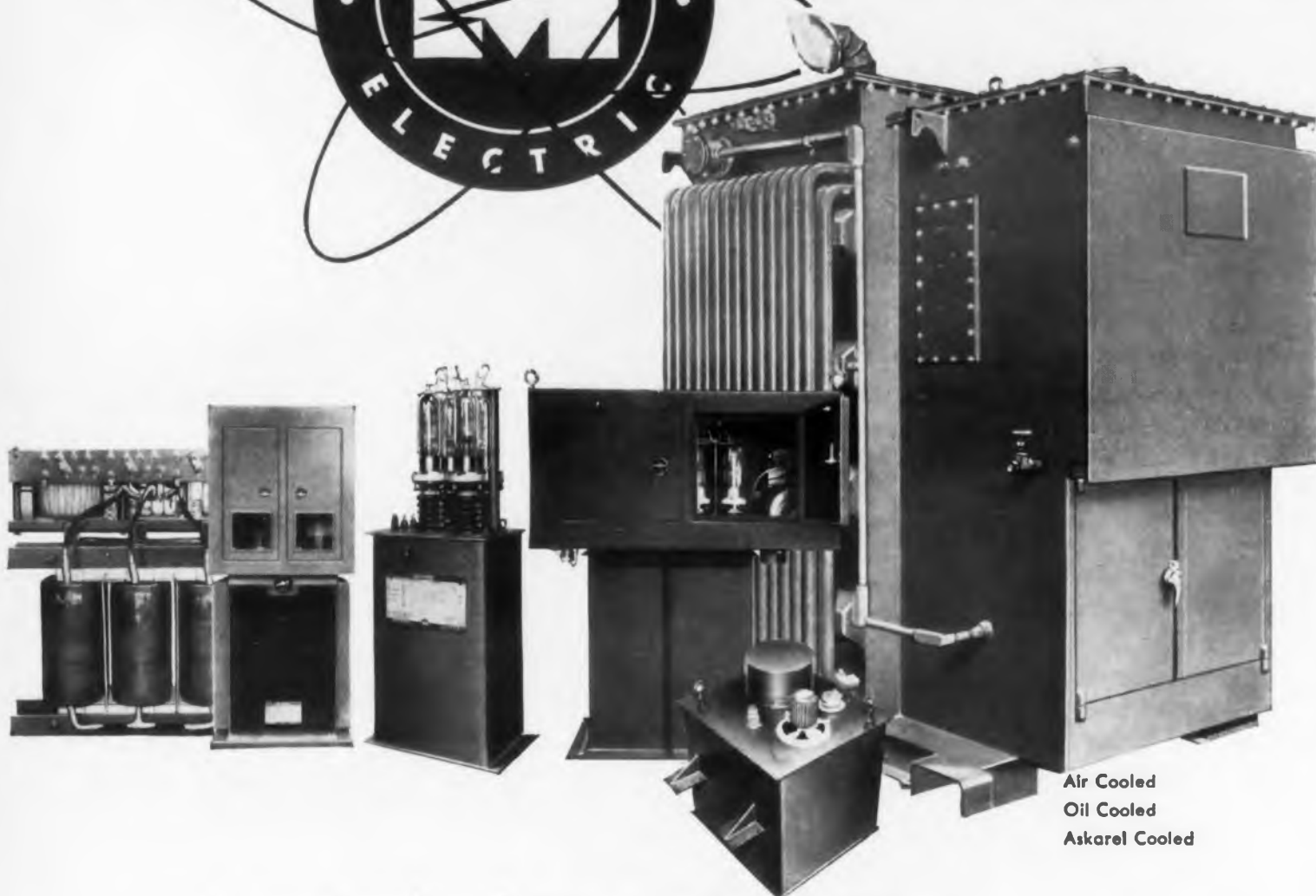


## B-52 H-Bomb Carrier Defense

A new era of aerial gunnery, where one gunner replaces six, has been ushered in by the Arma Division of American Bosch Arma Corp., Roosevelt Field, L.I., N.Y. Medium and long range bombers can be equipped with a automatic electronic system which automatically detects, tracks, leads and actuates a fire control system to destroy enemy fighters. The gunner assumes optical control of his weapons.



# UNIT RECTIFIERS



Air Cooled  
Oil Cooled  
Askarel Cooled

... meet all essential requirements of AC to DC voltage conversion.

Moloney's advanced design means:  
Reduced Weight • Easier Handling • Versatile Installation.

You save engineering time and transmitter cabinet space . . . and you save the cost of individual rectifier components with Moloney Unit Rectifiers.

Moloney Unit Rectifiers are available with vacuum tube, gas tube, or dry-plate rectifier elements. DC ratings from 2 KW through 10,000 KW and up — voltages of 1 KV through 250 KV and up — frequencies from 25 through 400 cycles and other special frequencies — and optional automatic or manual load-tap-changing equipment. *Specify Moloney.*

ME88-20

## M O L O N E Y E L E C T R I C C O M P A N Y

Plate and Filament Transformers • Chokes • Unit Rectifiers • Modulation Transformers  
and Reactors • Pulse Transformers and Charging Chokes • HyperCores for Magnetic Components  
Developmental Magnetic Components • Power and Distribution Transformers

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT 5390 BIRCHER BLVD., ST. LOUIS 20, MO., AND TORONTO, ONT., CANADA

CIRCLE 4 ON READER-SERVICE CARD FOR MORE INFORMATION



Write for Catalog SR 206 "HyperCores for Magnetic Components" and Catalog ST 3506 "Magnetic Components for Electronic Applications."

### Observing TV Camera

Getting up close to watch gun tests is unnecessary for Navy Ordnance observers. Risks that accompany observing these tests are taken by a ruggedized small TV camera. Viewing screen can be located at a safe distance.

Previously, only one or two officers could watch the tests through an observation port. Now, only the camera need be near the gun. A projection TV system permits large groups to watch the tests.

Made by General Precision Laboratories, the camera is made to stand noise levels of over 120 db. Clear, detailed pictures are sent despite shock waves produced by the weapon.



Ruggedized TV camera observes a gun test and transmits pictures to a safe location for viewing by large groups.

### New Epoxy-Base Enamel

A new enamel, developed for industrial use by Rexton Finishes, Irvington, N.J., is heat, chemical, corrosion and abrasion resistant.

Conventional glossy black or brown phenolic molded articles as well as metal, glass, wood and plastic can be covered with a single coat without a primer. Available in a variety of colors, the enamel air-dries in about 2 hours, and in less time if force dried or baked.

### Chapel Bells For US Airmen

Forty-three electronic carillons are being built by the Special Products Division of Stromberg-Carlson, Rochester, N.Y. to sound the liturgical bells used in worship services of all faiths at USAF bases throughout the world.

In electronic carillons of this type, bell sounds are produced by striking small metal tone bars with tiny plastic hammers, electronically controlled, and amplifying the sounds through special magnetic pickup and loudspeaker systems.

The equipment also includes a clock-controlled record player for carillon recordings of hymns and other familiar music.

### Versatile Man-Made Mineral

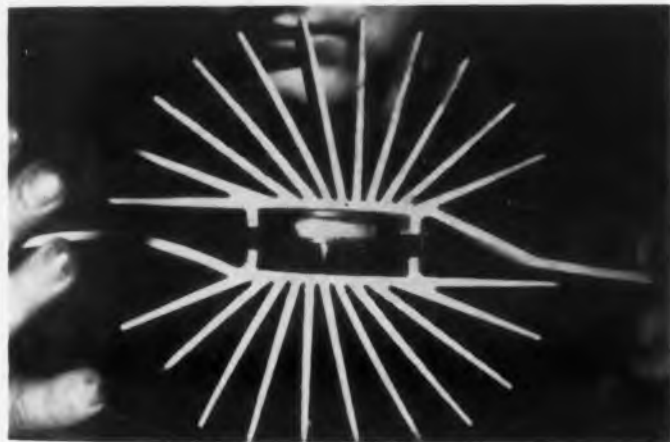
A cheap man-made mineral may free the U.S. from foreign sources of strategic and costly materials, such as tungsten. The new material, Sintox, may be used in applications in automobile and aircraft production, electronic and electrical fields, the machining of metal, wood, paper, and rubber, and in the manufacture of plastics and textiles.

Developmental batches of Sintox, made by Sintox Corp., Allentown, Pa., indicate a unique combination of properties for electronic applications. Its dielectric strength is twice that of porcelain and its high resistance is so little affected by temperature that at 300 C it is one million times that of porcelain.

### Civilian Defense Radio Traffic Communication

In those localities where radio control of street intersection traffic signals is already in effect, it could be a relatively simple task to incorporate a system of motorist and pedestrian guidance for city evacuation or other safety directives.

Elmer W. Hassell, G.E. Supervisor, Syracuse, N.Y., indicated at the WESCON Show recently that voice messages could utilize traffic light equipment by using amplifiers mounted in the same cabinets containing intersection radio tone control units.



### Heat Conducting Aluminum Fins

Silver-plated aluminum fins conduct heat away from dime-sized germanium cell. General Electric Co., Schenectady, N.Y.

### Shielded Rooms Sport Rf-Free Lighting

Cold cathode fluorescent tubes, which deliver interference-free illumination at lower temperatures than conventional tubes, are now being employed in shielded enclosures.

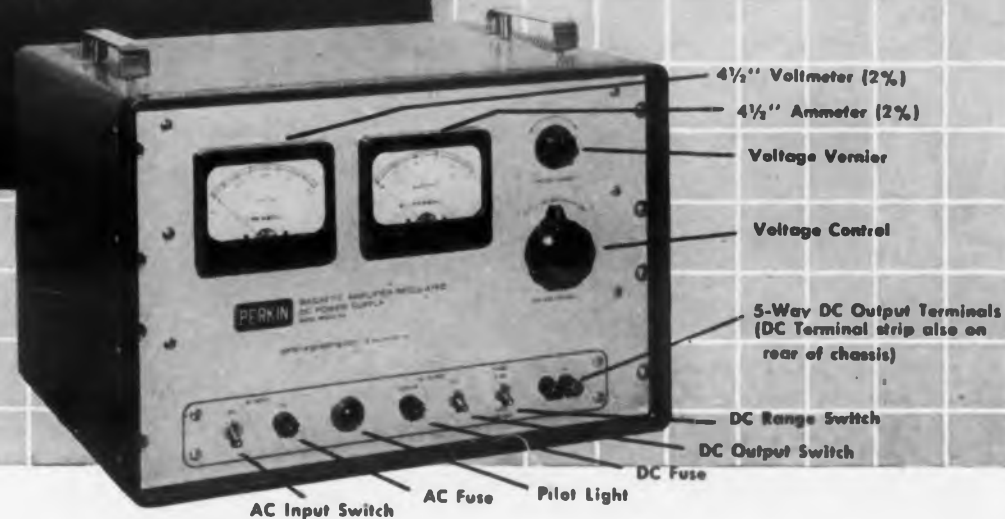
The room incorporates the development by Cold Cathode Lighting Corp. to permit instant starting, long life and full lumen output in refrigerated or high temperature spaces.

The shielded rooms are built by Ace Engineering & Machine Co., Philadelphia.

2 TO 36  
VOLTS  
@ 15 AMPS  
DC POWER SUPPLY

The **NEW PERKIN**  
MODEL MR532-15A  
with  $\pm 1/2\%$  REGULATION

**IMMEDIATE  
DELIVERY!**



**Now... for Your Laboratory... the most versatile TUBELESS,  
Regulated and Filtered Power Supply**

#### OTHER STANDARD MODELS AVAILABLE:

VOLTS	AMPS	REG.	MODEL
0-32	25	$\pm 1\%$	M60V
24-32	10	$\pm 1/2\%$	28-10WX
24-32	30	$\pm 1/2\%$	28-30WX
5-40	30	$\pm 1\%$	MR 1040A
24-32	100	$\pm 1/2\%$	100 XA

Ripple on all above models: 1% rms  
6, 12 and 115 V models also available.  
Write for complete specifications  
on all models listed above.

- REMOTE SENSING • VERNIER VOLTAGE CONTROL
- NO TUBES, MOVING PARTS OR VIBRATING CONTACTS

#### Specifications . . . .

**REGULATION:** 5-32V Range:  $\pm 1/2\%$  for combined line changes of 105-125VAC and load of 0-15A. DC.

2-5V Range:  $\pm 2\%$  for combined line changes of 105-125VAC and load changes of 0-15A. DC.

32-36V Range:  $\pm 2\%$  for combined line changes of 110-125VAC and load changes of 0-15A. DC.

**RIPPLE:** 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load.

**AC INPUT:** 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

**RESPONSE TIME:** 0.1 to 0.2 seconds maximum.

**DIMENSIONS:** 19 1/2" wide x 15 1/2" deep x 13 1/4" high with cabinet. (19" wide x 14 3/4" deep x 12 1/4" high rack panel construction)

**FINISH:** Gray Hammertone **WEIGHT:** Approx. 135 lbs.

Representatives in principal cities throughout the country.  
Wire collect for complete price information.



**PERKIN ENGINEERING CORP.**

345 KANSAS ST. • EL SEGUNDO, CALIF. • Oregon 8-7215 or EAsgate 2-1375



# AVIATION PROGRESS with G-E aircraft motors

## NEW G-E AIRCRAFT GUN MOTOR DEVELOPS TWO HP PER POUND FOR 10 SECONDS!

POWER PLUS HAS BEEN PACKED INTO THIS COMPACT 18 POUND, 400 CYCLE MOTOR WHICH DELIVERS 37 HP FOR A 10 SECOND FIRING INTERVAL. NEWLY DEVELOPED INSULATION SYSTEM PROTECTS AGAINST INTENSE HEAT. DOUBLE ROTOR DESIGN PROVIDES HIGH STARTING TORQUE AND EXCELLENT OPERATING EFFICIENCY - PERMITS UTILIZATION OF SINGLE OR DUAL POWER SOURCE.

## G-E HERMETIC MOTOR PARTS LESS THAN 6½ INCHES IN DIAMETER DELIVER 25 HP CONTINUOUSLY TO COOL AIRLINERS!

HERMETIC MOTOR PARTS WEIGHING ONLY 18 POUNDS DELIVER 25 HP CONTINUOUSLY AT A SPEED OF 23,500 RPM. TWO-POLE, 400-CYCLE POWER PACK CONSISTING OF STATOR, ROTOR AND SHELL IS DESIGNED TO POWER AIRBORNE COMPRESSOR.

## DIGITAL COMPUTER DETERMINES BEST MOTOR DESIGN IN SECONDS!

DAYS OF CALCULATIONS BECOME SECONDS WHEN G-E AIRCRAFT MOTOR DESIGNERS PUT THIS COMPUTER TO WORK IN DETERMINING OPTIMUM MOTOR DESIGN IN THE FASTEST POSSIBLE TIME! AFTER PRELIMINARY DESIGN WORK HAS BEEN COMPLETED, COMPUTER CAN THEN BE INVALUABLE AID IN ASSURING BEST - AND FASTEST - POSSIBLE ANSWER TO YOUR MOTOR REQUIREMENTS.

THESE ARE ONLY A FEW EXAMPLES OF G.E.'S CONTINUING DESIGN LEADERSHIP. FOR HELP ON YOUR AIRCRAFT MOTOR PROBLEMS, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE. GENERAL ELECTRIC CO., SECT. 634-5 SCHENECTADY, N. Y.

### Slow Scan TV Converter

A compatible system making it possible to combine slow and fast scan TV has been developed by the GE Electronics Laboratory. The system changes fast scan to slow scan TV by means of an electronic converter. Slow scan TV produces one picture every 4 or 5 secs, contrasted with fast scan which sends 30 pictures per second.

Still in the developmental stage, the conversion system promises to widen the combined use of fast and slow TV scan in commercial and industrial applications.

Slow scan has the greatest possibilities in uses not requiring transmission of motion. Picture distortion results from movement of the subject. Pictures without much action, such as signature comparisons, can be sent over lines that approach the telephone line bandwidth and can be received by slow TV monitors.

Since coaxial lines are not required for slow scan, the employment of telephone lines will reduce the cost of closed circuit TV. It is even possible to take a fast scan TV from an airplane, without a direct hookup to a fast camera, and convert it for slow scan TV.

### Automatic Germanium Plating Rectifier

Incorporating automatic voltage stabilization and remote stepless reactor control at no extra cost, a new air cooled germanium plating rectifier has been announced by GE's Rectifier Dept., Lynn, Mass.

Output voltage is controlled by a reactor, eliminating moving parts, and reducing maintenance cost and down time. Voltage is maintained automatically, regardless of changes in tank load or variations in ac line voltage.

Heart of the reactor control system is a magnetic amplifier that signals the control reactor to make adjustments whenever the actual voltage is different from the desired voltage set at the remote control station. A cooling system, utilizing silver-plated aluminum fins that surround the germanium cell, conducts heat away from both sides. Germanium junctions, formerly, were cooled from only one side.

◀ CIRCLE 6 ON READER-SERVICE CARD

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

### Forward Scatter Researchers Get Gold Medal

A research group consisting of Ross Bate-man, Dana K. Bailey, and Richard C. Kirby, all one-time members of the Ionospheric Research Section, Boulder Laboratories, National Bureau of Standards, has been awarded the Department of Commerce Gold Medal for exceptional service . . . "For major contributions to the advancement of the science of radio wave propagation and long distance radio communications. . ."

The research group took part in the discovery of ionospheric forward scatter and has studied the physics of the phenomena involved. In addition, they directed the application of scientific studies to construction of practical communication circuits, which has resulted in supervising Air Force contracts for installation of several such circuits in the Arctic.

### Teflon and Rulon Bonded to Other Materials

Both Teflon and Rulon are being surface treated by Dixon Corp., Bristol, R.I., to enable these anti-adhesive substances to bond with almost any other material.

The new method is essentially a surface treatment but may penetrate the material to a depth of 0.001 to 0.003 in. Either part or all of any surface may be treated, so that only a portion can be bonded and the balance retains its non-adhesive properties. Flat shapes can be treated on either side or both, as required.

Solid Rulon bearings, with their high resistance to wear, have given excellent performance with no lubrication, and, within their load range, can be run indefinitely. Since solid bearings are expensive, however, use of a thin film of Rulon cemented to a metal bearing core is now practicable. It is particularly attractive as a method of reducing costs and increasing the range of loads and speeds for which the bearing may be used. Film thickness is said to speed heat transfer to the adjacent metal, permitting the bearing to run cooler.

CIRCLE 7 ON READER-SERVICE CARD >

# C I B A



\*Ciba Araldite Epoxy Resins come with the assurance that they have met not only our rigid PRODUCTION quality control standards but the specific APPLICATIONAL requirements of the user as well.

Ciba produces basic resins only which are formulated for intermediate and end uses by accredited formulators.

# Araldite® First in Epoxies

Wherever great strength with light weight, excellent electrical properties, chemical resistance, and an ability to adhere to almost every kind of surface are needed, Araldite "Double Check"\* Epoxy Resins are ready to step in with this unbeatable combination of properties unavailable before in one class of basic resins. Results? Case histories like these to point the way to advance your own engineering planning and stream-line production with overall savings in time and money that will bring the all-important "plus" to your profit picture!

### SLASHES TOOLING COSTS UP TO 40%!

This die for the forming of airplane part shown is fabricated with a 1/2" facing of Epoxy Resin over a rough kirk-site casting. Time formerly spent on grinding with a blue block is eliminated, and tooling costs are slashed up to 40%.

Formulator: Furane Plastics, Inc.  
Customer: Lockheed Aircraft Corp.

### LOW COST RETREAD REDEEMS COSTLY DIES!

Details of worn dies, which would cost thousands of dollars to reclaim by former methods, are easily refaced and put back into use by casting Epoxy Resin against a pattern, or actual part. Male punch is faced with a flexible Epoxy formulation.

Formulator: Rezolin, Inc.  
Customer: R. Wallace & Sons Mfg., Co.

The Technical Services of Ciba's Plastic Division are the finest in their field. For full information on how Ciba Araldite Epoxies lead to product development and production improvements, write . . .

CIBA COMPANY INC., Plastic Division  
627 Greenwich St., New York 14, N. Y.

ED

Please send me full information on CIBA Epoxy Resins for

- Tooling                       Structural Laminates                       Surface Coatings  
 Electrical                       Hi-Strength Adhesives                       Plastic Body Solders

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_ TITLE \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_

CIRCLE 7 ON READER-SERVICE CARD >



## Washington Report

Albert Warren

**Spectrum Dissection . . .** *Re-evaluation of entire radio spectrum by Govt and industry, with eye to more efficient allocation among services, is being demanded in more and more quarters—and experts consider it inevitable. Move is being precipitated by plight of uhf TV stations, but their problems are so involved with the whole jigsaw of allocations that any move affecting them would affect vast number of military & industry users of the spectrum. Federal Communications Commission has proposed that all TV stations be moved to uhf, if further study proves it feasible technically & economically. At same time, FCC told other services to show they could best use the 72 mc of vhf space (scattered between 54 mc & 216 mc) if TV is moved out. This has produced a powerful drive by industrial radio users to get more vhf channels. One top FCC official puts it this way: "Technical developments have far outstripped the allocation scheme. The present setup isn't efficient. Of course, the economics of moving services around, of obsoleting equipment, must be considered. However, industry can afford to change equipment for the sake of efficiency—and the military are now pretty well capable of persuading Congress to allocate necessary funds for changes. Naturally, the most difficult problem is that of obsoleting broadcast receivers in the hands of the public, or of taking away service the public now gets." With industries of all kinds relying heavily on communications radio and closed-TV for speeding manufacturing operations, pressures on FCC to provide more channels for such services is illustrated by this comment from an FCC commissioner: "I thought the broadcast industry had good lobbyists. You should see the other industries move into this field. We're getting more and more insistent calls from Congressmen, and they're pressured by manufacturer constituents." Last complete evaluation of whole spectrum was during World War II, accomplished by Radio Technical Planning Board under aegis of FCC; it was made up of radio manufacturing and broadcasting representatives.*

# Direct Reading Spectrum Analyzer

- for**
- Visual frequency calibration — high resolution
  - Leakage and interference measurements
  - Standing wave measurements
  - Pulse modulation analysis
  - Sensitive receiver

## The BASIC SCOPE for VISUAL MICROWAVE



### SPECIFICATIONS

Model No.	Equipment
Model Du.....	Spectrum Display and Power Unit
Model STU-1...	RF Tuning Unit 10-1,000 mc.
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4...	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

Frequency Range: 10 mc to 44,000 mc.  
Frequency Accuracy:  $\pm 1\%$   
Resolution: 25 kc.  
Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)

Frequency differences as small as 40 kc measurable by means of variable frequency marker with adjustable amplitude. Portable and completely self-contained.

CIRCLE 8 ON READER-SERVICE CARD FOR MORE INFORMATION

Input Impedance: 50 ohms—nominal  
Overall Gain: 120 db  
Input Power: 400 Watts  
Sensitivity: (minimum discernible signal)  
STU-1: 10-400 mcs—89 dbm  
400-1,000 mcs—84 dbm  
STU-2A: 910-2,200 mcs—87 dbm  
1,980-4,560 mcs—77 dbm  
STU-3A: 4,370-10,920 mcs—75 dbm  
8,900-22,000 mcs—60 dbm  
STU-4: 21,000-33,000 mcs—55 dbm  
STU-5: 33,000-44,000 mcs—45 dbm  
Attenuation:  
RF internal 100 db continuously variable (STU-1, STU-2A, STU-3A)  
IF 60 db continuously variable

# Broadband 10-44,000 mc

Now, the Polarad Model TSA Spectrum Analyzer provides the same visual advantages for microwave testing as the standard oscilloscope accomplishes for low frequency signals. This is a "must" instrument for microwave work! It displays with high sensitivity on a bright easily defined CRT, pulse modulation components, frequency differences, attenuation and band width characteristics, leakage detection, radiation and interference signals, and VSWR information.

This is visual instrumentation—it provides immediate and complete information because of the high resolution obtainable.

Frequencies are read directly on the linear dial with 1% accuracy as the set is tuned. Maximum reliability and long life are assured through use of non-contacting oscillator plungers. A variable frequency marker with both frequency and amplitude adjustable is provided.



## ANALYSIS

Write today—directly to Polarad, or your nearest Polarad representative—to find out how the Model TSA Spectrum Analyzer can speed your research and solve your microwave measurement and testing problems.

Write for your copy of the Polarad "Handbook of Spectrum Analyzer Techniques". 50c per copy. Includes discussion of Spectrum Analyzer operation, applications and formulae for-analysis techniques.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

Phone Polarad Collect for information regarding the Spectrum Analyzer, Model TSA. EXeter 2-4500



**ELECTRONICS CORPORATION**  
43-20 34th Street, Long Island City 1, N. Y.

REPRESENTATIVES: Albuquerque, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Denver, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, St. Louis, San Francisco, Schenectady, Syracuse, Washington, D. C., Winston-Salem, Canada; Arnprior, Ontario. Resident Representatives in Principal Foreign Cities  
CIRCLE 8 ON READER-SERVICE CARD FOR MORE INFORMATION

**Washington Trends & Briefs** . . . Faith in electronics industry was expressed recently by Edward P. Curtis, special asst. to President Eisenhower for aviation facilities planning, who said he expects industry to solve by March 1957 some of the **problems of preventing air collisions**. He said following were among companies working on problem: Ramo-Wooldridge, Sperry Rand, GE, Hoffman Electronics, Crosley div. of Avco. . . . Nine transistor development contracts, totaling \$11,597,084, were let recently by Army Signal Supply Agency, Philadelphia—to RCA, Sylvania, Motorola, Western Electric, Philco, Hughes Aircraft, Texas Instrument, Transitron Electronics. . . . Revised booklet "**Functional Classification and Definition for Electronic Test & Measuring Equipment**" is available to all Govt and commercial contractors from Co. Melvin Abramovich, Office of Asst. Secy of Defense (R&D), Room 3D-132, Pentagon Bldg., Washington 25, D.C. . . . "**Electronic trail**" is being extended 100 mi over Greenland ice cap by Army engineers. System comprises 2 parallel wires fed ac, signal from which is picked up by receiver on "Weasel" vehicle. Indicators show driver position with relation to wires, give warning when he strays. System is designed to keep travelers from wandering into crevasses. Development continues at Ft. Belvoir, Va. labs and at General Mills, Minneapolis. . . . **Growth of transistor production** is emphasized by RETMA sales statistics: 4,758,603, valued at \$13,728,111, produced in first half 1956, compared with total 1955 production of 3,646,802, valued at \$12,252,741. . . . **Desperately short of engineers**, Federal Communications Commission now offers grade II jobs (\$7035) to those who have 4 years of college engineering study or equivalent, plus 4 years experience. FCC officials point out that many engineers are more qualified for the jobs than they think, urge them to write to Personnel officer, FCC, Washington 25, D.C. . . . **Symposium on propagation of frequencies** under 100 kc will be held in Denver, Colo. Jan. 23-25, sponsored by Bureau of Standards and Denver-Boulder chapter of IRE. . . . **Multiple-antenna towers**, for TV, fm and other services, are getting more attention—under urging by FCC and aviation interests. Collection of all or most antennas in any area on one tower substantially reduces air hazards. Latest plans are for San Francisco, where KRON-TV plans 981 ft structure on San Bruno Mt., to support up to 15 antennas, candelabra fashion, and KGO-TV plans 980 ft tower on Mt. Sutro, to carry 5 vhf and 2 uhf antennas. Govt will have to make choice between them.

when a "standard type" of vibrator won't do . . .

# OAK

## vibrators

CUSTOM DESIGNED and CUSTOM BUILT

**complete engineering  
cooperation** from  
prototype to production

With information about what you want to accomplish, in voltage, current, signal or frequency conversion for your performance, environmental and load conditions, OAK can pre-engineer for your application by:

- *Designing or checking your circuit.*
- *Specifying protective components.*
- *Designing your transformer.*  
*(we do not manufacture transformers).*
- *Designing and producing your vibrators—in any quantity.*

*vibrator performance and life depend on its suitability to the application.*



send for descriptive brochure and performance chart—address dept. "O"

### OAK MFG. CO.

1260 clybourn ave. • chicago 10, ill.

also manufacturers of OAK switches, tuners, choppers and other electro-mechanical devices.



CIRCLE 9 ON READER-SERVICE CARD FOR MORE INFORMATION

## Letters to the Editor

Dear Sir:

On Page 102 of ELECTRONIC DESIGN, July 15, 1956, there is an announcement regarding a subscription to the REPORT OF NRL PROGRESS. Will you be good enough to print a correction of this. The REPORT OF NRL PROGRESS is available for purchase from the Office of Technical Services, Department of Commerce, Washington 25, D. C. for \$1.25 per issue. At this time I understand no subscription price has been set and each issue must be ordered separately. Copies of this publication are not available from the Naval Research Laboratory, except for official use. One of the purposes of the Office of Technical Services is to make reports of the Government research available to the public.

*Ruth H. Hooker, Librarian  
U. S. Naval Research Laboratory*

Dear Sir:

In your May 15 issue (page 141), you asked for comments on a definition of instruments proposed by Mr. Hausz.

Enclosed is the definition formulated by M. H. Aronson, Editor of the magazine *Instruments and Automation*, which is, in our opinion shorter, clearer, more specific, more useful, and more accurate in sense that it cannot be misinterpreted as easily as the one proposed by Mr. Hausz.

*F. D. Marton  
Managing Editor  
Instruments Publishing Co.*

Mr. Aronson's definition of Automation: "The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts." *Ed.*

Gentlemen:

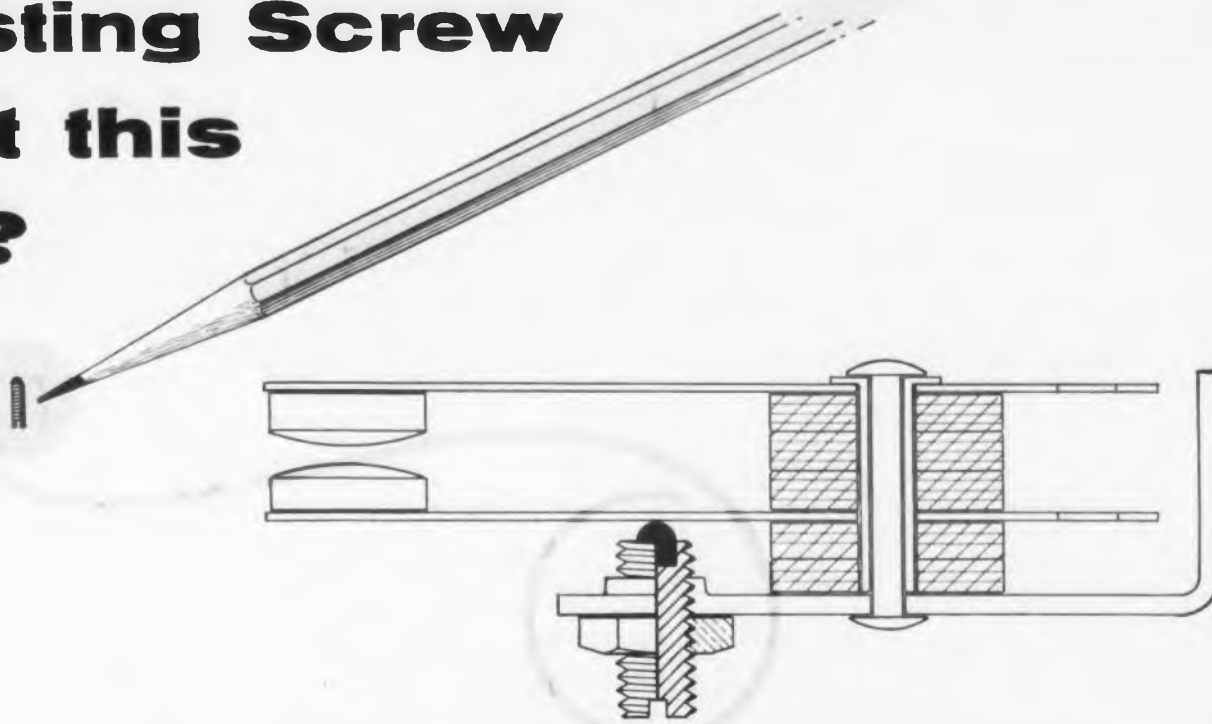
. . . about the importance of including derivations with equations . . . (they) are more important than the equations, for the following reasons:

ELECTRONIC DESIGN • October 1, 1956





## Can You Use a Glass Tipped Adjusting Screw about this Size?



They tell us *how* the author arrived at his results; therefore,

They inform us as to the validity of the results in a general case; and,

They inform us as to the validity of the results in special cases; and,

They give us information which will allow us to utilize the author's concepts in solving problems different than the one he presented.

The last item is most important . . . No two problems are exactly alike, and more design mistakes are made by blindly using the wrong cookbook recipe than all the others combined. If it is worth while to formulate a useful equation, it is certainly worth while to show the conditions under which the equation is valid.

**A. Lange**  
Raytheon Manufacturing Company  
Wayland Laboratory  
Wayland, Massachusetts

Derivations, if published, would take up space in ELECTRONIC DESIGN that could be used for other timely material. Do you agree with Mr. Lange? We would like some more opinions. **Ed.**

Sir:

I am in hearty agreement with your editorial (Meetings Are Not Job Marts) in the May 1, 1956 issue. In fact, I was once moved to drop a note to the editor of another magazine stating much the same ideas.

Your point about job dissatisfaction because of refusal of permission to attend conference is a particularly sore point with me. It was actually a factor in my decision to leave two different jobs.

I now find conferences much less interesting than I once did, but it is my feeling that there is a phase in an engineer's professional development in which attendance at conferences is very useful.

**Merwin E. Frank**  
Los Angeles, Calif.

If you make a relay, switch, thermostat or any component in which a metal part is adjusted by an insulated screw, please read on.

As pioneers in the field of glass-to-steel hermetic terminals, Fusite has come to grips with many problems involving the interfusion of glass with metal.

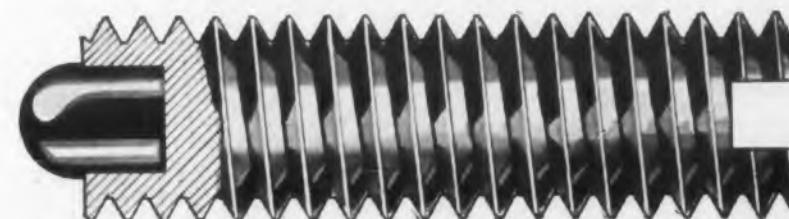
While we can only guess at the potential market for our tiny new product, we offer every assurance as to its complete practicality.

These screws, now available in standard threads one through six, have a tip of high density glass actually fused to the metal (not cemented or pressed in).

This promises perfect performance in the face of changing temperatures, humidity, friction, and corrosive chemicals.

*We will be happy to send you samples without obligation.*

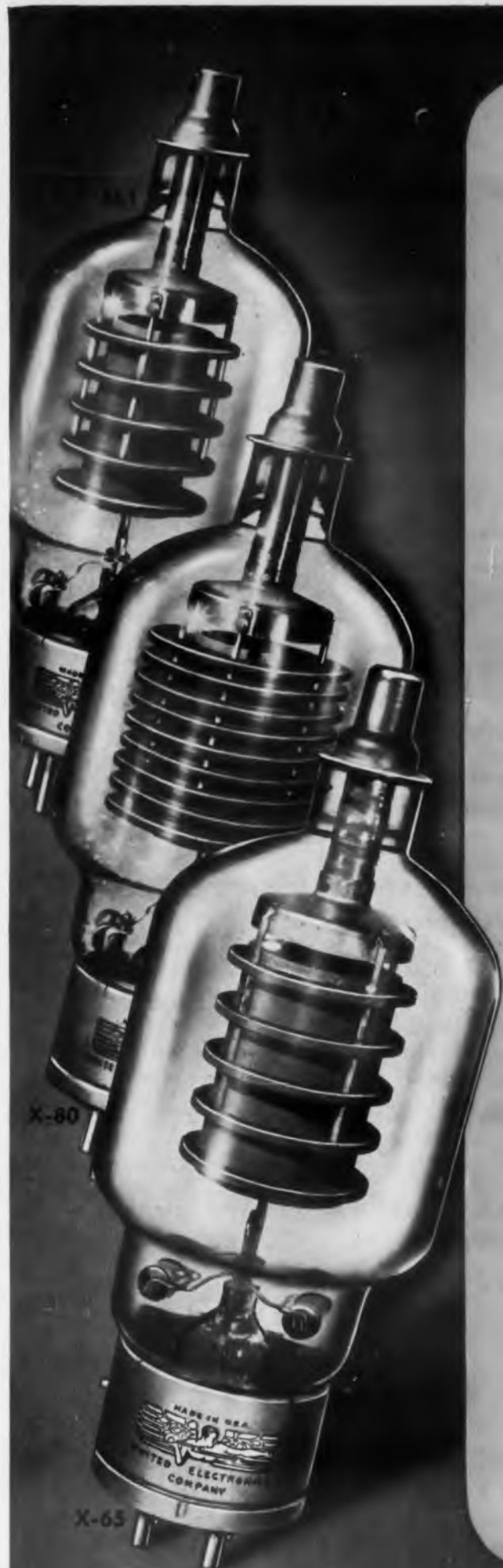
*Write Fusite Dept. L-5*



THE **FUSITE** CORPORATION

6028 FERNVIEW AVENUE, CINCINNATI 13, OHIO

CIRCLE 10 ON READER-SERVICE CARD FOR MORE INFORMATION



from  
**UNITED ELECTRONICS**

# NEW TUBES for HIGH POWER RADAR

## Graphite Anode Rectifier-Diodes

For their size, these new tubes have greater power handling capacity than any other high vacuum convection cooled types, when used either as power supply rectifiers, clipper, hold-off or charging diodes.

**NEW**  
**Major**  
**SERIES**

Custom designed, they can supply the main basic diode needs for efficient tube performance in the functional as well as protective areas of new heavy radar circuitry.

Type	Code	Filament		opx kv	Anode		Maximum Dimensions	
		Vac	Aoc		lb a	lb Adc	Length Inches	Diameter Inches
561	A B	11.5	15.5	30 30	2.7 80	.860 .075	9.750	3.630
X-80	A B	11.5	15.5	40 40	2.5 80	.800 .075	9.750	3.630
X-65	A	5.0	11.5	65	1.0	.250	9.750	3.630

CODE: A) Rectifier B) Clipper Diode

### ALSO UNDER DEVELOPMENT

Several additional high vacuum diodes are being designed by UNITED ELECTRONICS which will extend the new MAJOR series with tubes of much higher power stature. If you will advise us of your rectifier-diode needs for equipment you are now designing we may be able to be of great help to you.

UNITED ELECTRONICS, 42 Spring Street, Newark 4, N. J.

## Meetings

### Oct. 1-3: Twelfth Annual National Electronics Conference.

Hotel Sherman, Chicago, Ill. Sponsored by the AIEE, IRE, Illinois Institute of Technology, University of Illinois, and Northwestern University. More than 100 technical papers and 240 commercial exhibits will be featured. For information, write to Victor J. Danilov, Illinois Institute of Technology, Chicago 16, Ill.

### Oct. 1-3: Canadian Institute of Radio Engineers Convention.

Automotive Building, Exhibition Park, Toronto, Canada. Technical papers are planned on medical electronics, scatter propagation, application of electronics to atomic energy projects, use of computers in automation and engineering problems, and transistors. An exposition will include many of the latest improvements in radio, radar, TV, control mechanisms, computers, and other electronic items. For information, write to Grant Smedmor, Convention Manager, 745 Mount Pleasant Rd., Toronto 12, Canada.

### Oct. 1-5: AIEE Fall General Meeting.

Morrison Hotel, Chicago, Ill. Tentative schedule includes sessions on rotating machinery, protective devices, metallic rectifiers, insulated conductors, dielectrics, air transportation, land transportation, switchgear, feedback and control systems, electronics, computing devices, nucleonics, and management. For information, write to AIEE, 33 W. 39th St., New York 18, N. Y.

### Oct. 3-5: Fifth Annual Meeting of the Standards Engineers Society.

Willard Hotel, Washington, D.C. Topics expected to be of particular interest to standards engineers in the electronic field are the session devoted to "Dynamic Standards for the Median Company" and the session devoted to "Drawing Practice Standardization." Additional information may be obtained from the Washington Section, Standards Engineers Society, 4042 N. 35th Street, Arlington 7, Va.

### Oct. 8-9: Second Annual Symposium on Aeronautical Communications.

Hotel Utica, Utica, N. Y. Sponsored by the IRE Professional Group on Communications Systems.

CIRCLE 11 ON READER-SERVICE CARD FOR MORE INFORMATION



The symposium will stress communication requirements in support of present and future aeronautical activities. For additional information, write to R. C. Benoit, Jr., 138 Riverview Parkway N., Rome, N.Y.

**Oct. 8-12: Society of Motion Picture and Television Engineers Convention.**

Los Angeles, Calif. A technical session will be devoted to a program of papers on transistors and their applications to motion pictures and television. For additional information, write John B. Olsson, Houston-Fearless, 11801 W. Olympic Blvd., Los Angeles 64, Calif.

**Oct. 9-10: Computer Applications Symposium.**

Morrison Hotel, Chicago, Ill. Sponsored by the Armour Research Foundation of Illinois Institute of Technology. For information, contact J. J. Kowal, Conference Secretary, Armour Research Foundation of Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

**Oct. 16-18: Conference on Magnetism and Magnetic Materials.**

Hotel Statler, Boston, Mass. Sponsored by the AIEE, IRE, American Physical Society, American Institute of Mining and Metallurgical Engineers. For further information, write to T. O. Paine, Measurements Laboratory, General Electric Co., W. Lynn, Mass.

**Oct. 18-19: Third Annual International Meeting of the Institute of Management Sciences.**

Statler Hotel, Los Angeles, Calif. Theme of the conference is "Management Sciences—A Progress Report." Program plans include the presentation of technical papers on the latest developments in the application of advanced sciences to business and industrial management. For further information, please contact Al N. Seares, Vice President Remington Rand, Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

**Oct. 22-24: AIEE Machine Tool Conference.**

Sheraton Gibson Hotel, Cincinnati, Ohio. For information, write to AIEE, 33 W. 39th St., New York 18, N. Y.

**Oct. 29-30: Third Annual East Coast Conference on Aeronautical and Navigational Electronics.**

Fifth Regiment Armory, Baltimore, Md. Sponsored by the Baltimore Section and Professional Group on Aeronautical and Navigational Electronics of the IRE. Theme of the conference is "Electronics in the Jet Air Age." For information, write to W. D. Crawford, Publicity Chairman, Westinghouse Electric Corp., Air Arm Div., Friendship International Airport, Baltimore 27, Md.



**WHY USE 1945 SYNCHROS IN 1956 DESIGNS?**



STANDARD UNITS		ROTOR					STATOR				IMPEDANCE			PHASE SHIFT				Length			
SYNCHRO FUNCTION	CPPE TYPE	Input Volts	Input Amps	Input Watts	Ohms (DC)	Output Rotor (MV/deg.)	Sensitivity (MV/deg.)	Output Volts	Sensitivity (MV/deg.)	Input Volts	Input Amps	Input Watts	Ohms (DC)	Zin	Zso	Zrss	R-S	S-R	Nulls (MV)	Possible Error	Spd. in inches
Torque Transmitter	CGC-8-A-7	26.0	100	.5	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	76.4+j19.6	8°	—	30	7' 14"	1.240
Control Transformer	CTC-8-A-1	26.0	.050	.25	143	24	410	11.8	200	11.8	.090	.23	25	220+j740	28+j110	246+j60	—	8.5°	30	7' 14"	1.240
Control Transformer	CTC-8-A-4	—	—	—	381	24	410	—	—	11.8	.037	.09	60	508+j1680	67+j270	640+j190	—	9.2°	30	7' 14"	1.240
Control Differential	CDC-8-A-1	—	—	—	36	11.8	200	—	—	11.8	.085	.21	25	38+j122	27+j120	48.6+j13.8	—	9°	30	7' 14"	1.240
Electrical Resolver	CSC-8-A-1	26.0	.039	.43	230	23.2	400	10.6	180	11.8	.084	.27	27	280+j600	38+j136	70+j136	20°	11°	30	7' 14"	1.240
Torque Receiver	CRC-8-A-1	26.0	.100	.50	37	—	—	11.8	200	—	—	—	12	54+j260	12+j45	85.1+j20.4	8°	—	30	30' 30"	1.240
Vector Resolver	CVC-8-A-1	1.26	.057	.34	78	—	—	—	—	11.8	.294	—	27	103+j444	28.8+j27.9	—	—	—	—	1.240	



In equipment which must be flown, why load on extra weight? Clifton's new Size 8 Synchros can take the place of larger units at very significant saving in bulk and weight. These new Size 8's are now in use in some of the latest and lightest avionic equipment. Samples are available from stock, quantities from the production line.

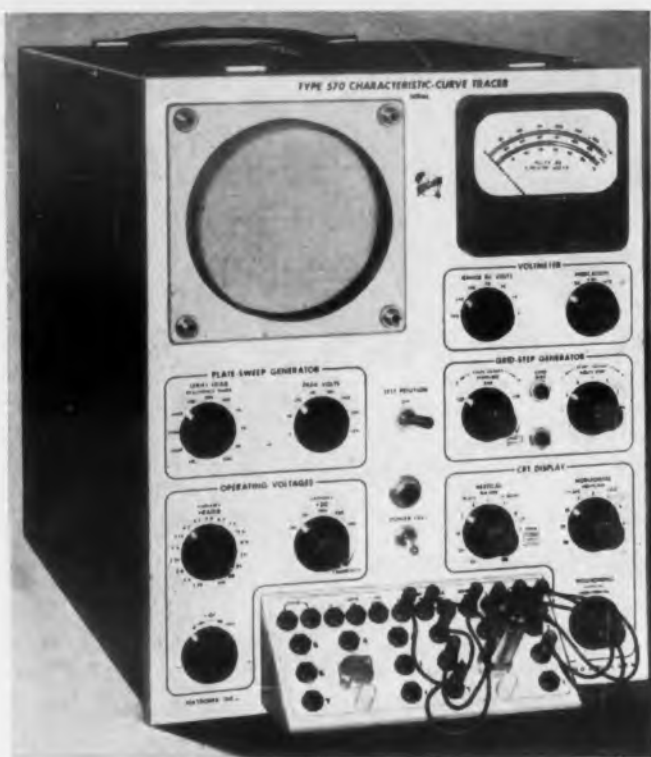
**CLIFTON PRECISION PRODUCTS CO. INC.**  
CLIFTON HEIGHTS PENNSYLVANIA

CIRCLE 12 ON READER-SERVICE CARD FOR MORE INFORMATION



# Save Time in Circuit Design

Get advance information...in graphic form...  
on vacuum-tube behavior in new circuitry —  
with the **Type 570 Characteristic-Curve Tracer**



The **Tektronix Type 570** Characteristic-Curve Tracer can save you many hours in circuit-development work by providing quick, accurate pictures of vacuum-tube characteristics. You have complete control of the operating-condition setup, permitting a realistic approach to actual circuit conditions, whatever they may be. You get curves that can be very important in a particular circuit problem; but are rarely, if ever, published in handbooks.

The Type 570 can also be used for rapid preselection of vacuum tubes, either by comparison with another vacuum tube, or with curves outlined on a crt mask.

**Please call your Tektronix Field Engineer or Representative or write direct for new booklet, Type 570 Technical Description.**

#### Displays Families of Curves on CRT Screen

Choice of four to twelve characteristic curves per family—with as many as 8 positive-bias curves per family.

#### Plots All Important Characteristics

Plate current against plate voltage.  
Plate current against grid voltage.  
Screen current against plate voltage.  
Screen current against grid voltage.  
Grid current against plate voltage.  
Grid current against grid voltage.

#### Calibrated Controls

Accurate current and voltage readings directly from the crt screen.

#### Wide Display Range

11 current ranges from 0.02 ma/div to 50 ma/div.  
9 voltage ranges from 0.1 v/div to 50 v/div.  
11 series-load resistors from 300 ohms to 1 megohm.  
7 grid-step values from 0.1 v/step to 10 v/step.

**Price — \$925**

f.o.b. Portland, Oregon

**ENGINEERS** — interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Write to Richard Ropiequet, Vice Pres., Engineering.

## Tektronix, Inc.

P. O. BOX 831 • PORTLAND 7, OREGON  
Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

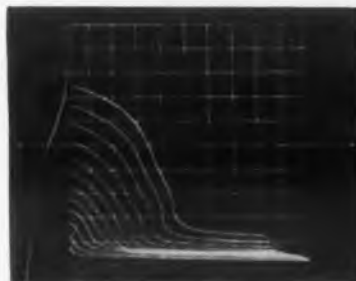
CIRCLE 13 ON READER-SERVICE CARD FOR MORE INFORMATION



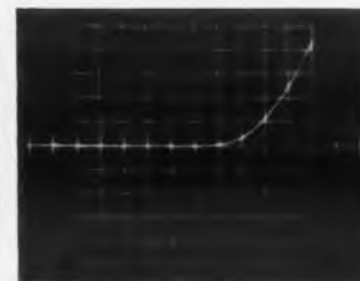
**Fig. 1** — Plate current plotted against plate voltage for one triode section of a 12AU7. Plate load is 5 k, peak plate-supply voltage is 500 v. Grid voltage is changed 5 v between curves, from -35 v. to zero. Vertical sensitivity is 5 ma/div, horizontal sensitivity 50 v/div. Calibrated controls permit accurate current and voltage readings directly from the screen.



**Fig. 2** — Same triode section of 12AU7 with only 20-v peak plate supply and sensitivities increased to 0.2 ma/div vertical and 2 v/div horizontal. Grid voltage is changed 2 v between curves, from -14 v to zero. This is essentially a 25-times magnification of the lower left portion of Fig. 1, showing the operating characteristics at low plate-supply voltage.



**Fig. 3** — Screen current plotted against plate voltage with positive grid bias on a 6AQ5. Plate load is 300 ohms, peak plate voltage is 100 v, screen-grid voltage is 100 v, with grid voltage changing 2 v/step from +16 v to below zero. Vertical scale is 10 ma/div, horizontal scale 10 v/div.



**Fig. 4** — Typical Germanium Diode curve. Inherent flexibility of the Type 570 permits accurate evaluation of diode characteristics and detailed examination of any part of the curve. Calibrated scales above are 0.2 v/div horizontal, 0.5 ma/div vertical, with zero points at center of screen.

#### Oct. 29-Nov. 2: Convention on Ferrites.

London, England. Sponsored by the Institution of Electrical Engineers. Program will include sessions on theory, preparation, and properties of ferrites, microwave application, square loop applications, radio and TV applications, and carrier frequency applications. For further information, write to W. K. Brasher, Secretary, Institution of Electrical Engineers, Savoy Place, London W.C. 2, England.

#### Oct. 31-Nov. 3: Gaseous Electronics Conference.

Westinghouse Research Laboratories, Pittsburgh, Pa. Co-sponsored by the Division of Electron Physics of the American Physical Society and the Westinghouse Research Laboratories. For more information, contact A. V. Phelps, Westinghouse Research Laboratories, Beulah Rd., Pittsburgh, Pa.

#### Nov. 7-9: Conference on Electronic Technology in Medicine and Biology.

McAlpine Hotel, New York, N. Y. Sponsored by the AIEE, IRE, Instrument Society of America. For information, write to AIEE, 33 W. 39th St., New York, N. Y.

#### Nov. 14-16: Symposium on Optics and Microwaves.

George Washington University, Washington, D. C. Sponsored by the IRE Professional Group on Antennas and Propagation, the George Washington University and the Optical Society of America. For further information, contact the IRE, 1 E. 79th St., New York 21, N. Y.

#### Nov. 15-16: New England Radio-Electronics Meeting.

Hotel Bradford, Boston, Mass. Co-sponsored by the Boston and Connecticut Valley sections of the IRE. For additional information, contact NEREM, Room 1006, 73 Tremont St., Boston, Mass.

#### Nov. 26-30: Third International Automation Exposition.

Trade Show, Building, New York, N. Y. Clinic sessions will be offered in electronic computers, process automation, machine tool automation, office automation, automatic materials handling, servomechanisms, electromechanical components, and electronic components. More than a hundred exhibitors will participate in the clinics. For information, write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 22, Pa.

#### Dec. 5-7: Second IRE Instrumentation Conference.

Biltmore Hotel, Atlanta, Ga. Sponsored by the Professional Group on Instrumentation and the Atlanta Section of the IRE. Sessions will be devoted to industrial applications, missile range instrumentation, and the application of solid state devices. For further information, contact the IRE, 1 E. 79th St., New York, N. Y.



**D. c. 10-12: Eastern Joint Computer Conference.** Hotel New Yorker, New York, N. Y. Sponsored by the IRE, AIEE, Association for Computing Machinery. "New Developments in Computers" is the theme of the meeting. In addition to an extensive program of technical papers, the meeting will feature exhibits by many manufacturers in the computing field. For information, contact Al Forman, Room 639, 480 Lexington Ave., New York 17, N. Y.

**Jan. 9-11, 1957: Symposium on Communication Theory and Antenna Design.**

Boston University, Boston, Mass. Sponsored by the Air Force Cambridge Research Center and Boston University. For information, contact Miss Alice Cahill, Air Force Cambridge Research Center, Air Research and Development Command, Laurence G. Hanscom Field, Bedford, Mass.

**Jan. 14-15, 1957: Third National Symposium on Reliability and Quality Control in Electronics.**

Hotel Statler, Washington, D. C. Sponsored jointly by the IRE Professional Group on Reliability and Quality Control, the American Society for Quality Control, and RETMA. For information, write to IRE, 1 E. 79th St., New York 21, N. Y.

**Jan. 23-25, 1957: Very Low Frequency Symposium.** NBS Boulder Laboratories, Boulder, Colo. Co-sponsored by the Denver-Boulder chapter of the IRE PGAP and the Boulder Laboratories, National Bureau of Standards. The program is titled "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Frequency Electromagnetic Waves (less than about 100 kc)." Authors are being requested to submit summaries for appraisal as soon as possible to Dr. J. R. Wait, Chairman, Denver-Boulder PGAP Chapter, National Bureau of Standards, Boulder, Colo. For further information, contact U. S. Dept. of Commerce, NBS, Boulder Laboratories, Boulder, Colo.

**April 8-11, 1957: Fourth National Electrical Industries Show.**

71st Regiment Armory, New York, N.Y. Sponsored by the Eastern Electrical Wholesalers Association. For more information, contact William S. Orkin, Co-Producer, The American Electrical Industries Expositions, Inc., 19 W. 44th St., New York, N.Y.

**April 11-13, 1957: Southwestern IRE Conference and Electronics Show.**

Houston, Texas. Sponsored by the Houston Section of the IRE. For information, write to Ninth Southwestern IRE Conference and Electronics Show, P. O. Box 1234, Houston 1, Texas.

ADSMANSHIP HANDBOOK

Chapter III; Volume I

THE AD THAT YEARNED TO BE COLORFUL

(color costs extra, y'know)

*There was once an ad that longed to break through the color barrier . . . only it couldn't decide which color. Consulting a spectrophotometer, it reduced the color data to digital form, fed it to a giant computer . . . and got a plotted solution looking like the cross-section of the spectrum. The ad couldn't afford to pay for all those colors . . . so it became blue.*  
**MORAL:** *If you can't think it up . . . ink it up (because without color, it's sure to be duller)*



*In the interest of greater adsmanship, this advertising parable is provided as a public service by the Benson-Lehner Corporation. Incidentally, some new OSCAR J applications include oscillograph record reduction in the fields of: air pollution, static and dynamic testing, medical research and petro-chemical analysis. For information re: data reduction, write:*



**benson-lehner** corporation

11930 Olympic Boulevard, Los Angeles 64, California

OFFICES: LOS ANGELES, BALTIMORE, KANSAS CITY, SUMMIT, N.J., WASHINGTON, D.C., LONDON, OTTAWA, PARIS  
For a permanent file of this series write to Benson-Lehner, Dept. O9, for your Adsmanship Handbook folder

CIRCLE 14 ON READER-SERVICE CARD FOR MORE INFORMATION



# Meaning and Prediction of System Reliability\*

Arthur Kohlenberg

Research Department  
Melpar, Inc.

**S**YSTEM reliability can be defined in terms of the probable value of a system's performance of its intended function. Such an approach is important in system design. Unreliability, like noise, produces a reduction in system capacity.

The first stage towards building system reliability has been the improvement of component reliability. One might expect that if parts are perfect, nothing can go wrong with a system of such parts. However, *perfectly* reliable components are obviously not the complete answer to the reliability problem in the foreseeable future. Still, the work of improving components, and particularly learning everything possible about their expected failures, is fundamental.

The second stage of system reliability development has been in combining unreliable components in such a manner that the system has greater reliability than the individual elements. An example is the technique of paralleling functional elements so that if one fails, another still performs the job. The recent work of Claude Shannon on synthesizing reliable relay networks with unreliable elements is perhaps the most sophisticated example. Such efforts are extremely valuable because they accept the realistic limitations of the imperfect.

The third stage of developing system reliability is to examine what the system is supposed to be doing, the probabilities of error, and the *costs* of such errors. The costs of malfunction must be weighed in terms of the possible performance modes of an imperfect system. This third stage is of the greatest importance to the engineer who is generally concerned with the problems of system design, as opposed to the specialist in reliability.

## Probability of Reliability

### ■ Example 1.

As an example, consider a teletype system with 26 keys—one for each letter of the alphabet. Assume that after a specified time, two keys stop working. What is the reliability of the system? Has it lost 2/26 or 1/13

of its operation, and therefore have a reliability of about 92 per cent? Probably not. Before being able to state the reliability in meaningful terms one must ask: "What is the teletype going to be used for, and what is the final effect of its failure to operate perfectly?" If the system is sending coded messages such that each letter is independent of the preceding letters, and all are equally probable, it will have lost about 8 per cent of the text.

Depending upon the code used this may mean 8 per cent of the content is lost, or it may mean 100 per cent is lost. On the other hand, if ordinary, clear English text is being transmitted over the system, practically nothing is lost of the content. If two letters are suppressed from a passage of English text, it is still possible to restore almost the complete meaning. In this application, then, the ultimate reliability of the system is perhaps 99.9 per cent. Therefore, one must measure the reliability of a system in terms of its functions based on the effect of the possible malfunctions of the system. The same system may have a reliability of 99 per cent or 1 per cent depending on its application.

### ■ Example 2.

Consider also a telemetering system for giving aircraft pilots a direction vector for flying towards some chosen point. As shown in Fig. 1, there are eight "registers" or "relays" in the aircraft which, on the basis of a data link, give the proper heading in eight-bit binary form. The first bit, in  $R_1$ , gives a 180 deg term, the second bit,  $R_2$ , gives a 90 deg term, and so on, the eighth bit giving the final accuracy of 1.4 deg. The problem is to find the necessary reliability of the individual relays for an overall system reliability of 95 per cent. For simplicity, the possibility of errors in the data link itself, can be ignored.

Of course, the first question to be asked is, "What is meant by the requirement of 95 per cent reliability?" It might mean that the probability all the relays will be operative, must be 0.95. This is Case I shown. If  $p$  is the individual probability of no failure for each

relay, then it is required that  $p^8=0.95$ , giving  $p=0.994$ . Thus we need relays giving only 6 failures per 1000 operations.

However, in determining what is meant by requiring 95 per cent operation, it is found that the pilot must reach his target, or be able to follow the directional vector, with 95 per cent certainty. This is a realistic and very different form of requirement when one examines the cost of a system malfunction or loss of a piece of data. The aircraft pilot cannot realistically maintain a course direction to better than about 3 deg because of uncertainties in local winds and errors in his navigation system. To lose the contents of  $R_8$ , the 1.4 deg information, really effects the pilot only about 1 per cent of the time. Similarly, to lose  $R_7$  is probably only to lose 5 per cent of the directional information. Furthermore, the pilot's bearing is being constantly corrected so that, even if he gets a little off course, he reaches the target after a small delay. On this basis, a realistic assignment of value can be made to the information in each register. Letting  $L_i$  be the fractional cost of losing the data in the  $i$ -th register, it is estimated that  $L_1=L_2=L_3=L_4=1$ ,  $L_5=0.8$ ,  $L_6=0.25$ ,  $L_7=0.05$ , and  $L_8=0.01$ .

In view of these estimates, and the requirement that the system perform its directing function with 95 per cent effectiveness, a computation of the necessary reliability of the individual register gives a probability of one and only one specific register failing of  $p^7(1-p)$ . Ignoring the probability that more than one register fails, the expected value of the system operation can be set equal to 0.95:

$$p^8 + p^7(1-p) [(1-L_1) + (1-L_2) + \dots + (1-L_8)] = 0.95$$
from which  $p=0.989$ . That is, using an estimate of what each failure costs we can afford relays with 11 failures per 1000 operations.

A further consideration should be made regarding the effect of a relay failure. In most practical equipments, failure will cause the relay to remain permanently in either the 0 or the 1 position. If it sticks in

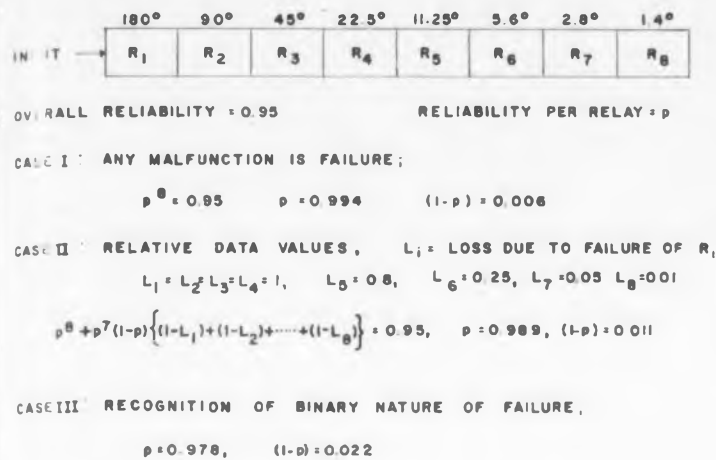


Fig. 1. Reliability calculations for aircraft telemetering system.

Let P = probability that alarm system works

Let σ = probability that pressure fails

Assign Risks

0	pressure and alarm operating
0	alarm fails, pressure operates
1	pressure fails, alarm operates
100	pressure fails, alarm fails

$$R = \sigma P + 100\sigma(1-P) = \sigma(100 - 99P)$$

R > 1 implies σ = 0.1, P > 0.91; σ = 0.05, P > 0.81; σ = 0.01, P = 0

$$\sigma(\alpha) = e^{-\alpha}, \quad \alpha = \text{pressure system maintenance}$$

$$P(\beta) = 1 - e^{-\beta}, \quad \beta = \text{alarm system maintenance}$$

$$R = e^{-\alpha} + 99e^{-(\alpha+\beta)}$$

$$\alpha + \beta = K; \quad R(\alpha, K) = e^{-\alpha} + 99e^{-K}$$

$$R(\beta, K) = e^{-(K-\beta)} + 99e^{-K}$$

$$\text{Minimum for } \alpha = K, \beta = 0$$

Fig. 2. Reliability probability calculations for pilot's Oxygen pressure warning system.

λ = parameter labelling modes of system operation

P(λ, t) = probability that system is in state λ at time t

C(λ, t) = cost of state λ at time t

Reliability Risk  $R(t) = \int C(\lambda, t) P(\lambda, t) d\lambda$

$$= \sum_{\lambda=1}^N C(\lambda, t) P(\lambda, t)$$

If P(λ, t) depends on design parameters a<sub>1</sub>, ..., a<sub>r</sub>

$$P(\lambda, t; a_1, \dots, a_r)$$

set  $\frac{\partial P}{\partial a_i} = 0$  for minimum-risk design criteria

Fig. 3. Reliability calculations for warning system taking time factor into account.

the 0 position, it will give an incorrect indication when a 1 is transmitted. When 0 is transmitted, on the other hand, it will give a correct indication. Thus, half of the time correct results occur even if the relay is not working. The final conclusion, then (Case III in Fig. 1) is that an individual relay error rate of 22 per 1000 can be tolerated, or about four times the original estimate.

Still further thought on the above example might well lead to the conclusion that where R<sub>8</sub> is worth only 1 per cent in information, only seven relays are required instead of eight. This would result in cost reduction and simplification of the system.

### Example 3

Consider another example—a hypothetical system for supplying a pilot with oxygen at high altitudes. A warning device is included which operates an alarm when the partial pressure of the oxygen falls below a prescribed limit. When the alarm goes off, the pilot knows that his supply is endangered for one reason or another, and that he must take steps to restore it by increasing the flow from the storage cylinder attached to the system, switching in a reserve cylinder, or some other appropriate action. None of these actions for increasing the oxygen flow amounts to more than a minor annoyance to the pilot. If, however, the alarm system fails to operate, the pilot's reflexes may deteriorate to such an extent, before he realizes what has happened, that his safety is jeopardized.

To approach the question of system reliability assumptions must be made as to the risks involved in the various types of failure. As shown in Fig. 2, let P be the probability that the alarm system is in working order, and let σ be the probability of pressure failure. Also, assume that the two are statistically independent. A relative risk of zero can be assigned to the situation in which both pressure and alarm system are operating properly, a risk of unity to the case where pressure is not operating correctly but the alarm device is working, and a risk of 100 to the case where the pressure is incorrect and the alarm system does not operate. These are the risks, or values, of the possible malfunctions. Now, setting up the overall system risk, omitting the question of time variation of these probabilities, we get:

$$R = \sigma P + 100\sigma(1-P) = \sigma(100 - 99P)$$

One might first assume that a risk of more than one unit is intolerable, the risk involved in low pressure when the alarm is working. One can then find the relationship between the two probabilities, σ and P. For example: for σ=0.1, it is required that P>0.91; while for σ=0.05 it is only necessary that P>0.81. In fact, it can easily be computed that if one keeps the likelihood of pressure failure below 0.01 there is no need for the warning device at all.

If one applies the formula to the design objective of minimum possible risk, which might well be the objective, values of σ and P that can be achieved

## ridiculous! you can't mix magic and Pulse Transformers



but—sir—you're wrong  
and here's why...

Samples appear with almost magic speed when you turn your pulse transformer problems over to Aladdin. We have a long list of stock items, plus the know-how to meet your specific performance requirements—if you'll give us just a hint about the circuit and what it's supposed to do.

Our construction is standard. We're big enough to stock thousands of standard core parts in readiness for your orders. We move with magic speed when we learn of a new requirement. We deliver quality components on schedule.

Send the coupon for our engineering bulletins.



ALADDIN RADIO INDUSTRIES, INC.  
715 Murfreesboro Road, Nashville 2, Tenn.

Send me technical information on Pulse Transformers.

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_

CIRCLE 15 ON READER-SERVICE CARD FOR MORE INFORMATION



# Now... 2 ratings in 1 circuit breaker



... for new simplicity in circuit wiring

From HEINEMANN . . . a new circuit breaker . . . *Dual-Rated* to protect equipment designed for operation on two different voltages—such as 6 or 12 V dc, 110 or 220 V ac.

Here is a practical way to reduce wiring complexity and manufacturing time . . . while improving equipment protection. For one Dual-Rated Circuit Breaker has two ampere ratings . . . provides constant overcurrent protection for either operating voltage . . . and serves as the common main power switch as well.

HEINEMANN Dual-Rated Circuit Breakers may be specified in any odd or fractional current ratings from 1 to 40 amperes, with standard current ratios of 2 to 1, special ratios up to 4 to 1. Your selection of time-delay characteristics or instantaneous overload response.

Obtain full information simply by sending for Bulletin 3430.

## HEINEMANN

HEINEMANN ELECTRIC COMPANY  
156 Plum Street, Trenton 2, N. J.

*Circuit breakers*

CIRCLE 16 ON READER-SERVICE CARD FOR MORE INFORMATION



must be considered. It is not unreasonable to assume that these depend largely upon maintenance. Maintenance devoted to the pressure system itself may be assigned a parameter  $\alpha$ ; and let

$$\alpha(x) = e^{-\alpha x}$$

Similarly, maintenance on the warning system ( $\beta$ ) may be written

$$P(\beta) = e^{-\beta x}$$

The expression for the reliability risk now becomes

$$R = e^{-\alpha} + 99e^{-(\alpha+\beta)}$$

Thus, increasing the maintenance effort on either the supply system,  $\alpha$ , or the warning system,  $\beta$ , decreases the risk, but the rate of decrease is greater with  $\alpha$  than with  $\beta$ .

Adding a further condition that the total rate of maintenance effort is fixed  $K = \alpha + \beta$ , the risk expression can be written, in terms of either  $\gamma$  or  $\beta$ , as

$$R(\alpha, K) = e^{-\alpha} + 99e^{-K}$$

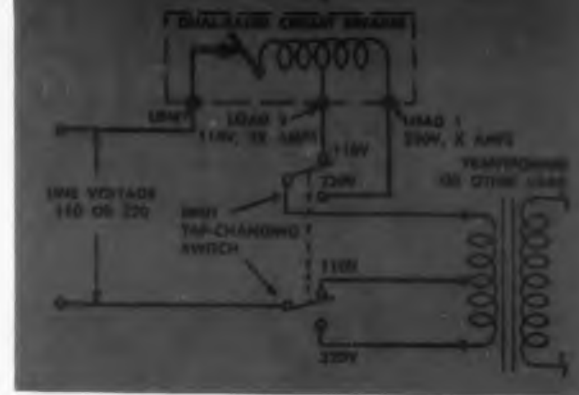
$$R(\beta, K) = e^{-(K-\beta)} + 99e^{-K}$$

The way to minimize the risk in this example, then, is to make  $\alpha = K$  and set  $\beta = 0$ . This means that all attention is given to the pressure system itself, letting the alarm system stop working completely. Certain assumptions have been made as to the relative values of failure and to the effect of maintenance efforts. Different assumptions would, of course, lead to different conclusions.

The last example contained the main elements of a system reliability calculation: probabilities of failure together with dependence on maintenance associated risks, and an overall measure of reliability risk. The time parameter has been omitted; yet, it should not be over-looked that failure probabilities and risks are time dependent. It is perhaps worth formulating a somewhat general expression containing these relationships. As shown in Fig. 3, let  $\lambda$  be a performance parameter which represents the possible modes of operation of the system. For an analog computer it might be a continuous variable giving the output accuracy, depending on partial system failures. For the oxygen supply system discussed above, it might have four discrete values: complete operation, failure of the pressure system, failure of the alarm system, and failure of both systems. In terms of these significant states of the system one can define the probability function  $P(\lambda, t)$  giving the probability density that  $\lambda$  will have some particular value at time  $t$ . Associated with each state of the system is an operational risk, given by  $C(\lambda, t)$ . Note that this risk can also be time dependent since the importance of various modes of system operation can be a function of time. For example, in the oxygen system, failures are not important at the beginning and end of a flight, when the aircraft is at low altitudes, for which auxiliary oxygen is not necessary. In terms of these functions, the overall reliability risk of the system can be defined as

$$R(t) = \int C(\lambda, t) P(\lambda, t) d\lambda$$

By explicitly writing out this expression for the system, including (where relevant) the effects of main-



A TYPICAL APPLICATION . . . Here a Heinemann Dual-Rated Circuit Breaker is used to protect a transformer capable of operating on either of two different voltages. Similar applications can be made on any equipment having provisions for two different input voltages.

ance and similar factors, one can study in a quantitative way the dependence of the overall system reliability on the many design parameters.

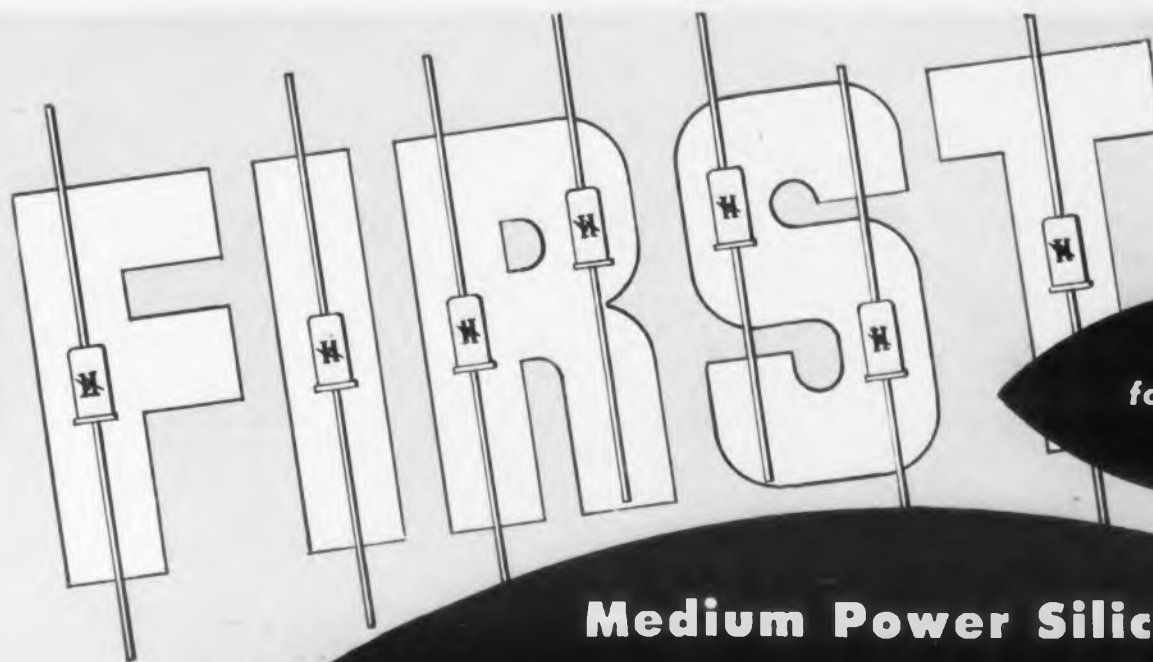
It is perhaps worth pointing out what determines the two functions  $C(\lambda, t)$  and  $P(\lambda, t)$ . The risk function,  $C(\lambda, t)$  is properly independent of the system design. It is purely determined by the operational purpose of the system, and by the cost of the partial failures of that purpose. The specific system design, maintenance, etc., enter in the function  $P(\lambda, t)$  which describes the probability of actual performance using a given, specific design. Thus, the designer has the function  $P(\lambda, t)$  to work with and should study which failures are costly and which are not before fixing a system concept.

It is a common misconception among system designers that simplicity means reliability, and that complexity means unreliability. This is only partially true since properly chosen complexity can provide increased reliability. Perhaps the best example of this is to be found in the system most commonly met in an engineering laboratory—namely, the engineers themselves. If one computes the number of cells in a human being and estimates the expected time-to-failure of the average cell, one has the data on the basis of which many pseudo-correct reliability calculations can be made. It is easy to show that a human being can only function for the first few days of life, and after that, everything has begun to go so seriously wrong that he ought to be tossed out. If not yet obsolete, he is, by his first birthday, at least obsolescent. In a sense, none of us satisfy JAN specs.

The ability of our bodies to readjust and maintain relatively steady output function while our detailed internal function is going rapidly and inexorably to pot, makes us act like the proverbial "One Horse Shy" in many ways. This "homeostasis" depends on our internal complexity. And our feeling that we do function satisfactorily during most of our lives is based on our assignment of function value: We measure our ability to function by our external actions, not by an examination of the relative hardness of our arteries or the detailed reaction times of our nervous systems.

It is an axiom of communication theory that one can swap bandwidth for signal-to-noise ratio to achieve a desired system reliability, and while it is perhaps not possible now to formulate these relationships as precisely for reliability as it is for communication capacity. The approach of defining reliability risk in terms of cost malfunction, and examining semi-quantitatively, the effects of differing system designs, maintenance procedures, and alternate modes of operation, in terms of their effect on the average risk, or operational success, is becoming of increasing importance as a basic design tool.

\* Based on a talk given by Dr. Kohlenberg at the 1956 New England Radio-Electronics Meeting at the Sheraton-Plaza Hotel, Boston, Mass., April 23, 1956.



Available  
for Immediate  
Delivery!

## Medium Power Silicon DIFFUSED Junction Rectifiers

with High Forward Conduction Independent of Reverse Voltage Ratings . . .

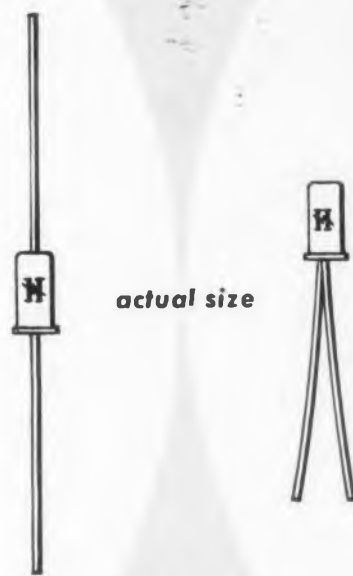
for all applications

including those involving

### AUTOMATION

These medium power silicon *diffused* junction rectifiers are designed for heavy forward conduction without the necessity of using an external heat sink.

Two types are provided to allow a choice of mounting: a two wire single ended type identical in size and physically interchangeable in mounting systems developed for the widely used IN200 series of alloy junction diodes; and an axial lead type\* for automation, printed circuit board or terminal board assemblies. Both types have exceptionally good stability, are highly efficient (approximately 99%) and can operate in ambients ranging from  $-65^{\circ}\text{C}$  to  $+175^{\circ}\text{C}$ .



Type	Max. Recurrent Inverse Working Voltage — $V_{R}$ (Volts)	Min. Zener (breakdown) Voltage — $E_z$ (Volts) (Note 1)	Max. RMS Voltage (Volts)	25°C Ambient Max. Avg. Forward Current — $I_{F}$ (Milliamps.)	Max. Avg. Forward Voltage at $I_F = 500$ mA (Volts)	125°C Ambient Max. Avg. Forward Current (Milliamps.)
HMP1 HMP1A*	50	70	35	500	1	250
HMP2 HMP2A*	100	125	70	500	1	250
HMP3 HMP3A*	200	250	140	500	1	250
HMP4 HMP4A*	300	375	210	500	1	200
HMP5 HMP5A*	400	500	280	500	1	200

Note 1 — Measured at a reverse current ( $I_R$ ) of 0.1 mA  
 Note 2 — Derate to 0 forward current at 175°C Ambient  
 Note 3 — Cathode is electrically connected to the case  
 \* — Axial lead types

We invite  
your inquiry



Hoffman Semiconductor Division  
of  
Hoffman Electronics Corporation

930 Pitner Avenue, Evanston, Illinois

MANUFACTURERS OF: silicon junction diodes - zener reference elements high power rectifiers - solar cells

formerly  
National Semiconductor Products

CIRCLE 17 ON READER-SERVICE CARD FOR MORE INFORMATION

Table II - 1

Element Values (in ohms, henrys, farads) for a Normalized Tschebyscheff Filter with 1/2-db Ripple  
( $\epsilon = 0.3493$ ,  $\epsilon^2 = 0.1220$ )

Value of n	$C_1$ or $L_1'$	$L_2$ or $C_2'$	$C_3$ or $L_3'$	$L_4$ or $C_4'$	$C_5$ or $L_5'$	$L_6$ or $C_6'$	$C_7$ or $L_7'$	$L_8$ or $C_8'$	$C_9$ or $L_9'$	$L_{10}$ or $C_{10}'$	$R_n$ or $1/R_n'$
a) D = 0 (For this case unprimed values correspond to a current-source input for n odd and to a voltage-source input for n even.)											
1	.3493										$\infty$
2	.7014	.9403									0
3	.7981	1.3001	1.3465								$\infty$
4	.8352	1.3916	1.7279	1.3138							0
5	.8529	1.4291	1.8142	1.6426	1.5388						$\infty$
6	.8627	1.4483	1.8494	1.7101	1.9018	1.4042					0
7	.8686	1.4596	1.8675	1.7371	1.9712	1.7254	1.5982				$\infty$
8	.8725	1.4666	1.8750	1.7508	1.9980	1.7838	1.9571	1.4379			0
9	.8752	1.4714	1.8856	1.7591	2.0116	1.8055	2.0203	1.7571	1.6238		$\infty$
10	.8771	1.4748	1.8905	1.7645	2.0197	1.8165	2.0432	1.8119	1.9816	1.4539	0
b) D = 1/2											
1	.5240										2.0000
2	1.0522	.8928									.42426
3	1.1972	1.2686	1.4940								1.6026
4	1.2527	1.3564	2.0409	1.0924							.43600
5	1.2793	1.3905	2.1601	1.4640	1.6242						1.5753
6	1.2940	1.4073	2.2060	1.5380	2.1663	1.1338					.43809
7	1.3029	1.4171	2.2287	1.5651	2.2716	1.5058	1.6619				1.5679
8	1.3088	1.4230	2.2422	1.5781	2.3099	1.5755	2.2046	1.1487			.43882
9	1.3128	1.4270	2.2507	1.5856	2.3284	1.5999	2.3055	1.5213	1.6779		1.5649
10	1.3157	1.4299	2.2564	1.5903	2.3389	1.6114	2.3406	1.5895	2.2214	1.1556	.43915
c) D = 1											
1	.6986										1.0000
2	1.4029	.7071									.50402
3	1.5963	1.0967	1.5963								1.0000
4	1.6703	1.1926	2.3661	.8419							.50402
5	1.7058	1.2296	2.5408	1.2296	1.7058						1.0000
6	1.7254	1.2479	2.6064	1.3137	2.4758	.8696					.50402
7	1.7372	1.2583	2.6381	1.3444	2.6381	1.2583	1.7372				1.0000
8	1.7451	1.2647	2.6564	1.3590	2.6964	1.3389	2.5093	.8796			.50402
9	1.7504	1.2690	2.6678	1.3673	2.7239	1.3673	2.6678	1.2690	1.7504		1.0000
10	1.7543	1.2721	2.6754	1.3725	2.7392	1.3806	2.7231	1.3485	2.5239	.8842	.50402
d) D = 2											
1	1.0479										.50000
2	2.1043	.4464									.42426
3	2.3944	.7916	1.9187								.62397
4	2.5055	.8899	3.1110	.5462							.43600
5	2.5587	.9293	3.4028	.8827	2.0153						.63480
6	2.5880	.9491	3.5106	.9664	3.2124	.5669					.43809
7	2.6057	.9604	3.5616	.9982	3.4944	.9038	2.0436				.63780
8	2.6176	.9674	3.5903	1.0136	3.5963	.9839	3.2428	.5743			.43882
9	2.6257	.9722	3.6078	1.0224	3.6436	1.0132	3.5220	.9119	2.0544		.63903
10	2.6314	.9755	3.6194	1.0279	3.6694	1.0271	3.6213	.9909	3.2560	.5778	.43915
e) D = 3											
1	1.3972										.33333
2	2.8058	.3140									.33571
3	3.1926	.5999	2.3205								.45860
4	3.3406	.6895	3.9223	.3958							.35545
5	3.4115	.7267	4.3318	.6735	2.4111						.47164
6	3.4507	.7455	4.4827	.7483	4.0228	.4131					.35918
7	3.4743	.7565	4.5532	.7776	4.4262	.6914	2.4366				.47530
8	3.4902	.7633	4.5925	.7919	4.5730	.7628	4.0521	.4194			.36048
9	3.5009	.7679	4.6162	.8002	4.6408	.7895	4.4537	.6984	2.4474		.47682
10	3.5086	.7711	4.6318	.8054	4.6774	.8023	4.5984	.7687	4.0646	.4223	.36109

Louis Weinberg

Research Laboratories, Hughes Aircraft Co., Culver City, Calif

TABLES presented in this series of articles make the design of three classes of practical networks simple. The tables give the element values for the normalized low-pass network with a Butterworth, Tschebyscheff, or Bessel-polynomial characteristic. To convert the normalized element values to practical design values requires only simple multiplications. The low-pass networks that are realized can also be transformed in a straightforward manner to serve high-pass, band-pass, or band-elimination functions. In Part I, Butterworth characteristics were covered (*ED, Sept. 15, 1956, p. 22*). In this part II, several Tschebyscheff characteristics are covered. Parts III and IV will cover additional Tschebyscheff characteristics, Bessel Functions, and conversions and transformation data.

### Tschebyscheff Characteristic

The Tschebyscheff<sup>1</sup> approximation to the magnitude characteristic of a low-pass filter is given by

$$\left| Z_{21}(j\omega) \right|^2 = \frac{1}{1 + [\epsilon T_n(\omega)]^2} \quad (3)$$

Here the parameter  $\epsilon$  is the ripple factor and  $T_n(\omega)$  is the Tschebyscheff polynomial of order (and degree  $n$ ). The first ten orders of  $T_n$  are given in Table II-3. The role played by  $\epsilon$  and the equal-ripple quality of the Tschebyscheff approximation are illustrated in Fig. II-1, where  $n = 3$  and a 1 db ripple are used.

From the magnitude given by Eq. 3 the complete transfer function can be found. It is given by

$$Z_{21}(s) = \frac{H}{V_n(s)} \quad (4)$$

where  $H$  again is a constant and  $V_n$  is formed from the left half-plane zeros of the denominator of Eq. 3.  $V_n$  is a polynomial of degree  $n$  with the coefficient of  $s^n$  equal to unity.



# Synthesis

## From Tables - II

Table II - 2

Element Values (in ohms, henrys, farads) for a Normalized Tschebyscheff Filter with 1-db Ripple ( $\epsilon = 0.5088$ ,  $\epsilon^2 = 0.2589$ ).

Value of n	$C_1$ or $L_1'$	$L_2$ or $C_2'$	$C_3$ or $L_3'$	$L_4$ or $C_4'$	$C_5$ or $L_5'$	$L_6$ or $C_6'$	$C_7$ or $L_7'$	$L_8$ or $C_8'$	$C_9$ or $L_9'$	$L_{10}$ or $C_{10}'$	$R_n$ or $1/R_n'$
a) D = 0 (For this case unprimed values correspond to a current-source input for n odd and to a voltage-source input for n even.)											
1	.5088										$\infty$
2	.9110	.9957									0
3	1.0118	1.3332	1.5088								$\infty$
4	1.0495	1.4126	1.9093	1.2817							0
5	1.0674	1.4441	1.9938	1.5906	1.6652						$\infty$
6	1.0773	1.4601	2.0270	1.6507	2.0491	1.3457					0
7	1.0832	1.4694	2.0437	1.6736	2.1192	1.6489	1.7118				$\infty$
8	1.0872	1.4751	2.0537	1.6850	2.1453	1.7021	2.0922	1.3691			0
9	1.0899	1.4790	2.0601	1.6918	2.1583	1.7213	2.1574	1.6707	1.7317		$\infty$
10	1.0918	1.4817	2.0645	1.6961	2.1658	1.7306	2.1803	1.7215	2.1111	1.3801	0
b) D = 1/2											
1	.7633										2.0000
2	1.3665	.8767									.32080
3	1.5177	1.1950	1.7806								1.7047
4	1.5743	1.2645	2.3525	1.0275							.32635
5	1.6012	1.2909	2.4701	1.3364	1.9021						1.6836
6	1.6159	1.3038	2.5144	1.3948	2.4641	1.0580					.32735
7	1.6248	1.3112	2.5361	1.4159	2.5682	1.3658	1.9368				1.6778
8	1.6308	1.3157	2.5490	1.4258	2.6054	1.4209	2.4979	1.0688			.32770
9	1.6348	1.3188	2.5570	1.4315	2.6232	1.4399	2.5978	1.3766	1.9515		1.6755
10	1.6377	1.3209	2.5624	1.4350	2.6333	1.4488	2.6321	1.4306	2.5126	1.0738	.32786
c) D = 1											
1	1.0177										1.0000
2	1.8219	.6850									.37598
3	2.0236	.9941	2.0236								1.0000
4	2.0991	1.0644	2.8311	.7892							.37598
5	2.1349	1.0911	3.0009	1.0911	2.1349						1.0000
6	2.1546	1.1041	3.0634	1.1518	2.9367	.8101					.37598
7	2.1664	1.1116	3.0934	1.1736	3.0934	1.1116	2.1664				1.0000
8	2.1744	1.1161	3.1107	1.1839	3.1488	1.1696	2.9685	.8175			.37598
9	2.1797	1.1192	3.1215	1.1897	3.1747	1.1897	3.1215	1.1192	2.1797		1.0000
10	2.1836	1.1213	3.1286	1.1933	3.1890	1.1990	3.1738	1.1763	2.9824	.8210	.37598
d) D = 2											
1	1.5265										.50000
2	2.7329	.4384									.32080
3	3.0354	.7010	2.5873								.58660
4	3.1486	.7677	3.8748	.5138							.32635
5	3.2023	.7938	4.1585	.7668	2.6957						.59397
6	3.2319	.8066	4.2609	.8231	3.9829	.5290					.32735
7	3.2496	.8140	4.3334	.8439	4.2552	.7815	2.7261				.59601
8	3.2615	.8186	4.3361	.8538	4.3510	.8353	4.0151	.5344			.32770
9	3.2696	.8216	4.3526	.8594	4.3951	.8544	4.2841	.7871	2.7390		.59685
10	3.2754	.8238	4.3635	.8630	4.4190	.8633	4.377	.8401	4.0290	.5369	.32786
e) D = 3											
1	2.0354										.33333
2	3.6439	.3131									.25776
3	4.0472	.5296	3.2077								.42057
4	4.1981	.5887	4.9727	.3741							.26734
5	4.2698	.6124	5.3738	.5817	3.3182						.42893
6	4.3092	.6242	5.5175	.6309	5.0886	.3866					.26913
7	4.3328	.6310	5.5840	.6494	5.4805	.5939	3.3489				.43127
8	4.3487	.6352	5.6213	.6583	5.6187	.6407	5.1223	.3910			.26976
9	4.3594	.6381	5.6437	.6634	5.6818	.6576	5.5117	.5986	3.3620		.43223
10	4.3671	.6401	5.6584	.6666	5.7159	.6656	5.6472	.6447	5.1368	.3931	.27005

Each value of  $\epsilon$  yields a different set of  $V_n$  polynomials. The zeros of these polynomials are given in Table II-4 and their coefficients are listed in Table II-5.

The element values of the ladder networks for values of  $\epsilon$  corresponding to 1/2 and 1 db ripple (also 2 db, in part IV) and for decrement ratios of 0, 1/2, 1, 2, and 3 are presented in Tables II-1 and II-2.

After the value of  $\epsilon$  has been calculated from a specified ripple factor, it is necessary to determine the required value of  $n$ . Formulas useful for this purpose are

$$T_n(\omega) = \frac{(\omega + \sqrt{\omega^2 - 1})^n + (\omega - \sqrt{\omega^2 - 1})^{-n}}{2} \quad (5)$$

or

$$T_n(\omega) = \frac{(\omega - \sqrt{\omega^2 - 1})^n + (\omega + \sqrt{\omega^2 - 1})^{-n}}{2} \quad (6)$$

Table II - 3 Tschebyscheff Polynomials  $T_n(\omega) = \cos(n \arccos \omega)$  for n Running from 1 through 10

n	$T_n(\omega)$
1	$\omega$
2	$2\omega^2 - 1$
3	$4\omega^3 - 3\omega$
4	$8\omega^4 - 8\omega^2 + 1$
5	$16\omega^5 - 20\omega^3 + 5\omega$
6	$32\omega^6 - 48\omega^4 + 18\omega^2 - 1$
7	$64\omega^7 - 112\omega^5 + 56\omega^3 - 7\omega$
8	$128\omega^8 - 256\omega^6 + 160\omega^4 - 32\omega^2 + 1$
9	$256\omega^9 - 576\omega^7 + 432\omega^5 - 120\omega^3 + 9\omega$
10	$512\omega^{10} - 1280\omega^8 + 1120\omega^6 - 400\omega^4 + 500\omega^2 - 1$

### Example

The use of the tables is illustrated in the example below.

Determine a ladder network that has the following characteristics:

1. Low-pass filter with a peak-to-peak ripple in the squared magnitude characteristic not exceeding 15%.
2. A cutoff radian frequency  $\omega_c = 5000$  (the bandwidth being measured at the minimum value of the ripple).

3. Resistance terminations at both ends with the load resistance equal to 1000 ohms.

4. The response is to be down at least 50 db at  $\omega = 4\omega_c$ .

5. The network is to be driven by a current source.

We first calculate the required value of  $\epsilon^2$ . At a trough of the ripple we have

$$\frac{1}{1 + \epsilon^2 T_n^2(1)} = 1 - 0.15 = 0.85$$

$$1 + \epsilon^2 = \frac{20}{17}$$

$$\epsilon^2 = 0.176$$

Since this value lies between 1/2 db and 1 db ripple we must use Table II-1.

Now we calculate  $n$ . At  $\omega = 4$ ,

$$\frac{1}{1 + \epsilon^2 T_n^2(4)} = 10^{-5}$$

$$1 + \epsilon^2 T_n^2(4) = 10^5$$

$$\epsilon^2 T_n^2(4) \cong 10^5$$

$$T_n(4) = 753$$

Now using Eq. 5, we have

$$\left. \frac{(\omega + \sqrt{\omega^2 - 1})^n + (\omega + \sqrt{\omega^2 - 1})^{-n}}{2} \right|_{\omega=4} = 753$$

$$(\omega + \sqrt{\omega^2 - 1})^n \Big|_{\omega=4} \cong 1506$$

Table II-4 Zeros of Polynomials  $V_n$  derived from the Tschebyscheff Approximation

a) 1/2-db ripple ( $\epsilon = 0.3493114$ ,  $\epsilon^2 = 0.1220184$ )

$n=1$	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=8$	$n=9$	$n=10$
-2.8627752	-0.7128122 $\pm j1.0040425$	-0.6264565	-0.1753531 $\pm j1.0162529$	-0.3623196	-0.0776501 $\pm j1.0084608$	-0.2561700	-0.0436201 $\pm j1.0050021$	-0.1984053	-0.0278994 $\pm j1.0032732$
		-0.3132282 $\pm j1.0219275$	-0.4233398 $\pm j0.4209457$	-0.1119629 $\pm j1.0115574$	-0.2121440 $\pm j0.7382446$	-0.0570032 $\pm j1.0064085$	-0.1242195 $\pm j0.8519996$	-0.0344527 $\pm j1.0040040$	-0.0809672 $\pm j0.9050658$
				-0.2931227 $\pm j0.6251768$	-0.2897940 $\pm j0.2702162$	-0.1597194 $\pm j0.8070770$	-0.1859076 $\pm j0.5692879$	-0.0992026 $\pm j0.8829063$	-0.1261094 $\pm j0.7182643$
						-0.2308017 $\pm j0.4478939$	-0.2192929 $\pm j0.1999073$	-0.1519873 $\pm j0.6553170$	-0.1589072 $\pm j0.4611541$

b) 1-db ripple ( $\epsilon = 0.5088471$ ,  $\epsilon^2 = 0.2589254$ )

$n=1$	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=8$	$n=9$	$n=10$
-1.9652267	-0.5488672 $\pm j0.8951286$	-0.4941706	-0.1395360 $\pm j0.9833792$	-0.2894933	-0.0621810 $\pm j0.9934115$	-0.2054141	-0.0350082 $\pm j0.9964513$	-0.1593305	-0.0224144 $\pm j0.9977755$
		-0.2470853 $\pm j0.9659987$	-0.3368697 $\pm j0.4073290$	-0.0894584 $\pm j0.9901071$	-0.1698817 $\pm j0.7272275$	-0.0457089 $\pm j0.9952839$	-0.0996950 $\pm j0.8447506$	-0.0276674 $\pm j0.9972297$	-0.1013166 $\pm j0.7143284$
				-0.2342050 $\pm j0.6119198$	-0.2320627 $\pm j0.2661837$	-0.1280736 $\pm j0.7981557$	-0.1492041 $\pm j0.5644443$	-0.0796652 $\pm j0.8769490$	-0.0650493 $\pm j0.9001063$
						-0.1850717 $\pm j0.4429430$	-0.1759983 $\pm j0.1982065$	-0.1220542 $\pm j0.6508954$	-0.1276664 $\pm j0.4586271$
								-0.1497217 $\pm j0.3463342$	-0.1415193 $\pm j0.1580321$

Table II-5 Polynomials  $V_n$  in Expanded Form  $V_n = s^n + b_{n-1} s^{n-1} + \dots + b_1 s + b_0$

a) 1/2-db ripple ( $\epsilon = 0.3493114$ ,  $\epsilon^2 = 0.1220184$ )

$n$	$b_0$	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	$b_6$	$b_7$	$b_8$	$b_9$
1	2.8627752									
2	1.5162026	1.4256245								
3	0.7156938	1.5348954	1.2529130							
4	0.3790506	1.0254553	1.7168662	1.1973856						
5	0.1789234	0.7525181	1.3095747	1.9373675	1.1724909					
6	0.0947626	0.4323669	1.1718613	1.5897635	2.1718446	1.1591761				
7	0.0447309	0.2820722	0.7556511	1.6479029	1.8694079	2.4126510	1.1512176			
8	0.0236907	0.1525444	0.5735604	1.1485894	2.1840154	2.1492173	2.6567498	1.1460801		
9	0.0111827	0.0941198	0.3408193	0.9836199	1.6113880	2.7814990	2.4293297	2.9027337	1.1425705	
10	0.0059227	0.0492855	0.2372688	0.6269689	1.5274307	2.1442372	3.4409268	2.7097415	3.1498757	1.1400664

b) 1-db ripple ( $\epsilon = 0.5088471$ ,  $\epsilon^2 = 0.2589254$ )

$n$	$b_0$	$b_1$	$b_2$	$b_3$	$b_4$	$b_5$	$b_6$	$b_7$	$b_8$	$b_9$
1	1.9652267									
2	1.1025103	1.0977343								
3	0.4913067	1.2384092	0.9883412							
4	0.2756276	0.7426194	1.4539248	0.9528114						
5	0.1228267	0.5805342	0.9743961	1.6888160	0.9368201					
6	0.0689069	0.3070808	0.9393461	1.2021409	1.9308256	0.9282510				
7	0.0307066	0.2136712	0.5486192	1.3575440	1.4287930	2.1760778	0.9231228			
8	0.0172267	0.1073447	0.4478257	0.8468243	1.8369024	1.6551557	2.4230264	0.9198113		
9	0.0076767	0.0706048	0.2441864	0.7863109	1.2016071	2.3781188	1.8814798	2.6709468	0.9175476	
10	0.0043067	0.0344971	0.1824512	0.4553892	1.2444914	1.6129856	2.9815094	2.1078524	2.9194657	.9159320

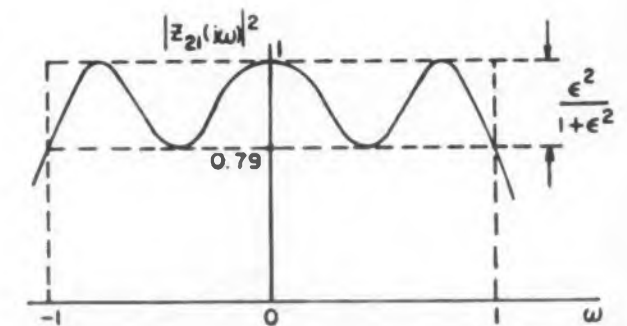


Fig. 11-1 Low-pass filter obtained by using the Tschebyscheff approximation with  $n = 3$  and a 1 db ripple.

$$(7.88)^n = 1506$$

$$n = 3.58$$

Therefore  $n = 4$  will be more than satisfactory.

Since no ratio of decrements or resistances was called for in the specifications, we may use b, c, d or e of Table II-1. Suppose we use both c and d so that we can choose the more practical network for laboratory use. Consulting the Table II-1 c and d for  $n = 4$  we find the normalized element values; we use the unprimed values since the input is a current source. Removing the normalization by multiplying all  $C$ 's by

$\frac{1}{Rw_c} = \frac{1}{5 \times 10^6}$ , all  $L$ 's by  $\frac{R}{w_c} = \frac{1}{5}$ , and the resistances by  $R = 1000$ , we obtain

$$\underline{D = 1}$$

$$\underline{D = 2}$$

$$\frac{1}{5 \times 10^6} C_1 = 0.334 \times 10^{-6}$$

$$\frac{1}{5 \times 10^6} C_1 = 0.501 \times 10^{-6}$$

$$\frac{1}{5} L_2 = 0.238$$

$$\frac{1}{5} L_2 = 0.178$$

$$\frac{1}{5 \times 10^6} C_3 = 0.473 \times 10^{-6}$$

$$\frac{1}{5 \times 10^6} C_3 = 0.622 \times 10^{-6}$$

$$\frac{1}{5} L_4 = 0.168$$

$$\frac{1}{5} L_4 = 0.109$$

$$1000 R_n = 504$$

$$1000 R_n = 436$$

The networks are shown in Fig. II-2.

**Acknowledgment:** The author expresses his thanks to the members of the Mathematics Section, Systems Analysis Department, Hughes Aircraft Company, who carried through the calculations for almost all of the tables in this paper.

#### Reference

4. Amplitude-Frequency Characteristics of Ladder Networks, E. Green, Marconi's Wireless Telegraph Co., Essex, England, 1954.

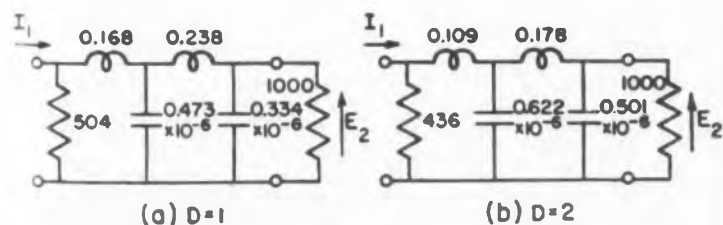


Fig. II-2 Networks obtained in example (values in ohms, henries, and farads).



All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied\* and tiny (actual dimensions: 0.265 by 0.105 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the

opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as... high back resistance... quick recovery... high conductance... or high temperature operation, *specify Hughes*. You will get a diode with mechanical and electrical stability built in. You will get a diode which

was manufactured first of all for reliability.

\*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.



**HUGHES PRODUCTS**

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For descriptive literature please write: HUGHES PRODUCTS · SEMICONDUCTORS

International Airport Station, Los Angeles 45, California

CIRCLE 18 ON READER-SERVICE CARD FOR MORE INFORMATION

© 1956, H. A. C.





#### SUBMINIATURE FILTERS

- for I.F. amplifiers, printed circuit use
- temperature compensated to .15% from  $-55^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- for operations above 1 mc
- dimensions:  $13/16'' \times 2-1/2'' \times 2''$  high



#### ENCAPSULATED TOROIDS

- hermetically sealed
- high Q
- center-mounting permits stacking
- complete range of sizes and types
- dimensions:  $21/32'' \times 3/8''$



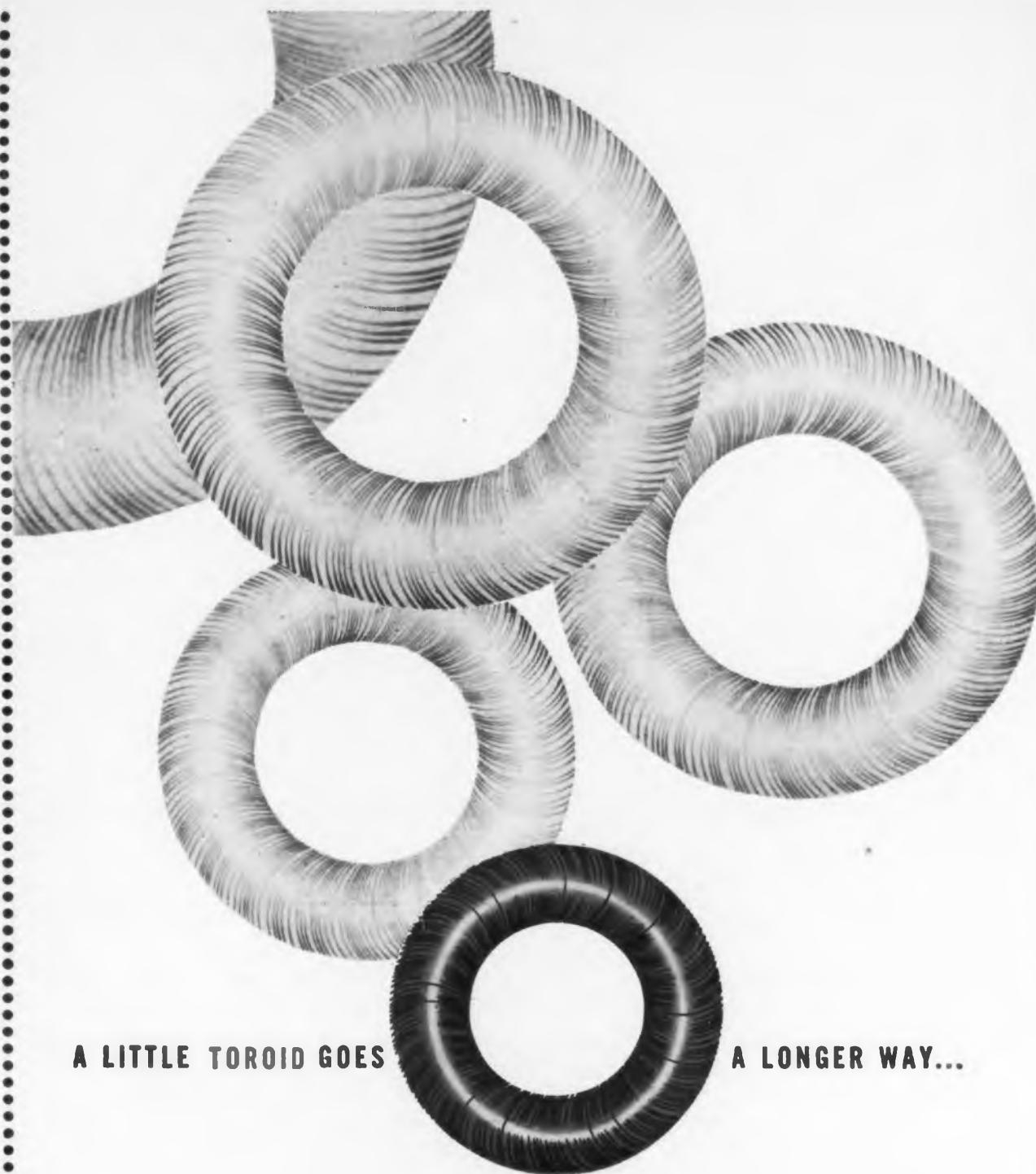
#### TOM THUMB TELEMETERING FILTERS

- miniaturized for guided missiles
- high temperature stability
- designed to withstand shock and vibration
- hermetically sealed —wt. 1.5 oz.
- dimensions:  $45/64'' \times 45/64'' \times 2''$  high



#### SUBMINIATURE ADJUSTOROIDS

- precise continuous adjustment of inductance over a 10% range
- no external control current needed
- hermetically sealed
- low cost—wt. .83 oz.
- dimensions:  $45/64'' \times 45/64'' \times 3/4''$  high



A LITTLE TOROID GOES

A LONGER WAY...

As the toroid shrinks — it expands.

The smaller and more accurate Burnell succeeds in making toroids the wider the applications they continue to find . . . In subminiature filters for aircraft and guided missiles. In communications filters for receivers. In side-band filters for carriers. In filters for telemetering systems. And in an array of other new and remarkably specialized equipment.

Burnell files contain thousands of special designs in subminiature components. If the one you need is not already among them—we will make it for you. Consult us on any network problem. Write today to:—

**Burnell & Co., Inc.**   
first in toroids, filters and related networks

45 WARBURTON AVENUE, YONKERS 2, N. Y. TELEPHONE: YONKERS 5-6800 TELETYPE: NEW YORK 3633  
PACIFIC DIVISION: 720 MISSION STREET, SOUTH PASADENA, CALIFORNIA TELETYPE: PASADENA 7578

CIRCLE 19 ON READER-SERVICE CARD FOR MORE INFORMATION



**T**HREE new miniature ceramic connectors have just been made available for applications where space is at a premium, and where unusual operating conditions are encountered.

Developed and manufactured by Raytheon Manufacturing Company, Ceramic Division, Waltham 54, Mass., the three connectors are a ceramic feed-through terminal (not shown), a miniature coaxial ceramic connector, and a multi-pin ceramic connector.

#### Ceramic Feed-Through Terminal

This terminal, less than 1/4 in. in overall diameter, is of alumina ceramic construction. It is designed for extremely high voltage applications and where high temperature and high altitude operation is anticipated. The all-ceramic construction results in a rugged terminal with the elimination of glass which has the disadvantage of crazing. The terminal meets all military specifications and is available with or without a metal flange. Either type can be soft or hard soldered directly to the chassis or the electronic package. This ceramic terminal passes mass spectrometer leak tests and permits true hermetic sealing of electronic equipment.

#### Multiple-Pin Ceramic Connector

Raytheon's multi-pin ceramic connector has 22 pins, vacuum sealed. This multi-pin connector is designed for hermetic sealing of electronic packages and is particularly adapted to printed circuitry, allowing for plug-in unit construction. The multi-pin connector meets all military specifications, is of rugged construction, and has the same advantage as the ceramic construction of the feed-through terminal mentioned above in that it is particularly useful at high temperatures

Ceramic coaxial miniature connector (left) and multi-pin connector (right)

## Miniature

# Ceramic Connectors

and high altitudes. Constructed of a non-water absorption ceramic, with a dielectric breakdown of 300 v per mil, an extra long creepage path adds to its high voltage operating feature. Other forms than shown can be manufactured, such as circular or linear shapes with other numbers of pin connections.

### Miniature Coaxial Connector

Believed to be the only ceramic coaxial connector of its size available, the coaxial connector shown is only 1/4 in. in diameter but is completely hermetically sealed. The high-shrink ceramic dielectric has a zero water absorption coefficient. Designed for use with subminiature cable, the outer metal conductor shell found on conventional designs has been completely eliminated. This allows further decrease in size. The connector can be soft or hard soldered directly to equipment chassis. It will withstand high shock and vibration and meet all military specifications. Not only is the connector the smallest in diameter but is also the shortest, measuring only 1 in. in length for the right-angle connector shown. The connectors can also be obtained straight if desired.

All of the connectors are good to 650 C or above as far as the connectors themselves are concerned. Temperature limitation may occur, however, because of the method of installation, such as soft soldering, hard soldering, brazing, etc. The connectors are especially adaptable to UHF frequencies and have very low losses in the microwave region, even to "K band."

For further information on these connectors fill out the Readers' Service card and circle No. 20.

# ENGINEERS

AC OFFERS YOU SECURITY

GM's long-standing policy of decentralization creates unlimited opportunities for qualified Electrical, Mechanical Engineers and Engineering Technicians.

DEVOTED TO  
RESEARCH

AC'S new, modern 225,000 square feet, glass-masonry, aluminum plant (being built in suburban Milwaukee) is another step in GM's Electronics Division's Permanent, Progressive Program.

For a confidential opinion as to how YOU can fit BEST in our Challenging Program write to us today.

AC



AVIONICS - MISSILE GUIDANCE  
- JET ENGINE FUEL CONTROLS - COMPUTERS  
- COMMUNICATION EQUIPMENT - CIVIL DEFENSE  
AVIATION - AUTOMOTIVE ELECTRONIC PRODUCTS

all offer you personally, opportunities that demand investigation. To arrange personal, confidential interview in your territory, write today to  
Mr. John F. Heffinger,  
Supervisor of Salaried Personnel.

AC THE ELECTRONICS DIVISION  
General Motors Corporation

Milwaukee 2, Wisconsin

Flint 2, Michigan

“Why, there’s an  
office here for  
**PHILLIPS**”



A Phillips man is just minutes away in many leading cities. He’s your local man with the *Phillips Plan*—a special combination of engineering skill\* and personal service, unique in the industry. A phone call or telegram will put the plan in action for you.

\*  
**FOR EXAMPLE:**  
*Phillips Engineered Relays*  
are used in the instrumentation program behind today’s industrial automation.



**TYPE 4COA** —  
Miniature multi-contact relay; highly sensitive, long lived, fast operation. O.D. 1-11/16" L x 1-1/8" W.



**TYPE 12QA / TYPE 12AC** — Power relay, six pole. Economical. O.D. 1" W x 1-23/32" L x 2-3/16" H.



**20489 TYPE 2** — Multi-contact enclosed plug-in relay. Available 8 through 20 pin plug. O.D. 2-1/16" W x 3-1/16" L x 5-1/16" H.

MULTI-CONTACT, POWER, HERMETICALLY SEALED RELAYS - ACTUATORS

# PHILLIPS

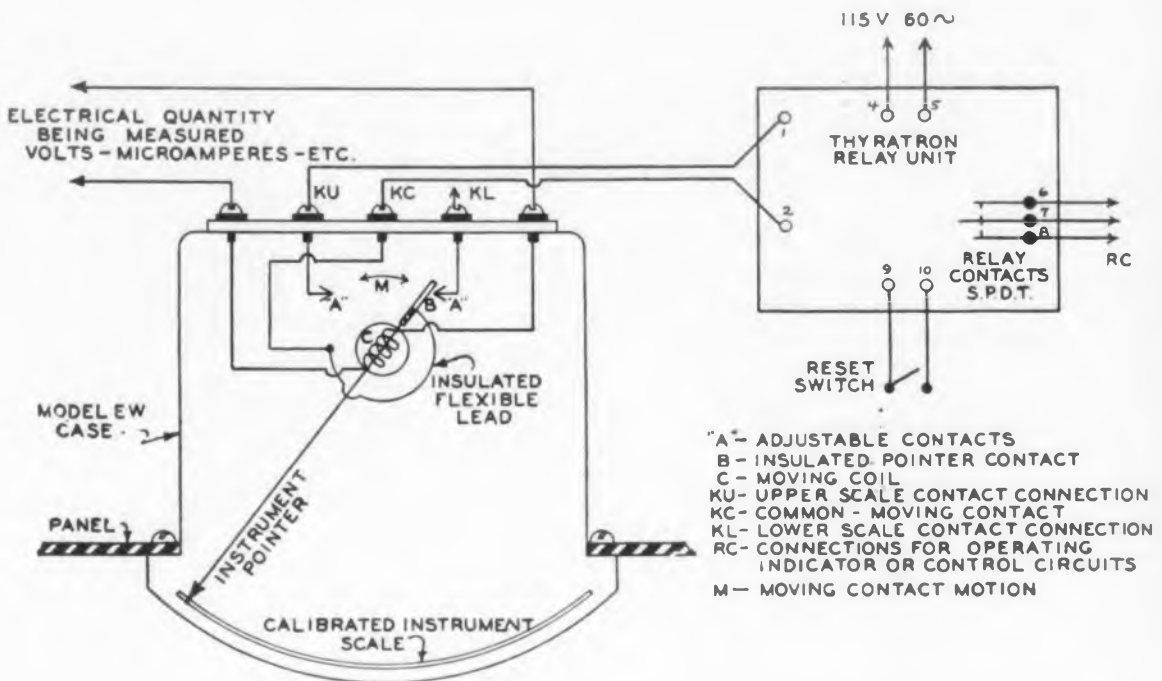
A THOR CORPORATION SUBSIDIARY

**PHILLIPS CONTROL CORPORATION . . . JOLIET, ILLINOIS**

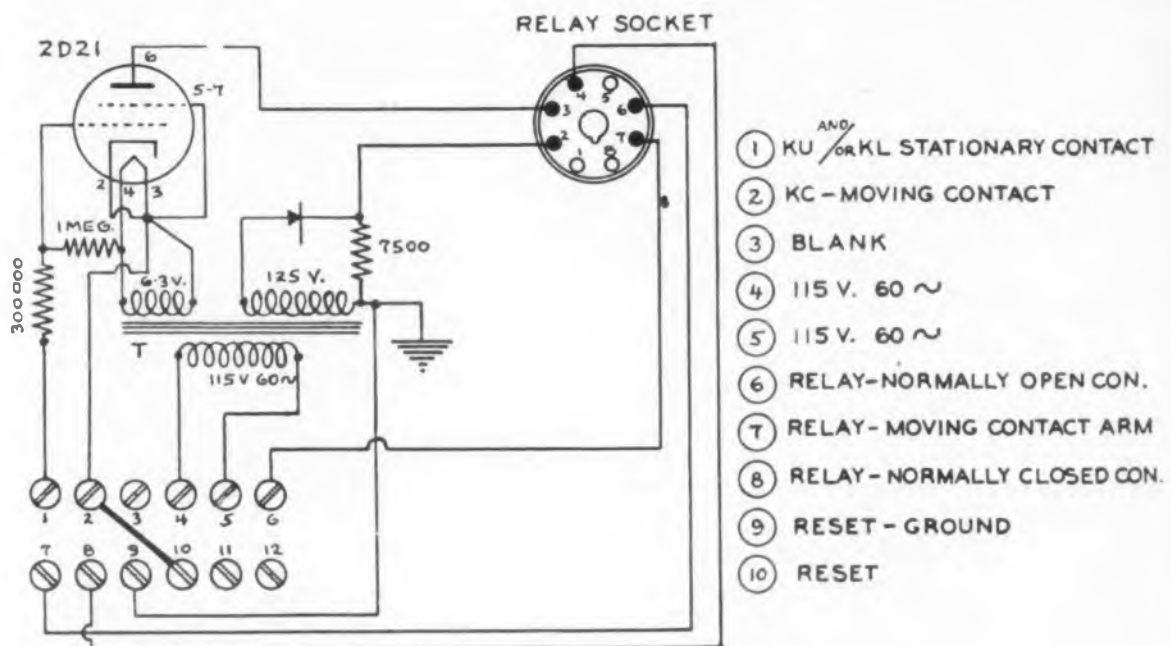
SALES OFFICES: NEW YORK - PHILADELPHIA - SAN FRANCISCO - DENVER - SEATTLE  
SANTA MONICA - CLEVELAND - DALLAS - BOSTON - WASHINGTON



# Precision Contact Making Deflection Meter



Instrument schematic, showing connection to typical relay unit.



Suggested companion contact relay unit schematic.

# Compare **LEACH** before you buy

*Your own tests will prove  
why so many critical buyers  
specify Leach relays*

Test any Leach relay against any comparable relay on the market. You'll learn in your own laboratory why the aircraft, missile and avionic industries have learned to look for the Leach label when they're looking for:

- Resistance to greater shock and vibration
- Dependability at higher temperatures
- Space-saving design
- Outstanding reliability

That's why you find designers depending more and more on Leach when system reliability is vital and components must not fail!



**T**HIS precise deflection contact-making meter has a wide range of application in controlling other circuits.

Manufactured by Sensitive Research Instrument Corp., New Rochelle, N. Y., the meter consists of three sections: On electrical direct reading deflection indication; a contact mechanism for sensing the indicator position; and a section to close and operate a thyatron relay unit, based upon a preset level of meter deflection.

Full scale deflection of 5-1/2 in. can be caused by an input of only  $4\mu\text{a}$  in the low mvdc region, with an inherent accuracy of 0.5 per cent. Multipliers or shunts can be incorporated to increase the range of meter indications. Both ac or dc sensitive meter movement instruments are made. Required power is 60 cy, 115 v.

The suggested companion thyatron relay unit utilizes a simple circuit with a SPDT relay switch whose contacts are rated at 1 amp, 115 v (non-inductive).

Electrical quantities to be measured, indicated, or controlled are connected to the appropriate binding posts. The connections for use in sensing the upper limit are shown on the instrument schematic. KC is connected to Terminal 2 of the Thyatron Relay Unit and KU is connected to Terminal 1. Sensing the lower limit instead of the upper is accomplished by connecting Terminal 1 of the relay unit to KL instead of KU. If the same signal is desired for either upper or lower limit contacting, the KU and KL binding posts may be connected to Terminal 1 of a single thyatron relay unit. Separate sensing of upper and lower limits requires the use of two thyatron relay units. Sufficient ventilation must be provided to prevent overheating of the unit.

The meter can be readily applied to the field of automatic inspection (electrical go, no-go gaging) or control between maximum and minimum limits.

For additional information on this product, turn to the Reader's Service card and circle 23.



Screw terminals



Potted leads



Solder terminals



Plug-in

*Leach's family of relays . . . offering the important advantages emphasized above*

# LEACH CORPORATION

## LEACH RELAY DIVISION

5915 AVALON BLVD., LOS ANGELES 3, CALIFORNIA

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA  
CIRCLE 24 ON READER-SERVICE CARD FOR MORE INFORMATION

Send for the latest Leach Relay Handbook . . . your best starting point when selecting any relay.





**R<sub>x</sub>**  
*Prescribed for design headaches*

Take as many TRIAD miniature and sub-miniature transformers as required for **good** electrical performance with adequate protection against failure due to environmental conditions, and extremely small size.

TRIAD miniature transformers are ideal for printed circuit use. 32 designs, available in hermetically sealed and open types for all tube and transistor applications, are listed in TRIAD's 1956 General Catalog. TRIAD's Engineering Dept. is available to solve your transformer design headaches.



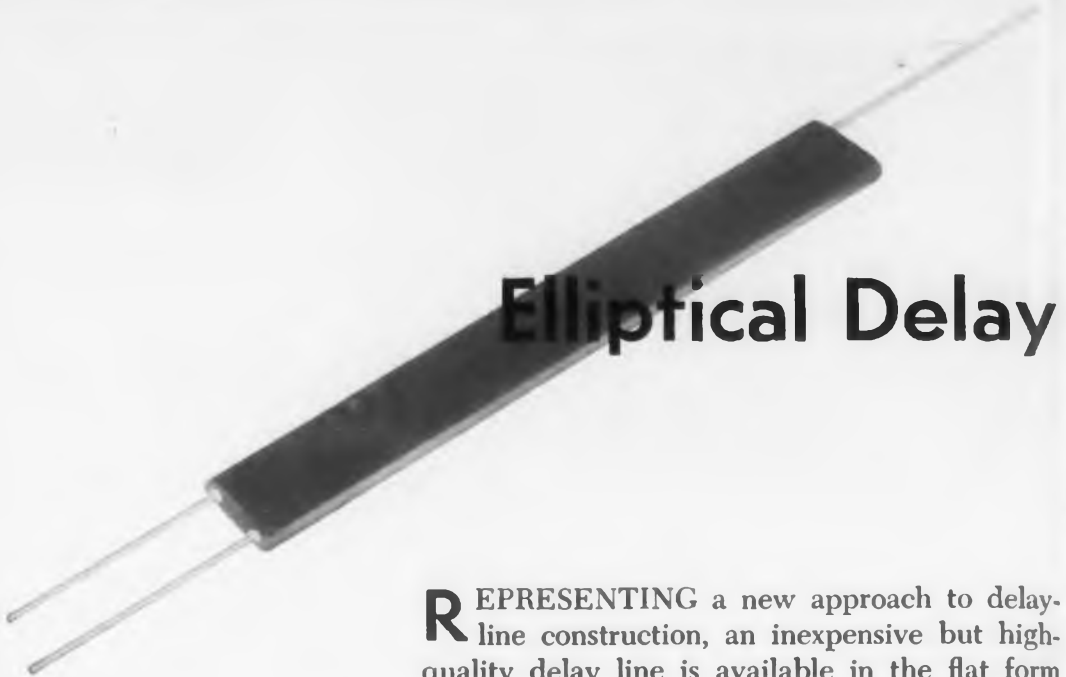
4055 REDWOOD AVE. • VENICE, CALIF.



30

CIRCLE 25 ON READER-SERVICE CARD FOR MORE INFORMATION

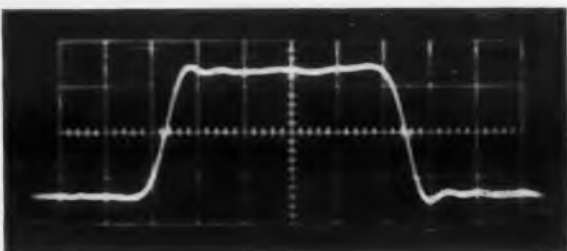




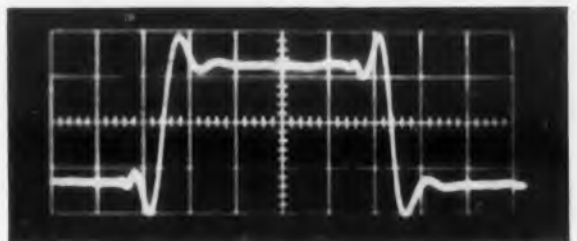
# Elliptical Delay

**R**EPRESENTING a new approach to delay-line construction, an inexpensive but high-quality delay line is available in the flat form shown. Elliptical in cross section, the line appears similar to TV transmission cable. Its size is 5/8 by 3/16 by 5 in. long and is obtainable in an impedance range from 75 to 7500 ohms with delays ranging up to 2  $\mu$ sec and beyond.

Known as a "Delay-Line Flat" and manufactured by Columbia Technical Corporation, of 61-02 31st Ave., Woodside 77, N.Y., this new-type delay line can be mounted in almost any position and location, even flat against a chassis. Because of its elliptical cross section, an advantage over the conventional distributed-parameter delay line of circular cross section results, in that it



Pulse output from 0.7  $\mu$ sec Delay-Line Flats. Impedance, 4000 ohms. Pulse width, 1  $\mu$ sec.



2.1  $\mu$ sec Delay-Line Flat output. Designed for computer application, rise time is only 0.17  $\mu$ sec. A 5.0  $\mu$ sec pulse is applied to the 2500 ohm Delay-Line.



Video amplifier pulse output from commercial TV receiver after passing through 0.7  $\mu$ sec, 1700 ohm Delay-Line Flat.



Pulse output from 0.7  $\mu$ sec Delay-Line. Impedance, 6800 ohms. Pulse width, 1  $\mu$ sec.

# Line

provides greatly increased capacitance per unit length. It also provides greater freedom in the choice of the L/C ratio, making it possible to cover a wider range of impedance and delay using the same core.

Standard low-impedance Flats are available with the following characteristics: 75 ohms at 0.05  $\mu$ sec delay; 120 ohms at 0.10  $\mu$ sec delay; 270 ohms at 0.30  $\mu$ sec delay; and 470 ohms at 0.75  $\mu$ sec delay. Beyond 500 ohms and up to about 1500 ohms, the maximum practical delay is 1.0  $\mu$ sec. Up to 2  $\mu$ sec or greater delay is possible on high-impedance lines varying from approximately 1500 to 7500 ohms. Longer delays can of course be obtained by connecting several Flats in series.


Maximum operating voltage for these lines is from 250 to 1000 v dc depending upon the line. Operating temperature ranges from  $-20$  to  $+80$  C for commercial applications, and through a choice of suitable materials can be widened to meet MIL-E-5400 Specification. Standard delay and impedance tolerances are  $\pm 10\%$  or  $\pm 5\%$ . Closer tolerances can be met if necessary.

The Delay-Line Flats are extremely rugged, and the leads of No. 20 AWG wire are molded into the core thus eliminating the danger of wire breakage. The conductor winding, ground plane, and insulation are covered with an impregnated jacket or are enclosed in a sealed plastic case.

Applications suggested for these delay lines are in the computer field, for tracking equipment, in oscilloscopes, and in the color TV field. A 2  $\mu$ sec Delay-Line Flat having an impedance of 2500 ohms and having a rise time of better than 10% has been recently developed for a computer application. Typical pulses obtained after delay through Delay-Line Flats are shown. A Hewlett-Packard Model 212A Pulse Generator was used to supply the input pulse. Also shown is pulse output from a commercial video amplifier used in a popular color TV receiver after passing through a 0.7  $\mu$ sec 1700 ohm Delay-Line Flat.

For further information about this product, fill out the Reader's Service Card and circle 26.





**keeping  
an idea  
locked  
between  
your ears?**

If that idea deals with the Guided Missile field, you'll find that Firestone has the key to unlock it—and open the door to a happier future for you. Firestone's creative climate and tangible rewards keep that door open to a steady flow of achievement.

Since the turn of the century, Firestone has built its phenomenal progress on men with ideas. Currently, Firestone is carrying forward the Army's vital program for the "Corporal," first surface-to-surface ballistic guided missile. This involves engineering, field test and service, and missile and component development.

But we need more men to fill more key spots than we can list here:

*Electronic Systems  
Propulsion Components  
Flight Simulation  
Mechanical Structures  
and Dynamics  
Field Engineering*

Let's get together to make the most of that idea...and your future. Write us today!

**Firestone**

**GUIDED MISSILE DIVISION**

RESEARCH • DEVELOPMENT • MANUFACTURE

"Find your Future at Firestone"—Los Angeles • Monterey

WRITE: SCIENTIFIC STAFF DIRECTOR, LOS ANGELES 54, CALIF.



THE pentode degenerative amplifier differs from the triode degenerative amplifier in several respects. For example, the transconductance developed in the cathode circuit of a pentode is affected by the screen voltage reference. The transconductance available in the plate circuit is less than that available in the cathode circuit by a percentage dependent on the ratio of plate current to screen current. The effects of different pentode techniques are examined here. Use of conductance curves as a means of evaluating and predicting circuit behavior is demonstrated. Modified equations are included as required.

### The Pentode Action Cathode Follower—Video Type

In order to obtain full pentode-type action from a pentode cathode follower, Fig. 1, the potential between screen and cathode should be kept fixed. Assume that a 12BY7 tube is to be used as a pentode-type cathode follower. (Curves in Fig. 2.) The maximum cathode resistance permitted by the video frequency response requirements is chosen as 1000 ohms. With a total of 50  $\mu$ fd loading capacitance, a rectangular pulse then should reach 90% of its rise or decay in about 20 millimicroseconds. If a minimum of 25 v peak-to-peak excursion is required, a screen voltage providing plate current somewhat greater than 25 ma for zero bias is indicated. From Fig. 2, 100 v for

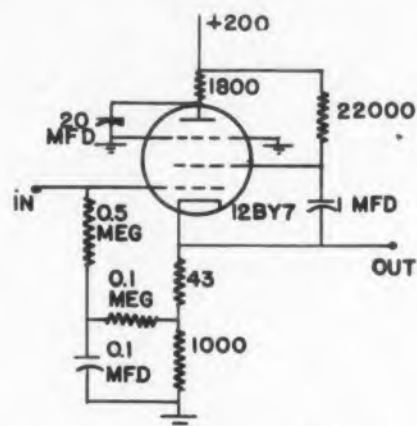


Fig. 1. Degenerative Amplifier

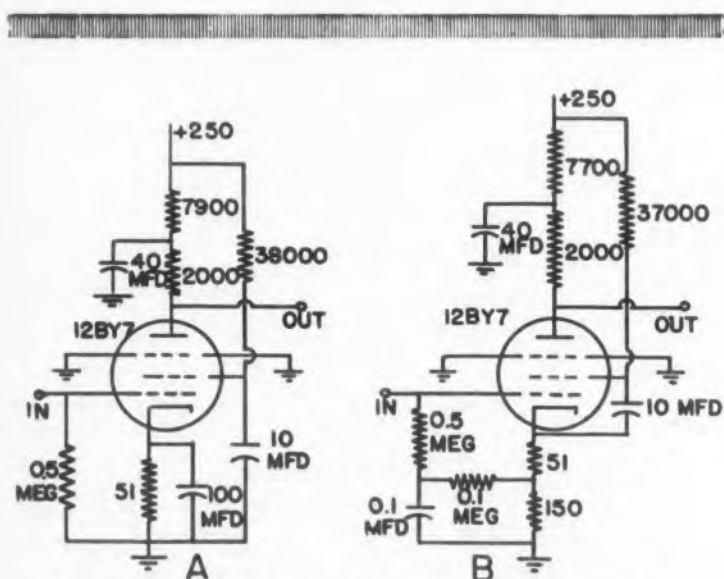


Fig. 3. Video Pentode Degenerative Amplifiers

# Design Techniques Using Conductance Curves

## Pentode Degenerative Amplifier and Cathode Follower

Keats A. Pullen, Jr.

Ballistic Research Labs.  
Aberdeen Proving Grounds, Md.

the screen to cathode voltage appears reasonable and 150 v as the static plate to cathode potential may be chosen. The zero bias cathode current is approximately  $I_p/[X_p + X_{c2}]$ , for  $E_p/E_i=1.5$ ,  $I_p=32$  ma or 37 ma. Neglecting the variations of  $X_p$  and  $X_{c2}$ , the minimum cathode current is 12 ma. This corresponds to a nominal plate current of 12/1.16 or 10.4 ma. The tube grid to cathode bias required for this plate current is -1.75 v. [Author's note:  $X_p$  and  $X_{c2}$  vary little in area of minimum cathode current, approaching the values at  $e_b/E_{c2}=2$  very closely.]

The nominal transconductance values at the two extremes of bias are 8800 and 15,000 micromhos. The actual values are 1.16 times these nominal values. They are 10,200 and 17,300. The cathode follower amplification for the pentode connected cathode follower is

$$VA = G_M (X_P) R_K / [1 + G_M (X_P) R_K] \quad (1)$$

For the two transconductance values given, the VA is 0.910 and 0.945. The resulting harmonic distortion is 0.60%. The average amplification is 0.927. The

applied peak-to-peak signal voltage required is  $25 + 1.75$  or 26.75 v.

The effect of the high cathode follower gain on the input capacitance of the tube is worthy of note. The screen is maintained at cathode signal potential in the pentode cathode follower. A major portion of the input capacitance is affected by voltage degeneration. As a result, the input capacitance of the tube may be as small as a quarter of that listed in the tube data sheets. If the incoming signal has a rapid negative going front, however, the front may cut off the tube plate and screen currents.\* If the tube is cut off by the incoming signal, then full tube input capacitance will be experienced momentarily. Cutoff of a capacitance loaded cathode follower under a negative voltage shift occurs more easily as the ratio of the input signal voltage to the zero to cutoff bias voltage becomes larger compared to unity\* ["Most of the input signal in a cathode follower is balanced by the output voltage from cathode to ground, leaving only a small voltage from grid to cathode. If, however, there is

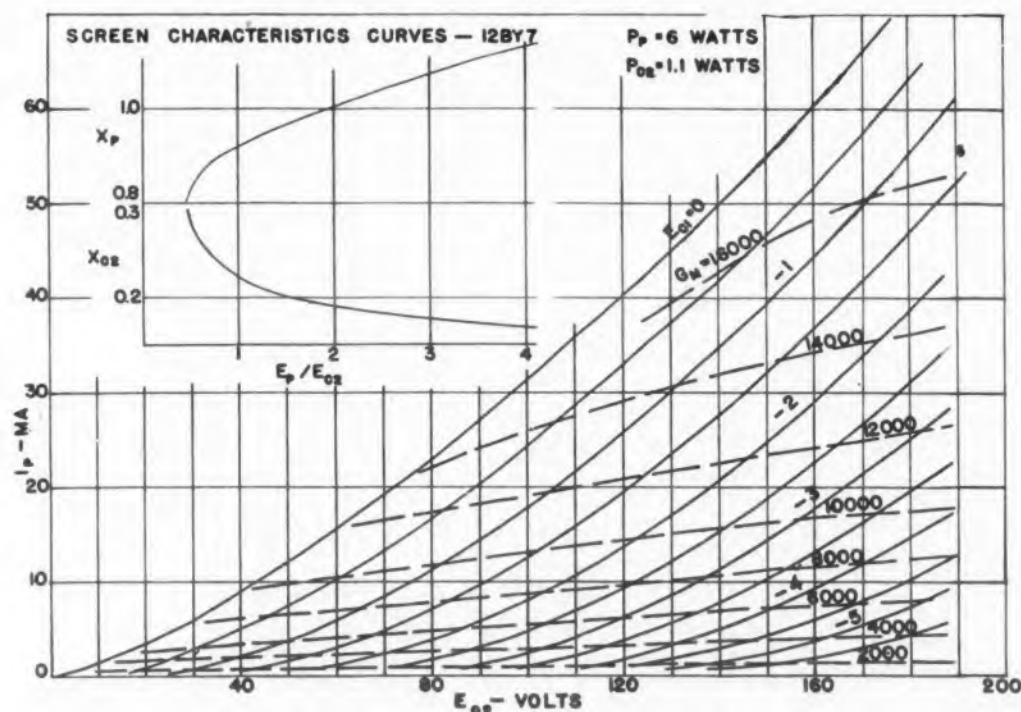


Fig. 2. Characteristics Curves on 12BY7 Tube

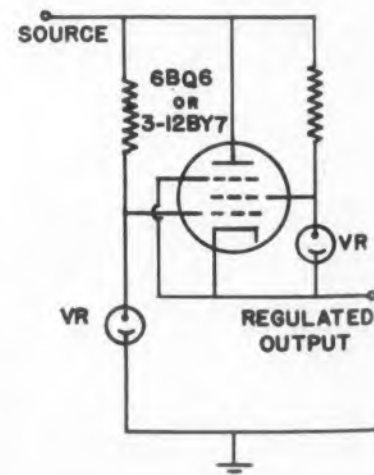


Fig. 4. Simple Voltage Regulator

appreciable capacitance from cathode to ground, then the capacitor may not discharge fast enough to permit the cathode voltage to follow the grid voltage. In this case, the portion of the input voltage applied from grid to cathode may become large enough to cut the tube off, making the output voltage in the cathode circuit that of the capacitor decay instead of the input signal. See sketch. Note that  $E_{c2}$ , the bias for tube cutoff, is approximately at the indicated location."]

Consequently, in video applications having stringent wave front requirements, the input voltage change applied to a cathode follower having an amplification near unity should be limited. The order of magnitude of the total grid to cathode voltage change should follow within the zero bias to tube cutoff range. For a supply voltage of 200 v, the screen voltage reducing resistor required to provide a voltage loss of 80 v at a grid bias of 0.875 v (screen current of 3.5 ma) is approximately 22,000 ohms. The screen is bypassed to cathode with a capacitance large enough to prevent the screen-to-cathode voltage change exceeding approximately 1 v at the lowest frequency to be passed. A voltage reducing resistor for providing the plate circuit voltage reduction of 30 v may be selected in a similar manner. The net plate current is 16.6 ma at the static bias of 0.875 v. The cathode resistors are found to be 1000 ohms and 43 ohms.

#### Screen Bypassed to Ground

The screen in the previous problem could have been bypassed to ground instead of to the cathode. Redesigning the previous problem assuming that the screen is bypassed to ground yields a cathode follower having two important differences. The first is that only part of the input capacitance effect can be controlled by degeneration. The grid-to-screen capacitance now is the same as that normally experienced, since the screen is at signal ground potential. The second is that a screen self-conductance type of term  $G_{C2} R_K$  must be included in the denominator of Eq. 1. The new equation reads

$$VA = G_M (X_P + X_{C2}) R_K / [1 + (X_P + X_{C2}) (G_M + G_{C2}) R_K] \quad (2)$$

where  $G_{C2}$  is the slope of the bias contour (ratio of nominal plate current change to screen voltage change). The value of  $G_{C2}$  at the nominal bias point,  $E_{c1} = -0.875$  v and  $E_{c2} = 100$  v is 0.0004. A small reduction in the voltage efficiency of the cathode follower results from bypassing of the screen to ground instead of to the cathode of the tube. The magnitude of the loss in voltage efficiency depends on the pentode tube concerned.

The provision of the suppressor and internal shield double connection arrangement for isolation of the input and the output in the 12BY7 tube is a very convenient aid to the application of degeneration to the tube. Where the screen and suppressor can not both be used to provide input-output isolation, the single electrode which is used to provide isolation must be

Table I Pentode Video Amplifier Design Data

Plate supply (net) volts	125 v	200 v
Mean plate current	15.9 ma	17.5 ma
Mean screen current	3.96 ma	3.43 ma
Series screen resistor	38000 ohms	44000 ohms
Bias resistor	51 ohms	49 ohms
Plate series decoupling resistor	7900 ohms	2900 ohms
Amplification; zero bias	26.0	28.5
Amplification, —2 v	14.1	15.6
Distortion	7.4%	7.3%

Table II Degenerative Video Amplifier

Plate series decoupling resistor	7700 ohms	2750 ohms
Screen series resistor	37000 ohms	43000 ohms
Amplification, zero bias	5.96	6.5
Amplification —2 v	5.16	5.56
Distortion	1.18%	1.95%

Table III Pentode Regulator-Filter

	6BQ6	3-12BY7
Screen voltage	75 v	105 v
Minimum plate voltage	60 v	84 v
Minimum plate dissipation	6 watts	2.8 watts per tube
Maximum screen dissipation	0.9 watts	0.67 watts per tube
Maximum $E_p$ (at 100 ma.)	100 v	180 v
Source impedance	85.5 ohms	19.5 ohms
Regulation (Eq 4) [ $E_p/E_{C2} = 1.5$ ]	0.005	0.0013
Regulation (Eq 5)	0.947	0.986
Nominal plate current	91 ma	27.6 ma

designed effectively. Combining the shield and the suppressor, using tandem connections, should provide effective isolation.

Design procedures for the triode condition pentode cathode follower is similar in all other respects to the pentode condition design.

#### The Pentode Degenerative Amplifier

In the analysis to follow the effect of degeneration on a video amplifier will be shown. A circuit using a 12BY7 tube is shown in Fig. 3a; modification for degeneration is shown in Fig. 3b. We will consider first the more-or-less conventional pentode video amplifier.

Assume that the supply voltage is 250 v, and the maximum load impedance permitted by circuit capacitance and frequency requirements is 2000 ohms. The design of the video amplifier needed to handle a 2 v peak-to-peak signal, using a 100 v screen potential is given in Table I.

For best video results with small signals, voltage changes at the screen and plate supply points resulting from screen or plate current changes should not exceed 1% of the output at the lowest frequency to be used. For critical applications, the changes should not exceed one part in a thousand.

Introduction of 200 ohms degeneration in the cathode circuit as in Fig. 3b and bypassing the screen to



the cathode makes several changes in the operation of the circuit. The main changes are the reduction of the input capacity, the reduction of the amplification, and the reduction of the distortion. The changed values are given in Table II. The peak output voltage for these distortion values is still approximately 40 v, p-p. The input voltage required is approximately 6 v, p-p.

An increase in screen voltage to 150 v, with a bias of approximately  $-1.7$  v, produces an amplifier capable of providing a peak-to-peak output of approximately 84 v. Without degeneration, and assuming a plate supply voltage of 200 v, its distortion is 7.5%. The zero bias amplification is 28.8, and the  $-3.4$  v bias amplification is 15.52. With a 100 ohm degenerative cathode resistor, the amplifications are 10 and 8, the distortion 3%.

The effect of factors beyond the designer's control may, particularly with pentodes, prevent one from realizing the calculated distortion. Consequently, one should allow reasonable leeway in selecting the distortion limit. Since the  $X_p$  and  $X_{ce}$  factors represent an average of the values for several bias values and several screen voltages, one cannot obtain more than a general average corrected value of these factors.

#### The Low Impedance Vacuum Tube Filter

The pentode tube can be used directly as a filter and voltage regulator. The use of the pentode tube as a replacement for a filter network has been described by Tomer.<sup>1</sup> This circuit can be modified to take advantage of the degenerative regulation. The filtering action described is obtained as a result of the relative independence of the plate current and plate voltage in pentode tubes having constant applied screen voltage.

The pentode regulator filter circuit uses a pentode connected cathode follower having a regulated control grid voltage and a regulated screen voltage, Fig. 4. The selection of the proper regulator tube is based on the maximum required current and the regulator tube plate and screen power dissipations. The conventional amplifier-triode (or triode connected) regulator circuit regulates by virtue of the high effective transconductance of the regulator triode and its comparatively low plate conductance. The pentode regulator has a high ratio of transconductance to plate conductance. Since, however, its effective transconductance is limited in general to less than 20,000 micromhos, as compared to an effective transconductance of many mhos for the regulator tube in the amplifier type regulator, the unamplified pentode regulator will have an appreciable variation of output voltage with load current change. The effective source impedance of a pentode tube is approximately

$$Z = 1/[G_{M1}(X_P)] \quad (3)$$

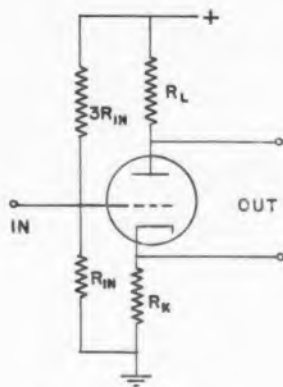


Fig. 6. Phase Splitting Amplifier

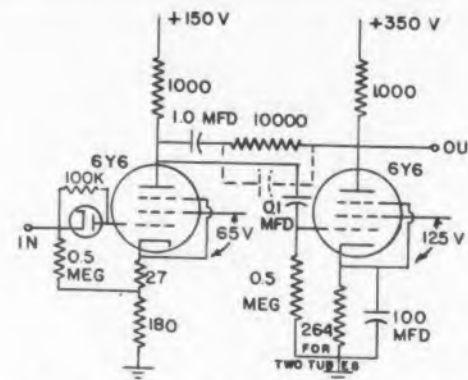


Fig. 7. Half of Push-Pull Video Power Amplifier

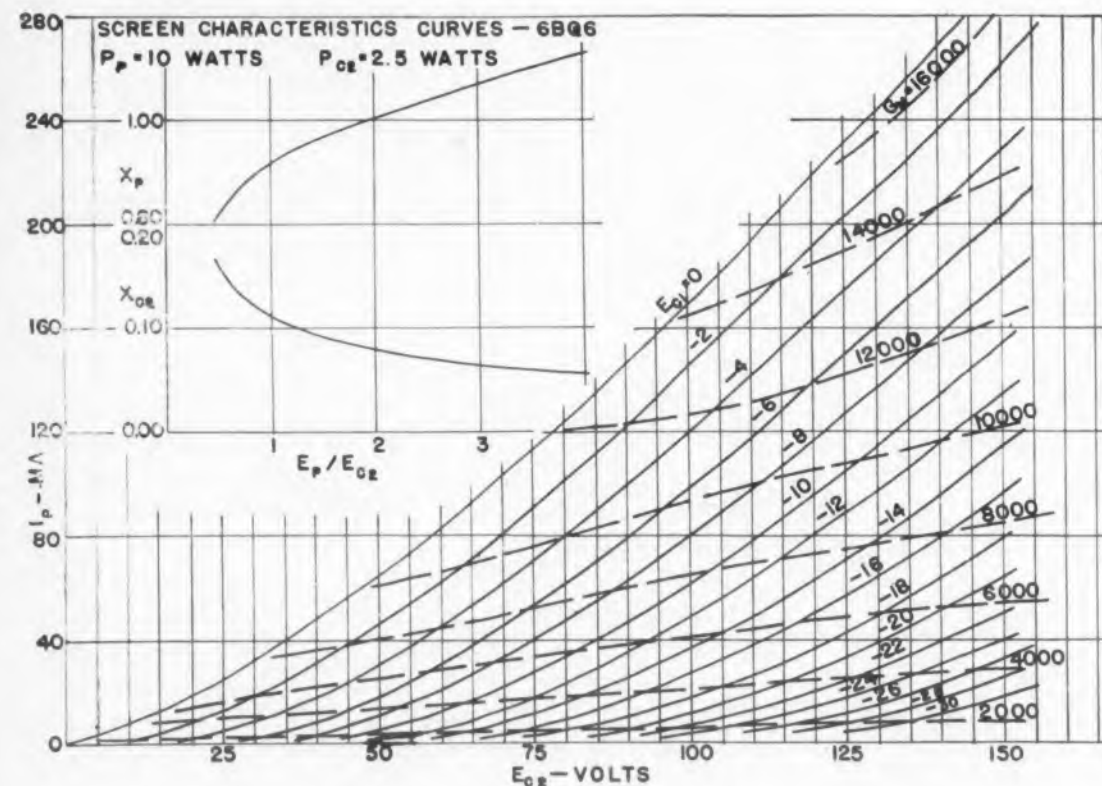


Fig. 5. Characteristics Curve on 6BQ6 Tube

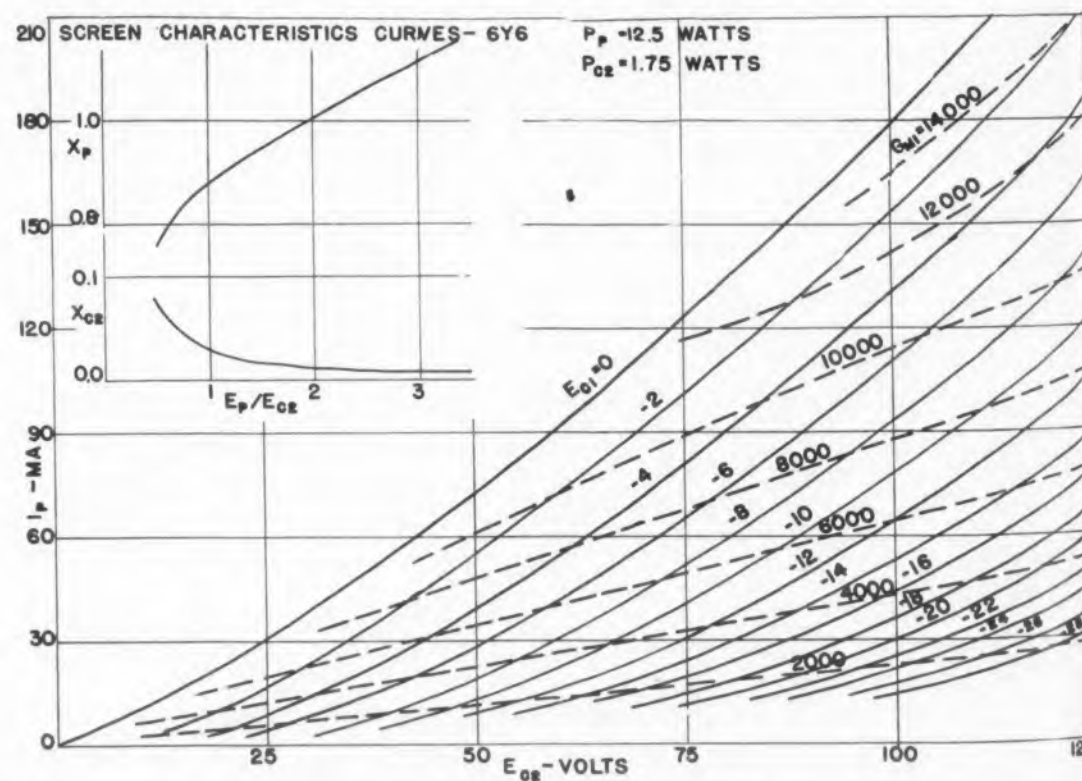


Fig. 8. Characteristics Curves on 6Y6 Tube

The regulation as a function of source voltage is expressed in terms of the voltage amplification equations,

$$VA_{source} = G_P R_K / [1 + G_M (X_P) R_K] \quad (4)$$

and for voltage changes in the load circuit,

$$VA_{load} = -G_M (X_P) R_K / [1 + G_M (X_P) R_K] \quad (5)$$

Assume that a regulator capable of providing 100 ma at 150 v were required. One might either choose three 12BY7 tubes in parallel, or a single 6BQ6 tube (Curves in Fig. 5). The designs for the two approaches are summarized in Table III.

As can be seen, better regulation is obtained from the group of three 12BY7 tubes. However, the 6BQ6 tube is good enough for most routine applications. A 50 v supply voltage change will cause a load voltage change of approximately a 0.25 v. A load current change from 50 ma to 100 ma will produce an output voltage change of approximately 4.2 v.

Where pentode tubes are used as series tubes in amplifier type regulators, the use of the series tube with a fixed screen to cathode potential can prove



useful. The reduced plate conductance in particular improves the independence of the regulator operation with respect to its supply voltage source.

### The Split Load Amplifier

The triode tube is commonly used as a split load amplifier, Fig. 6. As a source of equal out of phase voltages, it is unexcelled. It provides output voltages whose magnitudes are dependent solely on the size of the two load resistors. The cathode degeneration, even with only 1000 ohms in the cathode and plate circuits, may be high enough to provide cathode gain as high as 0.85 to 0.90 with a tube like the 12BZ7. Distortion cannot exceed 4% for transconductance values in excess of 2000 micromhos. The amplification equations for the triode split load amplifier are

$$VA_P = -g_m R_L / [1 + (g_m + g_p) R_K + g_p R_L] \quad (6)$$

$$VA_K = g_m R_K / [1 + (g_m + g_p) R_K + g_p R_L] \quad (7)$$

Inspection shows that the variation of  $R_L$  may produce a much smaller effect on  $VA_K$  than  $R_K$  produces on  $VA_P$ . Consequently, although the output voltages may be the same if  $R_K = R_L$ , the variation of  $VA_K$  and  $VA_P$  with variation of  $R_K$  and  $R_L$  are different. The effective impedances are not balanced.

For the pentode split load amplifier, Eqs. 6 and 7 take the following forms

$$VA_P = -G_{M1} X_P R_L / [1 + G_{M1} (X_P) R_K] \quad (8)$$

$$VA_K = G_{M1} (X_P) R_K / [1 + G_{M1} (X_P) R_K] \quad (9)$$

From Eqs. 8 and 9 it is seen that the ratio of  $VA_P$  to  $VA_K$  is

$$VA_P / VA_K = -R_L / R_K \quad (10)$$

Since for large signal conditions  $X_p$  cannot be constant, distortion is introduced into the plate circuit of a heavily degenerated pentode. This distortion might be called partition distortion in recognition of its existence as a result of current partitioning between the screen and plate. For small amounts of degeneration where  $G_M(V_P)R_K$  does not exceed about five to ten, the partitioning actually reduces distortion.

### Degeneration in Power Amplifiers

Often power dissipation limits on tubes prevents one from utilizing the full capabilities of a push-pull amplifier. Design to prevent exceeding the power dissipation limitation may introduce serious distortion. This distortion may be reduced by the proper use of degeneration.

One way of obtaining linearization by degeneration is by use of plate-by-plate feedback resistors coupling the driver stage plates to the final stage plates, Fig. 7. When checking the need for degeneration in a push-pull amplifier, it is helpful to plot the transconductance as a function of bias, summing for the two tubes at each bias point. The transconductance sum should be constant throughout the range of bias. Without degeneration the sum is usually roughly parabolic (See Table IV). The voltage amplification for the stages in Fig. 7 is given by

$$VA = \frac{G_{M1} X_{P1} R_{L1}}{1 + G_{M1} (X_{P1}) R_{K1}} \left[ \frac{R_F - 1/G_{M2} X_{P2}}{R_{L1} (1 + 1/G_{M2} X_{P2} R_{L2}) + \frac{1}{G_{M2} X_{P2}} \left(1 + \frac{R_F}{R_{L2}}\right)} \right] \quad (11)$$

Based on the data in Table IV and Figs. 7 and 8, the amplifier, without feedback, would have about 12% distortion for a plate-to-plate output of 180 v.

The design of the driver amplifier now must be considered. The voltage developed in  $R_{L1}$  is a function of both the current produced by the driver and the current fed back from the final stage. The total voltage developed by the driver is the sum of the bias applied to the final grid and the voltage fed back to the driver.

Table V lists several typical points in the operation of this feedback amplifier. In calculating each point, use the output tube bias as the starting point. The output tube amplification is determined from the bias, and the plate voltage excursion is determined. When the feedback voltage is found, the driver output is determined. The required driver plate current is then established. This current poses a significant design problem. The negative bias swing of the driver tube is the one which provides proper operation of the final stage. The effect of the positive swing, on the other hand, is unimportant, since the output 6Y6 tube is cut off on the negative swing. Because the design has to develop good transconductances on the negative portion of the signal, use of a tube capable of efficient operation with low plate and screen voltages is required. The driver tube should be biased near zero bias and the effect of the positive grid voltage swing may be minimized by the use of a blocking diode in the grid lead. Use of 65 v on the screen of a 6Y6 driver amplifier, a negative 2 v static bias, and an  $E_p/E_{c2}$  ratio of 1.0 at zero signal, the static plate dissipation of the driver tube is 4.5 w, the static screen dissipation is 0.25 w.

The next step is to determine the overall amplification at each of the indicated points. These data are tabulated in Table VI, taking  $R_{K1} = 200$  ohms. Overall distortion with feedback is 3%. Consequently, the distortion over the two stages in cascade is a quarter of that of the final without feedback.

The grid-to-cathode voltage change on the input 6Y6 is 10 v. The cathode-to-ground change is 7.5 v. The total signal required is therefore  $\pm 17.5$  v peak. The 12BY7 tube can provide this amount of signal drive with little difficulty. The peak output deflection voltage is 180 v for the operating conditions chosen.

### Conclusion

The development of difficulties in designing a circuit to accomplish a given purpose within tube dissipation ratings should be considered as a warning that the wrong tube is being used. For example, a 12BY7 tube as a driver amplifier, would prove to be overloaded for any satisfactory design. Redesign with a different tube is indicated.

The designs discussed indicate to some extent the value of the conductance design method as applied to low frequency electron tube circuits.

1. "Electronic Filter Choke," R. B. Tomer, Engineering Edition, *Radio and Television News*, December, 1952, p. 11.

Table IV Video Amplifier Transconductance Sums

Bias excursion	0	4	8	122	1616	2020	2424
Rough transconductance	6400	6700	7700	9200	11000	12300	16000
Corrected transconductance	6400	6750	7650	8950	10300	11100	12150

Table V Driver Current Calculation

Output tube Bias change	-8	8	16	24
Output plate current change	-18.0 ma	30.9 ma	86 ma	140 ma
Output voltage change	16.4 v	-28.1 v	-78.2 v	-127.3 v
Feedback voltage	1.49 v	-2.56 v	-7.1 v	-11.6 v
Total driver output voltage	9.5 v	10.56 v	25.1 v	35.6 v
Driver plate current change	10.4 ma	-11.6 ma	-27.6 ma	-39.2 ma

Table VI Overall Amplification of Video Loop

Final bias	-8	0	8	16	24
$G_{M1} X_{P1}$	9300	8800	7740	5890	3990
$G_{M2} X_{P2}$	1720	3400	5880	9500	12150
VA	2.87	2.84	2.72	2.43	2.00
VA	1.18	2.15	3.23	4.37	5.00
Eq. 11	3.39	6.10	8.24	10.6	10.0
Sum for PP stage	11.63	12.2	11.63	10.6	10.0

THE WRONG POT . . .  
CAN MEAN TROUBLE!



For the *right* pot,  
rely on DAYSTROM!

Model 300-00 is the tiniest, precision-built, wire-wound trimming potentiometer this side of "Lilliput." Despite its flyweight size, it easily handles **exacting** jobs throughout extreme temperature ranges.

For higher resistance ranges, the Model 303-00 fills the bill — using very little more space than the Model 300-00.

The **Potentiometer Division** of Daystrom Pacific Corporation is staffed with highly skilled engineers and technicians who dearly love to grit their teeth and come up with optimum solutions to all kinds of potentiometer problems.

So, rely on **DAYSTROM** for your right pot!

Some outstanding characteristics:

	Model 300-00	Model 303-00
Size .....	0.5" square by 0.187" thick	0.75" square by 0.28" thick
Weight .....	2 grams	7 grams
Resistance Ranges...	10 ohms to 50K	5K to 125K

Write today for literature on these or any of the many other production or custom-made precision potentiometers available. Names of local representatives on request.

Openings exist for highly qualified engineers.

POTENTIOMETER  
DIVISION

*Daystrom* PACIFIC CORPORATION

11150 La Grange Ave. West Los Angeles 25, Calif.

A SUBSIDIARY OF DAYSTROM, INC.

CIRCLE 28 ON READER-SERVICE CARD FOR MORE INFORMATION

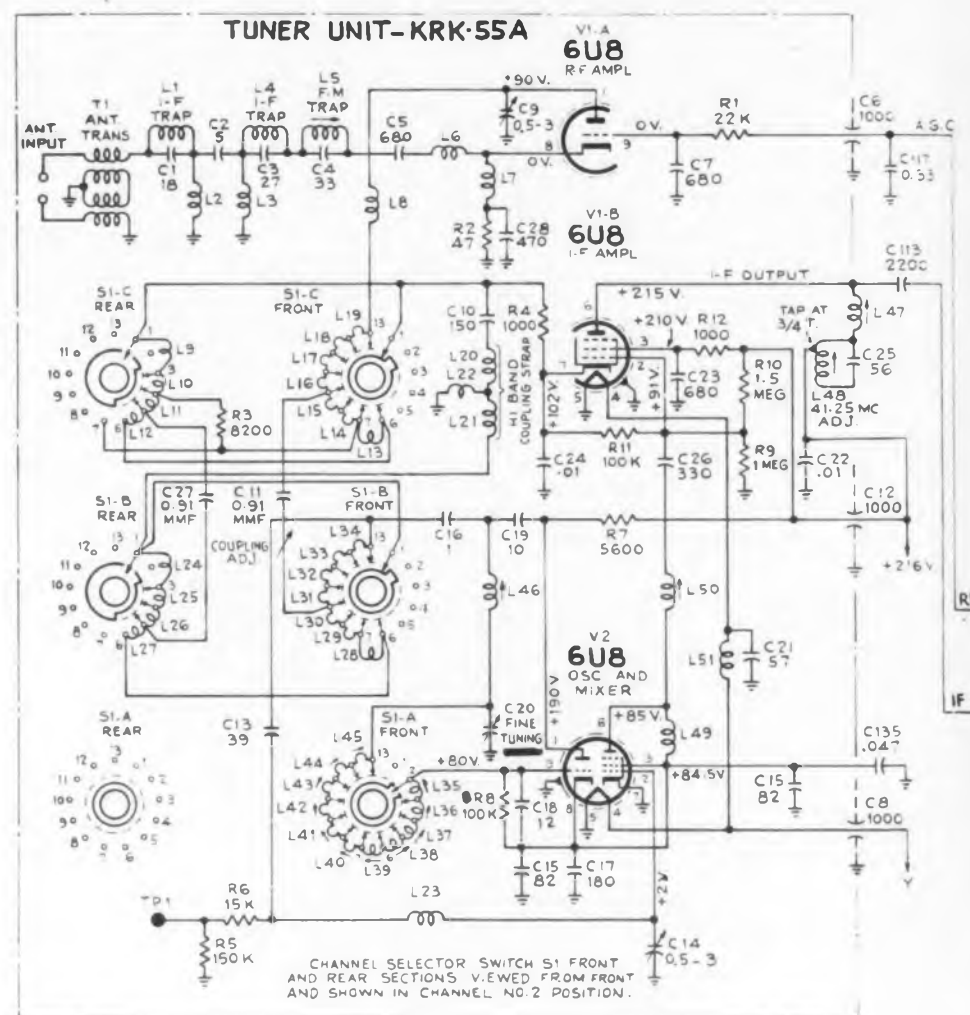
# Pentode Does Two Jobs

Leslie M. Balter  
Consulting Engineer

INTENSE merchandising competition in the television industry brought forth almost overnight the portable television receiver. The resulting technical developments striving for an overall small physical size and weight reduction so that the receiver will be easy to handle offer much of interest to designers.

One of the most significant developments of today's modern portable receiver design may be seen from a study of the RCA KCS 100 chassis, Model 8PT series (8DP4 picture tube).

A study of the set schematic reveals the development of a circuit which permits one tube to do the work of two. This is not the use of two separate tubes within one envelope, but truly is a circuit design which permits one pentode to be used to perform two individual functions. The same pentode tube is used as a sound intermediate frequency amplifier and also the first audio voltage amplifier.



Black portion shows 6U8 which acts as both sound if and first audio amplifier in RCA chasis KCS 100B.



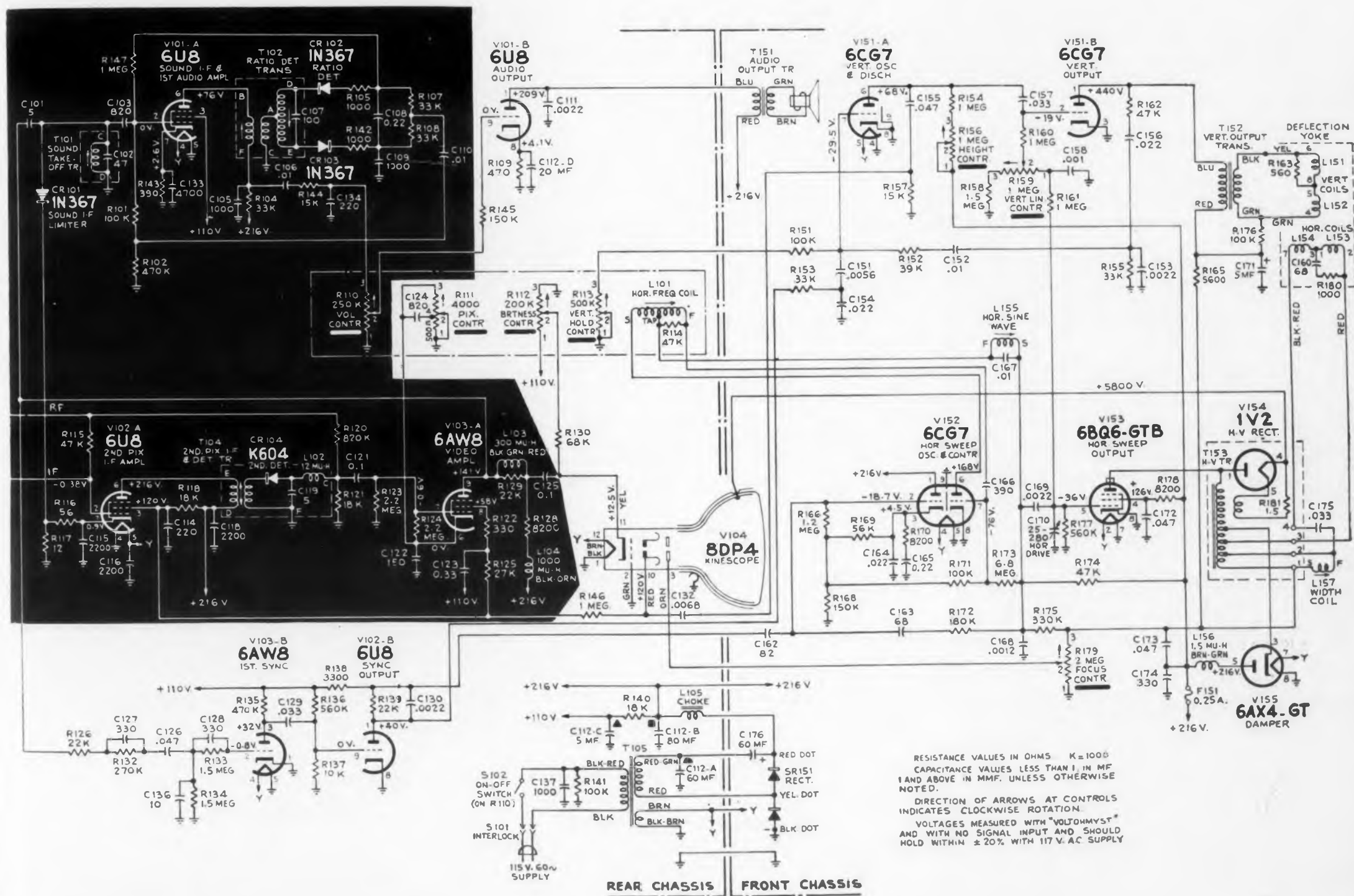
Referring to the blocked out portion, the 4.5-mc intercarrier fm sound is taken from the plate of the 6AW8 (V103A) video amplifier. This is the normal sound take off point in an intercarrier chassis. The 4.5-mc signal is then coupled through C101, a 5- $\mu$ f capacitor, which serves as a high pass filter to aid the separation of the fm signal from the video. The 1N367 diode acts as a limiter to hold the signal input to the 6U8 (V101A) at constant amplitude. The signal is then fed to T101 which is a parallel resonant circuit tuned to 4.5 mc across which the sound signal is developed. This 4.5-mc signal is then fed through C103 to the control grid, pin 2 of the 6U8. The series resistors, R101 and R102 act as Q dropping resistors to broaden the response and load down the grid circuit slightly. The 4.5-mc signal is then transformer coupled from the plate circuit of the 6U8 through the ratio detector transformer and is detected in a con-

ventional type of ratio detector circuit using two 1N367 diodes. The detected fm sound signal is then taken from the junction of R107 and R108 and coupled through C110 back into the control grid circuit, again pin 2, of the same 6U8. C103 presents a high impedance to the now audio signal and does not permit T101 to bypass the audio to ground. The audio signal through R101 is then applied into the grid of the 6U8. The primary of the ratio transformer has a low impedance to the audio frequency and the audio signal is developed across R104 which acts as a conventional plate load resistor. C105, 1000  $\mu$ f while acting as a bypass around R104 to the sound as if, is so small as not to cause much shunting of the sound as audio to ground. The audio voltage developed across R104 is then coupled through C106 and the de-emphasis network R144 and C134 to the volume control R110, and on into the other half of the 6U8 which acts as

a conventional audio output circuit. Note that the tuner section uses 6U8s also.

It is important to note that in a dual application such as this, the point at which the tube operates is extremely critical and must be closely held constant. It is for this reason that the diode limiter is used, even though theory indicates that when using a ratio detector, a limiter is not normally necessary. In order to hold the operating point of the control grid of the 6U8 constant, the if is limited. In addition, R147 serves to feed back a negative bias on strong signals to the same grid. These measures are necessary to insure proper operation and avoid rectification in the tube.

It thus can be seen that this is an application where one tube is made to serve as a high frequency tuned amplifier and an audio frequency amplifier simultaneously through a clever utilization of high and low pass filters.





# Design Tips For

- **Simplicity**
- **Cost Savings**
- **Reliability**
- **Usability**

These design suggestions are excerpted from a new 1956 edition of the booklet, "Suggestions For Designers of Electronic Equipment," prepared by the Reliability and Standards Branch, Engineering Division, of the U. S. Navy Electronics Laboratory. The booklet was prepared to help electronic manufacturers "produce simpler, more economical, and more reliable electronic equipment" for Bu Ships. All designers should find these suggestions valuable.

Suggestions given here should result in Electronic equipment which is simpler, more reliable and more usable and at the same time will save costs in manufacture. Although these tips are based on the premise that designers are developing equipment under Bu Ships contract, practically every suggestion is well worth considering for design of commercial and other military gear.

## General Design Tips

1. The use of assembly type construction is encouraged, where possible, coordinated with Bureau of Ships. (3.4)\*
2. Giving due consideration to maximum equipment reliability the use of miniature parts is encouraged. (3.3.8)
3. Use tubes from the list of Standard Electron Tubes, MIL-STD-200 (latest issue). Do NOT, under any circumstances, use tubes selected within a type. (3.3.45)
4. Do not use tubes in applications that require the use of parameters not controlled by authorized procurement specifications (example: do not use as a noise source a tube generally intended as a thyratron).
5. For Navy electronics equipment select electronic parts from MIL-STD-242 (latest issue). (3.3.1)
6. Provide 10 per cent spare terminals (at least 2) on terminal strips and connectors. (3.3.14)
7. All terminal strips and parts boards shall be adequately marked in a permanent manner. (3.3.14.4) (3.13.4.1)
8. Keep use of relays to a minimum. (3.9.6.3) (3.3.36)
9. Do not use acid or corrosive soldering fluxes or pastes. Rosin is the only noncorrosive flux. (3.11.3)
10. Conductors should be color-coded in accordance with Standard MIL-STD-122. (3.9.11)
11. Noninsulated leads should be color-coded by means of color

spots near all terminals. (3.9.11.1)

12. Make provision to lock chassis both in the closed and maintenance positions. (3.11.9.1)
13. All controls should be clearly labeled with standard nomenclature, and marked, indexed, or metered such that each position can be readily identified. (3.12)
14. Part reference designations shall be located adjacent to each part. Type designations of each tube and other plug-in part and the reference designation shall be marked on both sides of the chassis adjacent to the socket. (MIL-STD-16). (3.13.4)
15. No cable entrances on front panels. (3.9.8.2)
16. Keep "parts peculiar" to an absolute minimum. (3.3)
17. Transformers, chokes, and other potted networks shall have circuit diagrams with current, voltage, and impedance ratings stenciled on the outside. (MIL-T-27). (3.3.44)
18. Maximum size restrictions:
  - a. surface vessel installation (3.11.12.2)
    - (1) Height 72 inches;
    - (2) capable of passing through a 30-inch-by-30-inch hatch with round corners on 7 1/2-inch radius; or
    - (3) capable of passing through a 26-inch-by-45-inch door with round corners on 8-inch radius.
  - b. Submarine installation (3.11.12.3)
    - (1) Height 72 inches;
    - (2) capable of passing through a 25-inch diameter circular hatch; and
    - (3) capable of passing through a 20-inch-by-38-inch door with rounded corners on 10-inch radius.
19. Mount terminal strips or connectors so as to be accessible from the front of equipment when opened. (3.11.9). (3.3.14.3)

## Environmental Requirements

1. MIL-E-16400 extreme environmental conditions (may be modified by equipment specification) (4.4.4):
  - a. -62 to +75C (nonoperating) (4.5.7.1)

- b. -54 to +65C (operating) (4.5.7.2)
  - c. 95 per cent relative humidity. (4.5.8)
  - d. Equipment exposed to weather is expected to withstand winds of 100 knots and to operate in winds of 75 knots. (3.8.3)
  - e. Equipment exposed to the elements shall operate with an ice load of 4.5 pounds per square foot. (3.8.4)
  - f. Shock and vibration (MIL-S-901B, MIL-T-17113, MIL-STD-167, etc.) (4.5.14)
  - g. Line voltage and frequency (excursions per equipment specification)
  - h. Salt spray (for external finishes and materials) (4.5.15)
2. Equipment shall be dripproof, splashproof, or waterproof, as required by the equipment specification. See Standard MIL-STD-108. (3.11.8)

## Electrical Suggestions

1. Adequate derating in parts application must be used in order to increase reliability of equipment in service. (3.3.5)
2. Undesired radiation and radio interference must be within the limits specified by MIL-I-16910. (3.9.1) and (3.9.2)
3. Provide protection from damage due to overload, excessive heating, etc. (3.9.6)
4. Fuse or otherwise protect both sides of the line and provide spare fuses in a convenient location. (3.9.5) (3.9.6) (3.9.6.1)
5. Avoid use of friction or pressure contacts where possible. (3.11.6)
6. Provide dimmer control for all dial and indicating lights. (3.12.12)
7. Transmission line terminals shall be marked with the characteristic impedance of the line. (3.13.4.5)
8. Use of cable plugs and connectors should be kept to absolute minimum.
9. Lamp holders should be of the lock type and replaceable from the front. (3.3.32)
10. Do not series-connect pilot lights. (3.12.12)

\* Numbers in parentheses indicate applicable paragraphs in Specification MIL-E-16400A.

11. Provide running-time meters where required by the specifications. (3.12.13)
12. In mounting parts by pigtailed, the clearance between the soldered connection and the body of the part shall not be less than 3/16 inch and should not exceed 1/2 inch in length. (3.3.51)
13. All external metal parts shall be at ground potential. Antenna and transmission line terminals shall be at ground potential except with regard to the energy to be transmitted. (3.7.2.1)
14. Provide simple performance evaluation and equipment checking devices where possible. (3.10.3.2)
15. Regulate heater voltage for electron tubes (within ratings) to enhance reliability.
16. Apply electron tubes in conservative operation; derate for improved reliability.
17. In design, allow for change in tolerance of electronic parts for such factors as aging, temperature and humidity.

### Mechanical Suggestions

1. Electron tubes, large fuses, and other plug-in items must be secured by easily released positive holding clamps. (3.3.13)
2. Pigtail connected electronic parts which are large in comparison with the standard 2-watt composition resistor should be clamped down to the chassis or parts board to preclude lead breakage from fatigue under vibration. (3.3.51.1)
3. Self-tapping screws should not ordinarily be used. If used, approval must be obtained from the bureau or agency concerned. (3.3.42.10)
4. Devices for retaining panels and cover plates shall be of captive types with slotted or knurled and slotted heads. (3.3.42.14)
5. Use external-tooth type lock washers. (3.3.43.3)
6. Conductors shall be wound into a cable and held by means of lacing twine or other acceptable means. Wire harnesses and cables should be clamped down to the chassis at reasonable intervals to reduce conductor breakage under vibrations. (3.9.8)
7. Wires and cables running through holes in metal partitions must be protected from mechanical damage by grommets or other acceptable means. (3.9.8.3)
8. Stranded copper wire that has been soldered to a terminal should be secured so that vibration does not allow the conductor to flex near the area where the individual strands have been tinned together.
9. Do not joint leads without a support at their junction.
10. Equipment shall be of the lightest weight consistent with sturdiness, safety, and reliability. (3.11.13)
11. Make provision to lock chassis in both the closed and maintenance positions. (3.11.9.1)
12. Provide suitably labeled lifting-eyes on equipment weighing more than 150 pounds. (3.11.14)
13. Electronic equipment should use as few lubricants as practicable. (3.11.17)
14. Minimize need for special tools. Special tools must be securely mounted in a convenient place in the equipment. (3.11.18)
15. Control knobs should be kept to a minimum and have standard shape and color. Control knobs should be secured by means of two setscrews. (3.12.1)
16. Controls and indicators which are only occasionally required should be mounted behind access doors. (3.12.2.2)
17. Controls infrequently required shall be accessible when the equipment is open for maintenance purposes. Maintenance controls shall be screwdriver adjusted. (3.12.2.3)
18. Controls shall be arranged to facilitate smooth and rapid manipulation. Adequate end stops shall be provided on all controls with limited degree of motion. (3.12.4) (3.12.7)
19. Provide control locks where specified. (3.12.6)
20. Glass windows shall be secured to the panel by means of clips, snap rings, or other devices. Do NOT use cement alone. (3.12.1)

21. Light leakage shall be prevented. (3.11.8)
22. Do not use rivets to mount parts which may be subject to replacement, nor for electrical continuity.
23. Identification markings shall be permanent and legible. (3.13.4.4)
24. Positive identification of scales in use shall be provided.
25. Side and back plates for terminal tube mounting or clamps shall be removable. (3.9.8.2)
26. All setscrews shall have one type of head. (3.3.42.12)
27. Do not use flathead screws on thin panels. (3.3.42.13)
28. All moving parts shall operate smoothly and quietly without introducing objectionable electrical noise. (3.11.5)
29. Backlash and torque-lash shall be kept to a minimum. (3.11.5)
30. Lubrication points shall be accessible and clearly marked. (3.11.17)
31. Drawers or other removable chassis should have at least two guide pins on the front panel and two guide pins on the rear of the chassis. The guide pins on the front panel can be made part of the captive screw assembly, if desired. (3.3.42.14) (3.11.9.2)
32. Locate heavy parts (transformers, etc.) as low as possible in order to keep the center of gravity of the equipment low.
33. Electron tubes often break by striking against adjacent transformers during shock. Clamp tubes to prevent relative motion or maintain wide tube clearance to eliminate damage.
34. Avoid the use of cantilever brackets for mounting of parts.
35. Alignment pins or similar devices should be used to bear shock and vibrational loads between chassis, assemblies, and enclosures. Electrical connectors must not be depended upon to bear such loads.
36. Provide adequate ventilation facilities. Do not provide openings in top of equipment. (3.11.16)
37. Use of liquid cooling requires approval of the bureau or agency concerned. (3.11.16.3)
38. When forced-air cooling is used, provide suitable dust filters, mounting and size to be coordinated with bureau or agency concerned. (3.11.16.2)
39. Provide equipment heaters where necessary.
40. Locate parts for best heat dissipation and isolate critical parts from excessive heat sources. (3.11.15) (3.3.5)
41. Use conduction heat-transfer techniques to lower surface temperature of tubes, resistors, transformers, and small motors.

### Selection of Materials

1. Screws, studs, nuts, etc., shall be of nonferrous material. Corrosion-resistant steel or nickel-copper alloy may be used where required for reasons of strength. (3.3.42.4)
2. Avoid threading aluminum alloy into aluminum alloy parts. (3.3.42.7)
3. Do not use toxic or hygroscopic materials, nor materials which will support combustion or fungus. (3.5)
4. The use of magnesium requires approval of the bureau or agency concerned. (3.5.11.2)
5. Do not use dissimilar metals in contact where an increase in corrosion can be expected. (3.5.14)
6. Use glareproof and shatterproof glass. (3.5.10)
7. Iron and steel shall not be used except where required for electromagnetic or strength reasons. (3.5.11.3)
8. Plate or otherwise treat metals to protect them from corrosion. (3.5.13)
9. Materials for embedding electronic parts in assemblies shall be in accordance with Specification MIL-C-16923. (3.5.17)
10. Finish enamel shall conform with Specification MIL-E-15090 or TT-E-485, as indicated. (3.6.5.2)

### Design for Installation

1. Side and back plates for terminal tube mounting or clamps shall be removable. (3.9.8.2)
2. Mounting bolts should be accessible so equipment can be

### Some Common Faults

The following faults are often experienced with electronic equipment and should be avoided.

1. Bend radii too small in sheet-metal items.
2. Inadequate welds, rivets, or bolts in enclosure fabrication.
3. Poor finishing due to improper preparation of base metal.
4. Inadequate locking devices for hinges and drawers.
5. Assembly and installation work not properly inspected. All nuts, bolts, and screws should be tightened with a torque wrench.
6. Drawer guide pins of insufficient strength; or failure to provide steel inserts in mating parts.
7. No guide pins provided on front panel and rear of chassis drawers. Guide pins are especially important on shock-mounted equipment.
8. Inadequate gasketing on watertight and drip-proof enclosures.
9. Inadequate ventilation.
10. Improper design and location of louvers on drip-proof enclosures.
11. Shock mounts used in equipment which might better be designed for direct mounting.
12. Incorrect selection and location of shock mounts.
13. Shock mounts difficult to install and remove.
14. Inadequate protection of cables in drawer-type and hinged construction.
15. Inadequate protection of wires and cables passing through metal partitions.
16. Lack of adequate clearance between parts to prevent damage during shock conditions.
17. Inaccessibility of parts for maintenance.
18. Failure to secure larger resistors and capacitors which have pigtail leads.
19. Poor support of terminal boards and similar vulnerable assemblies and parts.
20. Use of inadequate or incorrect type of lock washers.
21. Patent fasteners (Dzus and other types) too small for application.
22. Gears secured with setscrews instead of being properly pinned.
23. Relays chatter under shock or vibration. See Specification MIL-R-5757 for relay requirements.
24. Inadequate stiffness in structures, resulting in resonances within the vibration test frequencies.
25. Use of screws of insufficient size in mounting heavy parts.
26. Inadequate power-line filters.
27. Operation of tubes and parts at levels above ratings.
28. Inadequate electrical design. Examples: sensitivity selectivity, hum, regeneration, spurious responses.
29. Excessive radiation and radio interference.
30. Excessive complexity in circuitry.
31. Poor design of controls.
32. Enclosures, structures, and chassis poorly designed with the result that the equipment is excessively heavy.
33. Many existing tube clamps are ineffective.
34. Excessive play in chassis drawer slides.



installed without the necessity for removing parts and assemblies.

3. Usual shipboard installations make access to the rear and sides of equipment difficult. Avoid the need for such access.

### Operational Considerations

1. Counter-type indicators should be of the large type.
2. Tuning instructions and calibration charts shall be mounted on the equipment when such instructions and charts are required. (3.13.3)
3. Minimize "nontamper" factory adjustments. When such adjustments are required, they should be marked as such. (3.12.10)
4. Provide indicators of equipment malfunctioning where possible. (3.10.3.2)
5. Prevent extraneous light escape. (3.11.8)

### Design for Maintenance

1. Insure complete interchangeability of all like removable units, maintenance parts, etc. (3.3.7)
2. Parts mounted on terminals and parts boards must be accessible for servicing. (3.11.9)
3. All terminal strips and parts boards shall be adequately marked in a permanent manner. (3.3.14.4)
4. Part reference designations shall be located adjacent to each part. Type designation of each tube and plug-in part and the referenced designation shall be marked on both sides of the chassis adjacent to the socket. (MIL-STD-16) (3.13.4)
5. Transformers, chokes, and other potted networks shall have circuit diagrams with current, voltage, and impedance ratings stenciled on the outside. (MIL-T-27) (3.3.44)
6. Conductors should be color-coded in accordance with standard MIL-STD-122. (3.9.11)
7. Noninsulated leads should be color-coded by means of color spots near all terminals. (3.9.11.1)
8. Fuse or otherwise protect both sides of the line, and provide spare fuses in a convenient location. (3.9.6.1)
9. Built-in test equipment (meters, etc.) should be used where possible to determine whether the equipment performance is normal. (3.10.3.2)
10. Provide test points for checking essential wave forms and voltages where terminals are not otherwise accessible. (3.10.3.1)
11. Provide voltage dividers with test points for measurement of voltages in excess of 1000 volts. (3.10.5)
12. All parts must be readily accessible for complete visual inspection and replacement without removal of parts and fixed assemblies to get to other parts. (3.11.9)
13. Provide rotating assemblies with means for hand training for maintenance and provide markings of normal direction of rotation.
14. Mechanical assemblies subject to maintenance disassembly should be indexed to insure proper relative position of parts on reassembly.
15. Minimize need for special tools. Special tools must be securely mounted in a convenient place in the equipment. (3.11.18)
16. Controls infrequently required shall be accessible when the equipment is open for maintenance purposes. Maintenance controls shall be screwdriver adjusted. (3.12.2.3)
17. Doors or hinged covers should be provided with slip hinges and stops to hold them open. (3.11.10)
18. Rear of plug connectors must be accessible for test and service.
19. When parts MUST be replaced at specified intervals, they should be clearly marked as such.
20. Leave about 1/16 inch pigtail on leads beyond terminals and do not mount more than three wires on one terminal. (3.3.51.2)
21. When devices protecting against overload conditions are used, it is preferred that they be accessible from the front panel.

### Built-in Safety

1. Provisions shall be made to prevent personnel from coming into contact with voltages in excess of 70 volts while installing, operating, or interchanging assemblies or plug-in parts. (3.7)
2. All external metal parts shall be at ground potential. Antenna or transmission line terminals shall be at ground potential except with regard to the energy to be radiated. (3.7.2.1)
3. Interlocks must be provided where potentials exceed 70 volts. (3.7.1)
4. Provide personnel protection from moving machinery. (3.7.6)
5. Provide protection to personnel from imploding cathode ray tubes. (3.7.3)
6. All control shafts and control shaft bushings shall be grounded. (3.7.3)
7. Plugs and connectors when disconnected should not expose "hot" leads.
8. Provide means for bypassing interlocks for servicing and have warning indicator. (3.7.1.1)
9. Doors or hinged covers should be rounded at corners and have slip hinges and stops to hold them open. (3.7.6) (3.11.10)
10. Provide rotating antenna assemblies with local power safety switch at the antenna. (3.7.1.2)
11. Provide guards, safety covers, and warning plates for potentials in excess of 350 volts rms on contacts, terminals, and like devices. (3.7.2.2)

### Human Engineering Design Tips

The following design suggestions are presented as background for good human engineering design.

#### Visual Displays

1. Visual indicators should be mounted as nearly perpendicular to the line of sight as possible.
2. Numerals on fixed displays should be mounted so that they do not have to be read upside down.
3. Numerals and letters should be simple in design, similar to Leroy lettering guides. Avoid extra flourishes.
4. Use capital letters for labels but use standard capitalized and lower case type for extended copy.
5. Scale graduation should not be finer than necessary within the accuracy of the instrument itself.
6. Separation between indices and numerals on a dial should be sufficient for accurate reading.
7. Instrument pointers should be designed to reduce parallax. They should not overlap numerals or indices.
8. Irregular scale breakdowns should be avoided.
9. When several instruments must be read at once as in check-reading, orient the instruments so that the "normal" operating positions of all pointers are aligned (preferably at the 9- or 12-o'clock position).
10. Utilize similar numbering and scale progressions for dials which may appear on the same panel.
11. Utilize color code techniques to define operating and danger ranges, to simplify check-reading.
12. Use scale breakdowns of units, fives, or tens when possible.
13. Orient scales to make critical ranges appear in the left or upper quadrants so that an increase in reading will progress in the expected direction.
14. For multirevolution dials, orient the zero position at 12 o'clock.
15. Numbering systems should increase from left to right or bottom to top whenever possible.
16. Provide suitable coding or labeling on both the display and control to tell which control affects which display.
17. Controls marked to indicate direction of operation.
18. For dials which have a finite scale, provide a definite scale break between the end of the scale and the zero position.
19. Utilize maximum contrast between the color of dial and scale markings and the background of the dial.

20. Dial pointers should be the same color as indices and numbers on the dial.

21. Select counter types in which the numbers "snap" into place.

22. An upward movement of a counter should indicate a numerical increase.

23. Avoid counter designs which have too much space between numerals when the numerals must be read as a whole number.

24. Avoid fractions or decimals on dial scales when possible.

25. Select counters which read from left to right.

26. When selecting warning lights, make sure they are compatible with the ambient illumination levels expected. A dim light will not be seen in bright sunlight, and a bright light may be detrimental to dark adaptation. Utilize dimmer controls if necessary.

27. When dark-adaptation is necessary, use red light only (wave-lengths longer than 620 millimicrons).

28. Flash rates for flashing warning lights may vary from 3 to 10 per second, but "duration on" should be at least .05 second.

29. Warning signals should not be obtrusive longer than necessary to attract attention. A device meant to provide a specific warning for a given purpose should never be designed also to actuate during any part of normal operations.

30. Critical warning lights should be isolated from other lights to be most effective.

31. Ambient illumination surrounding a cathode ray display for detection tasks should be controlled at about 0.1 millilambert.

32. Vibration of visual displays should be held to a minimum. Any display movement requires simpler design, higher illumination levels, and longer reading time.

33. Counters should be mounted close to the panel so that numbers are not obscured by bezel openings.

34. Don't combine unrelated information.

35. Avoid the use of more than two pointers on a single dial shaft.

36. Provide even illumination of all parts of a dial including the pointer.

37. In dial scale design, the fixed scale with moving pointer is preferred over the fixed-index moving-scale design.

38. Numeral and scale index designs are dependent upon the reading distance. Use optimum numeral/letter height-width and stroke ratios.

39. Provide a display to show that an instrument is not operating properly.

40. Up-to-date information is necessary for adequate visual display.

41. Instrument design should minimize mental translations of units and symbols.

42. Changes in visual indications should be easy to detect.

43. When reciprocal readings are necessary from a single pointer, make sure the two ends of the pointer are identifiable.

44. The opening for open-window dial display should permit viewing at least two numbers.

45. Keep visual displays as simple as possible within the informational requirement of (1) quantitative, (2) qualitative, or (3) check-type readings.

#### Control

46. Controls which must be located without having to be seen should be positioned in forward areas rather than to the side or behind the operator.

47. Often-used controls should be placed somewhere between elbow and shoulder height.

48. Control movement should be in the "Expected" direction; that is, increases should be caused by movement to the right or upward.

49. Control movements and location should be parallel to the axis of the display motion which they affect.

50. Cranks should be designed and positioned with respect to the speed or load which they administer; that is, small cranks,



at elbow height for fast wrist action, light loads; large cranks oriented for full arm motion.

51. Adjustment-type knobs for electronic equipments should be no more than 2 inches in diameter and should be used only for very light torques.

52. Round knobs should be used for controls requiring smooth continuous movement. Bar- or pointer-type knobs should be used for detent-type switching.

53. Toggle or bat-handle switches should provide at least 30° throw each side of center to give good visual indication of displacement.

54. Brake pedals should be mounted so that the knee angle (between the upper and lower leg) of the operator is somewhere between 105° and 135°.

55. Pedals should be pivoted so that control action is similar to the limb or foot motion (near the heel of the foot for ankle action on an accelerator pedal, or above the foot for leg motion as in the case of the brake).

56. Control actions should be positive without being sticky or stiff.

57. Joystick movement should be equally free in all directions. Small joysticks on table or desk-top installations should be mounted so that the hand has a resting place for steadying the control movement.

#### Panel Layout

58. Panel layout should be as functionally simple as possible. Compromises of primary position for controls and displays should be considered as a whole in order to see all interactive tasks.

59. Cover those displays and controls which are not absolutely necessary to actual operation.

60. Orient displays at proper eye height and arrange often-used controls near elbow height when possible. Make sure the operator cannot cover a display while manipulating a control.

61. Provide clear, legible labels. Use standard abbreviations. Provide illumination where necessary and be consistent in placing labels either above or below controls or displays.

62. Avoid glossy surfaces or highly polished metals. Use anti-glare coating on transparent instrument covers when possible.

#### Console Design

63. Cabinets, racks, and consoles should be designed with the dimensional statistics of the human operator in mind. Static dimensions are available to the designer, but he must exercise common sense in adjusting these figures to the dynamic situation.

64. Vertically mounted visual displays should be 50 to 70 inches above the floor when they are to be viewed from a standing position.

65. Use a 30-inch seat-to-eye height reference to locate visual displays used by a seated operator and specify the chair height along with the console dimensions.

66. For a comfortable display mounting angle, use the following rule of thumb: 60° from horizontal for seated operators; 45° for a combination sit or stand and 30° for a straight stand position. These angles provide a good compromise for mounting displays such as CRT's.

67. Use a 28-inch arm reach, measured from the operator's shoulder, as a limiting figure for the placement of controls which are to be used often.

68. Controls should be located near the display which they affect when this does not conflict with other manipulatory requirements.

69. When possible, controls should be arranged sequentially with respect to the expected or required order of operation. Activities for both hands should be evenly distributed.

70. Generally, control-display organization should be such that visual displays occupy central areas, and controls occupy peripheral areas, to avoid hand and arm interference with visual tasks.

71. Functional organization of displays and controls should be emphasized by using such techniques as color coding, marked outline, symmetry of grouping, and/or differential plane of mounting.

72. Where consoles are designed for seated operators, utilize good seating principles such as optimum dimensions with regard to the expected population of users, backrests, armrests, footrests, cushioning, and adjustability.

73. When desk positions are required, consider height of writing surface, working width and depth, knee and foot room, and elbow room if more than one operator is involved.

74. Storage space should be designed with man's physical dimensions in mind; consideration should be given to reach distance, eye height when stored items must be seen, and depth of bin for articles pushed to the rear).

#### Multiple Layout

75. When men and machines are grouped for system or team operations, consider not only the individual needs but also the equitable flow of human traffic and aural and visual communication links.

76. When multiple man-machine combinations are grouped together, make sure that operators primary control manipulations are not restricted.

77. When group activity demands use of a central visual display make sure that lines of sight to the display are not blocked by poor arrangement of people or equipments.

78. Corridor and passageway design should provide enough space for people to pass each other and for doors opening into passageways without hindering the flow of traffic.

79. Special consideration should be given to passageways and doorways used by personnel who are encumbered by special clothing or equipment.

#### Environment

80. Good illumination should include the following considerations: (a) suitable brightness for the task at hand, (b) uniform lighting on the task, (c) suitable contrast between task and background, (d) freedom from glare from either the light source or the work surfaces, and (e) suitable quality and color for the illuminants and surfaces.

81. For aircraft cockpits or other specialized military applications, consult recommended lighting-level tables for both the ambient and specialized lighting.

82. Do not assume that general ambient illumination will be adequate for individual tasks. A careful analysis of the entire lighting system will prevent later makeshift remedies.

83. Consider the environmental conditions under which the man-machine combination must work. If these conditions cannot be controlled directly, it is necessary to provide other safeguards. Temperature, ventilation, and noise are the major considerations, and modern protective measures should be used by the designer.

#### Maintenance

84. Design and use of displays that will indicate marginal or substandard performance to the maintenance technician. Although it is obvious when most equipments are inoperable, it is often difficult to determine when they are functioning poorly or below effective levels.

85. Consider the matter of maintenance simplification as well as operational simplification. Utilize unitization techniques, go-no-go indicators, and disposable packages where feasible.

86. Follow good display and control design practices when providing a display or control for the maintenance technician. Poor meter displays, screwdriver controls which are too sensitive, or poor use of color coding hinder maintenance.

87. Avoid large cumbersome back-access doors on cabinets or racks. These create a nuisance and a hazard. Utilize quickly-removable or small double-hinged doors which do not complicate the space problem.

88. Avoid cable entrances on the front of cabinets.

89. Screwdriver calibration adjustments are unsatisfactory from the standpoint of human manipulation. Use knobs whenever possible, and if these shouldn't be disturbed except in special cases, cover them or provide a special seal or danger code.

90. Provide an index for adjustment controls. It is difficult to remember settings without some marking, and this indexing in turn may reveal gradual deterioration in performance as settings need changing.

91. Keyways for tubes and tube sockets should be suitably marked so that the technician does not rely on "feel" to find the proper position. Tube labels should also be oriented so they can be seen from the maintenance position.

92. Use care in counting miniaturized parts. Their size often influences the designer to mount them too closely together. The hand remains the same size.

93. In mounting parts on chassis and chassis in racks, keep in mind the problem of maintenance. Provide access to both sides of a chassis. Leave sufficient hand room for the technician to remove and replace parts without danger. Provide hand grips for lifting.

94. Avoid mounting parts and assemblies so that several intermediate pieces have to be removed to get to one that requires frequent servicing.

95. When drawer slides are used, make sure they will not stick and will hold the unit firmly in the open position, and that the technician does not need three hands to manipulate fasteners or guide flexible cables.

96. Reduce the number of types of parts required. Utilize common parts where possible to simplify maintenance and storage.

97. Utilize legible and permanent tuning instructions, calibration graphs, labeling, and dial markings. Separate instructions that get lost hinder good maintenance.

98. Provide adequate illumination for maintenance. Ambient room illumination is seldom satisfactory. Dark colors for cabinet interiors are not recommended since they create shadows.

99. Provide routine check points which are available without removing the chassis from the cabinet.

100. Avoid using adjustable parts when part values need not change during the life of the equipment.

#### Selecting Proper Parts

1. Keep in mind the environments the equipment must meet eventually in the field (shock, vibration, temperature, humidity, salt spray, etc.).

2. Know electronic parts and their limitations. Know circuit conditions under which parts operate best.

3. Use military preferred reliable parts in all applications possible.

4. Compensate in equipment design for known limitations in parts.

5. Apply suitable margins of derating factors (safety factors) to compensate for variations encountered in use.

6. Use prescribed derating factors for temperature effects, especially of resistors, capacitors, and tubes.

7. Guard against voltage overload and excessive current.

8. Position parts in the equipment so that the heat radiated by surrounding parts and the temperature rise in individual parts and circuits do not exceed maximum safe operating temperatures.

9. Arrange parts so that they are easily accessible for testing and maintenance.

10. Provide adequate ventilation. If necessary, even add blowers to keep parts within safe operating temperatures.

11. Protect equipment with fuses, meters, etc., to prevent damage from unexpected operating conditions.

12. Check circuit function with random selections of tubes. Determine if shifts in tube characteristics or normal aging of other items are likely to affect operation seriously during the desired life of the equipment.

# UNEQUALED, ULTRAMODERN

A battery of the very latest type of centerless grinding machines turns out the precisely-ground rings of Fafnir instrument bearings.



assure new highs in quality for instrument bearings

The inspection area of the new Fafnir instrument bearing facilities — Fafnir-developed torque tester in the foreground. The air-conditioning system of this department supplies air completely free of dust particles larger than 0.2 of a micron, and a pressure differential to prevent dirt infiltration. Walls are of laminated plastics, room partitions of tempered plate glass.



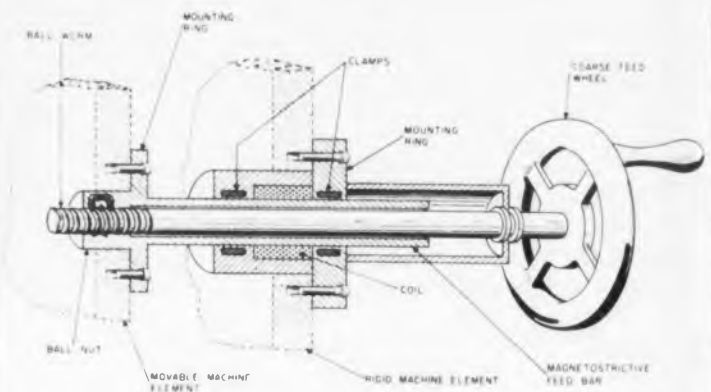
COMPLETELY new facilities for the manufacture, assembly, and inspection of precision instrument bearings increase Fafnir's ability to meet not only a rapidly-growing demand for instrument bearings, but also more exacting specifications.

The latest type of race grinders together with other advanced equipment including

ultrasonic cleaning, greatly increase production capacity. An assembly and inspection area featuring unique testing devices provides the means for setting new highs in quality control standards.

Write for new 8-page, colorfully-illustrated brochure. The Fafnir Bearing Company, New Britain, Connecticut.

# FAFNIR



Cross section view of linear motor.





# Magnetostriction Motor

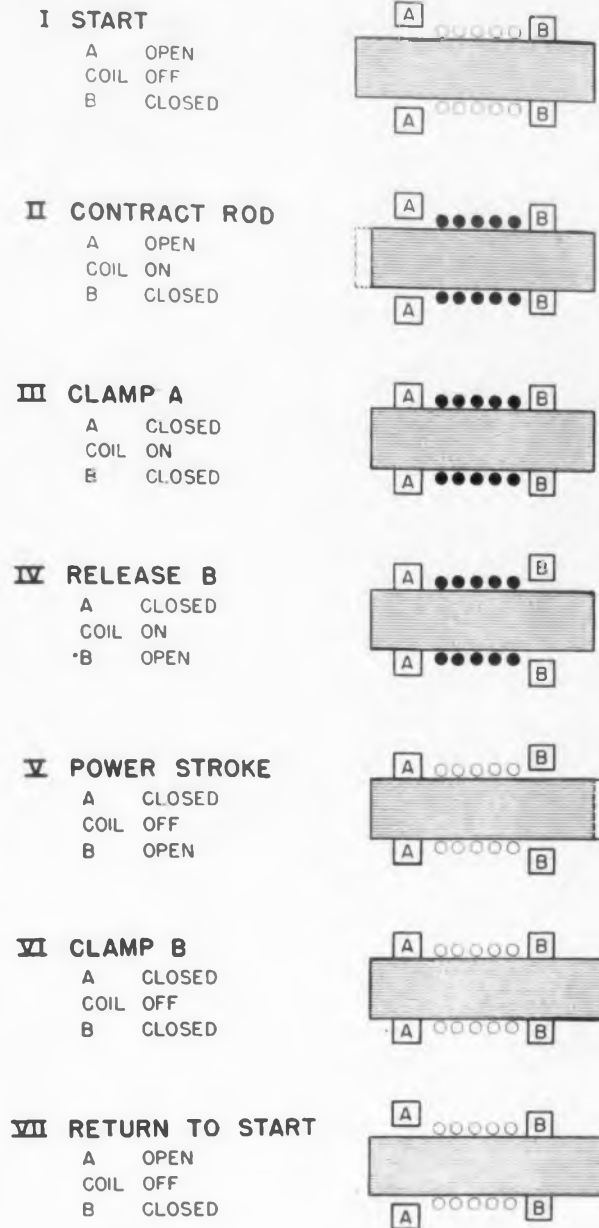
Linear motion in millionth of an inch increment



**T**HIS linear actuator is a logical successor to the lead screw in all feed mechanisms requiring micronich (0.000,005 in. to 0.0001 in.) dimensional control. Its first large-scale application in the machine tool field has been to replace the lead screws in centerless grinders. The device employs the magnetostriction effect. Expansion and contraction of the armature, when subjected to an electromagnetic field, is converted to forward or backward motion, reversing on demand without backlash.

Machine cutting tools are generally mounted on a heavy member which slides on accurate ways which are formed as part of the machine bed. Stick-slip, the characteristic of a larger force being required to start two members sliding than that required to maintain the motion once started, must be overcome or reduced to controllable limits before positioning in the millionths-of-an-inch region can be accomplished. The Inchworm actuator, developed by Airborne Instruments Laboratory, Inc. has brought the stick-slip problem under control to the extent that the minimum increment of slide motion in typical installations has been reduced by a factor of 15 through Inchworm replacement of conventional feed mechanisms. These installations have consistently repeated to an accuracy  $\pm 5$  millionths of an inch under machine load conditions requiring a break-loose force of 300 pounds and a sliding force of about 220 pounds (Cincinnati Milling Machine Co. flat bed No. 2).

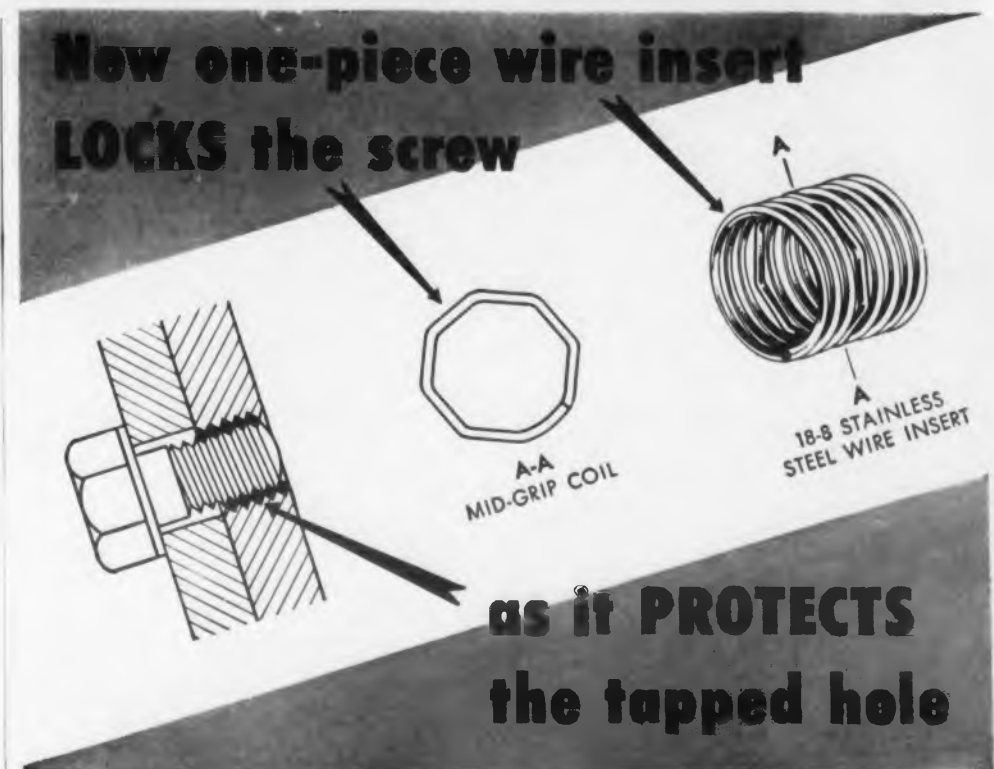
The Inchworm lends itself well to the automation trend in the machine tool field



Step cycle of magnetostriction action.

in that it will, through a simple converter, respond directly to gage signals. In this manner, machines may be made continuously responsive to tool variations as well as material hardness variations and the many other variables that enter into precise machine finishing.

It is refreshing to see the magnetostriction principle put to use in this new way. Its another example of design engineer's ingenuity in making his knowledge play an important expanding role in industry.



Withstands vibration, heat, corrosion — Meets AN-N-5b lock nut specifications

Here is a ONE-PIECE stainless steel thread insert that will *lock the screw against loosening* as it permanently protects the tapped hole. The secret is in the Mid-Grip coil. Shaped like a polygon, its chords exert a spring pressure on the screw thread and prevent rotation at less-than-rated torque. No loss of torque occurs at elevated temperatures or after repeated disassemblies.

**NO EXTRAS**—The Heli-Coil® Screw-Lock (Mid-Grip) Insert employs no locking rings, pins, plugs, tabs or wiring. It can be installed from the front or top. Think of the money — and assembly time — you can save!  
**NO PROJECTIONS** — Screw-Lock Inserts furnish AN-N-5b lock nut torque *right down inside the parent piece* . . . eliminate costly weight and space . . . improve design.

**NO WEAR, NO CORROSION**— Like regular Heli-Coil Inserts, new Screw-Lock Inserts are made from 18-8 stainless steel wire, and normally outlast the unit they protect. They permit smaller, fewer fastenings, and require minimum surrounding material. Screw-Lock Inserts are available in popular NC and NF sizes with choice of two lengths.

Mail coupon for complete data—or better still, see Yellow Pages of your phone directory — “Inserts — Screw Thread” for name of your local Heli-Coil Applications Engineer. Call him now!

Regular Heli-Coil Inserts (no locking action) put corrosion-proof, strip-proof stainless steel threads in soft materials . . . permit smaller, fewer fastenings, lighter weight, reduced cost.



## SCREW-LOCK INSERTS

Products of Heli-Coil Corporation, Danbury, Conn.

\*Reg. U. S. Pat. Off.



### HELI-COIL CORPORATION

25 Shelter Rock Lane, Danbury, Conn.

- Send complete design data on Heli-Coil Screw-Lock Inserts.
- Send design manual on standard Heli-Coil Screw Thread Inserts.
- Put me on a list to receive “Heli-Call,” case history periodical.

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

IN CANADA: W. R. Watkins Co., Ltd., 41 Kipling Ave. S., Toronto 18, Ont.

CIRCLE 30 ON READER-SERVICE CARD FOR MORE INFORMATION



# New Products

## Subminiature Tube Mounting Shield Button Base Tubes



This right angle subminiature tube clamping shield with integral socket with round button base subminiature tubes permits placing complex elec-

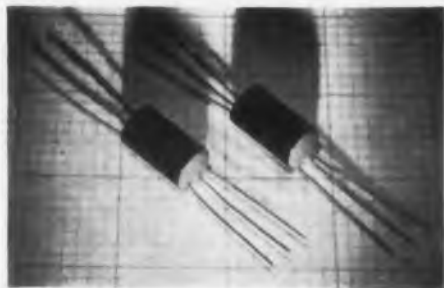
tronic components in confined places while retaining ready access to them for service and replacement. Increased tube life and reliability by reduction of bulb temperature, maximum tube retention under severe shock and vibration, and effective electrostatic shielding is afforded.

International Electronic Research Corp., Dept. ED, 145 W. Magnolia Blvd., Burbank, Calif.

CIRCLE 31 ON READER-SERVICE CARD FOR MORE INFORMATION

## Pulse Transformer

For Low Power Applications



The "Stat-Tran" is designed to replace miniature broadband pulse transformers in most applications with improved wave-

form, better impedance match, lower losses, higher output, and higher voltage rating. It is produced semi-automatically at reduced cost. Values of leakage inductance and distributed capacitance make it a valuable for the power levels encountered in missile and computer circuitry. It is particularly useful in pulse coupling and differentiation where high efficiency is desired.

Pulse Engineering, Dept. ED, 2431 Spring St., Redwood City, Calif.

CIRCLE 32 ON READER-SERVICE CARD FOR MORE INFORMATION

## Forced-Air Cooled Triode Has Thoriated-Tungsten Filament



The ML-5530-H is a thoriated-tungsten filament, forced-air cooled triode designed for industrial heating equipments in the 3 kw to 6 kw power level. A modification of the ML-5530, the ML-5530-H incorporates a new terminal structure

and has been given increased plate voltage and power ratings for the usual dielectric heating frequency band.

The tube is rated for a maximum plate input of 10 kw at frequencies to 30 mc. It offers a broad load impedance range varying from 8.5 k, to 1.18 amp to 5.7 kv, 7.75 amp. Anode dissipation of 4 kw requires only 250 cfm at 1.7 in. of water static pressure.

Machlett Laboratories, Inc., Dept. ED, Springdale, Conn.

CIRCLE 33 ON READER-SERVICE CARD FOR MORE INFORMATION

## 5000 V DC Power Supply

Weighs Only 2 Pounds



Model PS503, a 5000 v dc power supply, measures 4 x 2-5/8 x 5-1/2 in. Input of 275 v dc provides 5000 v dc at 300  $\mu$ a. Lower output voltage at correspondingly higher currents are obtainable too. The transformer hermetically sealed in an epoxy resin casting, operates on 30 kc.

Servo Corp. of America, Dept. ED, 20-20 Jericho Turnpike, New Hyde Park, L.I., N.Y.

CIRCLE 34 ON READER-SERVICE CARD FOR MORE INFORMATION

## Speed Reducers For Control Shafts



Designed for adjustment and control of indicator or circuit functions of electronic and mechanical apparatus, speed reduction in these units is obtained from the differential-planetary rotation of precision ball bearings, providing efficient and smooth rotary motion.

The units are completely enclosed and factory lubricated for life. All materials used comply with Govt specifications. Known as the RD series, these reducers are available with 6 different input-output ratios from approx 2.5-1 to 20-1.

Jan Hardware Mfg. Co., Dept. ED, 75 N. 11th St., Brooklyn 11, N.Y.

CIRCLE 35 ON READER-SERVICE CARD FOR MORE INFORMATION

## Low-Level DC Amplifier

Eliminates Gain Variations



Unprecedented gain stability is provided by the Micromag MMO-422 low-level magnetic dc signal amplifier for telemetering and instrumentation applications.

Incorporation of a transistor oscillator permits the Model MMO-422 to operate directly from a dc power source.

The MMO-422 finds particular application in the amplification of thermocouple and strain gage output. It serves equally well as a very stable dc voltage amplifier for radio telemeter systems or as a high-gain dc power amplifier for relay-type temperature and servo control systems.

Magnetic Research Corp., Dept. ED, 200-202 Center St., El Segundo, Calif.

CIRCLE 36 ON READER-SERVICE CARD FOR MORE INFORMATION

## New 5-Inch Oscilloscope

### For Color TV Testing

Model 632, in the medium price range, is a new 5-inch oscilloscope for testing voltage and wave forms in color as well as black and white TV receivers. The unit is designed to complement the Model 616 Color Bar Dot Generator.

Hycon Mfg. Co., Dept. ED, 2961 E. Colorado St., Pasadena, Calif.

CIRCLE 37 ON READER-SERVICE CARD

## Thermostats Cut Heating

### "Peaks" and "Values"

Two new line voltage thermostats have been developed to take hot "peaks" and cold "valleys" out of electric heating. One does it by fast cycling (up to 20 times per hour), and the other by cycling only 3 to 6 times an hour.

The fast cycling T-40 is responsive to as little as 0.4 deg of temperature change, and is designed to cycle up to 15 to 20 times per hour under a normal 50 per cent heating load requirement.

The T-41 thermostat uses slow cycling periods when used with large-mass heating elements of the type normally mounted in ceilings, floors and similar installations. Its differential is 1 deg.

Minneapolis - Honeywell Regular Co., Dept. ED, Wayne & Windrum Aves, Philadelphia, Pa.

CIRCLE 38 ON READER-SERVICE CARD

## New Cable Identification Sleeve

### Resists High Temperatures

A printable material, IDENTASLEEVE, which resists temperatures up to 700 F, still retains cable or harness identification marks. IDENTASLEEVE is a semi-rigid, finely woven fibre-glass sleeve, coated and impregnated with GENCOTE 125C, a specially formulated polymer. Numerals and letters are printed on the sleeve using systems such as the Kingsley Marking Machine. Unaffected by corrosive chemicals, gasoline and oils, the sleeve is also non-burnable.

General Plastics Corp., Dept. ED, 165 Third Ave., Paterson, N. J.

CIRCLE 39 ON READER-SERVICE CARD

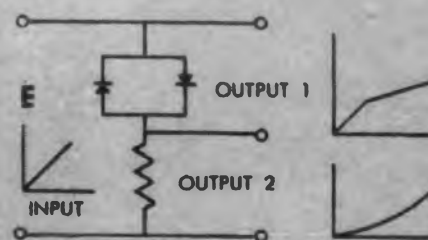
CIRCLE 40 ON READER-SERVICE CARD >

# Bradley VARISTORS SOLVE non-linear circuit requirements



SR3M12A114

## SCHEMATIC



### TYPICAL USES

- Voltage and/or current regulation.
- Meter protection.
- Expansion and compression circuits.
- Arc suppressors.
- Contact protection.
- Servo systems.
- Gating circuits.
- Limiters, slicers and clippers.

"Compact, rugged Bradley varistors can be used for non-linear resistance purposes practically in any circuit. They can be supplied in voltage ranges from less than a hundred millivolts to as high a voltage as required. Current range is from a few microamperes on up. Bradley selenium and copper oxide varistors display unusual life and stability characteristics. Non-linear characteristics of both selenium and copper oxide are developed to the highest degree by Bradley's exclusive vacuum process, assuring superior performance."

**RECTIFIER HANDBOOK:** Complete information for product designers. Most comprehensive manual available. Kept up to date. Cost: \$2.00 postpaid.

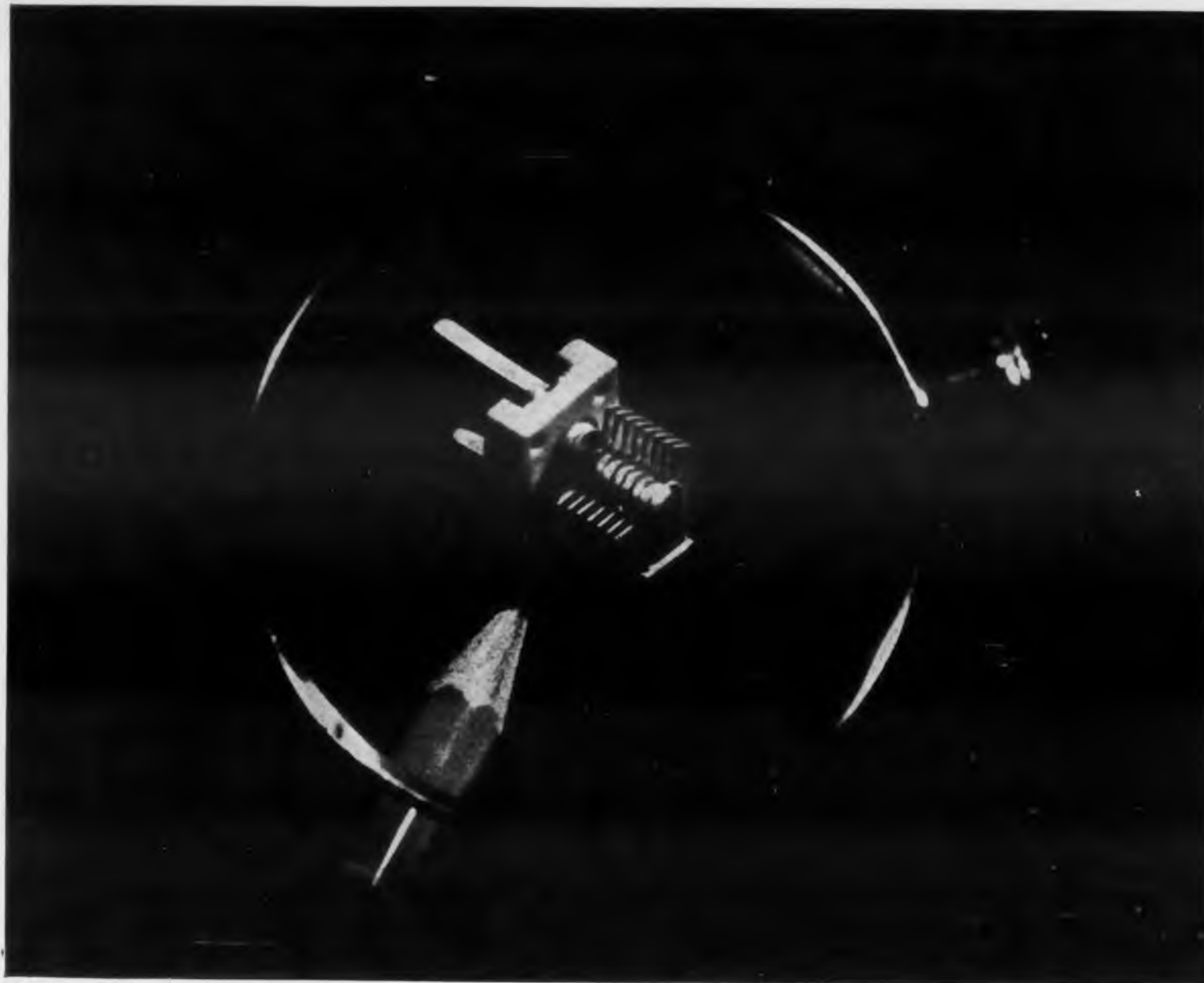
## BRADLEY LABORATORIES, INC.

174 Columbus Avenue, New Haven 11, Connecticut

**VACUUM PROCESSED FOR PERFORMANCE AS RATED**

Bradley





More than 1½ times actual size.

## NOW! even smaller air trimmer capacitors

For every type of electronic equipment—printed wiring board or conventional chassis—Radio Condenser's new Series 75 trimmers mean more circuit in less space. Measuring just 25/64" x 7/16" x 17/32" behind mounting surface, they're the tiniest trimmers ever made in the United States.

Three capacitance ranges are available, as tabulated below. Each is equipped with plug-in tabs for printed wiring board insertion, as well as two holes for conventional screw mounting. The sturdy low loss ceramic body, brass plates soldered and silver plated, assure a rugged unit, able to take extreme shock, vibration and temperature change. Capacitance is easily varied by means of a screwdriver slot in the rotor shaft.

Insulation resistance, "Q" and thermal stability characteristics are excellent.



## RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey  
 EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y.  
 CABLE: MINTHORNE  
 CANADA: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

CIRCLE 41 ON READER-SERVICE CARD FOR MORE INFORMATION

Complete Engineering data and specifications for the new Series 75 Subminiature Trimmer capacitors are provided in Bulletin TR-123, available free on request. Write Radio Condenser now for your copy.

### RADIO CONDENSER MINIATURE AIR TRIMMER CAPACITORS

Type No.	Min. Cap. $\mu\text{F}$	Effective Max. Cap. $\mu\text{F}$	Air Gap	No. Plates
875001	1.2	5	.014	9
875002	1.2	10	.008	11
875003	1.5	15	.008	15

## Coaxial Connectors For Hi-Voltage Uses



The Teflon Hi-Volt 259 and 239 UHF Coaxial Connectors are designed expressly for high voltage applica-

tion where RG Cable is used in conjunction with power supplies. These connectors are rated for 5000 v dc.

The assembly of the cable to the connector employs the same techniques as the conventional UG, uhf type connectors. These connectors are not impedance matches but may be used in the same circuitry where the SO239 and PL259 are employed.

Coaxial Connector Co., Inc., Dept. ED, 37 N. 2nd Ave., Mount Vernon, N. Y.

CIRCLE 42 ON READER-SERVICE CARD FOR MORE INFORMATION

## Dynamotors

In Powers up to 110 w



A line of dynamotors, the 3000 Frame Series, includes units with power output up to 110 w, depending on duty cycle and ventilation. All units operate in

the temperature range from -55 to +105 C. Specific input and output voltages are available to meet engineering requirements. The unit illustrated is the BD3011 D, with input of 27.5 w at 3 amp, output of 160 v at 250 ma, and speed of 9000 rpm.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, L.I., N.Y.

CIRCLE 43 ON READER-SERVICE CARD FOR MORE INFORMATION

## Datables

Self-Adhesive Labels



Engineering handbook and standard data, in concise tabular form for easy, quick reference, are washable, transferable, heat and moisture resistant, and can be mounted on any smooth surface.

Timber Top Products, Dept. ED, P.O. Box 14, Freeport, N. Y.

CIRCLE 44 ON READER-SERVICE CARD FOR MORE INFORMATION



### Tube Pin Straightener Is Also Cut-Off Tool



The JE 20 Combination Subminiature Tube Pin Straightener and Cut-Off Tool speeds up the alignment and trimming of leads of both

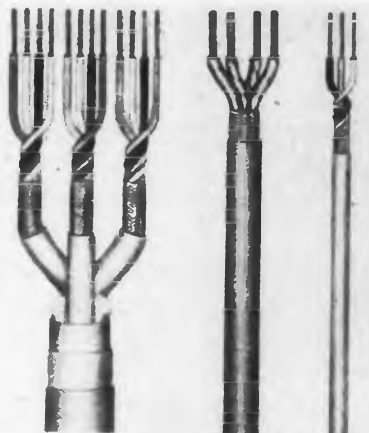
inline and round base subminiature tubes. It features stainless steel 303 inserts set in a black anodized aluminum base. Holes of the stainless steel inserts are precision drilled and counter-sunk to exacting specifications.

Star Expansion Products Co., Dept. ED, 142 Liberty St., New York 6, N. Y.

CIRCLE 45 ON READER-SERVICE CARD FOR MORE INFORMATION

### New Multi-Conductor Cable

Teflon Insulated



Teflon insulated cables, designed in constructions from single through thirty-seven conductor assemblies, are available.

The primary insulation suggested for these constructions, is parallel wrapped Teflon, featuring high cut-through resistance and

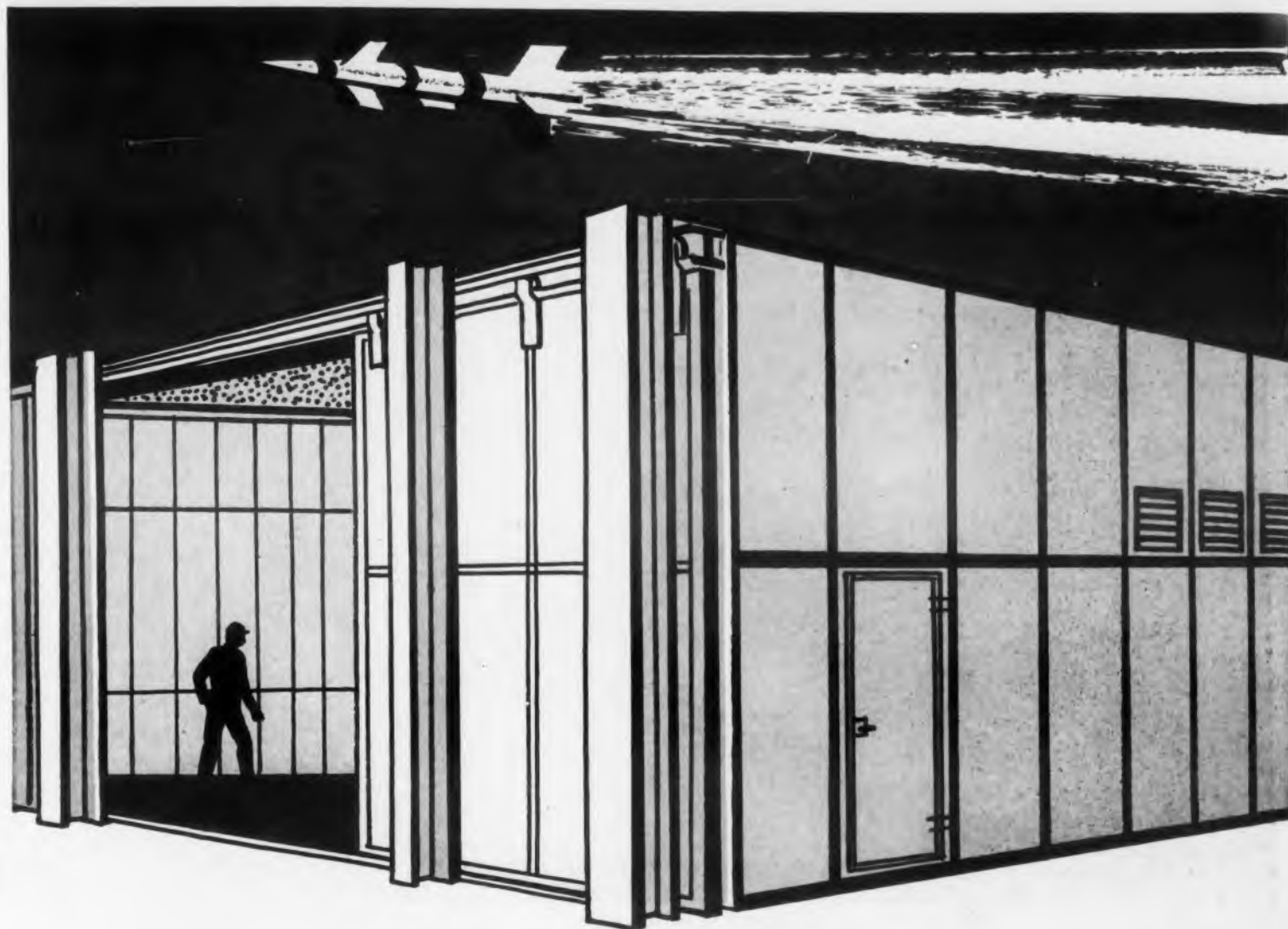
ease of stripping combined with maximum flexibility. The insulated conductors conform to the requirements of MIL-W-16878B, Types E and EE.

Any of the insulated wires may be individually shielded, but usually an overall silver-plated copper shield is supplied with various outer jackets. For high temperature applications a Teflon outer jacket is recommended, or a glass braid can be provided lacquered with silicone or Teflon. For lower temperatures, extruded vinyl or nylon jackets and lacquered nylon braids are supplied.

Teflon insulation offers a broad working temperature range of  $-90$  to  $+250$  C, high dielectric strength, low capacitance, and complete resistance to all chemicals.

Tensolite Insulated Wire Co., Dept. ED, 198 Main St., Tarrytown, N. Y.

CIRCLE 46 ON READER-SERVICE CARD FOR MORE INFORMATION



## HUGE ENCLOSURE SHIELDS GUIDED MISSILES FOR RADIO-FREQUENCY TESTS AT BELL

Current F.C.C. regulations governing radio-frequency interference give much publicity to the need for adequate shielding. But an even greater need arises from those who must conduct electronic tests *without interference from external sources*.

This was the need at Bell Aircraft Corporation, Buffalo, N. Y. But further, Bell asked ACE to design, build, and install an enclosure large enough to shield a guided missile in its entirety. The result is the largest prefabricated shielded enclosure ever built.

This gigantic shield measures 40 feet long, 35 feet wide, and stands 18 feet high. Made of ACE prefabricated panels of galvanized sheet steel, the entire structure can be taken down, moved, and reassembled at another location if necessary. Yet it provides the high levels of attenuation required

to test aircraft electronic equipment for conformance with all military interference specifications.

Other unique features include electrically controlled sliding doors for maximum opening of 16 feet high by 21 feet wide . . . air operated contact fingers around the door periphery for positive r-f seal . . . two personnel access doors . . . air-conditioning . . . electric and pneumatic service entrances . . . 5000 watts of lighting . . . and a specially reinforced floor capable of supporting extremely heavy loads.

ACE can solve your shielding problems with comparable success — from small bench-size "boxes" to huge enclosures even larger than the Bell "hangar" described above—meeting all the varied requirements of industry, military, and medical work. An Ace sales engineer will be glad to show you how. Or, write for free catalog on ACE standard enclosures.



First and Finest in Shielded Enclosures

ACE ENGINEERING & MACHINE CO., INC. 3644 N. Lawrence St. • Phila. 40, Pa.  
CIRCLE 47 ON READER-SERVICE CARD FOR MORE INFORMATION

## Notable Achievements at JPL

**MISSILE GUIDANCE AND CONTROL...** In applying advanced servo and noise-theory techniques to missile control systems, JPL has led and advanced the field of missile guidance.

Among specific achievements are the application of Wiener RMS methods to multiple-input, multiple-loop servos, and matching missile trajectory to missile control transfer function for optimum accuracy.



## Research in Guided Missile Technology

JPL JOB OPPORTUNITIES ARE WAITING FOR YOU TODAY in these fields

RADIO GUIDANCE

MICROWAVES

SYSTEMS ANALYSIS

GUIDANCE ANALYSIS

APPLIED PHYSICS

ELECTRO MECHANICAL

INSTRUMENTATION

INERTIAL GUIDANCE

TELEMETERING

PACKAGING

MECHANICAL ENGINEERING

The Jet Propulsion Laboratory is an organization devoted entirely to scientific research and development. Covering an 80 acre area in the rising foothills of the San Gabriel mountains, north of Pasadena, it occupies an ideal location close to residential districts.

The working staff of the Laboratory consists of about 1250 people, all employed by the California Institute of Technology. The various projects are conducted under continuing contracts with the U. S. Government.

The prime objective of JPL is obtaining basic information in the various sciences related to missile systems development and in all phases of jet propulsion. Underlying the entire Laboratory activity, a major continuous program of fundamental research in the physical sciences is constantly in progress.

In its missile system and jet propulsion undertakings, the Laboratory maintains a broad technical responsibility, from basic research to prototype engineering. By virtue of this and the integrated nature of the JPL technical staff, each individual is drawn into close contact with the general field to which his specialized technical abilities contribute the most.

If you are interested in knowing more about our work and the specific employment opportunities now open, please send us an outline of your technical background and experience.

CALTECH



**JET PROPULSION LABORATORY**

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY  
PASADENA, CALIFORNIA

### Sealed Switch

Offered With Roller Actuator



This snap-action, W-Blade sealed switch is now available with a versatile roller-actuator that features: low

cost; complete protection against water, dust, dirt, and chemicals; long life (up to 1 million cycles under rated load); precise calibration; and high capacity compared to size.

The actuator is available without the roller where a simple leaf actuator is desired. Also, it may be ordered without the roller or the arm to which it is mounted, but with a pin which the arm normally actuates. This enables the customer to select the actuator type. The W-Blade switch also is available either as a limit or as a toggle switch.

Electra Manufacturing Co., Dept. ED, 4051 Broadway, Kansas City, Mo.

CIRCLE 50 ON READER-SERVICE CARD FOR MORE INFORMATION

### Non-Destructive Hipot Tester

5  $\mu$ a Circuit Breaker



Sensitive Hipot Testers, which automatically de-energize high voltage when leakage current in samples reach 5  $\mu$ a, are available from 2 kv up to

120 kv, and special

units can be custom built. The smaller units are adjustable up to 1000  $\mu$ a and larger units up to 5000  $\mu$ a.

The tester avoids the brute force method of burning up fine equipment and components when testing for leakage. Hipot testing allows convenient and accurate dielectric testing of equipment, components and materials. With the new Series "H" tester, leakage currents in insulation show up which may appear to be perfect on less sensitive instruments.

Standard features include both ac and dc outputs and continuously adjustable output voltage. Accurate, hand calibrated dual scale metering, which is directly across the HV output, can be recalibrated at any time by a simple screw driver adjustment. A selfholding primary contactor prevents the accidental reapplication of high voltage after a line failure.

Peschel Electronics Inc., Dept. ED, New Rochelle, N. Y.

CIRCLE 51 ON READER-SERVICE CARD FOR MORE INFORMATION



## Analog Computing Systems

### Compact, Wide Range Instruments



Complete analog computing facilities capable of operating at speeds 3000 times faster than real time are now available in the form of General Purpose Simulators,

Models GPS-6 and GPS-12. A wide variety of linear and nonlinear computing elements and special function generators are available for use with these basic systems, allowing a wide class of design problems to be handled.

GPS General Purpose Simulators can perform complete problem solutions up to 50 times per second, allowing the research operator to change problem parameters, and observe instantaneously and continuously the resulting changes in problem solutions. They are particularly useful for the rapid study of alternative system configurations, for optimizing the parameters of a defined system, for the solution of boundary-value problems, and for the trial-and-error design of any given physical system.

The GPS-6 system consists of a Master Generator and a Basic Computing Unit capable of solving problems up to sixth order. The GPS-12 system consists of a Master Generator and two Basic Computing Units, and is capable of simulating linear physical systems up to twelfth order. Basic Computing Units are 29 x 13 x 36 in. high and weigh 60 lb each.

The Master Generator used measures 26 x 10 x 13 in. and weighs 35 lb.

GPS Instrument Co., Dept. ED, 811 Boylston St., Boston, Mass.

CIRCLE 53 ON READER-SERVICE CARD FOR MORE INFORMATION

## VU Level Indicator

### Conforms to ASA and JAN Specs



VU Meters are now built into Beede styled cases, Model #23 in clear plastic, Model #16 in satin black. Zero power level is 1 mw, in 600 ohm line. Instrument impedance is 3900 ohms; 3600 ohms external resistance is

supplied on special request giving a total of 7500 ohms.

Beede Electrical Instrument Co., Dept. ED, Penacook, N.H.

CIRCLE 54 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • October 1, 1956

**BROADBAND MICROWAVE COMPONENTS**

**Broadband-Pass Filters**  
Five Models Covering 500 to 12,000 mc  
High SWR immunity. Low pass band insertion loss. 50 ohm coaxial connections.

**Microwave Test Antennas**  
Six Models Covering 1,000 to 26,000 mc  
Rugged, portable. For field measurements; leakage measurements and other laboratory uses  
Excellent front to back ratio.

**Microwave Attenuator**  
Model 431 Covering 4,000 to 12,400 mc  
Continuously variable, slide-tuned waveguide beyond cut off attenuator. For use in making microwave measurements with spectrum analyzers, signal sources, receivers, and power meters.

**Sub-Miniature S-Band Cavities**  
Plate and Grid Pulse Models Covering 2,750 to 3,000 mc  
... only 3" long and 1" diameter. Useful where miniaturization and high power are essential. Frequency can be varied by simple tool adjustment. Meets stringent military requirements for shock and vibration.

In addition to this wide range of Broadband Microwave Components, Polarad manufactures an extensive line of microwave equipment created to accomplish a variety of difficult testing tasks with a minimum of operational procedure.

For information regarding Polarad General Electronics, Microwave and Color TV Equipment consult your Polarad Field Representatives.



## ELECTRONICS CORPORATION

43-20 34th Street • Long Island City 1, N. Y.

REPRESENTATIVES: Albuquerque, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Denver, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, St. Louis, San Francisco, Schenectady, Syracuse, Washington, D. C., Winston-Salem, Canada; Arnprior, Ontario. Resident Representatives in Principal Foreign Cities

CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION



## Black India Ink

### Ball Point Pen

Black India ink has been gelatinized so that it can be used in a ballpoint pen with a stencil-like point which permits writing directly on all types of technical Diazo sensitized and similar papers. Perfect opacity makes possible clear, legible copy.

The ink is indelible, waterproof, instant drying, it won't smear, won't run and won't corrode.

Samuel Taubman & Co., Dept. ED,  
76 Madison Ave., New York, N. Y.

CIRCLE 56 ON READER-SERVICE CARD

## New Miniature Dc Relay

### Compact Design

Type S, a new miniature dc relay, measuring only 7/8 in. wide, 1-3/16 in. long, and 1 in. high overall, is suitable for use in low cost electronic equipment, radiosonde, expendable devices, printed circuits, automotive applications, electrical toys, etc. Additional specifications are: sensitivity rated at 40 mw; coil resistance up to 500 ohms, standard; contact rating -1/2 amp at 115 v ac, for SPDT; cross-bar contacts available; choice of two mounting styles, single stud 6-32 5/16 in. or insulated base.

Comar Electric Co., Dept. ED, 3349  
W. Addison St., Chicago 18, Ill.

CIRCLE 57 ON READER-SERVICE CARD

## Enjoy Electrical Appliances

### In Your Car

"Powercons", designed specifically for the automotive market to convert the normal 6 or 12 v dc battery power supply to 60 cps 110 v ac, has been introduced.

These small, box-like units with various power ratings can be installed in convenient spaces, such as under the dashboard or in a car's trunk compartment.

The line of "Powercons" for mobile service range in size, weight and capacity from 20 w to 150 w or 200 w units. Several models have output voltage control built in.

Cornell-Dubilier Electric Corp.,  
"Powercon" Div., Dept. ED, South  
Plainfield, N. J.

CIRCLE 58 ON READER-SERVICE CARD

CIRCLE 59 ON READER-SERVICE CARD >

# NEW GENERAL ELECTRIC MOTOR- IMPROVED PERFORMANCE,

WITH General Electric's three new advanced-type thyratrons, the electronic motor-control designer can work to new, high standards of circuit efficiency. Built into the GL-6807, 8, and 9 are such basic tube improvements as outside-air cooling of anode and grid . . . solidly brazed anode terminal . . . metal-to-glass-bonded internal tube structure.

Here are cooler-operating, longer-life thyratrons than any built before. Three base designs—pin, spade-lug, flying terminal—give application flexibility. Still more important . . . price of the tubes is down! The GL-6807, 8, and 9 come to you for 16% less

than the 5545 they replace. New, more efficient manufacturing methods have made this possible.

General Electric leadership in thyratrons is exemplified by these three new motor-control types. They do a better job, and do it for less. Also, they increase G-E type selection—always the industry's largest—to 46 thyratrons, enabling you to pinpoint every control and circuit requirement.

A convenient selection chart has been prepared to help you find the exact thyatron you need. Write to *Electronic Components Division, General Electric Company, Schenectady 5, New York.*

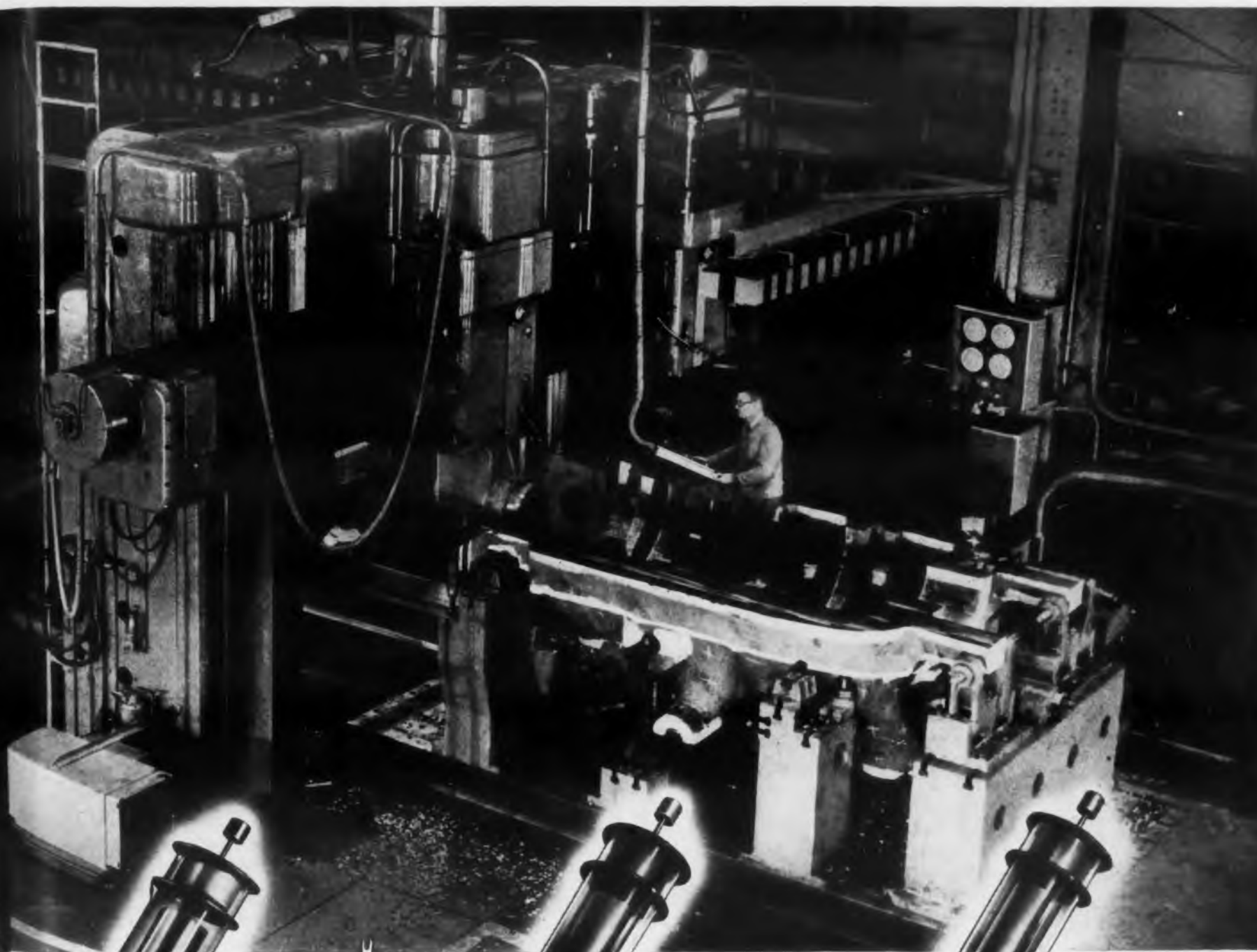
This mammoth planer-miller depends on new-design General Electric thyratrons to provide efficient and flexible motor control for finishing steam-turbine shells. Here a large turbine casting is moved through the planing phase of the machine's operation. ▶

Micro-milling a casting joint. A cut 4/1000" deep, 10" wide, is being taken at a steady rate of four inches per minute. The machinist guides each move of cutter and casting electronically, by means of a push-button control panel. ▼

A maintenance electrician checks four General Electric GL-6807 thyatron tubes in the planer-miller control cabinet. These new G-E motor-control thyratrons are available with three different base structures, as shown at lower right. ▼



# CONTROL THYRATRONS GIVE WIDEN DESIGNERS' CHOICE OF TYPES!



**GL-6807**

Replaces the 5545; has identical ratings. A conventional pin-base type.



**GL-6808**

Bracket-mounted with flying leads. Same tube design, ratings as GL-6807



**GL-6809**

Equipped with spade-lug terminals. Same tube design, ratings as GL-6807

*Progress Is Our Most Important Product*

**GENERAL**  **ELECTRIC**

## "Dust Control" Hoods

### Use Filtered Air

This blower system is a combination housing through which air is passed and filtered to a 1/2 micron efficiency. The filter can be changed externally to prevent internal contamination of the working area. The aerodynamic shape and contour of the housing eliminates internal turbulence of the pressurized air. The "Dust Control" hoods are cast in a single piece of transparent shatter-proof plastic.

P. M. Leonard Co., Dept. ED, 19 De Graw St., Brooklyn, N. Y.

CIRCLE 60 ON READER-SERVICE CARD

## Small Oscillograph

### Withstands Shock, Acceleration

Model 560 Oscillograph records under extreme acceleration and shock conditions, even in excess of 3000 g. It is packaged in a cast aluminum case measuring only 6-5/8 x 7 in.

Facilities for mounting damping resistors on each of the 14 channels are included inside the unit. All operating controls and the viewing screen are accessible from one end, allowing the instrument to be more easily operated. A wide range of galvanometers is available with natural frequencies up to 3500 cps.

Midwestern Instruments, Dept. ED 41 St. and Sheridan Rd., Tulsa, Okla.

CIRCLE 61 ON READER-SERVICE CARD

## Synthetic Mica

### In Powder and Sheet Form

"Synthamica" synthetic mica is now available in quantity for industrial application. Four forms are currently offered: 202, a high quality, synthetic fluor-phlogopite mica in flake or powder form; 707, a bonded, inorganic punching material, 0.005 to 0.100 in thickness; 727, a flexible, inorganic bonded material for creating formed parts or insulation wrapping to be heat cured; and 807, reconstituted mica paper sheets with no binder.

"Synthamica" is capable of withstanding sustained temperatures as high as 2000 F without physical or electrical failure.

Synthetic Mica Corp., Dept. ED Caldwell Township, N.J.

CIRCLE 62 ON READER-SERVICE CARD

← CIRCLE 59 ON READER-SERVICE CARD





## Operating room conditions for Inertial Instrument Development Engineering

The work in this 5000 square-foot room at AUTONETICS is surgical in its precision, clinical in its standards of cleanliness. Here are assembled the precise mechanisms devised by the engineers and physicists engaged in the new field of INERTIAL NAVIGATION SYSTEMS. Among the units are highly-specialized types of Gyros and Accelerometers as delicate as a living organism.

Each cubic inch of air in this room contains fewer than 6 dust particles whose diameter exceeds 0.3 micron. Temperature variation is held to plus or minus 1°; humidity to less than 50%. AUTONETICS provides these ideal conditions, comparable with the standards attained in primary laboratory instrument work, to insure optimum results in the function of the tiny components, so painstakingly designed. The men who create them are reaching the highest levels of professional skill, as they obtain definitive answers to the problems of miniaturization and reliability under environmental extremes.

This facility is soon to be doubled. The hitherto unpublicized program is already ahead of the rest of the field. Prime need of the current expansion is for

See us at booths 626 and 627 at the Instruments and Automation Conference and Exhibit, New York, September 17-21.

men who can make a *creative* contribution.

**You Can Participate In This Work. Act Now:** Here are the fields in which your individual contribution can bring you distinction in your profession:

**Mechanical Engineering:** Analysis, Development, Design and Test of ultra-precision inertial sensing and measuring instruments.

**Physics:** Solution of unique instrumentation problems far beyond the scope of routine design or mere extrapolation from existing knowledge.

**Electrical Engineering:** Design and development of miniature, continuously-rotating and servo motors, and special transducers of extreme precision.

**Electronic Engineering:** Development of transistor and vacuum tube circuits as integral parts of instrument systems, and the electronic equipment for the unique and elaborate testing demanded by inertial systems.

*Response to your inquiry will be prompt.*

**Write: Mr. A. Brunetti, Autonetics Engineering Personnel, Dept. 991-10ED, P.O. Box AN, Bellflower, California.**

### **Autonetics**



A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

## Microwave Antenna

### Rear Feeds



Microwave antenna rear feeds used with parabolic reflectors produce pencil shaped rf beams. Each unit consists of a section of rectangular waveguide, terminated by a weather-proof teflon sealed cup feed. Input connectors are standard choke flanges. Available standard models and center frequencies are: MA-625 (9.375 Kmc/s), MA-624 (16.5 Kmc/s) and MA-1046 (34.86 Kmc/s).

The MA-1046 rear feed and a 1 foot diameter parabolic reflector of 3 in. focal length produces a pencil beam of approximately 2 deg width over the frequency range 34.5-35.225 Kmc/s.

Feeds designed for specific applications are available on special order.

Microwave Associates, Dept. ED, 22 Cummington St., Boston 15, Mass.

CIRCLE 64 ON READER-SERVICE CARD FOR MORE INFORMATION

## Video Distribution Amplifier

### Extremely Compact



Video distribution amplifier, Model PA-1002, is designed especially for use in the distribution and transmission of video signals, both color and monochrome.

This unit is capable of any number of outputs from a common input signal source, all isolated from the input to prevent disturbances from being reflected back into the signal source.

The frame can accommodate a total of eight amplifiers. The frame also contains a pair of compensating inductors for each amplifier input which effectively neutralized input capacity, thus maintaining resistive line termination.

The new amplifier features an exceptionally flat amplitude frequency response of  $\pm 1\%$  to 6 mc, and it is down less than 3 db at 10 mc. Differential gain characteristics are indicated by a variation of less than 1% for  $\pm 3\%$  B + voltage variation of 5% filament voltage variation. Similarly, differential phase is less than 0.5° at 3.6 mc.

The amplifier has high impedance input, and output is 75 ohm internally terminated. Power consumption is low.

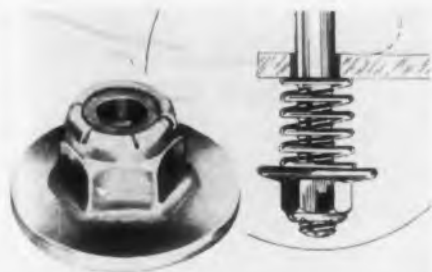
General Precision Lab., Inc., Dept. ED, Pleasantville, N. Y.

CIRCLE 65 ON READER-SERVICE CARD FOR MORE INFORMATION



## Flanged Base Self-Locking Nut

### For Spring Mounting Applications



A new flanged hexagon self-locking nut with a large washer type seat for fastening applications involving spring tension,

such as compressor motor mountings in refrigerators, has been developed. The large built-in bearing area of the ESNA Type 1994, eliminates the need of individual nuts and special washers in such applications.

During shipment of a spring mounted unit, the nut can be turned down compressing the spring and making a solid mounting which cannot shift. Upon delivery of the ESNA self-locking nut is backed off to the proper spring tension to float the unit. As a self-locking fastener the 1994 will remain locked at any desired position on the bolt permitting exact spring tension adjustment.

The base flange against which the spring seats is 1 in. in diam. ESNA's red fiber insert provides the locking feature of the nut and retains it in any position on the bolt despite pressure of the spring or severe vibration. The new flanged self-locking nut is made of steel with a plain or plated finish.

Elastic Stop Nut Corp. of America, Dept ED, Union, N. J.

CIRCLE 67 ON READER-SERVICE CARD FOR MORE INFORMATION

## Beacon Cavity Oscillator

### Applicable to Missiles



Model 193 Rocket Tube Cavity Oscillator has small size and light weight, making it especially suitable for aircraft, guided missile, and beacon applications.

It is a coaxial line cavity oscillator, employing the Sylvania UHF Planar Triode tube, and it provides a highly stable rf pulse signal source.

The unit features a single control for tuning, and it utilizes fixed feedback. It is available for frequencies from 2500 to 4000 Mc, with a tuning range of 200 Mc/sec. Its overall length is only 5-1/2 x 1-5/16 in. diam. and it weighs only 14 oz. Peak plate voltage is 1200-1500 v with a peak output of 200 w. Output connection is a BNC jack. The cavity may be furnished with a regulated power supply.

Amerac, Inc., Dept. ED, 116 Topsfield Rd., Wrentham, Mass.

CIRCLE 68 ON READER-SERVICE CARD FOR MORE INFORMATION

## MEMOTRON

HUGHES PRODUCTS

presents 3 unusual new

## STORAGE TUBES

The MEMOTRON, a direct-display cathode ray storage tube, retains traces and transients until intentionally erased. Analysis and comparison are possible without photography because MEMOTRON visually displays successive transient writings. All displays occur at uniform brightness, regardless of writing speeds, so are easily photographed for file records. Applications: viewing transients in shock testing, read-out of solutions from analog computers, curve plotting at high and low speeds, electrocardiography, vectorcardiography and heart sounds.

### General Specifications:

RESOLUTION...50 to 60 written lines per inch.

WRITING SPEED...0 to at least 100,000 inches/second.

BRIGHTNESS...50 foot-lamberts.

USABLE SCREEN DIAMETER...4 inches.

DIMENSIONS...

Over-all length: 18 1/2 inches  $\pm$  1/2 inch.

Bulb diameter: 5 5/8 inches maximum.

Neck diameter: 2 1/4 inches  $\pm$  3/32 inch.



Photos show single transient pulses, 20 microseconds wide with a one microsecond rise time, showing writing capabilities of one million inches per second. These photos were taken in full daylight without a hood.

## TONOTRON

The TONOTRON, another exclusive Hughes direct-display cathode ray storage tube with a 5-inch screen, presents a complete spectrum of grey shades. The high light output makes a hood unnecessary, even when viewing in full daylight. TONOTRON's length of persistence and rate of decay are controllable. Superior presentation of the grey scale assures "high fidelity" picture reproduction. Applications: radar, Narrow Band Television, instrumentation, etc.



Photos: Left, weather radar with brilliant halftone picture on TONOTRON. Right, TONOTRON freezes action picture until intentionally erased.

## TYPOTRON

The TYPOTRON is the first commercially available storage tube for displaying printed data rapidly. A choice of 63 characters is available for the presentation of data in words, numbers or symbols. As a high-speed digital read-out device, the TYPOTRON writes characters 3/8 inch in size at speeds of at least 25,000 characters per second. The written information remains visible indefinitely without fading or blooming, until intentionally erased. This feature makes TYPOTRON an ideal read-out device in many digital computer applications.



Photo: Presentation of all available characters.

## HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

ELECTRON TUBES

Our applications engineers invite your inquiries regarding specific uses of these tubes. For further information and descriptive literature please write to:

HUGHES PRODUCTS • ELECTRON TUBES

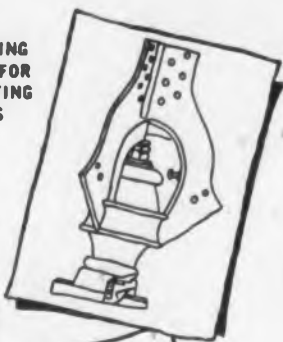
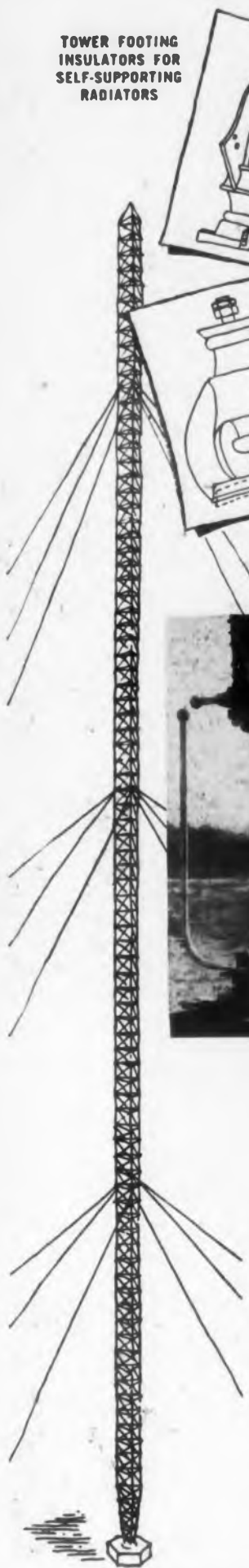
International Airport Station

Los Angeles 45, California

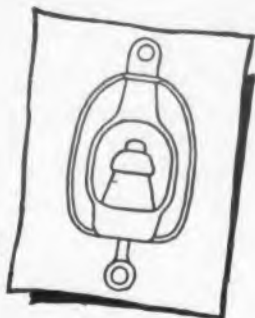
© 1956, H. A. C.

CIRCLE 69 ON READER-SERVICE CARD FOR MORE INFORMATION

TOWER FOOTING  
INSULATORS FOR  
SELF-SUPPORTING  
RADIATORS



MAST BASE  
INSULATORS



RADIO GUY  
INSULATOR



# LAPP ANTENNA TOWER INSULATORS

We at Lapp are mighty proud of our record in the field of tower insulators. Over 30 years ago, the first insulated broadcasting tower was erected—on Lapp insulators. Since then, most of the large radio towers in the world have been insulated

and supported by Lapp insulators. Single base insulator units for structures of this type have been design-tested to over 3,500,000 pounds.

A thorough knowledge of the properties of porcelain, of insulator mechanics and electrical qualities has been responsible for Lapp's success in becoming such an important source of radio insulators. Write for description and specification data on units for any antenna structure insulating requirement. Lapp Insulator Co., Inc., Radio Specialties Division, 941 Sumner Street, LeRoy, N. Y.

# Lapp

CIRCLE 71 ON READER-SERVICE CARD FOR MORE INFORMATION

## All Metal Mount

### Isolates Helicopter Vibrations



Low speed rotating components and rapid changes in flying attitude, for example, set up severe vibrations which are characterized by low forcing frequencies and unusually high excursions. These two factors, unlike those in conventional craft

which have high frequencies and low excursions, rule out the use of ordinary vibration controls for isolating electronic equipment.

The new mount with a low natural frequency, ranging from 4 to 4.5 cps and a large deflection which also provides some degree of shock control, takes an extremely high excursion, 1/4 in. peak-to-peak load, with a magnification factor of 1.8 or less at resonance.

Known as Series 600, the Belleville spring type design consists of two load-carrying convex springs, a circular coil spring and wire mesh pads. The new Finn mount is an all-metal captivated mount, lightweight, and is available with both short or long studs in load ranges from 3-1/2 to 28 lb.

T. R. Finn & Co., Electronic Div., Dept. ED, 200 Central Ave., Hawthorne, N. J.

CIRCLE 72 ON READER-SERVICE CARD FOR MORE INFORMATION

## Medium Duty Power Relays

### AC or DC



These rugged relays can be applied to lighting systems, signal devices, motor starting, heater loads, photographic applications, or any load circuit requiring fast posi-

tive switching of ac or dc power.

All coils are formvar wound, baked varnish impregnated for protection against mechanical and moisture damage.

Properties are: pure silver contacts, 1/4 in. diam, rated at 10 amps, 115 v 50-60 cps, non-inductive load; contact pressure, factory adjusted, minimum of 25 grams; dimensions: 2-3/8 x 1-1/12 x 1-11/16 in. high; mounting: Two, 6-32 tapped holes on 2 in. centers.

Line Electric Co., Dept. ED, 1407 McCarter H'way, Newark 4, N. J.

CIRCLE 73 ON READER-SERVICE CARD FOR MORE INFORMATION

# HOLTZER -CABOT



R-24 Motor

## Synchronous and Induction Capacitor Type Motors



R-25 Motor

**R-24.** Typical applications for this reversible, 4-pole induction motor are in servo mechanisms, as a balancing motor in recording instruments or as a control motor for voltage regulators. It has low rotor inertia for fast response applications. When operated 2 phase, it can be controlled electronically; or operated single phase as a permanent split capacitor motor.

**R-25.** Typical uses are for recording instruments, dictating and adding machines. Approximately 2 1/2" in diameter, it is available in either induction or synchronous construction with reversible rotation.

Both the R-24 and R-25 are available with gear case speeds from 1/2 to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single phase, 2 or 3 phase.



**HOLTZER-CABOT MOTOR DIVISION  
NATIONAL PNEUMATIC CO., INC.**

125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me data sheets on the Holtzer-Cabot R-24 and R-25 Size Motors.

Please have representative call \_\_\_\_\_ (date)

Name \_\_\_\_\_

Company \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 74 ON READER-SERVICE CARD



## Teflon Terminals

### Takes Press Fit

The "Press-Fit" line of Teflon press-fitted terminals has been expanded until it now includes hundreds of standard types of stand-offs, feed-thrus, breakaway connectors, and contact receptacles. All numbers are available in RETMA standard color codings: yellow, orange, red, blue, green, brown, gray, and white. This firm also offers test points which, mounted externally, accept standard 0.080 in. test probes for quick checkups and measurements of housed radio-electronic or electrical equipment.

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

CIRCLE 76 ON READER-SERVICE CARD

## Germanium Transistors

### Diffused Base Type

These transistors feature unusually good high frequency performance. They are particularly suited to vhf oscillator, medium power if, and broad band video amplifier applications. Representative units have provided 50 mw output as oscillators at 200 Mc. Other units of this type as video amplifiers have given about 19 db gain per stage with an 8 Mc bandwidth.

Although subject to change with state-of-the-art diffusion techniques employed, typical units produced at present have an alpha frequency-cutoff median value of approx 400 Mc, with some units showing alpha frequency-cutoff in excess of 600 Mc. Power dissipation is 150 mw max at 25 C with an appropriate heat sink. Common emitter short circuit current gain at 50 Mc is 12 db min.

The emitter layer and base contact are made from films of aluminum and gold-antimony by using techniques of vacuum evaporation and alloying. Electrical connections to the base and emitter areas are made through spring point contacts. The completed assembly is mounted in a hermetically sealed metal case of approx 5/16 in. diam x 3/8 in. high.

Radio Div., Western Electric Co., Dept. ED, 120 Broadway, New York 5, N.Y.

CIRCLE 77 ON READER-SERVICE CARD



# Dow high temperature magnesium alloys have excellent fabrication characteristics

Lightweight structural metals with high strength, stiffness and elasticity at elevated temperatures! A new group of Dow magnesium alloys offers a great combination of these properties without the fabricating difficulties normally experienced with other high temperature materials.

Specially developed for use in airframes, missile and engine structures, the new alloys are already making weight reductions possible for several manufacturers. These alloys show advantages at temperatures up to 700°F. Limited test data on properties up to 800°F. are available for some of them.

**FABRICATION:** Fabrication characteristics are equal to those of standard magnesium alloys.

**WELDABILITY:** 95 to 100% weld efficiency at elevated temperatures.

**FORMABILITY:** Single deep draws can be easily accomplished.

**MACHINABILITY:** Best machining characteristics of any structural metal.

One of the new alloys is magnesium-thorium composition HK31A. It is now available in rolled form from stock. Castings and sheet in mill quantities are also readily available. A companion alloy for extruded shapes and forgings will soon be in production.

For more information about the new high temperature magnesium alloys, contact your nearest Dow Sales Office or write

to THE DOW CHEMICAL COMPANY, Magnesium Sales Department MA 362B, Midland, Michigan.



**EASILY FORMED.** These HK31A parts were drawn using production dies and processes for standard magnesium alloys. The parts retained a higher percentage of original properties than standard alloys.

you can depend on **DOW MAGNESIUM**

**DOW**

CIRCLE 78 ON READER-SERVICE CARD FOR MORE INFORMATION

# TECHNICRAFT

for complex **WAVEGUIDE** assemblies like this



Technicraft advanced design, engineering and manufacturing facilities are available to serve your needs from the face of the Magnetron through to the antenna.

**MAKE**

## **TECHNICRAFT**

**YOUR PRIMARY SOURCE**

*Designed with Precision*

*Built with Precision*

*Tested with Precision*

One of our representatives is near you. Sales engineering offices in: Dallas • Dayton • Los Angeles • Chicago • Seattle • St. Louis • Toronto (Canada).

**SERVING RADAR AND COMMUNICATIONS WITH THE BEST IN MICROWAVE TRANSMISSION DEVICES**

**TECHNICRAFT LABORATORIES**

INCORPORATED

1560 THOMASTON RD. • THOMASTON, CONNECTICUT

Designers and Manufacturers of Rigid and Flexible Waveguide Assemblies, Microwave Test Plumbing and Components, Waveguide Systems.

CIRCLE 80 ON READER-SERVICE CARD FOR MORE INFORMATION

## Voltage Divider Networks

### In Variety of Configurations



A variety of sizes and configurations of precision voltage divider networks is offered by this firm. The same method of construction is used on all networks, involving internal cushioning and the applica-

tion of synthetic resins during winding.

A typical network has 11 precision wire wound resistors of values ranging from approximately 7 K to 171 K and matched to 0.005% at both dc and 400 cps over a temperature range of 50 C. The network is mounted on an anodized engraved aluminum faceplate containing Teflon feed-throughs to minimize leakage. Four studs are provided for mounting. The network is encapsulated in thermosetting resin with zero percent shrinkage characteristics to avoid external pressure effects on the resistors and to meet MIL-R-93.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn 7, N.Y.

CIRCLE 81 ON READER-SERVICE CARD FOR MORE INFORMATION

## X-Band Circulator

### Has High Front-to-Back Ratio



Model 601 X-Band Ferrite Circulator, with a front-to-back ratio approaching 300:1, is a medium power microwave component developed around the non-reciprocal differential phase

shift principle as outlined by Kales, Chait, and Sakiotis. Power entering the circulator is transmitted in sequence from one terminal to another: power entering at "A" leaves at "B", while power entering at "B" leaves at "C". Power entering at "C" leaves at "D", while that entering at "D" returns to "A". The 601 is a high performance component for such uses as a low-loss, broad band isolator, or in passive duplexing applications.

Frequency range is 8500-9600 Mc; isolation is 30 db min; insertion loss is less than 0.2 db; return loss is 30 db min; input vswr is 1.2 max; waveguide is RG-52/U-RG67U; flanges are UG-39/U, 135/U at B, C, and D; input terminals are UG-40A/U, UG-136A/U.

Microwave Development Laboratories, Inc., Dept. ED, 92 Broad St., Wellesley 57, Mass.

CIRCLE 82 ON READER-SERVICE CARD FOR MORE INFORMATION

# Unique...



## 10 MC

NEW

MARCONI

FM

SIGNAL GENERATOR

## 470 MC

AERO  
MARINE  
MOBILE  
AERO  
MOBILE  
20  
INDUST L  
GOV T

30  
MOBILE  
PHONE  
GOV T  
40  
TRANSP  
PORT

50  
INDUST L  
60  
T  
V  
70  
80  
90  
100  
BROAD  
CAST

AERO  
GOV T  
MARINE  
MOBILE  
PHONE

200  
T  
V  
TELE-  
METER

GOV T  
300  
MET  
AIDS  
GLIDE  
PATH

400  
CITIZEN'S  
MOBILE

Model 1066 meets the urgent need for a precision Signal Generator in the 450-470 Mc band. It also covers lower bands and is the only FM generator with this complete range. For your present and future channels Model 1066 is available NOW.

**Frequency Range:**  
10—470 Mc in 5 ranges

**Frequency Mod.:**  
0—20 and 0—100 kc,  
continuously variable

**Amplitude Mod.:**  
0—80%

**Frequency Stability:**  
.005% per 10 minutes  
after warm-up

**Carrier Shift Control:**  
Calibrated 1 to 200 kc

**Output:**  
.02 $\mu$ V to 200 mV, 52 $\Omega$   
Piston attenuator

**Tubes:**  
6AK5, 6C4, 12AT7, 5861,  
6L6, 5Z4G, OB2

**Price:**  
**\$1075**

\*Premium quality model 1066/1 includes temperature-compensation, stabilized oscillator filament supply and other special features giving even greater stability.

**Price: \$1250**

Detailed specifications on request



**MARCONI**  
**instruments**  
**44 New Street**  
**New York 4, N.Y.**

CIRCLE 83 ON READER-SERVICE CARD



# Bendix

needs  
**ELECTRONIC**  
and  
**MECHANICAL**  
**ENGINEERS**

FOR AIRBORNE RADAR  
AND SONAR SYSTEMS

in  
**SOUTHERN**  
**CALIFORNIA**



Unusual engineering positions in electrical and mechanical design of Telemetry Systems are available. These positions, which are directly associated with our long-range projects for industry and for defense, are available at all levels.

There also are important positions open for Electronic Test Equipment Designers, Circuit Designers and Microwave and Transistor Engineers.

You are invited to consider becoming a member of this vital engineering group — with a forward looking company in Southern California.

Please fill in the coupon or write us for complete information.

W. C. Walker, Engineering Employment Manager  
Pacific Division, Bendix Aviation Corp.  
11606 Sherman Way, North Hollywood, Calif.

I am interested in Telemetry Engineering.  
I am a graduate engineer with \_\_\_\_\_ degree.  
I am not a graduate engineer but have \_\_\_\_\_ years experience.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 85 ON READER-SERVICE CARD

## Ultrasonic Transducer

In Water Jacket or Open Frame



This is a new ultrasonic transducer of the stack-tool type. The unit has been designed so that tools can be mounted on it for soldering,

cutting or other ultrasonic applications. Water cooled jackets may be supplied. The unit is available as a separate item for application to already existing generators manufactured for ultrasonic or other uses.

The transducer operates at a standard frequency of  $19.2 \pm 5\%$ , input power 250 to 500 w at 75 ohms, tool end tapped 1/2 - 28.

Alcar Instruments, Inc., Dept. ED, 17 Industrial Ave., Little Ferry, N. J.

CIRCLE 86 ON READER-SERVICE CARD FOR MORE INFORMATION

## Phase Generator

Accurate Simple Measurements



When excited with a fixed voltage at a fixed frequency, the phase generator, Model PG-1, produces a constant output voltage of the same frequency whose time phase varies in linear response to a dial rotation. Two such outputs are provided which in-

stantaneously differ from each other by 90 degrees time phase. The engraved dial graduations represent the output phase. Each unit is operative at one frequency only. Though the output attenuates with loading, the operation remains unaffected.

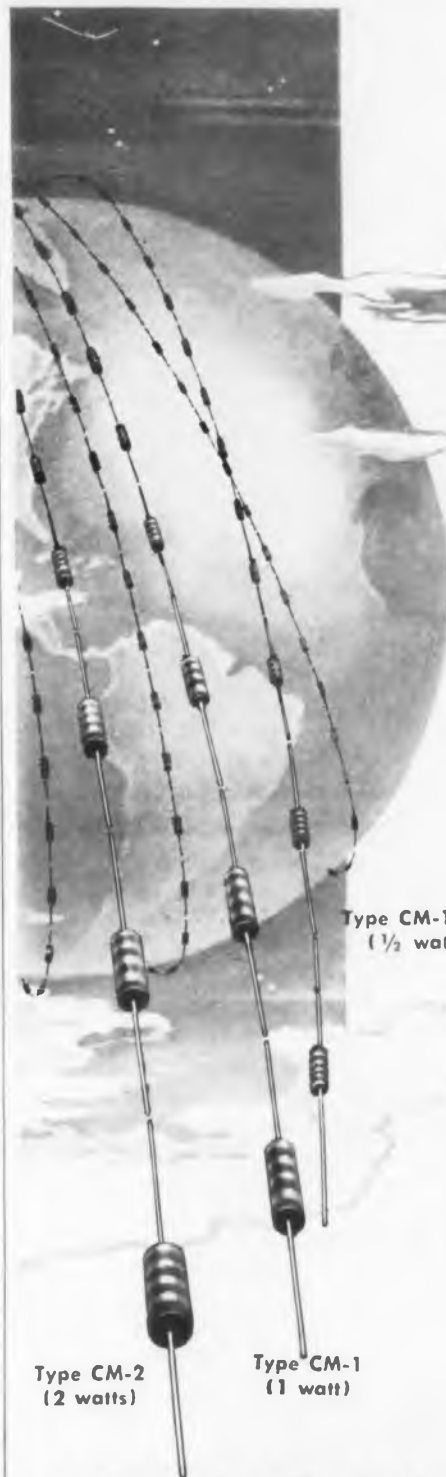
Specifications: Excitation: 115 v, 400 cps; Output: 10 v, 400 cps, two phases; Phase Shift Range: 360 degrees, continuous rotation; Phase Shift Accuracy: Dial reading within one degree. Variations to customer requirements: Excitation: 1 v to 500 v, 20 cps to 10 kc; Phase Shift Accuracy: Dial reading within 5 minutes of arc.

Theta Inst. Corp., Dept. ED, 204 Market St., E. Paterson, N. J.

CIRCLE 87 ON READER-SERVICE CARD FOR MORE INFORMATION

# AROUND THE WORLD

## again and again!



A fair idea of the extent to which Stackpole fixed composition resistors are used may be gained from this illustration.

Laid end to end, the total number of these tiny components produced to date by Stackpole would extend many times around the world.

Such acceptance is a tribute, both to the high quality of the resistors and to the dependable, personalized service, that Stackpole puts behind each resistor order.

Type CM-1/32  
(1/2 watt)

**PACKAGED FOR  
YOUR CONVENIENCE!**

... in "strip pack"; "stack pack"; or "reel pack" assemblies. Ask your Stackpole field engineer for details.

Type CM-2  
(2 watts)

Type CM-1  
(1 watt)

**STACKPOLE**  **RESISTORS**  
FIXED COMPOSITION

Distributors' Division

STACKPOLE CARBON COMPANY • 26 Rittenhouse Place, Ardmore, Pa.

CIRCLE 88 ON READER-SERVICE CARD FOR MORE INFORMATION

**Systems  
Career:** a  
laboratory  
for  
learning



*... an exciting and rewarding  
career awaits the E.E. or Physics  
graduate who joins this highly  
respected Engineering team.*

As a Field Engineer at Hughes, through training and assignment you will become familiar with the entire systems involved, including the most advanced electronic computers. With this knowledge you will be ideally situated to broaden your experience and learning for future application in either the military or commercial field.

The national respect which Hughes commands in the field of advanced electronics is in no small part due to the technical support provided by the Field Engineers. Other contributors to the suc-

cess of the Field Service and Support Division are the Technical Manuals Engineer, Training School Engineers, Technical Liaison Engineers, and Field Modification Engineers.

This Hughes activity is a highly trained organization of expert engineers, giving support to the armed services and airframe manufacturers using the company's equipment. Locations are in Southern California, continental U.S., overseas. We invite you to join this team. For further information write us at the address below.

**HUGHES**

*Scientific Staff Relations*  
RESEARCH AND DEVELOPMENT LABORATORIES  
HUGHES AIRCRAFT COMPANY  
Culver City, California

**Some extra advantages for  
Field Engineers include:**

Training at full salary for 3 months before assignment.

Generous moving and travel allowance between present location and Southern California (Culver City).

Additional compensation plus complete travel and moving on assignments away from Culver City.

Ideal living conditions in the unsurpassed climate of Southern California.

Reimbursement for after-hours courses at UCLA, USC, or other local universities.

Employee group and health insurance paid by company, retirement plan, sick leave, and paid vacations.

**Printed Circuit Solder Pot**

**Has Mechanical Dial Thermometers**



This new line of 25 sizes of printed circuit solder pots, in the temperature range of 300 to 600 F, has mechanical type dial thermometers to indicate solder temperature. All components except the elements may be serviced easily without taking the pot apart.

High-low heat switch controls approximately 35 per cent of the total wattage so that the pot may be used for either hand dipping or fast machine dipping without excessive cycling time.

Standard equipment includes 2 pilot lights, a magnetic contactor on units of more than 3000 w, and a power switch on standard units of 2500 w or more. Models are available in 110, 220 and 440 v.

Dee Electric Co., Dept. ED, 1101 N. Paulina St., Chicago 22, Ill.

**CIRCLE 91 ON READER-SERVICE CARD FOR MORE INFORMATION**

**Electronic System Housing**

**Units Individually Accessible**



Modu-Rak line of miniature desk racks, designed for modular construction of test equipment, makes possible any number of separate units in one rack.

Easily accessible for assembly or repair, Modu-Raks are designed for standard 19, 9, and 4-3/4 in. rack panels. They are available 21-3/4 wide x 12 in. deep and 12-1/4 wide x 12 in. deep, in a variety of heights with removable rear panels or doors. Panel mounting holes are tapped for 10-32 machine screws on universal spacings and panels fit into a recess so edges are not exposed.

Modu-Raks are sturdily constructed of 16 gauge cold rolled steel and are attractively finished in gray hammertone with rounded front corners and red striped chrome trim top and bottom. A complete selection of vertical strips, angle brackets, horizontal dividers and panels are available.

Premier Metal Products Co., Dept. ED, 337 Manida St., New York, N. Y.

**CIRCLE 92 ON READER-SERVICE CARD FOR MORE INFORMATION**

**ELECTRONIC DESIGN • October 1, 1956**



## Flow Rate Indicator

### Direct Reading Digital Unit



Designed primarily for use with the company's turbine flowmeters, this flow rate indicator features a complete digital system, operating

from the frequency output of the turbine meter, taking full advantage of the linearity and repeatability inherent in the turbine meter primary. In-line, illuminated, truly digital indication is provided in 1 in. high edge-illuminated numbers. Only the relevant number appears; there is no distracting mechanical movement in going from one digit to another.

Direct reading of flow is provided with manual correction for specific gravity as an optional feature. Conversion into the desired flow units and correction for the calibration factor of the primary are accomplished electrically. In addition to straight indication, the digital information stored in the indicator can be fed directly to complete data handling and automation systems.

Fischer & Porter Co., Dept. ED, 758 Jacksonville Rd., Hatboro, Pa.

CIRCLE 94 ON READER-SERVICE CARD FOR MORE INFORMATION

## Spring Tension Gage

### Tests Springs in Electronics



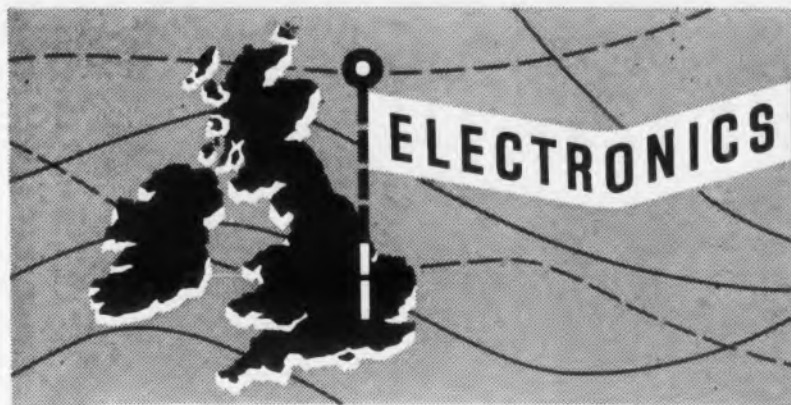
To meet the need for a method of testing springs in delicate electronic applications, this company has introduced a Spring Tension Gage for accurately determining settings or for checking the tensions of relay or other springs. Tensions are registered in grams.

It is made with a nickel silver frame on which are assembled an indicating spring, a folding handle, and an adjustable tension attachment. The folding handle, when closed, serves as a protector for the indicating spring. The adjustable tension attachment provides for setting the indicating spring at an initial tension. The scale is calibrated front and back so the gage can be used for indicating left to right or right to left.

Size is 4-1/2 in. x 1-1/2 in. overall. Four models with different scale ranges are available.

K. Neuses, Inc., Dept. ED, W. Euclid and Dwyer Sts., Arlington Heights, Ill.

CIRCLE 95 ON READER-SERVICE CARD FOR MORE INFORMATION



*in Britain*

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

## For medium power equipments

## British high fidelity experts choose the

The Mullard range of high fidelity tubes is accepted in Britain as the standard by which others are judged. This is because many years of research and development have been spent in producing a range that will meet the requirements of high fidelity sound reproduction in all respects. Take the Mullard EL84 for example. A pair of these tubes provide a power output of 10W at a distortion level of less than 1%. Furthermore, their transconductance of over 11,000  $\mu$ mhos results in an exceptionally high sensitivity. The EL84 may be used for higher powers too. Two tubes in push-pull will provide outputs of up to 17W at an overall distortion of 4%.

At maximum ratings one EL84 has a plate dissipation of 12W and gives an output of 5-6W for an input signal of less than 5V r.m.s.

Supplies of the EL84 for replacement in British equipments are available from the companies mentioned below.

# EL84



### Principal Ratings

Heater	.....	.....	6.3V, 0.76A
Max. plate voltage	.....	.....	300V
Max. plate dissipation	.....	.....	12W
Max. screen voltage	.....	.....	300V
Max. screen dissipation (max. signal)	.....	.....	4W
Max. cathode current	.....	.....	65mA

### Base

Small button noval 9-pin

### Supplies available from:—

**In the U.S.A.** International Electronics Corporation,  
Dept. ED-10, 81 Spring Street, N.Y. 12, New York, U.S.A.

**In Canada** Rogers Majestic Electronics Limited,  
Dept. JM, 11-19 Brentcliffe Road,  
Toronto 17, Ontario, Canada.

# Mullard

## ELECTRONIC TUBES

*used throughout the world*

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd. and is registered in most of the principal countries of the world.



CIRCLE 96 ON READER-SERVICE CARD FOR MORE INFORMATION



cut  
 assembly costs  
 ■  
 ■  
 ■  
 with  
 U.S.G.-fabricated  
 precision parts  
 of



**TEFLON\***  
**KEL-F†**  
**BAKELITE**  
 Fluorothenes  
**NYLON**

■ U.S.G. precision-molded or machined parts from the fluorocarbons and other plastics meet exacting specifications, assure uniform density and dimensional stability, uniform electrical, chemical and physical characteristics of the highest quality.

Strict quality control "from powder to part" and many years of experience in the particular technique of fabricating these unique plastic materials, assure cost-cutting results in your production line.

*Write for 20-page brochure "Inside U.S.G." which suggests how this organization can serve you. Or send us your blue prints for quotations.*

**UNITED STATES  
 GASKET COMPANY**

CAMDEN 1, NEW JERSEY



\* du Pont's trademark for its tetrafluoroethylene resin.  
 † Kellogg's trademark for its trifluorochloroethylene resin.



CIRCLE 98 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Weighing Counter

Records Up To 200 Per Minute



A new remote electric counter permits the user to tabulate and record up to 200 weighings per minute from any point in his plant. It can be used to keep production records, as well as tabulate customers' orders.

The counter's high recording rate is attributed to the speed and

accuracy of the clutch arrangement, which prevents "double count" even when the counter is actuated by chattering contact or a washing mercury switch.

Model 31-41 has two row digits, one for an accumulative total and one for individual weighings. Model 31-42 records only individual weighings.

Richardson Scale Co., Dept. ED, Van Houten Ave., Clifton, N. J.

CIRCLE 99 ON READER-SERVICE CARD FOR MORE INFORMATION

## Paper Base Laminate

Resists Arcing and Flame



Phenolite Y-2500 is bonded with a modified phenolic resin that gives fire resistant qualities for service in electrical and electronic applications. General

properties correspond to NEMA Grade XX, but this paper base laminate also provides arc resistance up to 100 sec. It is designed to punch and shave better than melamine paper base laminates presently used for arc-resistant applications. As a self-extinguishing laminate, it passes the standard Underwriters Laboratory flame test.

The laminate is particularly suited for such applications as arc deflectors, circuit breaker components, electrical switches, and other interrupting devices. It is available in sheet sizes of 39 x 47 in. and 39 x 39 in., and in thickness of 0.015-1.0 in. It comes in a standard semi-gloss and a special dull finish in either natural (light brown) or red.

National Vulcanized Fibre Co., Dept. ED, 1056 Beech St., Wilmington, Del.

CIRCLE 100 ON READER-SERVICE CARD FOR MORE INFORMATION

An Engineer  
Speaks Out...



## ...about Buying Design Breadboards

When you purchase a breadboard, the prime considerations should be flexibility, ease of assembly, precision and price.

You get more flexibility, easier, quicker assembly, higher precision, and greater value for your dollar with Servoboard™ electro-mechanical assembly kits than with any other breadboard on the market.

There are over 250 standard precision parts (hangers, clutches, couplings, etc.) in the Servoboard line—more parts than in any other breadboard array. Only the Servoboard kits offer such exclusive precision parts as: 4 different adapter gears, calibrated inertia load discs, pulse discs... only Servoboard offers a complete line of spur and pinion gears... and only Servoboard offers you 14 pre-bored hangers which accept over 150 standard electronic servo components. With Servoboard, you have the kind of flexibility to mock-up and test any type of servosystem or component that requires a combination of electrical and mechanical parts.

The rigid, tapped mounting board is one of many Servoboard exclusives. You get maximum ease and speed of assembly because the tapped board lets you assemble components at any angle, from the top—where you can see what you are doing.

Here's another Servoboard bonus. In addition to breadboarding pilot models, Servoboard precision parts also serve as permanent, integral components of a system or instrument. When a system design has been mocked-up and tested with Servoboard, you can place your order with us for production quantities of the same Servoboard parts tested and proven on the prototype. These components will perfectly match design specifications for the production run of the new system.

**Murder in the Model Shop**  
Send now for your free copy of this new, thrilling detective story.



Lloyd Knight

Manager of  
Engineering  
Services

Electro-  
mechanical  
Control Systems  
and Components  
for Industry by



**SERVO**  
CORPORATION  
OF AMERICA

Lloyd Knight, Dept. K-20  
Servo Corporation of America  
20-20 Jericho Tpke., New Hyde Park, L.I., N.Y.  
Please send me my free copy of "Murder  
in the Model Shop."

Name .....

Title .....

CIRCLE 101 ON READER-SERVICE CARD

# GET THE FACTS

LOW and constant contact drop  
 LOW electrical noise  
 HIGH current density  
 LONG life...



**HIGH PERFORMANCE**



# BRUSHES CONTACTS SLIP RINGS

**& Slip Ring Assemblies**

BRUSH HOLDERS, CONTACT ASSEMBLIES,  
 BRUSH ASSEMBLIES



USED EXTENSIVELY IN:

**SERVOS • GUN-FIRE CONTROLS  
 TELEMETERING • ROTATING  
 THERMOCOUPLE and STRAIN  
 GAGE CIRCUITS • ROTATING  
 JOINTS • DYNAMOTORS**

Wide range of grades available for standard and special applications. Call on our 40 years of design experience to help solve your problems.

**OTHER GRAPHALLOY**

**PRODUCTS:** Unique (oil-free) self-lubricating Bushings and Bearings (applicable -450° to +700°F.; with expansion coefficient half that of steel will not seize shaft at low temperature); Oil-free Piston Rings, Seal Rings, Thrust and Friction Washers, Pump Vanes.



**GRAPHITE METALLIZING CORPORATION**

1046 Nepperhan Ave. • YONKERS, NEW YORK

- Please send data on Graphalloy BRUSHES and CONTACTS.  
 Send data on BUSHINGS.

NAME & TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

STREET \_\_\_\_\_

CITY \_\_\_\_\_

ZONE \_\_\_\_\_

STATE \_\_\_\_\_

CIRCLE 103 ON READER-SERVICE CARD

## High Current DC Power Supply

Close Regulation, Fast Response



Balanced design in a new thyratron dc power supply controlled by fast acting circuits results in performance that has been exceeded only by series-tube supplies. Ripple, peak-to-peak is 0.1 per cent; load

regulation, no load to full is 0.15 per cent; line regulation,  $\pm 10$  per cent variation is 0.15 per cent; 20 per cent of load is 0.15 per cent; 5 per cent step of line voltage is 0.15 per cent; response time is 10 ms.

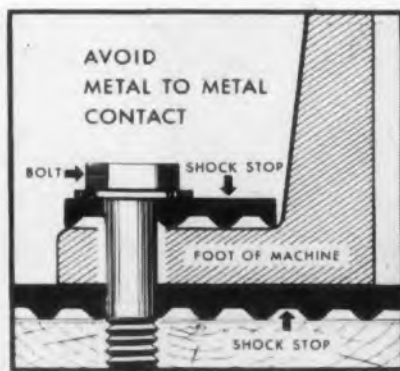
These compact supplies operate from 60 cps power and are available for output voltages up to 500 v and for currents larger than 3 amp. Several voltage units can be packaged in one frame. Covers are optional.

Dynamic Controls Co., Dept., ED, 31 Davis Ave., Arlington 74, Mass.

CIRCLE 104 ON READER-SERVICE CARD FOR MORE INFORMATION

## Shock Stops

Vibration Pads



Inexpensive rubber vibration dampening pads effectively isolate noisy, irritating or destructive vibration. Known as Cohr-lastic "Shock Stops," the pads are installed be-

tween the base or feet of equipment and the floor or foundation.

Shock stops come in 18 x 18 in. molded sheets which are easily cut and installed to a weight/size formula. Their effectiveness is due to a waffle design which gives sure support, yet soaks up vibration to a remarkable degree. Laid on a smooth surface, additional dampening effect is provided by the air trapped within the waffle cups. When equipment must be bolted to the foundation or floor, the bolts may also be isolated with shock stops. Made of Neoprene rubber, shock stops are not affected by fuels and oils.

The Connecticut Hard Rubber Co., Dept. ED, 407 East St., New Haven 9, Conn.

CIRCLE 105 ON READER-SERVICE CARD FOR MORE INFORMATION



When network discharge service needs

**HIGH**

**RESISTANCE**  
to **SHOCK** and  
**VIBRATION—**

Specify  
THE NEW  
**Kuthe**  
**3C45W**



Product of  
the world's  
largest  
manufacturer of  
**HYDROGEN**  
**THYRATRON**

**Ruggedized, smaller size—for more dependable performance in missiles, aircraft, vehicles and other heavy-duty applications . . .**

Kuthe's new 3C45W is a unipotential cathode, 3-element hydrogen-filled thyratron designed for network discharge service . . . producing pulse outputs of 50 KW at an average power level of approximately 65 watts.

Smaller in size and featuring ruggedized construction to a remark-

able degree, the 3C45W is outstandingly reliable under the most severe conditions of shock and vibration. It is equipped with a reservoir for longer, more stable life.

Kuthe's new 3C45W incorporates the broadest engineering experience, highest quality and finest craftsmanship in the industry.

**Principal Electrical-Mechanical Data and Ratings:**

Heater voltage	6.3 ±5.0%
Heater current	2.6 amps.
Minimum heating time	3 min.
Mounting position	Any
Overall length	3.75" (max.)
Greatest diameter	1.56" (max.)
Base	Med., 4-pin, A4-9
Anode connector	Small metal, C1-1
Reservoir	Connected internally across cathode heater
Anode supply voltage	800 v. (min.)
Peak anode voltage, forward	3000 v. (max.)
Peak anode voltage, inverse	3000 v. (max.)*
Peak anode current	35 amps. (max.)
Anode current rate of rise	750 amps./-usec. (max.)

Average anode current	45 ma.
Grid drive voltage	175 v. (min.)
tad	0.6 μs.
Δ tad	0.15 us.
tj	0.02 us.
Pb	0.3 x 10 <sup>9</sup>
* 25 us. after end of pulse.	

**Typical operation as Pulse Modulator, DC Resonance Charging**

Anode supply voltage	1.5 KV DC
Pulse repetition rate	2500 PPS
Pulse duration	0.5 microseconds
Pulse forming network impedance	50 ohms
Trigger voltage	200 volts
Peak power output	45 KW
Average power output	56 watts
Anode current	40 ma. DC

**For complete information, write to Dept. W-235**

***Kuthe Laboratories, Inc.***

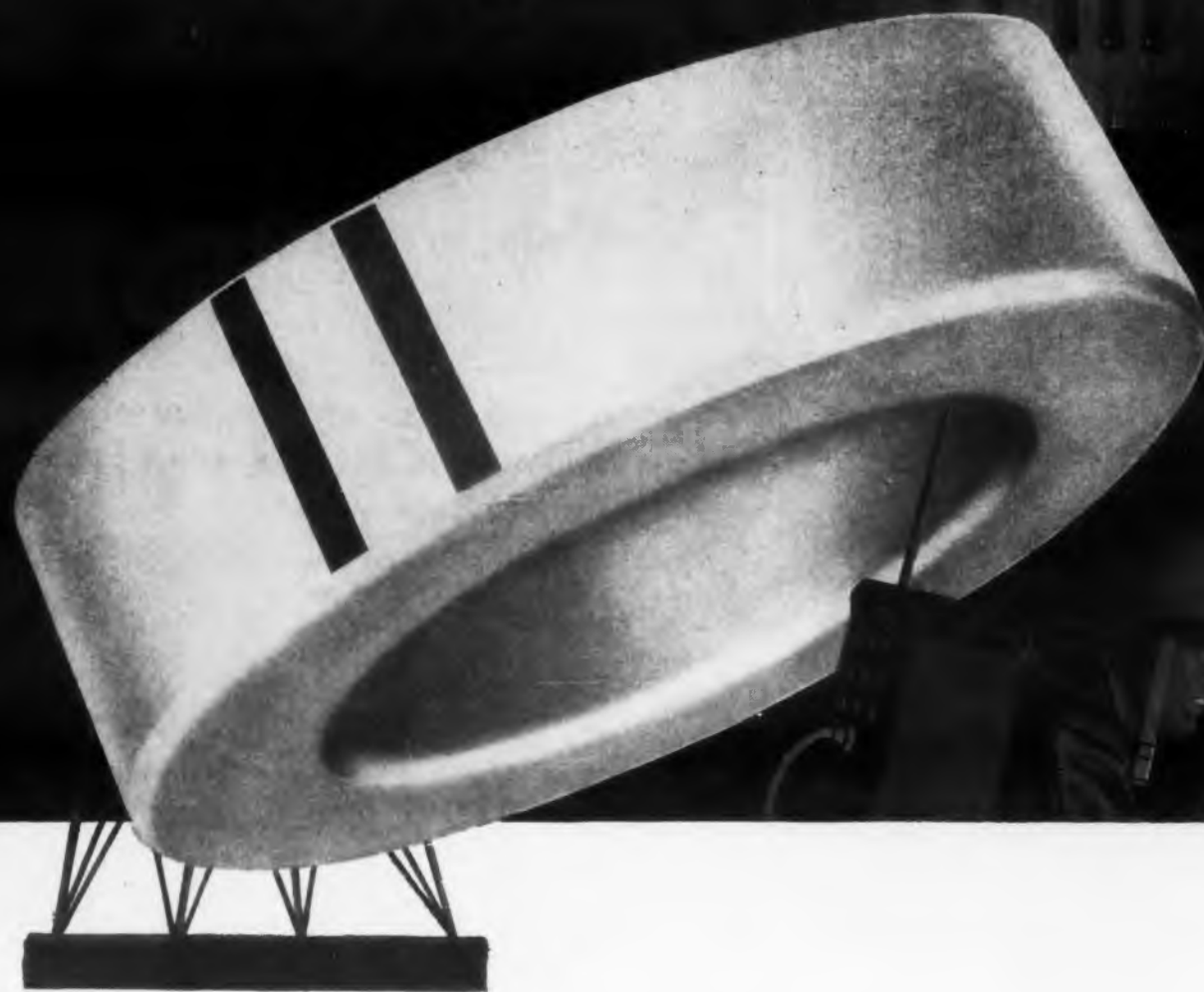
An Associate of

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION  
730 South 13th Street • Newark, N. J. • Blgelow 2-6000



CIRCLE 106 ON READER-SERVICE CARD FOR MORE INFORMATION

Magnetics, Inc. makes the  
**performance-guaranteed**  
 permalloy powder core



We have taken the guesswork out of using molybdenum permalloy\* powder cores, for Magnetics, Inc. Powder Cores are Performance-Guaranteed. What's more you can specify as an extra, Magnetics' exclusive feature . . . color-coding. Color-coding tells your assemblers, without special testing, how many turns to put on these cores, for they are graded and coded according to inductance before they reach you.

Bulletin PC-103 gives you detailed information, and the Powder Core Color-Coding Card guides your assemblers and others with production responsibility. Why not write for your copies today? Magnetics, Inc., Dept. 30 ED

CIRCLE 108 ON READER-SERVICE CARD FOR MORE INFORMATION



CABLE: Magnetics

**High-Precision Impedance Comparator**

**Direct Indication**



Type 1605-A impedance comparator indicates not only the difference in magnitude between the two components being compared,

but also indicates simultaneously the phase-angle difference.

The impedance comparator is completely self-contained, including a calibrating voltage. The internal oscillator provides frequencies from 100 cy to 100 kc in decade steps. Meter voltages are available externally to operate recorders, remote indicators, or selecting devices.

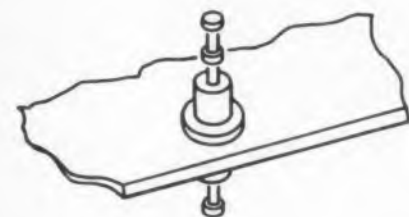
The range of impedances which can be compared is nominally from 2 ohms to 20 megohms. Four independent ranges are provided for the impedance-difference ( $\pm 0.3\%$ ,  $\pm 1\%$ ,  $\pm 3\%$ ,  $\pm 10\%$ ) and the phase-angle-difference ( $\pm 0.003$ ,  $\pm 0.01$ ,  $\pm 0.03$ ,  $\pm 0.1$  radian full scale).

General Radio Co., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 109 ON READER-SERVICE CARD FOR MORE INFORMATION

**Feed-Through Terminals**

**For Chassis Mounting**



These insulated feed-through terminals may be mounted directly on a metal chassis where no room is available for a terminal board. The units use a high electrical grade of melamine for insulation.

Terminals mounted on metal chassis have withstood breakdown tests in excess of 1500 v.

The terminals may be swaged directly onto the metal part, without warpage. Because they are completely rigid when mounted, they will withstand heavy shock without causing noise problems. Two models are offered: 6065 and 6066; they use MME insulation material, and are available for board thicknesses of 1/32 to 3/32 in. Model 6065 has a double tie on one end, and Model 6066 has a double tie on both ends.

Lerco Electronics, Inc., Dept. ED, 501 S. Varney St., Burbank, Calif.

CIRCLE 110 ON READER-SERVICE CARD FOR MORE INFORMATION

### Junction Transistor Checker Is Battery Operated



The Junction Transistor Checker measures the significant characteristic of p-n-p or n-p-n transistors: collector leakage with base grounded, collector current at zero base current (base open), and base to collector current gain at 4.5 v on the collector. Self-contained, with batteries lasting over a year in normal use, the

checker is quick and easy to use (no warm-up time).

The meter reads gain directly, showing up defective units and indicating relative gain. A useful feature is the provision of pin jacks connected to base emitter and collector circuits for plugging in clip leads; this makes easy the checking of transistors not readily plugged in (those with long leads, in circuits, etc.).

Instant Circuits Div., Alfred W. Barber Laboratories, Dept. ED, 32-44 Francis Lewis Blvd., Flushing 58, N. Y.

CIRCLE 112 ON READER-SERVICE CARD FOR MORE INFORMATION

### Cooling-Effect Detector

#### Protects Electronic Equipment



Series 18801 Thermo-switch is a cooling-effect detector designed to detect inadequate cooling of air-cooled electronic components. This detector senses the combined cooling effect contributed by both ambient temperature and mass rate of air flow. Since the detector has its own source of heat, it can be

set to simulate the temperature condition of the equipment it protects. It can be connected to an alarm device or, by suitable relay, control solenoid or motor-actuated valves to produce the additional cooling action required for an over-temperature condition.

The adjustment range of the detector allows it to be used at air flow rates of 500 to 20,000 lb/hr/sq ft (or higher with modification) in ambient temperatures of  $-65$  to  $+160$  F, and at any heater voltage between 0 and 32 v ac or dc. The detector is normally flange mounted with the sensing leg extending into the duct at right angles to the airstream.

Fenwal, Inc., Dept. ED, Ashland, Mass.

CIRCLE 113 ON READER-SERVICE CARD FOR MORE INFORMATION

**RAYTHEON**

*Excellence in Electronics*



### Which direction are you going?

The Boston Area has everything . . .

Fine Suburban Living

Exceptional education and cultural facilities

Nearby famous winter sports and summer resort areas, and—

Opportunity to Travel the Road to Success with RAYTHEON in the fields of AIRCRAFT NAVIGATIONAL AND CONTROL SYSTEMS, and GUIDED MISSILES.

As one of the largest, fastest growing and most progressive Electronics Companies in New England, RAYTHEON can offer—numerous advancement possibilities, interesting professional challenges, tuition support plan for engineering courses, regular salary review, adequate supporting technical personnel, large company advantages, including Life and Health Insurance, paid vacations, and other employee benefits.

*We are interested in ENGINEERS for:*

- CIRCUIT DESIGN
- ELECTRONIC RELIABILITY & TEST EQUIPMENT
- ELECTRONIC PRODUCT DESIGN
- RADAR SYSTEMS
- TUBE APPLICATIONS
- MECHANICAL DESIGN
- ANALOG COMPUTERS
- MICROWAVE COMPONENTS
- AERODYNAMICS
- MECHANICAL PROCESS ENGINEERING
- SPECIFICATIONS ENGINEERING

Call or send resume to

G. P. O'Neil

CResview 4-7100, Ext. 224

**RAYTHEON**

MISSILE  
SYSTEMS  
DIVISION

B E D F O R D , M A S S .



# RADIO INTERFERENCE AND FIELD INTENSITY *measuring equipment*

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

**AIR FORCE—MIL-I-6181B**

*150 kc to 1000 mc*

**BuAer—MIL-I-6181B**

*150 kc to 1000 mc*

**BuShips—MIL-I-16910A (Ships)**

*14 kc to 1000 mc*

**SIGNAL CORPS—MIL-I-11683A**

*150 kc to 1000 mc*

**SIGNAL CORPS—MIL-S-10379A**

*150 kc to 1000 mc*

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

**F.C.C. PART 15**—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

*Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.*



**NM-10A (AN/URM-6B)**  
14 kcs to 250 mcs



**NM-20B (AN/PRM-1A)**  
150 kcs to 25 mcs



**NM-30A (AN/URM-47)**  
20 mcs to 400 mcs



**NM-50A (AN/URM-17)**  
375 mcs to 1000 mcs



The Stoddart NM-40A is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of 30 CPS to 15 kc. It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

**STODDART** *Aircraft Radio Co., Inc.*

6644-J SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA • Hollywood 4-9294

CIRCLE 116 ON READER-SERVICE CARD FOR MORE INFORMATION

## Clamp

For Tubes, Relays, Capacitors



This clamp is designed to hold radio and transmitting tubes, as well as relays and capacitors, to chassis. Opened and closed from the top, it allows tubes to be placed close together, saving

space and weight. Diameter tolerance is  $\pm 1/8$  in., which reduces the number of sizes required in the stock room.

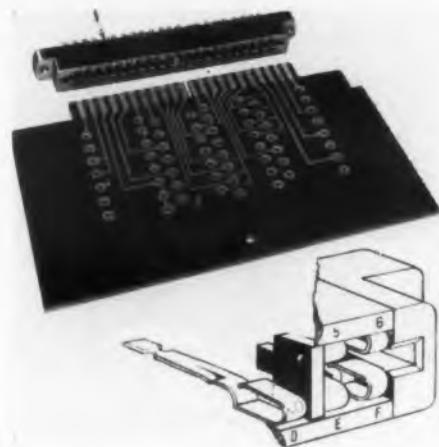
Sizes range from 9/16 to 3 in. diam. All material used is stainless steel, and attaching parts are silver soldered. Over 65 types or sizes are available. In addition to the standard clamps, both wire and hat type clamps are available.

Electronics Div., Peerless Machine Co., Dept. ED, 5338 Alhambra Ave., Los Angeles 32, Calif.

CIRCLE 117 ON READER-SERVICE CARD FOR MORE INFORMATION

## Printed-Circuit Varicon Connectors

Series 6,000 Polarized



For use with printed circuit boards, these connectors have contacts designed to make good connection with printed circuitry regardless of normal warpage or variation in thickness inherent in

the boards. This is accomplished by the double spring action incorporated in the contact form.

Contact terminals are designed for use with either taper tab or conventional soldered connections. All contacts are securely locked in position and cannot be pushed out by taper tab tools.

Polarizing tabs may be snapped in between contacts with finger pressure. They will not come out under vibration, but may be removed with long nose pliers if a change in polarity is desired.

The ease with which polarization is accomplished makes it unnecessary to stock more than one type of connector.

ELCO Corp., Dept. ED, "M" St. below Eric Ave., Phila. 24, Pa.

CIRCLE 118 ON READER-SERVICE CARD FOR MORE INFORMATION

★

★



THIS IS THE CENTER FOR

# HIGH PURITY FUSED QUARTZ APPARATUS

When critical purity is required for fused quartz and silica laboratory or production equipment, industrial specifications call for Amersil as the primary approved source.

In addition, a unique service is keyed to your requirements. Here, standard apparatus, crucibles, trays, cylindrical containers in a full range of sizes and tubing (up to 25" diam.) are available for early delivery.

Amersil engineers will be glad to assist in developing special equipment to individual requirements. Your inquiry will receive prompt attention.

**AMERSIL**  
COMPANY, INC.

**FUSED SILICA  
AND QUARTZ**

685 RAMSEY AVE., HILLSIDE 5, NEW JERSEY

ENGELHARD INDUSTRIES

CIRCLE 119 ON READER-SERVICE CARD



*direct-current*  
**TACHOMETER  
 GENERATOR**  
*permanent-magnet*

**APPLICATIONS**

- **VELOCITY SERVOS** Ideal for use as a rate generator in servo or integrating devices where a highly linear speed/voltage relationship is required with minimum ripple.
- **DIRECT READING TACHOMETER** Makes an excellent tachometer when combined with a d-c voltmeter having proper voltage range.
- **SPEED TRANSDUCER** Ideal for use as a speed transducer in connection with fast response direct writing oscillographs.

**FEATURES**

- **SIZE** Miniature. Approx. dia. 1 1/4".
- **LINEARITY** Output voltage is proportional to speed to better than 1/2 of 1%.
- **SPEED** Excellent service life at 12,000 rpm. Higher speeds possible.
- **OUTPUT** Various models up to 20 volts per 1,000 rpm.
- **RIPPLE** The rms value will not exceed 3% of the d-c value at any speed in excess of 100 rpm.
- **BRUSH LIFE** Better than 20,000 hours at 1800 rpm.
- **BIDIRECTIONAL OPERATION** Output in either direction is held to a 1/4 of 1% tolerance.
- **CONSTRUCTION** Aluminum housings with protective treatment; stainless steel shafts; fully shielded ball bearings; Mylar insulation.

**SEND FOR COMPLETE DATA**



**SINGLE UNITS**

from **\$19.50**

priced lower  
in quantity

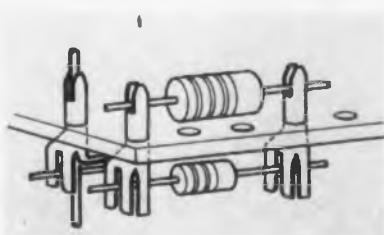
**IMMEDIATE DELIVERY**

**Servo-Tek**  
 PRODUCTS CO.  
 INCORPORATED  
 1086 Goffle Rd., Hawthorne, N. J.  
 Phone HAWthorne 7-3100

**CIRCLE 121 ON READER-SERVICE CARD**

**Quick Push-In ZIP Terminals**

**No Staking Required**



Vector Push-in Zip Terminal needs only to be pushed into the 0.093 in. wall or deck hole and it holds itself securely without staking. The

serrated slots grip inserted wires tightly for testing or dip soldering. The Push-in Zip Terminal is a formed strip brass terminal having a partially tubular end which fits into the holes in the board and is held by spring tension. The upper portion of the terminal has a narrow tapered slot with serrated edges, which firmly grip the wire lead of any size between 0.030 and 0.045 in. The slot is offset from the axis of the tubular hole by approximately 0.040 in. so that a riser wire coming up through the hole does not interfere with the cross-wire. The portion of the tubular member which protrudes from the opposite side of the board also has a slot which grips wires on that side of the panel. In addition, there is a thumb on the terminal, used for small wires such as are found on transistors, diodes, and miniature tubes; or the thumb may be bent outwardly to form a junction with an adjacent terminal, thus making a cross-section.

Vector Electronics Co., Dept. ED, 3352 San Fernando Rd., Los Angeles 65, Calif.

**CIRCLE 122 ON READER-SERVICE CARD FOR MORE INFORMATION**

**Portable Tracing Table**

**Low Cost**



This modern, extra-thin tracing table is lightweight, portable, easy to store and yet strong enough to permit tracing on Bristol board. Called Porta-

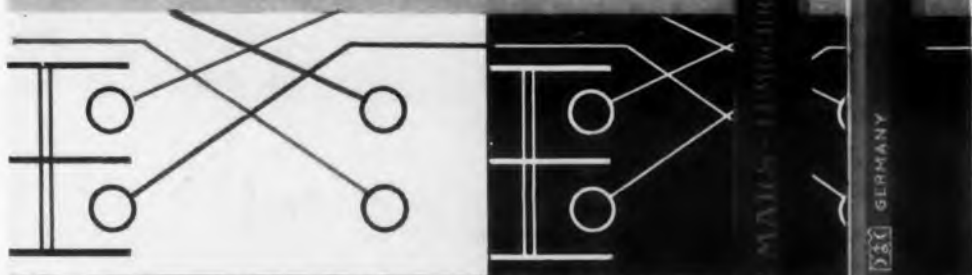
Trace, it is 1-7/16 in. thick. Because of its low height and flush top, drawings which are actually larger than the unit, can be traced, and Porta-Trace can be used easily under a string straight edge. The flush plexiglas top provides for light diffusion with minimum glare; fluorescent lighting gives high light output with minimum heat. In addition, rubber feet on the bottom of the unit keep it stationary even on tilted drawing or drafting boards. Tables are made in four sizes: from 11 x 18 in. to 24 x 36 in.

Porta-Trace Inc., Dept. ED, 342 Clinton St., Binghamton, N. Y.

**CIRCLE 123 ON READER-SERVICE CARD FOR MORE INFORMATION**



an  
important  
new  
drafting  
technique



possible only with  
**MARS-LUMOCHROM**

All colors blueprint perfectly,  
making color-drafting possible.

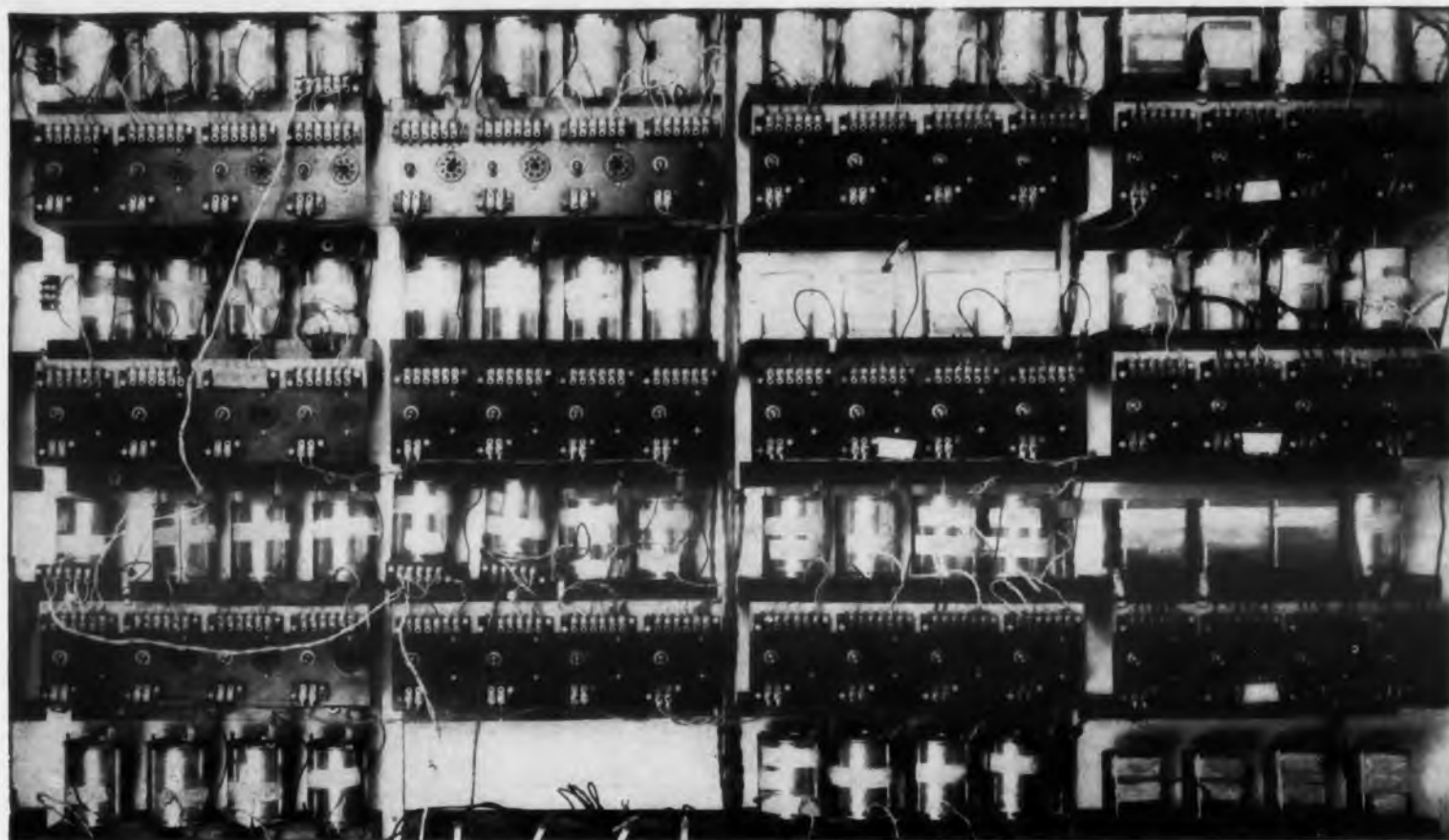
**MARS-LUMOCHROM** does not fade  
... does not smear ... is waterproof  
... erases perfectly ... keeps finest point

Send for free sample

**S**TAEDTLER also proudly introduces the Mars-Pocket-Technico for field use, the Mars "Draftsman's" Pencil Sharpener with the adjustable point length feature, and the efficient, clean Mars lead sharpener. All available—along with the established standards: Mars-Lumograph black graphite drafting pencils, Mars-Technico lead holder and leads, and Tradition-Aquarell painting pencils—at all leading art material and drafting supply dealers.

J.S. STAEDTLER, INC. HACKENSACK, NEW JERSEY

CIRCLE 124 ON READER-SERVICE CARD FOR MORE INFORMATION



**TORTURE TESTS** like these for Syncroverter Switches are typical of Bristol's continuing drive for product quality.

## 100 billion operations and they're still going strong!

### Syncroverter Choppers have run almost six years continuously at 400 and 600 cycles per second

That's the laboratory shelf-test record of a group of Bristol's<sup>®</sup> Syncroverter<sup>®</sup> Switches that are being run at no load as a test for actual mechanical wear out. They are still operating after almost six years.

These Syncroverter Switches are predecessors of those being used in aircraft fire control systems, guided missiles, electronic instruments, ground control equipment, and many other electronic systems.

Long life is a feature of the miniature Syncroverter Chopper and High-Speed Polar Relay. They are unaffected during severe shock and vibration and are available with the typical operating characteristics shown in the tables at right. They meet a wide variety of requirements. Write for further information on these precision components. Or we'll be glad to discuss specific application problems with you. The Bristol Company, 151 Bristol Road, Waterbury 20, Conn.

TYPICAL CHARACTERISTICS	
<b>Bristol's Syncroverter Switch</b> (covered by patents)	
Driving frequency range:	0-2000 cps (400 cps used for these characteristics)
Coil voltage:	6.3V sine, square, pulse wave
Coil current:	55 milliamperes
Coil resistance:	85 ohms
*Phase lag:	55° ± 10°
*Dissymmetry:	Less than 4%
Temperature:	-55°C to 100°C
*Switching time:	15° ± 5°
Operating position:	Any
Mounting:	Flange or plug-in—fits 7-pin miniature socket
*These characteristics based on sine-wave excitation	
<b>Bristol's Syncroverter High-Speed Relay</b> (covered by patents)	
Temperature range:	-55°C to 100°C
Operating shock:	30G; 11 milliseconds duration
Vibration:	10-55 cps (see below, mounting); 10G
Contact ratings:	Up to 35V, 45 microamperes
Stray contact capacitance:	Less than 15 mmf.
Pull-in time (including bounce):	As low as 200 microseconds
Drop-out time:	300 microseconds
Life:	Over a billion operations under dry-circuit conditions
Mounting:	Octal tube socket, others available, including types for vibration to 2000 cps

# BRISTOL

TRAIL-BLAZERS  
IN PROCESS AUTOMATION

AUTOMATIC CONTROLS • RECORDERS • TELEMETERS • SOCKET SCREWS •

CHOPPERS AND HIGH-SPEED RELAYS • AIRCRAFT PRESSURE-OPERATED DEVICES  
CIRCLE 126 ON READER-SERVICE CARD FOR MORE INFORMATION

## Rotary Joints

### X, S, and C-Bands



A rotary joint employing one or two in-line transitions is offered at the X, S, and C-bands. The in-line transitions make possible improved packaging of rf components and drive mechanisms in many applications.

The L-type unit illustrated operates over the frequency range of 5400-5900 mc and has a vswr under 1.20. Special attention has been given to designing both the in-line and right-angle transitions to handle high power. This C-band unit withstands in excess of 500 kw at atmospheric pressure and mates with a standard 1 x 2 in. waveguide. It may be rotated at 20 rpm and is pressurized to 30 psig. Other pressurized rotating joints are available operating up to 3600 rpm.

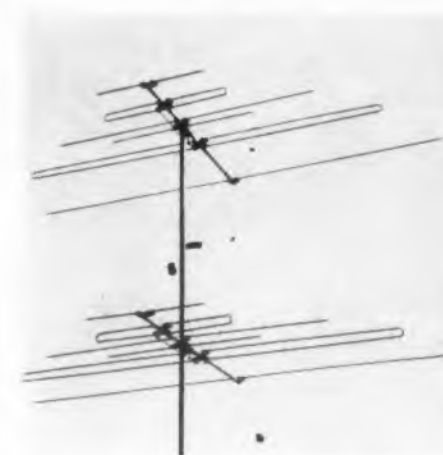
This firm offers a complete line of standard L-shaped and in-line rotary joints, as well as the more conventional rotary joints employing two right-angle transitions.

Canoga Corp., Dept. ED, 5955 Sepulveda Blvd., Van Nuys, Calif.

CIRCLE 127 ON READER-SERVICE CARD FOR MORE INFORMATION

## TV Antenna

### High In Performance



Emphasizing the "compact completeness" found in the Winegard Color-Beam, Color 'Ceptor, and Minute-Mount, the "303," an all channel vhf (2-13) antenna, stresses these deluxe features:

a) the ends of all elements are crimped; b) booms are plugged; c) hi-impact polystyrene insulators; d) 300 ohm driven elements to ensure 100% signal transfer to transmission lines; e) streamlined appearance of top quality aluminum construction; f) metal phasing lines.

It can be used conveniently with top performance in the city-single bay, and in the country-double bay.

Winegard Co., Dept. ED, Burlington, Iowa.

CIRCLE 128 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • October 1, 1956

## Varipad Variable Attenuator

### Compactly Built



Low cost VARIPAD 3 to 50 db variable attenuators, to provide smooth, stable control of rf signals up to 250 mc, has a flat frequency response for

wide band applications.

A 3 to 30 db variable attenuator in conjunction with a switchable 20 db pad affords a continuously variable output in two ranges.

Three ruggedly built models are available for use on 75 or 300 ohm cables. One model also includes a broad band matching transformer for application in the 50 to 250 mc band.

Test bench setups are greatly simplified by eliminating the need for large quantities of fixed attenuators, since VARIPADS provide an infinite number of settings.

Entron Inc., P.O. Box 287, Dept. ED, 4902 Lawrence St., Bladensburg, Md.

CIRCLE 130 ON READER-SERVICE CARD FOR MORE INFORMATION

## Magnetic Pushbutton

### Has Holding Relay



This magnetic pushbutton is the same size as normal pushbutton keys and should have many switching applications. It combines the features of a position indicator with a holding relay. By means of the two colored buttons, the position of the key is easy to determine. The unit is held in actuated position by means of a built-in electro-magnet and is released by switching off the

holding current. According to the circuit requirements, this operation can be performed by a separate release key, a relay, or manually (by pulling the depressed button up). The second key may be located anywhere.

Holding current operating voltage of the pushbutton is 15 ma; operating voltage is 12 v; and key pressure in pressed down position is 250 gr. Contact sets are available in 12 varieties. Should higher operating voltages be required, a resistor can be placed in series with the magnet coil.

International Standard Trading Corp., Dept. ED, 22 Thames St., New York 6, N.Y.

CIRCLE 131 ON READER-SERVICE CARD FOR MORE INFORMATION

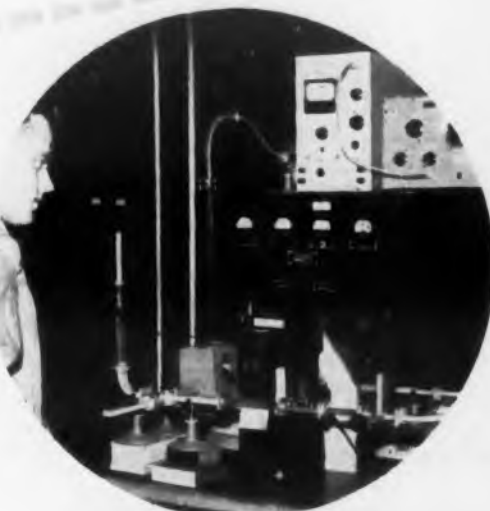
## The right people with the right facilities produce the right solutions



Results of gaseous electronics investigation concerned with wide-band tunable microwave oscillations are examined at the Microwave Physics Laboratory. From left: Laboratory Manager, O. T. Fundingsland; Dr. R. M. Hill, senior project leader, gaseous electronics; Dr. P. H. Vartanian, senior project leader, ferrites; and Dr. A. L. Aden, assistant laboratory manager.



The new Sylvania Microwave Physics Laboratory, Mountain View, California.



Frequency doubling in ferrites, a phenomenon newly discovered at Sylvania Mountain View laboratories, is studied by engineer A. L. Helgesson.

## More problem-solving power... Sylvania's new Microwave Physics Laboratory

NEW PROBLEM-SOLVING POWER has been added to Sylvania's growing capability for research and development in highly advanced military and industrial electronic systems.

With the establishment of the Microwave Physics Laboratory at Mountain View, Calif., Sylvania is expanding its work in new magnetic materials and ionized gaseous media for microwave electronic control devices and systems

for radar, communications, and electronic countermeasures.

Fields of research at the laboratory include magnetic ferrites, gaseous electronics, radio wave propagation, electromagnetic resonance phenomena in ferrites and ionized gaseous media.

Besides the new Microwave Physics Laboratory, the Microwave Tube Laboratory and the Electronic Defense Laboratory are also located at Mountain

View. Each is a vital part of Sylvania's Electronic Systems Division.

In addition to the Mountain View laboratories, the Electronic Systems Division has plant and laboratory facilities at Buffalo, New York, and extensive research facilities at Waltham, Massachusetts. All are staffed with top-ranking scientists and engineers, backed by Sylvania's extensive resources in the electronics field.

### SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS

Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.



# SYLVANIA



LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

See Sylvania at the Annual Symposium on Aeronautical Communications, Oct. 8, 9, 10, Hotel Utica, Utica, N. Y., Booth 9



# MICRO precision switches



... THEIR USE IS A PRINCIPLE OF GOOD DESIGN

there is always  
"SOMETHING NEW"  
at MICRO SWITCH  
for product designers

Experienced designers know both time and money are saved when they check with MICRO SWITCH on their complex switching problems. If we have not already solved their problem, MICRO SWITCH engineering is experienced in cooperating with product designers to quickly develop a precision switch to meet the requirements.

Here are four such new switches, each developed to meet a specific need, each capable of many variations of actuation, circuitry and housings.



3-LIGHT  
PUSHBUTTON  
SWITCH  
FOR COMPLEX  
CONTROL PANELS

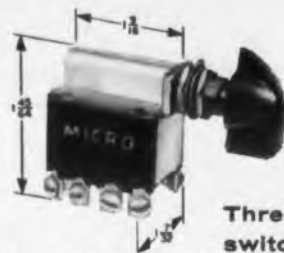
"PB" Series 3-light  
pushbutton actuated switch

Here is a new, unique indicating pushbutton switch which lights in three different colors. This compact assembly is the result of an original requirement for a "super-reliable" long-life pushbutton switch for use in computer consoles for guided missiles control systems.

Designed for use in applications where *absolute dependability* is required, this switch is manufactured under extremely careful quality control procedures. The result is a reliable life through hundreds of thousands of operations.

A special, exclusive feature is the incorporation of a "radio tube" type connector, or plug-in base, which carries all the connections to the basic switches and lamp terminals. The entire assembly is easily pulled out for lamp replacement. (Send for Data Sheet 110)

MICRO SWITCH Engineering is at your service from convenient branch offices in key cities everywhere. It is as close as your telephone. Consultation costs you nothing. Can save you time and money.



THIS TOGGLE  
SWITCH HAS LONG  
LIFE AND BETTER  
DETENT "FEEL"

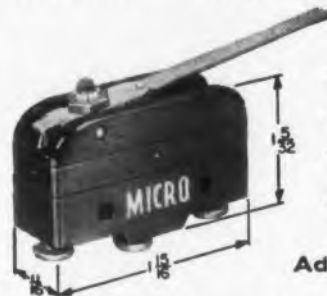
Three-position rotary type toggle switch. "TR" Series

Here is a new solution to the problem of mechanical actuation of many circuits with a single manual motion. This new series of "TR" switches offers all the advantages of a toggle switch mechanism plus *longer operating life and better detent "feel."*

These switches provide a high electrical capacity in a very small space, permitting the elimination of relays and other electrical devices in many circuits.

They are rugged enough for most airborne and industrial applications and have successfully passed rigid tests for impact, shock, acceleration and vibration.

The "TR" switch shown is a four-pole double-throw switch with 12 terminals. It is maintained in all three actuation positions: on-off-on. Other "TR" switches are available with up to 24 terminals (8 poles). (Send for Data Sheet 112)



PRECISE,  
UNERRING ACTUATION  
THROUGH MILLIONS  
OF OPERATIONS

Adjustable lever actuated switch

An adjustable lever actuator on this switch permits close adjustment of the operating point without removing the switch from its mounting.

This switch is designed for use on such equipment as timers, computers or other multiple-mounted switch devices which require *precise, unerring actuation through millions of operations.*

The operating position is adjustable through .210 inch. The switches are available with a wide selection of pre-set operating characteristics. They are also available with split-contact double-throw circuitry. (Send for Data Sheet 100)



THIS SWITCH GIVES  
PRECISE PERFORMANCE  
UNDER MOST  
EXTREME CONDITIONS

The MICRO "EN" Switch is completely sealed, cylindrical in shape. Tests have shown its precise performance to be unaffected by ice-coating at  $-65^{\circ}\text{F}$  or by heat to  $+180^{\circ}\text{F}$ . A thousand hours in salt brine spray or 30 days operation at  $104^{\circ}\text{F}$  (95% humidity) still finds it going strong—and precisely. No chattering of contacts, no loosening of parts occurs during vibration tests of 10 to 500 cycles per second.

Contact arrangement is double-pole, double-throw. Weight (without leads)  $2\frac{1}{2}$  oz.

(Send for Data Sheet No. 105)

## MICRO SWITCH

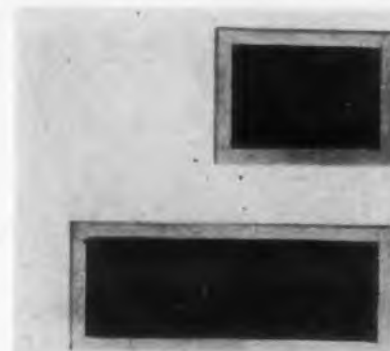
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS



CIRCLE 134 ON READER-SERVICE CARD FOR MORE INFORMATION

## "K" Gaged Mica Permits Smaller Capacitors



"K" gaged mica is offered to design engineers as an aid in creating transistorized printed circuits utilizing much smaller components than formerly possible. Mica capacitors can be

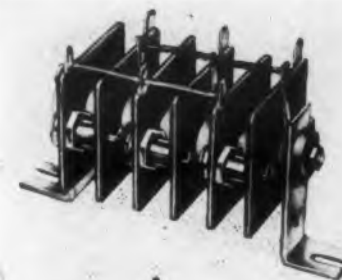
designed to have the same capacity but only 1/2 to 1/4 the size as those previously used in transistorized and other printed circuits.

"K" gaging is a new electronic method of accurately gaging mica film, which permits utilizing smaller area mica to obtain predetermined capacity. Any desired tolerance can be held on electronically "K" gaged mica film, including tolerances as close as the mechanical equivalent of 0.00025 in. After silvering, costly time-consuming hand adjusting or scraping on mica may be entirely eliminated because capacity is accurately predetermined. In addition, waste in cut 40% to 50%.

Perfection Mica Co., Dept. ED, 20 N. Wacker Dr., Chicago 6, Ill.

CIRCLE 135 ON READER-SERVICE CARD FOR MORE INFORMATION

## Rectifier Stacks High Temperature Silicon



Silicon rectifier stacks, "TL" series, combines the superior performance of silicon rectifiers with the versatility of stack mounting. These rectifiers overcome the basic limitations of germanium, selenium and copper oxide to provide

trouble-free operation under severe environmental conditions. The "TL" rectifier stack series provides reliable operation at temperatures up to 150 C, and features voltage ranges up to 5100 v rms, and current ratings up to 10 amp. Standard stack types are available for single-phase, three-phase and six-phase power supply circuits.

This stack series is especially designed to meet the critical requirements of missile, aircraft and other military equipments. Four JAN type rectifiers, the 1N253, 1N254, 1N255 and 1N256, may be optionally incorporated into these stacks.

Transitron Electronic Corp., Dept. ED, Melrose 76, Mass.

CIRCLE 136 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • October 1, 1956

## Brushless Frequency Converter

400 Cycle 25 KVA



"Nobrush" 25 KVA alternator, direct mounted on a continuous duty induction motor, offers a 3 phase, 4 wire, 120/208 v output. Exciter is unnecessary.

Due to the absence of rf disturbance, suppression is not required. For loads of high power factor, intrinsic regulation is adequate, thus eliminating need for regulator.

The generator is virtually immune to damage by grit, moisture or short circuits and conversion efficiency is high. Temperature rise is less than 40 C. Due to absence of brushes, the unit is non-sparking.

Overall dimensions of unit is little larger than the motor alone, 36 x 20 x 20 in.; weight is 925 lb. Usual maintenance is limited to infrequent lubrication of motor bearings. Unit is especially adapted for highly dependable, continuous operation under adverse environmental conditions.

Georator Corp., Dept. ED, Manassas, Va.

CIRCLE 138 ON READER-SERVICE CARD FOR MORE INFORMATION

## Pressure Cells

### For Pressure-Sensing Systems



These highly sensitive pressure-sensing devices are for use as transducers, strain gages, inverters, altimeters, non-mechanical switches and push buttons, weighing scales, shock and force recorders, and scores of other applications. They have

wide resistance ranges, some types as much as 1,000,000 ohms per lb of force. Over 300 types are regularly carried in stock to fit many special conditions.

The cells have excellent repeatability; for example, a low resistance type shows 2.6 ohm at 10 lb force,  $\pm 0.01$  ohm every reading for 5000 times, without fatigue or drift. Illustrated is the 5 w size for pressures of 0-10 lb. This unit is 1 in. diam x 1/4 in. thick and can easily carry its rated load without the use of an amplifier.

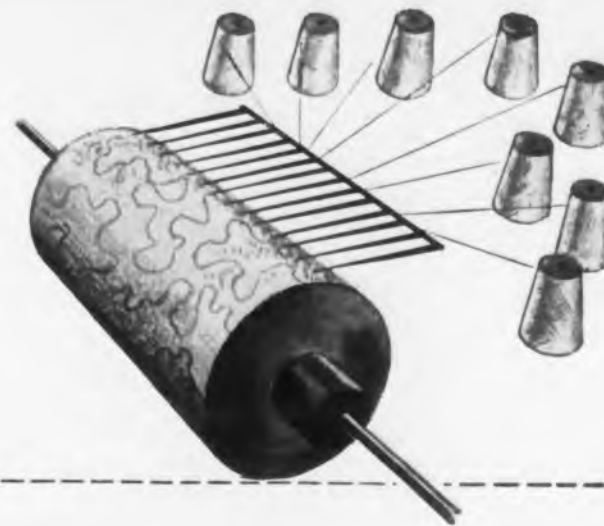
The cells are made of metal inlaid on one side with "Celab" plastic. Highly specialized cells are also available in pressure ranges from a few grams to many tons, for either steady pressure or shock.

Clark Electronic Laboratories, Dept. ED, Box 165, Palm Springs, Calif.

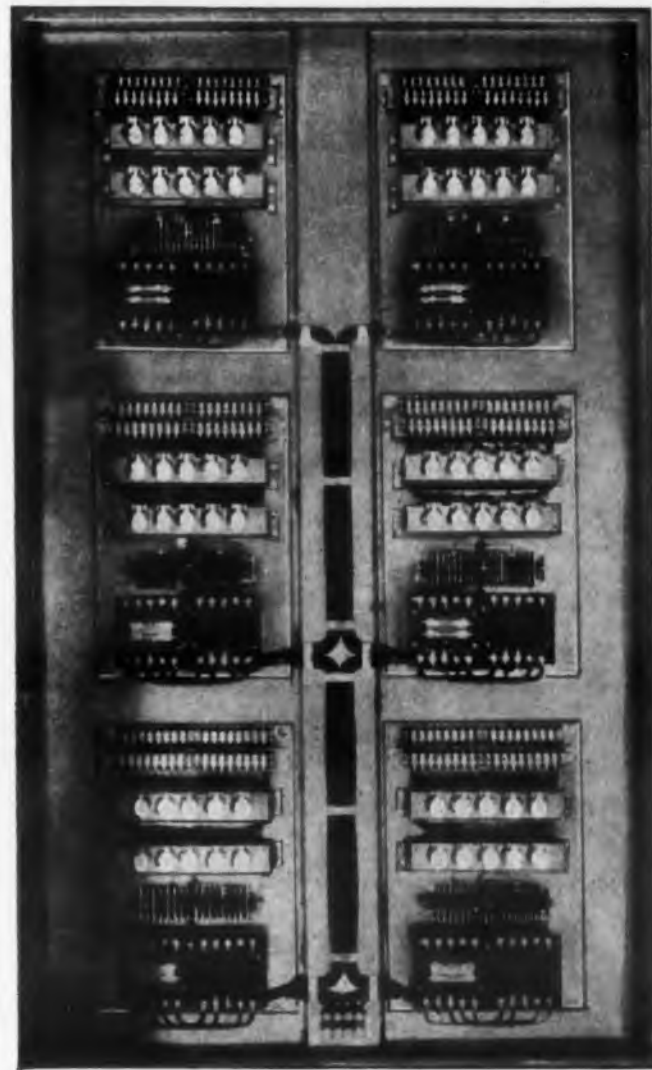
CIRCLE 139 ON READER-SERVICE CARD FOR MORE INFORMATION

## WARNER ELECTRIC BRAKE & CLUTCH CO.

*"puts the finger" on  
automatic rug machinery  
with the aid of*



# RADIO RECEPTOR SELENIUM RECTIFIERS



Guiding the 120 electric clutches that act as automated fingers in a new rug tufting machine is a Warner control panel whose key components are six Radio Receptor rectifiers. These fingers "feel" the rug pattern on a revolving roll, send information to the control station from which actuating impulses are relayed to clutches controlling yarn feed.

A Radio Receptor customer for many years, Warner Electric Brake & Clutch Co. utilizes RRco. selenium rectifiers in this application and many others because long experience has proved they can depend upon them for continuous and heavy duty, without fear of costly breakdowns.

If you have a problem in rectification, do as many fine companies do in the United States and throughout the world — Specify RRco. selenium rectifiers. Millions are in service in almost every possible type of circuit. Would you like our most recent literature? Please write section D 10.

Semiconductor Division

## RADIO RECEPTOR COMPANY, INC.

Radio and Electronic Products Since 1922

240 WYTHE AVENUE, BROOKLYN 11, N. Y. Evergreen 8-6000

OTHER PRODUCTS OF RADIO RECEPTOR: Germanium and Silicon Diodes, Dielectric Heating Generators and Presses, Communications, Radar and Navigation Equipment.



CIRCLE 140 ON READER-SERVICE CARD FOR MORE INFORMATION





W. W. Crissinger  
Chief Field Engineer  
Galion, Ohio



P. Van Valkenburgh  
Field Engineer  
Northeast



John Billis  
Field Engineer  
Midwest



Uriah I. Allen, Jr.  
Field Engineer  
Washington, D. C.



Ned B. Earley  
Field Engineer  
Central



Clayton Kielich  
Field Engineer  
Midwest



H. E. Peters  
Field Engineer  
Pacific Coast

# HAVE YOU PUT THESE MEN TO WORK?

Meet the Industrial Field Engineering Staff of North Electric Company. Their job is to serve your design groups as engineering consultants (without fee) in determining whether and how to use relays as control components.

This exclusive North engineering service pays off for you, and for North, because of the many cases in which they can aid in the development of simplified dependable systems . . . with all relay controls. These competent engineers are based near the key centers of industry. One of them can be at your doorstep promptly if you will write, wire or call the Galion office — Galion 2-4201 . . . regarding

## NORTH RELAYS

as components or control assemblies

"BUILDING BRAINS IS OUR BUSINESS"

INDUSTRIAL DIVISION



NORTH ELECTRIC COMPANY

490 S. Market St.

Galion, Ohio



## Transformers

### Rugged Resin-Potted Miniatures



These resin-potted transformers, to withstand temperatures up to 170 C, are hermetically sealed and designed for airborne use. They

are impervious to humidity and altitude, and withstand abuse without electrical or mechanical damage.

The potting material permits making transformers of smaller size and weight due to the improved thermal conductivity. The material also welds core, coil, case, and terminals into an integral unit. Shrinkage is precluded, eliminating separation from the case.

The transformers may be qualified under MIL-T-27A, Grade 1, 2, 4, or 5 as required. In addition, less expensive commercial types can be supplied with most of the benefits required by military specifications.

Electro Engineering Works, Inc., Dept. ED, 401 Preda St., San Leandro, Calif.

CIRCLE 143 ON READER-SERVICE CARD FOR MORE INFORMATION

## Broad Band DC Amplifier

### Chopper Stabilized

This unit features 10 feedback controlled gain ranges from 20 to 1000 with a gain accuracy of  $\pm 2$  uv drift. Input impedance is 100,000 ohms and output impedance is less than 1 ohm. Frequency response is  $\pm 0.3$  db to 10 kc and less than 3 db down at 40 kc. Equivalent input noise is less than 5  $\mu$ v peak-to-peak from 0 to 3 cps and less than 12  $\mu$ v rms from 0 to 50 kc. The Model 111 contains an integral power supply. The amplifier output capability is  $\pm 35$  v or  $\pm 40$

ma. These amplifiers are light and compact and may be mounted in modules where multiple units are required.

Kay Lab., Dept. ED, 5725 Kearney Villa Rd., San Diego 11, Calif.

CIRCLE 144 ON READER-SERVICE CARD FOR MORE INFORMATION

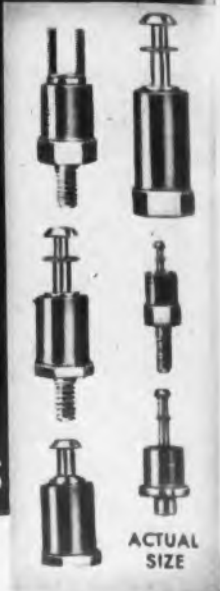


YOU CAN ALWAYS

RELY ON  
WHITSO

FOR  
INSULATED  
TERMINALS  
AND OTHER  
ELECTRONIC  
COMPONENTS

HERE'S  
WHY:



We are specially equipped to furnish standoff and feed through terminals in a full range of materials and sizes . . . in economical quantity runs . . . from either our standard line or custom fabricated to your specifications . . . and deliver them promptly.

**Whitso Standoff Terminals** are available in over 100 varieties . . . fork, single and double turret, post and miniature types . . . male, female or rivet mountings . . . molded or metal base. They are molded from melamine thermosetting materials for best electrical properties.

**Whitso Feed Through Terminals** can be furnished as standard or to your individual specifications.



**Whitso Melamine Jacks** are electrically and mechanically designed for long, reliable service. A wide range of colors are available for color coding. Special colors can be supplied.



**Whitso Pointer Knobs**, widely popular in military use, are readily suited to countless communications and industrial applications. They are supplied in attractive black phenolic with satin finish.



**Whitso Custom Molded Parts** for electro-mechanical use include general purpose, mica filled and high impact phenolics, ureas, melamines, alkyds, glass reinforced alkyds and nylons.

Get full facts on Whitso terminals and other electronic components. Ask for our new catalog.



**WHITSO, INC.**

9326 Byron Street, Schiller Park, Illinois  
(Chicago Suburb)

CIRCLE 145 ON READER-SERVICE CARD

# Basic to Dependable Lab Ware -VITREOSIL<sup>®</sup>



The most exacting needs of laboratories throughout the world are most eminently and successfully met by Vitreosil ware (pure fused silica) produced to the highest standards of quality.

Chemical purity, high resistance to heat shock, unusual electrical resistivity, best ultra-violet transmission (in transparent quality) and low initial cost compared to platinum are some features of Vitreosil fused quartz.

In addition to our unusually large stock of transparent and opaque, including glazed and unglazed crucibles, evaporating dishes, beakers, tubing and rods in all diameters and sizes, we offer prompt fabrication of special items.



Write today, giving full details of your requirements or ask for illustrated bulletin.

**THERMAL AMERICAN  
FUSED QUARTZ CO., INC.**

18-20 Salem Street, Dover, New Jersey

Please send illustrated bulletin or information on \_\_\_\_\_

Company \_\_\_\_\_

Name \_\_\_\_\_ Title \_\_\_\_\_

Street \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 146 ON READER-SERVICE CARD

## Quarter-Turn Fastener

In Many Head Styles



The 5F, a quarter-turn fastener, is a small, lightweight, inexpensive device that provides a high strength-weight ratio particularly adaptable to thin materials and miniaturized equipment. Designed for use on such equipment as airborne electronics,

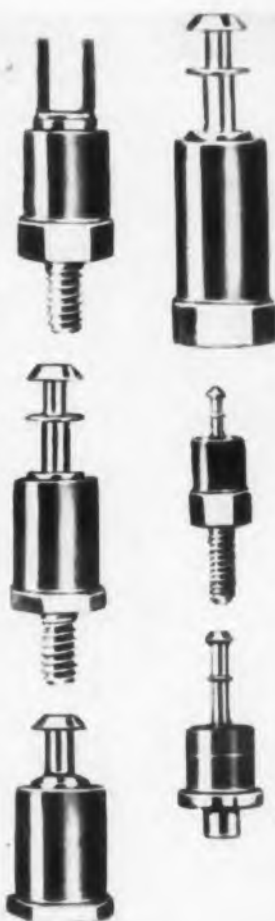
small electro-mechanical and computing devices, and communications components, it is offered in many different head styles. It is valuable for attaching lightweight components in "packaged" equipment, or for holding access panels on equipment ranging from washing machines to radar units.

Camloc Fastener Corp., Dept. ED, 61 Spring Valley Rd., Paramus, N. J.

CIRCLE 147 ON READER-SERVICE CARD FOR MORE INFORMATION

## Standoff and Feed Through Terminals

Complete Range of Sizes



Standoff and feed through terminals in a full range of sizes are offered in fork, single and double turret and miniature types, male or female threaded or with rivet mountings. Both metal or molded bases can be furnished. Hardware and insulating materials include a wide variety of combinations to meet military or other specifications.

Standard body materials are melamine, electrical grade (MIL-P-14 Type MME); and melamine, impact grade (MIL-P-14 Type MMI). A wide variety of plating combinations for terminals and mountings are available. Individual specifications, sizes or materials, can be furnished to fit special requirements.

Feed through terminals are also offered either standard or in sizes and materials to specification.

Whitso Inc., Dept. ED, 9330 Byron St., Schiller Park, Ill.

CIRCLE 148 ON READER-SERVICE CARD FOR MORE INFORMATION

*Miraculous!*



## **SILICON RECTIFIERS**

by

## **SARKES TARZIAN**

*For your future power supply in all radio, television, electronic devices and other rectifier replacements. Write for complete information.*



*Patent Applied For*

**Sarkes  
Tarzian, INC.**

**RECTIFIER DIVISION**  
**DEPT. C-5, 415 NORTH COLLEGE AVE., BLOOMINGTON, IND.**  
*In Canada: 700 Weston Rd., Toronto 9, Tel. Murray 7535*  
*Export: Ad Auriema, Inc., New York City*

**CIRCLE 149 ON READER-SERVICE CARD FOR MORE INFORMATION**





## A good combination...for an argument

*Laminated plastics...a combination of properties that speaks for itself!*

Many industrial applications require materials that can deliver more than one property and can perform more than one function. Such a material is Synthane laminated plastic. This widely used basic material satisfies such diverse property requirements as good tensile, compressive and flexural strengths, low moisture absorption, low dielectric constant and low power factor, light weight and easy machinability. Various grades of Synthane are available to the designer in order to provide him with just the right combination of properties according to the mechanical, electrical and chemical requirements of his application.



This insulation plate made of Synthane has to take the toughest kinds of outdoor punishment. Used in heavy-duty generators for bulldozers and tractors, it must battle all kinds of weather, road dust, oils, greases, and vibrations. In addition to meeting these tough service conditions, Synthane also possesses the necessary light weight, mechanical and dielectric strengths, good machining properties, and the ability to be post-formed to the desired shape.



A wide choice of combined properties! Synthane offers over 30 individual grades in sheets, rods, tubes, moldings, and completely fabricated parts. Send for free illustrated catalog today.



DIELECTRIC STRENGTH



LIGHT WEIGHT



WEAR RESISTANCE



EASILY MACHINED

# SYNTHANE

SYNTHANE CORPORATION, 42 RIVER ROAD, OAKS, PA.

CIRCLE 150 ON READER-SERVICE CARD FOR MORE INFORMATION

## Two-Channel Audiometer For Wide Range of Hearing Tests



A clinical 2-channel audiometer, that conducts nearly all types of hearing tests with speed and accuracy, is designed for use by physicians, clinicians, and audiologists, in either one or two-room arrangements. The audiometer, Model 15-A, can perform all types of speech tests, including recorded and live voice.

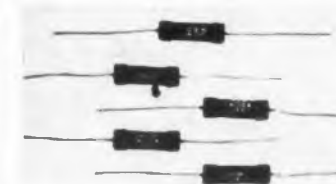
The audiometer has a complete range of octave frequencies from 125 to 8000 cy and intermediate frequencies from 750 to 6000 cy. It has extra 500 to 1000 cy oscillators and provides both manual and automatic pulsing of tones.

Beltone Hearing Aid Co., Dept. ED, 2900 W. 38th St., Chicago, Ill.

CIRCLE 151 ON READER-SERVICE CARD FOR MORE INFORMATION

## Glass Resistors

### Increased Max Resistance Values



Precision film-type glass resistors are now available with greatly increased maximum resistance values. The range of the 1 and 2 w, 1% tolerance resistors has been increased by a factor of 10.

Improvement of the range of the Type N resistor has increased the maximum resistance in the 1w size from 40 k to 400 k and in the 2 w size from 100 k to 1 megohm.

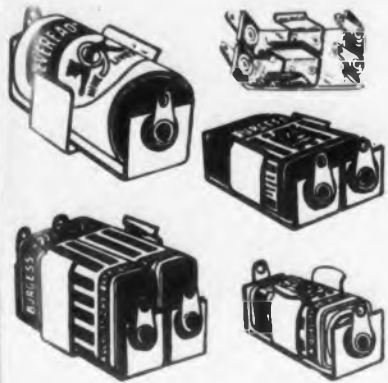
Temperature coefficients on the improved resistors have been reduced from 50 ppm to 300 ppm/°C. Other basic characteristics conform to specification MIL-R-10509B. These resistors are recommended for computer circuits, pulse networks, high frequency circuits, and low signal level, high-gain amplifier stages.

Corning Glass Works, Dept. ED, Corning, N. Y.

CIRCLE 152 ON READER-SERVICE CARD FOR MORE INFORMATION

## Battery Holders

Made in 25 Types



A standard line of battery holders is offered in 25 types designed for use in transistor circuits, meters, radios, Geiger counters, etc. Made of spring temper aluminum alloy, they hold batteries securely in spe-

cially designed snap clips. Mounting holes are provided for screws, eyelets, or rivets.

Keystone Electronics Corp., Dept. ED, 423 Broome St., New York 13, N.Y.

CIRCLE 154 ON READER-SERVICE CARD FOR MORE INFORMATION

## Direct Reading Dosimeter

Calibrated, Compact, Unlimited Life

RADAD Dosimeter, a new major exposure radiation detector for personnel, provides both cumulative measurement and instantaneous reading of dangerous amounts of gamma ray exposure. Consisting of a hollow, hermetically sealed ionization chamber containing Polystyrene beads which serve as indicators of exposure to radiation, these indicator beads are electrostatically charged simply by shaking the tube.

Pacific Transducer Corp., Dept. ED, 11836 West Pico Blvd., Los Angeles 64, Calif.

CIRCLE 155 ON READER-SERVICE CARD FOR MORE INFORMATION

## Microscope-Telescope

Fits in Pocket



This handy pocket instrument combines a 50 power microscope and a 10 power telescope. Approximating a fountain pen in size, it can be used for close-

up examinations of small parts and components, and it is handy for checking machining operations, threads, chamfers, etc. For use as a telescope, the metal reflector is unscrewed, and the eyepiece tube and sight drawn out. The instrument is equipped with a clip to hold it in coat or shirt pocket.

Edmund Scientific Corp., Dept. ED, Barrington 13, N.J.

CIRCLE 156 ON READER-SERVICE CARD FOR MORE INFORMATION



## THE CONVAIR CHALLENGE TO THE ENGINEER OF EXCEPTIONAL ABILITY

Beyond the obvious fact that Convair in San Diego offers you a way of living judged by most as the nation's finest from the standpoint of weather, beauty and interesting surroundings, the Convair Engineering Department offers you challenges found in few places.

It is, we believe, an "engineer's" engineering department—interesting, energetic, explorative—with the diversity that means security for capable personnel.

*As proof, consider this:* Convair developed and flew the world's first turbo-prop airplane, first delta-wing airplane, first vertical take-off airplane, first delta-wing seaplane—engineered and built the world's biggest transport, the world's safest high-performance commercial aircraft.

*Or this:* Convair's B-36 is the world's largest operational bomber, Convair's B-24 Liberator was World War II's most used heavy bomber, Convair's XP5Y-1 holds the world's endurance record for turbo-prop aircraft.

*Or this:* Convair was awarded the nation's first production missile contract and the first production contract for supersonic interceptors.

*Currently . . .* Convair has the greatest diversity of aircraft engineering projects in the country, including the "F-102A" supersonic interceptor, the new Metropolitan 440 airliner, the "Convair 880 jet liner", the Atlas intercontinental ballistic missile, plus a long-range study of nuclear aircraft.

*Currently . . .* Convair has a completely integrated electronic development section engaged in advanced development and design on missile guidance, avionic projects and radar systems.

*Would you like to join us?* We earnestly need engineers of proven ability—men who want to make full use of their time, their minds, their skills and abilities solving the complex problems confronting us in these projects. If you are such a man, write us and we'll send you a free booklet about us, plus other interesting material to help you make the decision.

Write: H. T. BROOKS, Engineering Personnel

Department 1022

**CONVAIR**  
CV GD  
A DIVISION OF GENERAL DYNAMICS CORPORATION

3302 PACIFIC HIGHWAY

IN BEAUTIFUL SAN DIEGO, CALIFORNIA

# 4 NEW

## SUBMinax<sup>®</sup>

(shown actual size)



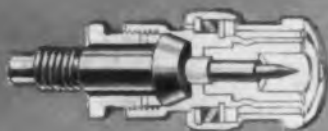
27-27



27-801



27-800



27-28

AMPHENOL now adds modified versions of the LT series of RF connectors to its large availability listing. Specifically designed for use with Teflon RG-117/U coaxial cable (also made by AMPHENOL), the LT series 82-116 plug and its matching 82-117 receptacle are made largely of aluminum to keep weight low and cadmium-plated for durability. Impedance is 50 ohms, maximum voltage rating is 5000 volts.

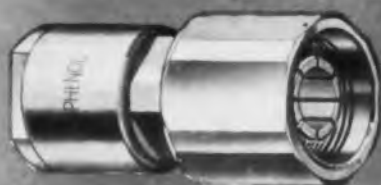
Write for data.

## look to AMPHENOL for RF Connector PROGRESS

AMPHENOL's Subminax have provided the electronic industry for the first time with extremely reliable subminiature RF connectors. Where space and weight savings are important, but not at the expense of reliability, AMPHENOL Subminax are finding ever-increasing utilization. Now, four new 50 ohm connectors have been added: 27-27 hermetic seal receptacle, 27-801 cable termination, 27-800 printed circuit receptacle and 27-28 Subminax to BNC adapter. Write for data sheet, which includes a listing of all thirty available Subminax RF connectors.

# NEW LT SERIES

(shown one-half size)



82-116



82-117



AMPHENOL ELECTRONICS CORPORATION

chicago 50, illinois

AMPHENOL CANADA LIMITED • toronto 9, ontario



## Null Indicator

Has 50% Longer Scale



This new 2-1/2" null indicator offers far greater readability than conventional round instruments of the same size, yet occupies no more panel space. Increased readability re-

sults from the longer dial arc, larger numerals and better scale illumination from all angles.

High null point sensitivity allows accurate observation of large amounts of unbalance in bridge or other detection circuits, without physical or electrical overload of the instrument.

Marion Electrical Instrument Co., Dept. ED, Grenier Field, Manchester, N. H.

CIRCLE 159 ON READER-SERVICE CARD FOR MORE INFORMATION

## Oscillograph

Has 12 Chart Speeds



Known as the S25 oscillograph, this new instrument features: 12 chart speeds from 1/16 to 160 ips; speed changes possible during operation; timing line intervals from one to 1/1000-

sec automatically controlled by chart speed or selected manually; and the galvanometer trace zero adjustment is featured on an easy-to-use sloping top panel.

Hathaway Instrument Co., Dept. ED, 1315 S. Clarkson St., Denver, Colo.

CIRCLE 160 ON READER-SERVICE CARD FOR MORE INFORMATION

## Silicone Power Rectifiers

For Airborne Power Supplies



The new rectifiers are ideally suited for airborne power supplies and other airborne electronic equipment. They may also be applied wherever minimum size, high operating temperature and resistance to vibration and shock are required.

Electrically, the rectifiers exhibit exceptionally low forward voltage drop when passing full rated forward current and negligible leakage current.

Federal Telephone & Radio Co., Dept. ED, 100 Kingsland Road, Clifton, N. J.

CIRCLE 161 ON READER-SERVICE CARD FOR MORE INFORMATION

◀ CIRCLE 158 ON READER-SERVICE CARD

PhD

MS

BS

(or equivalent experience)

## FULLY INTEGRATED MISSILE WORK

Program comprises over 100 major and sub projects, including inter-continental NAVAHO. Covers all aspects of complete missile building. Fascinating developments. Unusual engineering problems. Career prospects excellent. Check this list:

**AERO-DYNAMICISTS** Experienced in performance stability and control, wind tunnel operations (other than control systems), flight test planning, flight analysis and instrumentation.

**AERO-THERMODYNAMICISTS** Graduates in ME, Aero or Physics with experience in internal aero-dynamics, jet engines theory, wind tunnel test, supersonic inlet development, compressible flow phenomena, heat transfer or boundary layer theory.

**POWER PLANT SYSTEMS** Aero, Mechanical or Chem. engineers with experience in fuel systems, hydraulics, pneumatics, ram jet, turbo jet or rocket installations and temperature control. Also opportunities for men with backgrounds in heat transfer, air conditioning, refrigeration, power plant design, design for cooling systems layout and installations.

**TEST ENGINEERS** Research and development testing pointed toward new testing techniques on complete missile structures; electrical, hydraulic, pneumatic components and systems and ground handling and launching equipment. This is a rapidly expanding group with excellent laboratory facilities to support the increasing work load. (BS or MS in Mechanical Engineering, Civil, Aero or EE preferred.)

**STRUCTURES** Structures specialists with advanced degrees and experience applicable to investigations of thermo stress problems. Heat transfer experience desirable. Positions will be to investigate new methods of handling structural problems arising from high speed flight. Other positions available in structural analysis load investigations, weight control and design for vibration environment.

**FLIGHT TEST** Flight test engineers to plan, execute and evaluate Missile Flight Test. Positions open for engineers in data analysis, flight test facilities, flight test program planning, flight test coordination and specifications on flight test instrumentation.

**ADVANCED ENGINEERING** These are select positions to perform all aspects of composite analysis and design of advanced guided missiles including airframe structures, air breathing and non-air breathing power plants, missile internal systems and ground check out and support equipment. Advanced degrees preferred, equivalent experience acceptable.

**INTERESTING BROCHURES** on Missile Engineering, important to ambitious engineers. For your copy, send your qualifications (card or letter) to: M. D. Brunetti, Coordinator Engineering Personnel, Dept. 991-C10 ED, 12214 Lakewood Boulevard, Downey, Calif.

MISSILE DEVELOPMENT ENGINEERING

**NORTH AMERICAN  
AVIATION, INC.**



## Trimmer Potentiometer

From 100 to 15,000 Ohms



Using 20 ppm resistance wire exclusively, the resistance range of this unit has been expanded to cover from 100 ohms to 15,000 ohms. Standard values are 100, 150, 220, 330, 475, 680, 1000, 1500, 2200, 3300, 4700, 6800, 10,000 and 15,000 ohms.

The environmental range has been improved so that in addition to withstanding 30 G shock, the potentiometers will now pass rigid humidity, salt spray and vibration requirements.

Carter Mfg. Corp., Dept. ED, 23 Washington St., Hudson, Mass.

CIRCLE 162 ON READER-SERVICE CARD FOR MORE INFORMATION

## Dual Range Power Supply

Low Voltage Outputs



This dual range DC Power Supply has a continuous duty rating of either 0-32 v dc at 40 amp, or 0-64 v dc at 20 amp. Ripple is held to

within 1% of the average at maximum output. The Model KM95B operates on either 115 v or 230 v ac, 60 cycles single phase. All controls are conveniently arranged on the front panel. To prevent accidental switching, the line voltage selector is equipped with a special safety locking device.

Opad Electric Co., Dept. ED, New York 7, N.Y.

CIRCLE 163 ON READER-SERVICE CARD FOR MORE INFORMATION

## Scaler

For Scintillation Counter Uses



The N-W1 is a high-speed scaler for scintillation counter application. It is patterned after a P. R. Bell design. The discriminator section

has a speed compatible with the instrument's unusually small scaler dead time.

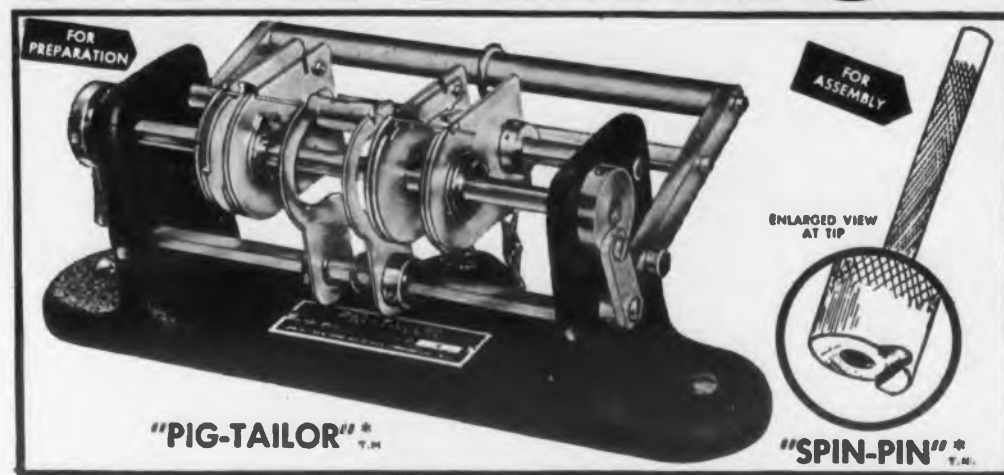
The N-201 is built on a "Vari-Flex" chassis for relay rack mounting or table top use.

Hamner Electronics Co., Inc., Dept. ED, Box 531 Princeton, N.J.

CIRCLE 164 ON READER-SERVICE CARD FOR MORE INFORMATION

# "PIG-TAILORING"

... a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

### PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control
9. Invaluable labor saving
10. Immediate cost recovery.

### PIG-TAILORING eliminates:

1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

\* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to ED-10 P

**BRUNO-NEW YORK INDUSTRIES CORPORATION**

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

460 WEST 34th STREET

NEW YORK 1, N. Y.



CIRCLE 165 ON READER-SERVICE CARD FOR MORE INFORMATION

problem:

get specially compounded rubber connector seals made within  $\pm .002$ " tolerance

answer:

minnesota rubber and gasket company

evidence:

These M. R. connector seals had to be made to an absolutely flash-free tolerance of  $\pm .002$  inch — and made of special rubber compounds for optimum performance in electrical applications. M. R.'s exclusive injection molding process gives you close tolerances never before obtainable on a mass production scale. And at low cost! No flash. No trimming blemishes on parting line. Intricate shapes and bonding-to-metals are no problem. M.R.'s laboratory formulates the correct rubber compounds, including Silicone, to meet your requirements. Complete facilities, strict quality control, and on-time deliveries keep our claims true.

free samples: Custom molded rubber parts. Silicone rubber. Rubber bonded to metal. Seals. Sub-miniature rubber parts. What is your rubber problem?

**minnesota rubber and gasket company**

Originators of modern rubber injection molding

Dept. 305, 3630 Wooddale Ave., Minneapolis 16, Minn.

Phone: WEst 9-6781

CIRCLE 166 ON READER-SERVICE CARD FOR MORE INFORMATION



## DC-MILLIVOLTMETER

0-1mV to 0-1kV



The MV-17C millivoltmeter, shown above (and its current-measuring companion, our MV-11C DC micro-micro-ammeter— $10 \times 10^{-12}A$  to 10A), has helped substantially to advance both research and production throughout the entire electronic field. Crystal diodes and transistors, for instance, have benefited from it due to its ability to measure small DC voltages with minimum circuit loading. As a null detector, in bridges, the MV-17C can be overloaded up to 100,000 fold, thereby eliminating suspension galvanometer trouble and increasing measuring ranges and sensitivity. Grid current measurements, small voltage drops in regulated power supplies, delicate temperature measurements, insulation material research are but a few other applications which have made this instrument a reliable stand-by in nearly all leading laboratories in America and abroad.

### MILLIVAC INSTRUMENT CORPORATION

BOX 997, SCHENECTADY, N.Y.

CIRCLE 167 ON READER-SERVICE CARD FOR MORE INFORMATION

## Rubber

Bonds to Metal



Called compound RRD-992, this super-soft rubber has a softness characteristic of 5 durometer, and can be used in temperatures up to 200 F. It is a reasonably good electrical insulator and can be vul-

canized or bonded to metal and other materials.

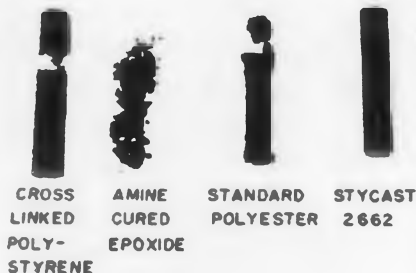
The company makes this rubber in sheets or strips up to 1 in. thick, or will mold or bond it to metal or other odd shapes to meet the customer's needs.

Roth Rubber Co., Dept. ED, 1860 S. 54th Ave., Chicago 50, Ill.

CIRCLE 168 ON READER-SERVICE CARD FOR MORE INFORMATION

## Casting Resin

For Use at 600F



CROSS LINKED POLY-STYRENE AMINE CURED EPOXIDE STANDARD POLYESTER STYCAST 2662

3 HOURS AT 600°F

This epoxide casting resin can be used at temperatures as high as 600 F. Designated Stycast 2662, the resin is simple to use. It pours readily and cures at low temperature.

Once cured heat distortion point is above 500 F.

High volume resistivity is maintained at elevated temperature, making it ideal as a potting and encapsulating compound.

Emerson & Cuming, Inc., Dept. ED, 869 Washington St., Canton, Mass.

CIRCLE 169 ON READER-SERVICE CARD FOR MORE INFORMATION

## Solenoid-Wound Chokes

In 1.1-120  $\mu$ h values



A complete line of solenoid-wound chokes is offered in values ranging from 1.1 to 120  $\mu$ h. Inductance values are in accordance with MIL-C15305A. These chokes are impregnated with fungus-resistant varnish to conform to MIL-V173A. They are designed specifically for top performance and durability in applications such as filament chokes, peaking coils, and resonant elements in high frequency rf or if circuits.

National Co., Dept. ED, 61 Sherman St., Malden 48, Mass.

CIRCLE 170 ON READER-SERVICE CARD FOR MORE INFORMATION

## NOW!

### Unlimited Phasing with Extreme Compactness



Phasing clamps available on three sizes of Gamewell RL-270A Blue Line Precision Potentiometers

This special Gamewell Phasing Clamp design has two important extras: Extreme compactness and High Temperature compatibility. Check these features . . .

- Only  $\frac{1}{8}$ " depth per section
- Continuous service up to 150C available
- Stainless steel clamps give unlimited phasing
- Large number of taps, limited only by physical spacing
- Exclusive Gamewell high unit pressure contacts give permanent, low resistance tap connection, no

- linearity distortion
- Will withstand High "G" and operation under severe vibration
- Three styles of mounting: Servo, Bushing and 3-hole bushing
- Available in ball or sleeve bearings, shafts as specified
- Comes in models RL-270A-1  $\frac{1}{4}$ ; RL-270A-2 and RL-270A-3.

More information, prices and delivery available from Gamewell representatives or write: THE GAMEWELL COMPANY Newton Upper Falls 64, Mass.



PRECISION POTENTIOMETERS SPECIAL! Send for New Gamewell Catalog on complete line.

CIRCLE 171 ON READER-SERVICE CARD FOR MORE INFORMATION

## NEW—self-locking UNBRAKO socket head cap screws



The Nylok\* self-locking feature locks these screws securely in place, seated or unseated, wherever you stop wrenching!

They won't work loose. Can be used repeatedly. Tough, resilient nylon locking pellets permanently installed. Successfully withstand temperatures ranging from  $-70$  to  $250^{\circ}F$ . Familiar UNBRAKO knurled heads for sure finger grip and fast assembly—accurate hex sockets for positive, nonslip internal wrenching. Heat treated alloy steel, controlled fillets, continuous grain flow lines, fully formed Class 3A threads for maximum strength and exact fit. Can be used as adjusting screws. Pellets act as liquid seals. Standard sizes from #6 to 1 in. diameter. Also available in plated finishes and in stainless steel. Write for Bulletin 2193. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 12, Pa.

\*TM Reg. U.S. Pat. Off., The Nylok Corporation

UNBRAKO SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

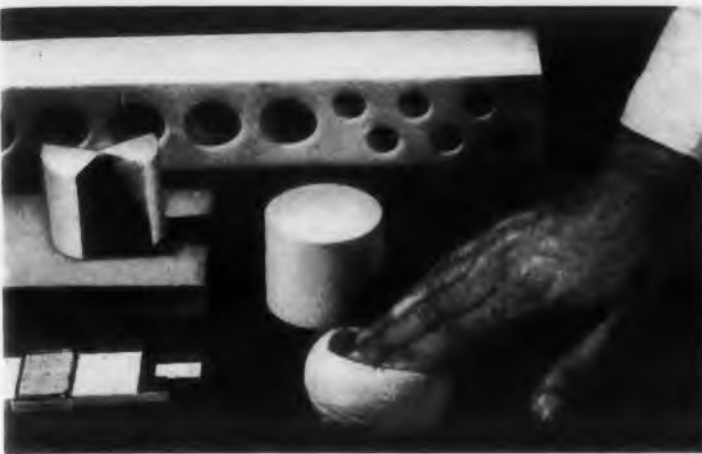
SPS

Unbrako Products are sold through Industrial Distributors

JENKINTOWN PENNSYLVANIA

CIRCLE 172 ON READER-SERVICE CARD FOR MORE INFORMATION





## NEW! Silicone Foam Rubber

complete flexibility -100°F to 480°F . . . extreme light-weight . . . molds into complex shapes, thick sections.

Available for the first time, silicone foam rubber . . . COHRfoam . . . is the lightest, most resilient form of silicone rubber. COHRfoam remains soft and resilient from -100°F to 480°F, recovers shape instantly when compressed for long periods at high temperatures. COHRfoam is immune to ozone and weathering, is odorless, tasteless, non-sticking and exhibits excellent electrical characteristics. Readily moldable into thick sections (up to 8") and complex shapes, COHRfoam presents a new design medium for mechanical sealing, thermal, electrical and vibration packing and insulation.

Specific Gravity: .20 to .35 (80 to 138 cu. in./lb.)  
 Compression-deflection: .75 to 1.25 psi. (25% compression, 1" thickness)  
 Compression Set: 14% (300°F, 22 hrs., 50% compression, 1" thickness)

**COHRFOAM®**  
 Silicone Foam Rubber

**FREE SAMPLE—**  
 and additional data . . . write,  
 phone or use inquiry card  
 . . . today.

**CHR THE CONNECTICUT HARD RUBBER CO.**  
 407 East St., New Haven 9, Conn., SPruce 7-3631

CIRCLE 173 ON READER-SERVICE CARD FOR MORE INFORMATION

## REGULATED POWER SUPPLY

0.001% Regulation and 0.1 Millivolts Ripple



MODEL UHR-220

The KROHN-HITE Model UHR-220 is a compact Power Supply for applications requiring up to 0.2 ampere of d-c at 0 to 500 volts with ULTRA-HIGH REGULATION, extremely low ripple and unusual stabilization under severe input line voltage transients. The internal impedance is less than 0.01 ohm for low frequencies and d-c, and less than 0.1 ohm for frequencies as high as 100 kc. Stabilization for  $\pm 10\%$  change

in line voltage is 0.003%. Transient response is 0.001 millisecond and typical 10-hour drift is 300 ppm. A 0-150 volt, 0-5 ma, bias supply with 0.05% stabilization and 0.002% ripple is available in addition to two 6.3 volt unregulated a-c outputs of 5A capacity. Price \$350.00, f.o.b. factory.

For Further Details Write

**KROHN-HITE INSTRUMENT CO.**

Dept. ED, 580 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 174 ON READER-SERVICE CARD FOR MORE INFORMATION

## Electric Counter Reset by Key



The PIC-600 is an electric counter that is reset by a key from the front of the panel and is designed for

use where it is necessary to guard against indiscriminate or unauthorized resetting. A single turn of the key resets the counter to zero.

Production Instrument Co., Dept. ED, 706-34 W. Jackson Blvd., Chicago 6, Ill.

CIRCLE 175 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Teflon Tape Abrasion Resistant

Pressure sensitive, adhesive Permacel 421, designed especially for application where Class H electrical insulation and resistance to abrasion are required, can be used as a dielectric for condensers where its nearly zero moisture absorption and high dielectric are needed, and as an insulation medium for fm and TV transmission lines, where its low power factor and high operating temperature are important. Industrially, it can be used as a barrier or protective coating against highly reactive chemicals and solutions.

Weather resistant Permacel 421 is also chemically inert to such active reagents as aqua regia, hydrofluoric, sulphuric and nitric acids. The slippery nature of Teflon makes the tape a good protective agent against abrasion and suitable as a bearing surface where oil would be impractical.

Permacel Tape Corp., Dept. ED, New Brunswick, N.J.

CIRCLE 176 ON READER-SERVICE CARD FOR MORE INFORMATION

## Random Noise Generator Provides Signals to 100 db



The Model 1 Random Noise Generator is designed to supply a random noise signal up to 100 db for testing the attenuation of screened enclosures,

performing susceptibility tests to military specifications, checking communications equipment, and for many other tests. It may be operated from a 6 v storage battery, "Hot-Shot" battery, or any 6 v dc power supply delivering from 5-10 amp.

Starr Instrument Co., Dept. ED, 44 Starr Lane, Jamaica Plain 30, Mass.

CIRCLE 177 ON READER-SERVICE CARD FOR MORE INFORMATION

for miniature  
 and sub-miniature  
 parts soldering

**IDEAL**

## THERMO-TIP RESISTANCE SOLDERING TOOL



Double Metal



Single Metal



Double Carbon



Single Carbon



Soldering large telephone jack with Thermo-Tip Resistance Soldering Tool and low voltage Ideal power unit.

Smaller, lightweight — for easy handling over prolonged periods of time. Thermo-Tip Tools are expressly designed as a production line tool. Reduces fatigue factor for women workers.

Pin-point accuracy. Pencil-small element fits into tight spots for foolproof soldering of small or miniature parts.

Fast, sure — Thermo-Tip elements concentrate high amperage current at soldering point for instant heat. Solder is melted by the parts to be joined—eliminates "cold flow joints", makes for positive union.

Versatile attachments—a variety of Thermo-Tip elements are available for every precision soldering purpose. Feed-thru electrodes on double metal, single metal and single carbon attachments provide longer life and easy length adjustment for specific job requirements.

**IDEAL IDEAL INDUSTRIES, INC.**  
 5098 Park Ave., Sycamore, Ill.

Gentlemen:

Kindly send us complete catalog information of Ideal's Thermo-Tip Resistance Soldering Tools.

Name .....

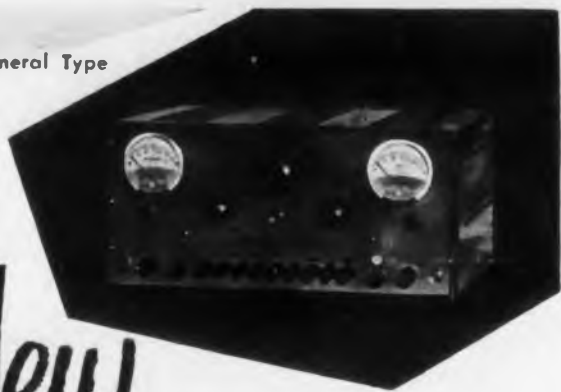
Company .....

Address .....

City ..... Zone ..... State .....

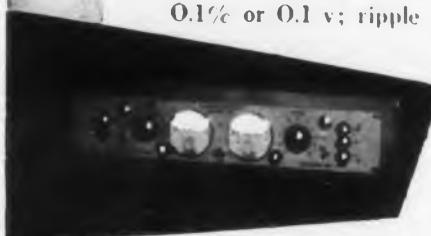
CIRCLE 178 ON READER-SERVICE CARD FOR MORE INFORMATION

General Type



# New PROGRAMMABLE (Remote Control) regatron power pack

Unique circuit design of these newly developed power supply units is intended for applications requiring remote control and/or programming according to commands from an operator or control system—such as in tube-test programming, automatic production testing, and other automated processes. Also useful for general applications, all models feature main and vernier controls. Regulation applies over full range and for all load conditions; 0.1% or 0.1 v; ripple 1 M. V.



## TRANSISTOR POWER PACK

- Main and Vernier Controls
- Auxiliary Bias and Filament outputs (General Type)
- Designed for Automation. Transistors, Test Consoles, Computers
- Ideal for Laboratory and Production Purposes
- Unusually low-priced, High-Quality Units

General Types:	Volts	Current
Model 231 A	0-300	0-100 MA
Model 232 A	0-300	0-200 MA
Model 233 A	0-300	0-300 MA
Transistor Types:		
Model 212 A	0-100	0-100 MA
Model 213 A	0-50	0-1000 MA
Model 214 A	0-100	0-1000 MA

Write today for Additional Information to Dept. D1

**Electronic**  
MEASUREMENTS COMPANY INC.  
EATONTOWN, NEW JERSEY  
Eatontown 3-0300

CIRCLE 179 ON READER-SERVICE CARD FOR MORE INFORMATION

## Digital Encoder Accepts 0-10 v Input Levels



This advanced digital encoder, Model R-1047-40-1, is an all electronic unit designed to accept 0-10 v input levels and generate 24,000 8-bit binary code groups per second defining the input at an over-all accuracy of one part in 256.

The overall dimensions of this piece of equipment are only 6-13/16 x 9-9/16 x 6-3/4 in.

Radiation, Inc., Dept. ED, Melbourne, Fla.

CIRCLE 180 ON READER-SERVICE CARD FOR MORE INFORMATION

## Fan-Blower For Airborne Applications



This is a new fan-blower unit for airborne application, which compensates for low air density by increasing blower speeds. The unit, BC 2914 F-1, has been designed especially to provide higher cfm rates at upper altitudes. The blower will provide

8000 rpm with 210 cfm at 2 in. back pressure at sea level. At 60,000 feet, blower speed is increased to 11,000 rpm.

Induction Motors Corp., Dept. ED, 570 Main St., Westbury, Long Island, N. Y.

CIRCLE 181 ON READER-SERVICE CARD FOR MORE INFORMATION

## Batch Counter With Speeds to 4000 Counts/sec



The Model 99 Electronic Batch Counter is for predetermined counting in the range of 0 to 99 counts. It will count speeds up to 4000/sec.

The unit incorporates a mechanical indicator on the front panel which is limited to counts of 1000/min and shows batch counts up to 999,999. The internal relay has two sets of spst contacts; one set is normally open and the other normally closed.

Spellman Television Co., Dept. ED, 3029 Webster Ave., Bronx, N.Y.

CIRCLE 182 ON READER-SERVICE CARD FOR MORE INFORMATION



REVOLUTIONARY BURGESS "WAFER-CELL" Offers

## SMALL, COMPACT POWER PACKAGES

A major step toward the application of automation to the manufacture of dry batteries has been achieved with the development of the new BURGESS "WAFER-CELL" making possible a 30 PER CENT INCREASE IN BATTERY LIFE.

The new cell consists of a sandwich of artificial manganese dioxide mix between tiny discs of flat zinc and carbon electrodes wrapped in plie-film envelopes and heat sealed. A dab of SILVER WAX on the positive and negative sides of the cells per-

mits stacking them in a column eliminating welded or soldered connections. Rigid inter-cell connections are maintained since the silver wax yields and molds itself to any necessary configuration between the cells to hold PERFECT ELECTRICAL CONTACT.

Small batteries for hearing aids, pocket radios, B-C photo guns and transistorized instruments are made by wrapping the cell stack in MYLAR FILM and packaging it in a leakproof tube of drawn aluminum.

Your local Burgess distributor carries complete stocks of fresh BURGESS BATTERIES including new "Wafer-Cell" types.



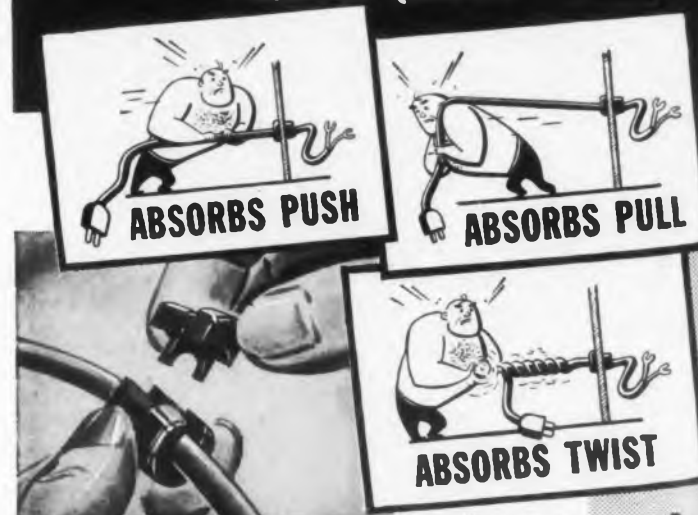
## BATTERY DESIGN SERVICE AVAILABLE

The same engineering "know-how" that made possible the new "Wafer-Cells" is available TO YOU. Long before you run into a battery design problem, call on Burgess for expert battery design assistance.

**BURGESS BATTERY COMPANY**  
FREEPORT, ILLINOIS

CIRCLE 183 ON READER-SERVICE CARD FOR MORE INFORMATION

## HEYCO NYLON STRAIN RELIEF BUSHINGS CUT PRODUCTION COSTS AND IMPROVE PRODUCT QUALITY



1—SLIP OVER WIRE  
2—SNAP INTO HOLE

**Approved**

With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly enhanced.

HEYMAN MANUFACTURING COMPANY  
Kenilworth 16 New Jersey



Send wire sizes for free samples and specifications.

CIRCLE 184 ON READER-SERVICE CARD FOR MORE INFORMATION



*Easily the Best Available*  
**Beat-Frequency Generator**  
*for Amplitude-Frequency Tests  
on Audio Equipment*



Frequency Range 20 c to 40 kc (the 20 c to 20 kc audio range covered in a single sweep of the dial)

Output Voltage essentially constant

Frequency Scale truly logarithmic . . . scale length 12 inches

High Output and Frequency Stability

Low Harmonic Distortion . . . less than 0.25% from 100 to 10,000 cycles

Output Voltmeter calibrated in volts open circuit and in dbm

Type 1304-B Beat-Frequency Audio Generator: \$575.00

**GENERAL RADIO Company** 

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

90 West Street NEW YORK 6 • 8055 13th St., Silver Spring, Md. WASHINGTON, D. C.  
1150 York Road, Abington, Pa. PHILADELPHIA  
920 S. Michigan Ave. CHICAGO 5 • 1000 N. Seward St. LOS ANGELES 38

CIRCLE 185 ON READER-SERVICE CARD FOR MORE INFORMATION

**Have you ever wondered how a Hi-Fidelity Loudspeaker produces sound?**

Send for this FREE book revealing the inner secrets of the loudspeaker—told in a fascinating easy-to-understand manner. Illustrated with delightful cartoons and diagrams—a wonderful guide!

This authoritative book is FREE—just send a dime to cover cost of mailing.



**UNIVERSITY LOUDSPEAKERS, INC.**



University Loudspeakers, Inc.  
80 So. Kensico Ave., White Plains, N. Y.

Gentlemen: Please send me a copy of "Speaking about Loudspeakers." Enclosed is 10c to cover the cost of mailing.

Desk C-11

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 186 ON READER-SERVICE CARD FOR MORE INFORMATION

**Wide Range Multimeter**  
Sealed Aluminum Case



Model NE 7-20-M Electronic Multimeter is a compact, portable multirange meter identical to the Military Model TS-

505B/U for measuring rms values of 0 to 150 vac, 0 to 1000 v dc, and dc resistance from 0 to 1000 megohms. An rf adapter is furnished to extend the range into the values of rf voltages up to 40 v rms at frequencies up to 500 Mc. The overall accuracy of the unit  $\pm 4$  per cent in ohms,  $\pm 5$  per cent in v dc and  $\pm 6$  per cent in v ac.

Northeastern Engineering Inc., Dept. ED, Manchester, N.H.

CIRCLE 187 ON READER-SERVICE CARD FOR MORE INFORMATION

**Voltage Divider**

Encapsulated, Subminiature Unit



Designed for use where space is at a premium, these disk resistors are capable of replacing two or more precision resistors em-

ployed as voltage dividers in circuitry. Available with temperature coefficients of ppm/C° or better, matched ratios over wide temperature ranges are possible with the selection of resistance wire matched to within 5 ppm/C°.

Eastern Precision Resistor Corp., Dept. ED, 675 Barbey St., Brooklyn, N.Y.

CIRCLE 188 ON READER-SERVICE CARD FOR MORE INFORMATION

**Linear Actuators**  
For Aircraft Applications

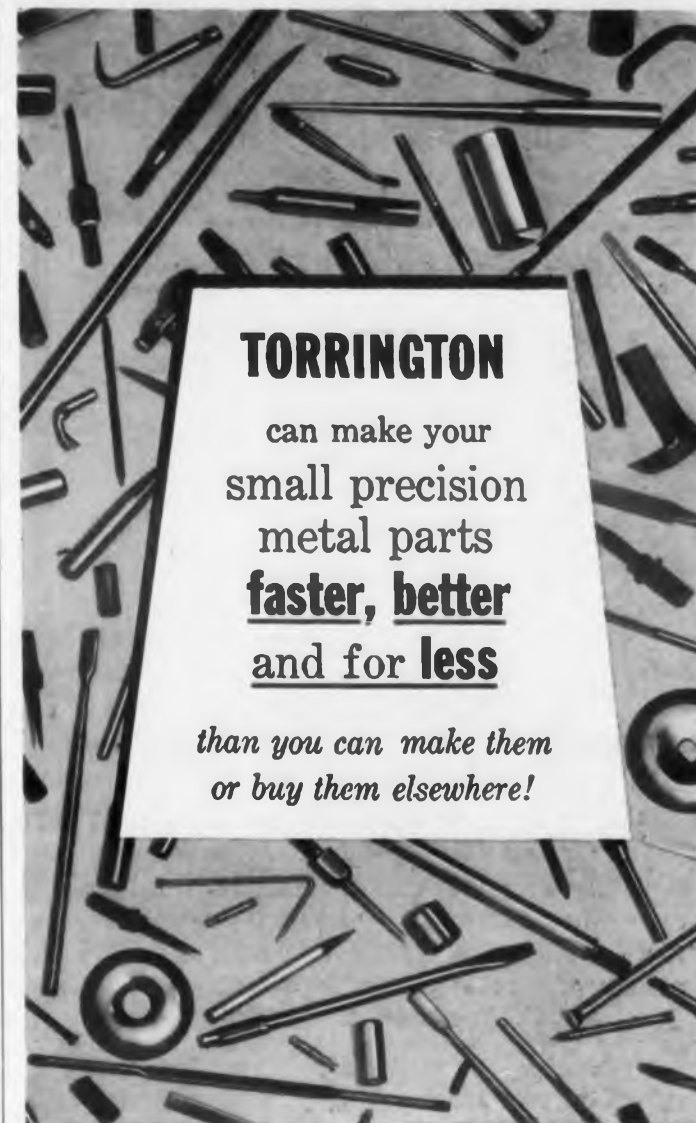


The R-5160 series of electro mechanical 26 v dc load-sensitive linear actuators is available in strokes to 7-1/4 in. The units feature an adjustable load, sensitive switches, magnetic braking, radio noise filter, optional thermal protection, positive stops, and an anti-rotation device. Maximum operating load is 650 lb with 18-

ipm speed. Ultimate static load is 1500 lb. Size is 3 x 3.5 x 4.66 in. (plus stroke length and overtravel).

Airborne Accessories Corp., Dept. ED, Hillside, N.J.

CIRCLE 189 ON READER-SERVICE CARD FOR MORE INFORMATION



**TORRINGTON**

can make your small precision metal parts **faster, better** and for **less**

*than you can make them or buy them elsewhere!*

These are typical of parts that Torrington produces daily by the hundreds or millions. If you use similar small precision parts, mail the coupon today for the Torrington Small Precision Parts condensed catalog. Even better, send a sketch, blueprint or sample part. We will give you a prompt quotation which will mean substantial savings to you.

**THE TORRINGTON COMPANY**  
Specialties Division  
37 Field Street, Torrington, Conn.

Please send the Torrington Small Precision Parts condensed catalog

Please have a salesman call

Name \_\_\_\_\_

Title \_\_\_\_\_

Company \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_



**THE TORRINGTON COMPANY**  
Specialties Division  
37 Field Street, Torrington, Conn.

**TORRINGTON SPECIAL METAL PARTS**

*Makers of Torrington Needle Bearings*

CIRCLE 190 ON READER-SERVICE CARD FOR MORE INFORMATION



**It will take  
still more years of testing—  
at  $1.89 \times 10^9$  operations a year—  
to fix the life span of this relay**



• *When we first claimed a life of a billion operations for CLARE Mercury-wetted Contact Relays, we were guilty of a serious understatement.*

**Here is the proof:**

A life test was started in January, 1955. The relays on test are carrying a contact load of 5 amperes at 50 volts d-c (resistive load). A suitable spark suppressor is employed.

These relays have been operating continuously at a rate of 5,184,000 operations a day ever since, without any attention whatsoever.

As this is written they are closely approaching the 3 billion mark with every indication they will go on operating for years.

*Think of it! Here is a relay that in normal service will outlast a man's lifetime.*

**Have you a job for which none but the best relay is good enough? It can cost you much more to settle for less than this CLARE RELAY.**

**Price is reasonable. Prices for Multi-element Mercury-wetted Contact Relays have recently been reduced. Delivery is quick—a few days to a few weeks, depending on assembly desired and size of order.**

**FOR COMPLETE INFORMATION** on CLARE Mercury-wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. CLARE & Co., 3101 Pratt Blvd., Chicago 45, Illinois. *In Canada:* C. P. CLARE & Co., 659 Bayview Ave., Toronto 17. Cable address: CLARELAY.

Send for CLARE Sales Engineering Bulletins Nos. 120 and 122

**CLARE RELAYS**  
**FIRST IN THE INDUSTRIAL FIELD**

CIRCLE 191 ON READER-SERVICE CARD FOR MORE INFORMATION

## New Literature

### A-C Induction Motor Drives 192

A brochure has been made available describing the company's ac adjustable speed drives. The company has incorporated into its ac drive the reliable, rugged and simplified features of the squirrel-cage induction motor through the addition of an equally-ruggedized and simplified ac tachometer. The bulletin includes typical operating curves, how the ac drives function, and efficiency and power factor curves.

WacLine, Inc., 35 S. Clair St., Dayton, Ohio

### Angular Position Encoders 193

A comprehensive 8-page bulletin has been published describing the new 13-digit and 16-digit optical-type analog to digital angular position encoders. The bulletin gives detailed information on the operation and construction of the two models and describes the manufacture of binary and other type code disks. Encoder and code disk specifications are also included.

The Baldwin Piano Co., 1813 Gilbert Ave., Cincinnati, Ohio.

### Materials Handling 194

Case histories on how six prominent manufacturers in unrelated fields improved their methods of handling materials has been made available. Entitled "Materials in Motion," this booklet describes the use of lightweight vulcanized fibre containers to increase efficiency, reduce costs, and simplify methods of materials handling.

National Vulcanized Fibre Co., 1056 Beech St., Wilmington, Del.

### Plastic, Light Metals Testers 195

Leaflet P-560 has been issued describing 31 instruments in the company's line used for testing plastics, light metals, paper, textiles, and other materials. Included are illustrations, applications, and dimensions of each of the units described.

Thwing-Albert Instrument Co., Penn St. at Pulaski Ave., Philadelphia, Pa.

advertisement  
**New Shielded Coil Forms**  
Miniature but rugged



Shown 3/4 size

Now CTC brings you miniaturized shielded coil forms that have all the ruggedness you expect from larger sizes but which snuggle perfectly into "tight spots."

CTC's LS-9 is  $\frac{1}{16}$ " diameter x  $\frac{1}{2}$ " high. LS-10 is  $\frac{5}{8}$ " diam-

eter x  $\frac{15}{16}$ " high and LS-11 is  $\frac{5}{16}$ " x  $\frac{1}{32}$ ". All sizes are when mounted, including terminals. Each mounts by a single mounting stud. All are constructed to CTC's rigid step-by-step quality control to the highest standards. All are highly shock resistant with mechanically enclosed, protected coil windings. They are ideal for use in IF strips, or as RF coils, oscillator coils, etc. Order them as coil form assemblies, or they can be wound to your specifications. For complete information and prices write Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Massachusetts.

CIRCLE 196 ON READER-SERVICE CARD FOR MORE INFORMATION

## NEW COMPUTING INDICATOR

*Normalizing; eliminates conversion calculations; reads ratios directly in digital form.*



The new DY-2500 Computing Indicator is a variable time-base counter providing direct, normalized ratio readings of unlike parameters in simple digital form. New dual input permits ratios between (for example) RPM and gallons-per-minute be read directly. Speed, pressure, thickness, weight, etc., may also be measured or compared with suitable transducers. In single input operation, DY-2500 may be easily switched from one transducer to another and results read directly in different kinds of units without calculation. A self-check assures correct operation; DY-2500 is portable, rugged, easily used by non-technical personnel. Frequency range 1 cps to 100 KC, variable sensitivity to 0.2 v minimum. Display variable 1 to 10 sec. \$1,350.00 f.o.b. factory (single input). Product of Hewlett-Packard affiliate, Dynac, Inc., 3961K Page Mill Rd., Palo Alto, Calif. Write Dynac for details.

CIRCLE 197 ON READER-SERVICE CARD FOR MORE INFORMATION



## DC-AC CHOPPERS

**For 60 Cycle Use**

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

Write for Catalog 370.

**STEVENS INCORPORATED ARNOLD**

22 ELKINS STREET  
SOUTH BOSTON 27, MASS.



5/A-10

CIRCLE 201 ON READER-SERVICE CARD FOR MORE INFORMATION

## Infrared Spectroscopy

203

A handy package of reprints has been made available on the subject of infrared spectroscopy for scientists, engineers, and technicians interested in learning more about it. Also included in the package is bulletin 472 on the new IR-4 infrared spectrophotometer, a copy of infrared notes, and a complete index of all infrared reprints now available.

Scientific Instruments Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

## Laboratory Instruments

204

"Cenco News Chats" No. 82 has been published containing descriptions and photos of new and re-designed instruments and apparatus for laboratory use. Included are a refrigerating incubator, vacuum pumps, pump plates for vacuum evaporation, projection meter, a new line of all metal ovens, and many others.

Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

## Batteries

205

A catalog has been offered describing and illustrating a new line of batteries featuring increased life and higher instantaneous discharge rates. Listed in the catalog are typical applications in electric utilities, emergency lighting, rural electrification, communications, railway signaling, electronics, laboratories, and industrial plants.

Exide Industrial Div., The Electric Storage Battery Co., Box 8109, Philadelphia, Pa.

## Wire Wound Resistors

206

Catalog data bulletin D-1a has been made available describing Military type precision wire wound resistors. Comprehensive data on winding technique, testing, tolerance, inductance, insulation, terminals, temperature coefficient, etc., are included in the bulletin.

International Resistance Co., 401 N. Broad St., Philadelphia, Pa.

## Shock and Vibration Mountings

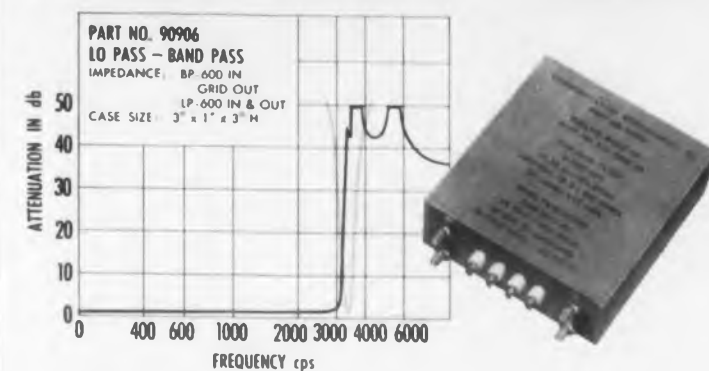
207

Bulletin No. 1000 has been offered describing all metal shock and vibration control mountings for smoother, quieter operation of machine tools, business equipment, and many other types of industrial applications. Included are illustrations, dimensions and load ranges of tested mounts and their recommended applications, as well as a review of the design factors.

Robinson Aviation, Inc., Teterboro, N.J.



## LC AND MECHANICAL FILTERS

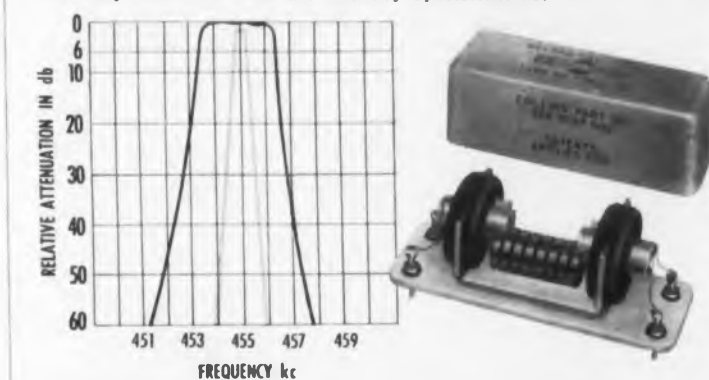


## L-C FILTERS

L-C filters utilizing high Q toroidal inductors and high quality capacitors are the heart of these frequency selective components. Recent developments of magnetic materials and highly stable capacitors have extended the useful frequency and temperature range of electrical wave filters. Use of impedance transformations, near unity coupling, and other applications of advanced network theory result in high performance units in small volume packages.

Low pass, high pass, band pass and band stop filters can be designed covering sub audio to over 500kc range. Line, interstage or other impedances can be specified. Filters can be designed for direct paralleling where required. High permeability cases and the closed toroidal form assure low hum pickup. Temperature stabilization on the order of 0.1% frequency can be attained through use of negative TC compensation to offset slightly positive coil and capacitor characteristics.

Depicted response curve is for integrally packaged low pass-band pass filter employing the latest design and production procedures. This unit uses less chassis area and is an excellent example of subminiature coil usage, impedance transformations, and printed circuitry. Hermetically sealed to meet the military specifications.



## MECHANICAL FILTERS (Developed and mfd. by Collins Radio Co.)

The Mechanical Filter provides far better bandpass selectivity in one small sealed unit than a series of bulky conventional IF transformers. Excellent characteristics allow closer spacing of information channels, lower adjacent-channel interference and improved signal to noise ratios. These Filters have been proven in thousands of military and commercial receivers, transmitters and microwave multiplex systems.

Units are designed for center frequencies of 60 to 600kc and various 6db bandwidths from 300cps to 16kc. In general, bandwidth is limited to 10% of the center frequency. In many types, the 60db bandwidth is only twice the 6db bandwidth. Filters have a frequency shift with temperature of + 10ppm/°C. Normal insertion loss for the filters is 6 to 8db. Most types comply with Mil-E-5400 on shock and vibration.

In receiver IF amplifier design the Mechanical Filter replaces one of the usual IF transformers and is fixed tuned. Preceding or following stages may be coupled with subminiature toroidal transformers using fixed tuning. Variable selectivity is obtained by using two or more Filters and switching connections.

Catalogs on Individual Components Available on Request

## COMMUNICATION ACCESSORIES CO.

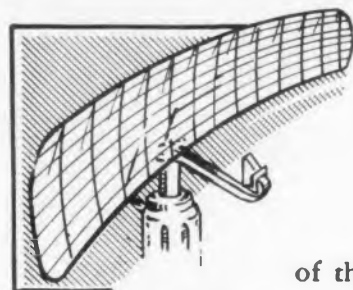
World's Largest Exclusive Producer of Toroidal Windings  
HICKMAN MILLS, MISSOURI • PHONE KANSAS CITY, SOUTH 1-6111

A Subsidiary of Collins Radio Company

CIRCLE 208 ON READER-SERVICE CARD FOR MORE INFORMATION

## RAYTHEON

A  
D  
A  
R



The Radar Department of the Wayland Lab has

several new and urgent development

programs. You can enhance your professional stature by contributing to ours.

## SERVO ENGINEERS

... for component and system design —experience in closed-loop control systems, analogue computers, or magnetic amplifiers desirable.



WAYLAND LAB

Send brief resume to:  
Professional Personnel  
Box 242  
Raytheon Mfg. Co.  
Wayland, Mass.



# THE NEW WAY TO MARK EQUIPMENT

with

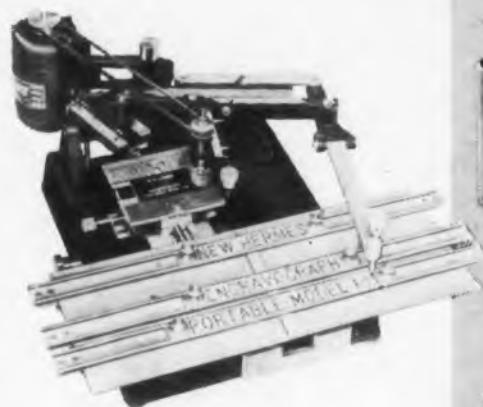
# GRAVO

# flex

the first chip-proof, flexible engraving stock  
on the  
versatile

Engravo  
graph

shear it



bend it



form it



punch it

So simple to engrave Gravoflex. Lettering will stand out permanently on contrasting background. No paint needed.

10,000 Engravographs in use for engraving on metals and plastics. Only the Engravograph has these patented features:

- Adjustable for 15 ratios.
- Automatic depth regulator.
- Self-centering holding vise.
- Adjustable copy holders.

Send for booklets  
Engravograph Booklet 1M-  
Gravoflex Booklet G-23  
On Company letterhead

**new hermes** ENGRAVING MACHINE CORP  
13-19 University Place, New York 3, N.Y.

## Transformers 212

General catalog TR-56 has been released describing and illustrating the company's line of electronic transformers. Included are nearly 700 items, of which 76 are new to the line. Applications, specifications, descriptions, dimensional drawings, and a price list and index are also included. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

## Printed Circuit Tolerances 213

A 2-page bulletin designated technical bulletin P-9 has been offered describing "Standard Printed Circuit Tolerances." Included in the bulletin are such items as diameter tolerances of unplated and plated holes, location tolerances between holes, hole to pattern tolerances, alignment tolerances, circuit pattern to outside dimension tolerances, and line width and spacing tolerances. Photocircuits Corp., Glen Cove, N.Y.

## Knitted Wire Products 214

A new 8-page bulletin, A-1, entitled "Knitted Alloy Wire Products," has been made available. The bulletin presents detailed descriptions of the interesting fields of application for knitted stainless steel and nickel alloy wire. Included in the bulletin are filters, liquid entrainment separators, shock absorption cushions, and electronic weatherstripping. H. K. Porter Co., Inc., Prospect Park, Pa.

## Radio-TV Valves 215

A second edition of the "World Radio Television Valve Handbook" has been published. This second edition contains characteristics on radio tubes, cathode-ray tubes, crystal diodes and transistors manufactured throughout the world. This edition contains tube data up to and including those tubes released in November 1955. Copies of this book are immediately available from the address shown below. Price per copy is \$2.50. Gilfer Associates, P.O. Box 239, Grand Central Station, N.Y. 17, N.Y.

## Aluminum Nameplates 216

A 2-color catalog sheet has been made available describing accessories for heat or solvent activated aluminum nameplates. The catalog describes four accessories used to apply the company's color anodized and etched aluminum foil nameplates to crinkled, uneven or curved surfaces. Each item is illustrated and described. North Shore Nameplate Inc., 214 Northern Blvd., Bayside, N. Y.



**CPC**  
PLASTIC CLAMPS

20 SIZES  
1/8" to 3"

## ALL SIZES, SHAPES and MATERIAL

- FASTER
- SAFER
- TOUGH
- SIMPLER
- MORE SECURE
- ENDURING

For wires, cables, conduits, tubing, light hose. Name the use and Commercial has a clamp... or will design one. Pioneering "know-how" and advanced production methods of CPC offer unmatched quality... and at a saving, too! Send for sample clamps and prices.



2808 W. NORTH AVE. CHICAGO, ILL.  
**COMMERCIAL PLASTICS Co.**

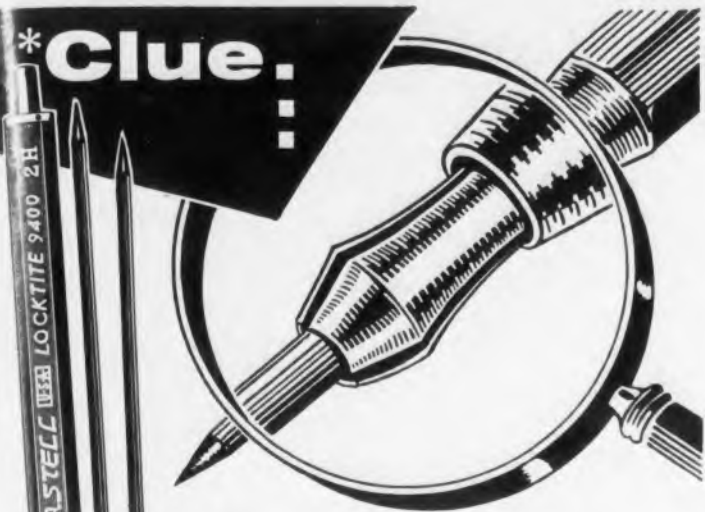
C RCLE 217 ON READER-SERVICE CARD FOR MORE INFORMATION

<p><b>UNIREG RELIABILITY</b> <i>that stays that way</i></p>	
<p>Model U32-10</p>	
<p>A line of sturdy, selenium rectifier regulated supplies that provide low voltages at relatively high currents. Good regulation, amazingly long service life. Highly adaptable for applications ranging from research and development to production testing and incorporation into automation systems. Latest model U32-10 has voltage range of 0-32V at 0-10 Amps. Write today for bulletin BF-56 describing these outstanding UNIREG power supplies.</p>	<p><i>mag amp controlled DC power supplies</i></p>
<p><b>UNIVERSAL ELECTRONICS CO.</b></p>	
<p>1720 Twenty-Second St., Santa Monica, California</p>	<p><i>Representatives in principal cities, U. S. and Canada</i></p>

CIRCLE 218 ON READER-SERVICE CARD FOR MORE INFORMATION



\*Clue...



**\*to a Lead Holder  
you can rely on in the "clutch"**

You can rely on CASTELL LOCKTITE Lead Holder in the *clutch*—and no pun intended. Because the gun-rifled clutch of LOCKTITE is the very heart of the mechanism which holds the lead like the jaws of a bull dog—prevents slipping, twisting and turning. Why risk your professional output? Lay it on the line with LOCKTITE—and imported CASTELL #9030 Lead. Call your dealer now.

**A.W. FABER - CASTELL**  
PENCIL COMPANY INC. NEWARK 3, N. J.

CIRCLE 221 ON READER-SERVICE CARD FOR MORE INFORMATION

**LEDEX ROTARY SOLENOIDS**  
GIVE POSITIVE, POWERFUL SNAP-ACTION!



**Here's how a LEDEX  
ROTARY SOLENOID operates...**

The magnetic pull moves the armature along the solenoid axis. This axial motion is efficiently converted to a rotary stroke by means of ball bearings on inclined races.

The rotary snap-action power of the compact Leduc can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models. Available in 7 basic sizes with torques from .4 to 54 lbs-inches.

**G. H. Leland INC.**  
WRITE FOR DESCRIPTIVE LITERATURE TODAY!  
123 WEBSTER STREET, DAYTON 2, OHIO  
In Canada: Marsland Engineering Ltd., Kitchener, Ontario

CIRCLE 222 ON READER-SERVICE CARD FOR MORE INFORMATION

**Microwave Silicon Diodes**

223

Catalog 56BG has been offered as a handy reference for performance data of microwave silicon diodes. Included are a complete listing of magnetrons, TR-ATR switch tubes, reference cavities, waveguide pressure windows, waveguide components and test equipment. Four new magnetron data sheets are enclosed. Described in the group are three new millimeter magnetron types ideally suited for airborne or mobile use.

Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass.

**Nickel and Nickel Alloys**

224

A new 20-page catalog has been published entitled "Nickel and Nickel Alloy Tubing," featuring brief but highly serviceable handbook information on nickel and nickel alloys for use by designers, production engineers, and purchasing executives. The catalog tabulates for ready reference the specific mechanical properties and chemical compositions of 13 analyses of nickel and nickel alloy tubing. Superior Tube Co., 1521 Germantown Ave., Norristown, Pa.

**Neutron Thermopile**

225

A specification sheet has been published describing the Model 3782 neutron thermopile. This instrument, approximately 6-1/2" long and 1/2" in diam is a differential type detector for the measurement of high level slow neutrons. Included in this data sheet are illustrations and applications. Various thermopiles connected in series within a pile are useful for the measurement of pile power when the ratio of the total neutron flux at such points to a total neutron flux in the pile is constant.

Nuclear Instrument & Chemical Co., 223 W. Erie St., Chicago 10, Ill.

**Heat Exchangers**

226

A 28-page booklet has been released containing articles on heat exchanger design, diesel-electric drilling rig power packages for the oil industry. The illustrated booklet specifies leaded steel for forged rings and gears. Addition of lead to steel lends cost-reducing machinability without changing basic steel properties; these are available in rolled forgings and rings. The fin-tube heat exchangers give high heat transfer performance, economy of installation, and building block flexibility. Also described are the Model 251 diesel engines which tests have proven have a variety of stationary and marine applications.

ALCO Products, Inc., P.O. Box 1065, Schenectady, N. Y.



- ★ Smooth exterior with no visible elements improves appearance.
- ★ Unique cam design simplifies sheet metal fabrication and cuts costs.
- ★ Inherent action of hinge tends to hold door open to allow full access.
- ★ Requires only 1/2" of space behind door.
- ★ Lengths from 2" to 6" in increments of 1" for variety of frame and door thickness.

For efficient access... original equipment of all kinds; cabinets, aircraft, trucks, trailers, trains, ships and for many uses in the plant.

Design with **HARTWELL flush Hinges and Latches**. Demand the high quality and faultless performance **HARTWELL** assures manufacturers in all types of industry.

*Manufacturers of Flush Latches and Hinges  
for Industry and the Military*

◀New Catalog gives full details of complete line.



**HARTWELL COMPANY**  
9035 Venice Blvd., Los Angeles 34, California  
Branch Offices: Hackensack, New Jersey  
Wichita, Kansas; Fort Worth, Texas  
Send illustrated new Catalog

NAME \_\_\_\_\_  
COMPANY \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

CIRCLE 227 ON READER-SERVICE CARD FOR MORE INFORMATION

## No Levigation Required

with *Linde* FINE ABRASIVES  
Trade-Mark

These fine alumina powders are directly calcined at a carefully controlled temperature to assure a uniform particle size that makes levigation unnecessary. Eliminating this preparatory step cuts polishing time and saves abrasive. Uniform particle size also assures an excellent, scratch-free finish on materials ranging from metallographic specimens to gem stones and noble metals.

Depending on the application, these powders can be used direct from the container or mixed with water or other vehicles to make a thin slurry or heavy paste. Users have also compounded them with waxes to make a convenient stick form. LINDE Fine Abrasives are available in two types. Type A removes stock faster than Type B, but Type B produces a superior finish.

For detailed information on the properties of these polishing powders, call or write your nearest LINDE office.

### Linde Air Products Company

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street  New York 17, N. Y.

Offices in Other Principal Cities

"Linde" is a registered trade-mark of Union Carbide and Carbon Corporation

CIRCLE 231 ON READER-SERVICE CARD FOR MORE INFORMATION

### Synchro Resolvers

233

Bulletin 374 has been issued giving specifications and characteristics of 36 precision resolvers available in standard frame sizes—10, 11, 15 and 23. They are offered from coarse  $\pm 0.2\%$  to precision  $\pm 0.05\%$ . They provide accurate solutions to problems encountered in high precision phase shifting, data transmission, industrial process controls, rectangular to polar coordinate transformations and rectangular coordinate rotations.

Norden-Ketay Corp., 99 Park Ave., New York, N.Y.

### Cap Screws

234

A 4-page pamphlet has been published entitled "Cap Screws . . . How Much Torque?" giving many answers for cap screws. A cap screw is ideally tight, when it is tightened with a wrench more than it will ever be in use. Dynamic stresses, flexing and relaxing an imperfectly tightened fastener, are the cause of fatigue failure whereas a properly pre-loaded screw cannot fail through fatigue. The booklet includes illustrations, tables and recommended torques for cap screw and place bolts.

Cleveland Cap Screw Company, Box 202, 2917 E 79th St., Cleveland 4, Ohio.

## NEW METER-RELAYS FROM 0-5 MICROAMPERES - UP

Ruggedized-Sealed, Black Bakelite, or Clear Plastic Case  
D'Arsonval indicating meters with built-in locking contacts for sensitive and accurate control or alarm

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact carried on moving pointer. The other on an adjustable pointer. When two pointers meet, contacts close and lock. Holding coil is wound directly over moving coil, locking action is electro-magnetic. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully.



Model 255-C, Single Contact, High Limit, 0-10 Volts DC \$42.50



Model 461-C, Double Contact 10-0-10 Microamps DC \$83.25

Ranges from 0-5 microamperes or 0-5 millivolts up, full scale. Temperature ranges from 0-300°F. (10 ohms external) have bimetal cold junction compensation. Standard Contact Rating 5 to 25 milliamperes DC. Can be built up to 100 milliamperes DC.

Ruggedized-Sealed metal cases are 2½", 3½" and 4½" round, shock-mounted, gasket-sealed.

Black Bakelite case, 4½" rectangular. Clear Plastic cases are 2½", 3¼", and 4½" rectangular. Maximum visibility and lower cost.

Panel meters and indicating pyrometers are also available in ruggedized-sealed, black bakelite or clear plastic cases. New 40-page catalog lists prices and specifications for meter-relays, meters, pyrometers and automatic controls using meter-relays. Write for Catalog 4-A, Assembly Products Inc., Chesterland 17, Ohio. HAmilton 3-4436 (Cleveland, O.) West Coast: Desert Hot Springs 17, Calif. Phone: 4-3133 & 4-2453.

Booth 1702, Metals Show  
October 8-12, Cleveland, Ohio

CIRCLE 237 ON READER-SERVICE CARD FOR MORE INFORMATION

## FREE SELECTION CHART

for  
**AGASTAT**<sup>®</sup>  
time delay  
relays



Now you can select exactly the right Agastat time delay relay for your particular timing need—in a hurry. This free selection chart lists data on every popular model in the Agastat line—the most complete line of pneumatic time delay relays in the industry. They're adjustable for timing from 0.1 second to 10 or more minutes, unaffected by voltage variation, dust-proof, light, and mountable in any position. And there's an Agastat model to precisely fit your requirements, including two-step, electrical interlock and double head units. A glance at the free selection chart tells you which model to order.

Write for your free copy to Dept. A26-1024



Elastic Stop Nut Corporation  
of America

1027 Newark Avenue, Elizabeth, New Jersey  
Pioneers in pneumatic timing.

CIRCLE 235 ON READER-SERVICE CARD FOR MORE INFORMATION

free send for the  
most widely used  
ELECTRONIC SUPPLY GUIDE

**ALLIED'S**  
COMPLETE 356-PAGE  
1957 CATALOG

SEND FOR IT!

your buying guide to the world's largest stocks  
of ELECTRONIC SUPPLIES FOR INDUSTRY

Here's how to simplify and speed *all* your purchasing of electronic supplies and equipment: send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types and makes), transistors, test instruments, audio equipment, electronic parts (transformers, capacitors, controls, etc.). Our expert Industrial supply service saves you time, effort and money. Send today for your FREE 1957 ALLIED Catalog—your complete Buying Guide to the world's largest stocks of quality Electronic Supplies for Industrial use.



One Complete Dependable Source  
for Everything in Electronics

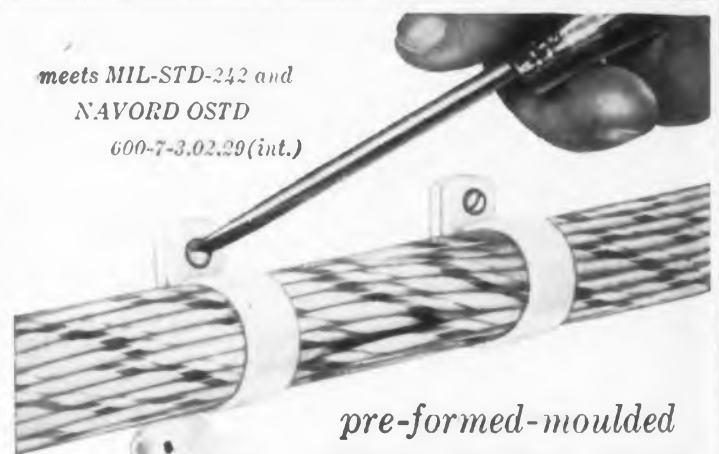
**ALLIED RADIO**

100 N. Western Ave., Dept. 69-K-6  
Chicago 80, Illinois

OUR  
36th  
YEAR

Send for  
FREE  
CATALOG

CIRCLE 232 ON READER-SERVICE CARD FOR MORE INFORMATION



meets MIL-STD-242 and  
NAVORD OSTD  
600-7-3.02.29(int.)

pre-formed-moulded  
**NYLOCLIPS**

Nyloclips fill the bill completely on all applications requiring light, self-insulating cable clamps. Seventy per cent lighter in weight than comparable metal clamps. Smooth, non-abrasive surfaces; rounded edges will not chafe conductors or cause grounds or shorts. Insulating properties reduce failures caused by grounds and shorts. Insoluble in common solvents, alkalies, dilute mineral acids and most organic acids. Retains strength at temperatures up to 300°F. (150°C), and is unaffected by petroleum oils and greases, lubricants, hydraulic fluids, lactic acid and photographic solutions. Good for -60°F. to 300°F.

SAMPLES of these Burndy Nyloclips will be sent you without cost upon your written request.

**BURNDY**

Merwalk, Connecticut • Toronto, Canada • Other Factories: New York, Calif., Toronto • Export: Philips Export Corp.  
CIRCLE 238 ON READER-SERVICE CARD FOR MORE INFORMATION

ELECTRONIC DESIGN • October 1, 1956



## Accurate, Space-Saving Temperature Controls . . .

Tiny Fenwal units ideal for aircraft and other applications



The Fenwal Two Wire Midget THERMOSWITCH Control produces maximum temperature control in a minimum of space — even under severe operating conditions.

Like all Fenwal thermostats, the Two Wire Midget utilizes the famous Fenwal THERMOSWITCH principle. The outer shell, which is  $\frac{1}{4}$ " O.D., is the activating element. This allows a short heat transfer path, built-in sensitivity of less than  $1^{\circ}\text{F}$ . That's why they're ideal for such applications as aircraft, guided missiles, antennas, elec-

tronic equipment, radar, motors, computers, wave guides, crystal ovens, etc.

Fenwal also precision manufactures single wire Midgets, and even smaller Miniature units for control of gases, solids, or liquids. Get all the facts on these small-space temperature controls. Write for free bulletin MC-124, Aviation Products Division, Fenwal Inc., 910 Pleasant St., Ashland, Mass.

CIRCLE 241 ON READER-SERVICE CARD FOR MORE INFORMATION

## Catalog of Welding Products

243

A 56-page catalog of resistance welding products, accessories and materials was made available recently. It describes and specifies standard and special spot welding electrodes, seam welding electrode wheels, dies, back-up bars, shafts, and bushings. In addition, illustrated and specified in this catalog are water-cooled electrode holders, adapters, horn-clamp-holder assemblies, and other accessories.

Sections are devoted to recommendations and usage of special alloys and electrode materials, applications, specification charts on physical and mechanical properties. Also included is a glossary of metallurgical processing and production terms.

Weldaloy Products Co., 11551 Stephens Dr., Van Dyke, Mich.

## Rivets

244

A 16-page catalog has been offered containing detailed dimensional descriptions of 1388 standard precision-made semi-tubular, full tubular and split rivets and bag studs and rivet caps. All are available in a wide selection of rivet metals and finishes. Information is included on how to select the proper size of rivet for any given assembly together with tables showing necessary clinch allowances.

Chicago Rivet & Machine Co., 950 So. 25th Ave., Bellwood, Ill.

## Miniature Tubes

245

A catalog has been published discussing the company's line of miniature electronic tubes. These tubes have a minimum of 10,000 hours operating life. The tubes have been combined with a minimum of fault risk, even under heavy vibration conditions. Very fine grid wire and very small pitch in the first grids ensure small variations in cathode current density along cathode, resulting in superior transconductance life and closely-controlled plate-current cutoff characteristics. The catalog gives complete ratings and specifications of tubes in the Longlife series, such as 404A, 407A, 408A, 417A, 2C51 and many others.

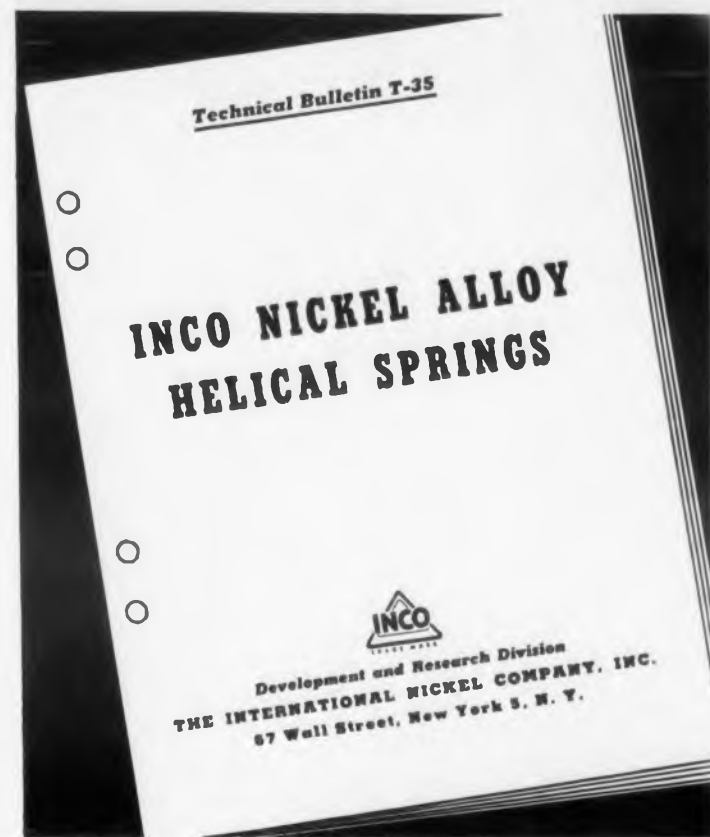
State Labs., Inc., 649 Broadway, New York 12, N. Y.

## Microwave Test Equipment

246

A 28-page catalog has been published on "Microwave and uhf Test Equipment," covering a complete line of coaxial and u-h-f equipment, microwave test equipment, bolometers and thermistors. Text, specification tables, and illustrations describe existing equipment and such recent additions as fixed and variable attenuators, high power impedance meters, tees, fixed and sliding terminations, and uhf coaxial directional couplers.

The Narda Corp., 160 Herricks Rd., Mineola, N.Y.



## This new booklet helps you pick the alloy for special springs

Are you designing a spring that must stay strong to resist fatigue and relaxation above  $500^{\circ}\text{F}$ ? Above  $700^{\circ}\text{F}$ ?

Do you want a spring that withstands corrosion? One that is non-magnetic or has special electrical properties at high temperature?

You'll find facts that help you in a new publication, "Inco Nickel Alloy Helical Springs."

It contains complete information, collected for the first time, on springs of Monel\* nickel-copper alloy, Inconel\* nickel-chromium alloy, and the age-hardenable Inco Nickel Alloys with favorable spring properties... design data and formulae... facts about corrosion resistance... production and properties of spring wire and springs... heat-treatment.

Send for your copy of this booklet — now. Just fill in the coupon and mail it.

\*Registered Trademark

**The International Nickel Company, Inc.**  
67 Wall Street, New York 5, N. Y.

Please send me a copy of  
"Inco Nickel Alloy Helical Springs."

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

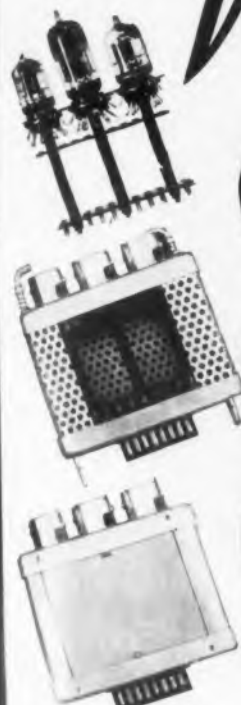
Address \_\_\_\_\_

City \_\_\_\_\_ Zone \_\_\_\_\_ State \_\_\_\_\_

CIRCLE 247 ON READER-SERVICE CARD FOR MORE INFORMATION

## Unitize—Miniaturize

WITH *Vector* STRUCTURES FOR CIRCUITRY



TAKE ONE  
STRIP  
TURRET

Choice of Deck, or Wall type strips in many sizes offers miniaturization, accessibility, ease of assembly and adaptation to semi-automatic machinery.

ASSEMBLE  
IN  
LIP-LOC  
CASE

A sectionalized case with a choice of plugs, quarter turn locks, ventilated or solid wall; with two piece center section or snap-open side ports.

Result  
PLUG IN  
UNIT

For circuit unitization, faster final assembly, stock reduction and ease of equipment maintenance.



**VECTOR ELECTRONIC COMPANY**  
3352 San Fernando Road, Los Angeles 65, Calif.  
Telephone (Clinton) 7-8237

CIRCLE 242 ON READER-SERVICE CARD FOR MORE INFORMATION



# STOP COLD JOINTS BURNED WIRE PRODUCTION DELAYS



**ZEPHYR**

*Electronic*

## MICROBRAZER FASTER PRECISION SOLDERING

- *Electronically* TIMED HEAT CYCLE
- *Eliminate* OVERHEATING
- SILVER Soldering TO 1250°
- ASSEMBLY LINE PRODUCTION
- *Automatic* OPERATION
- *Perfect* FOR MINIATURE SOLDERING

FREE DEMONSTRATION  
*in your own plant.*

WRITE FOR FREE  
CATALOG  
NO. K-1

**ZEPHYR  
MANUFACTURING CO.**  
*Electronic Dept. DD-2*  
201 HINDRY AVE.  
INGLEWOOD  
CALIFORNIA

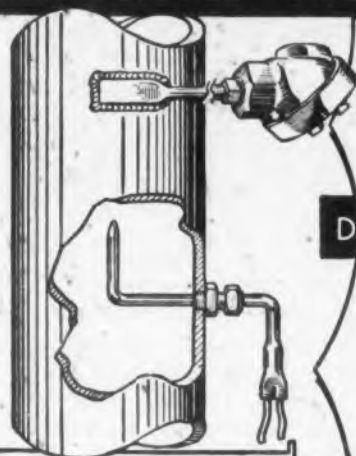
"Ask for this test in your own plant—  
Zephyr representative will gladly make  
a comparative test on your assembly line.

CIRCLE 251 ON READER-SERVICE CARD FOR MORE INFORMATION

## \*SWAGED MGO

FOR OPERATING  
TEMPERATURES  
-300 to 2000°F

### INSULATED THERMOCOUPLES



**SURFACE with  
STANDARD T/C Head**

- Extremely accurate since junction can be welded to surface.

### DESIGNING

**IMMERSION with  
LEAD WIRE ADAPTOR**

- Fast time response.
- Install in any pipeline without a thermo-well by simply drilling and tapping.
- Pressure and vacuum tight.
- Variable immersion depth—easily replaced.

### FABRICATING

**LEAD WIRE with  
QUICK DISCONNECT**

- Available in long lengths or spliced together to meet your length requirements.

\*SWAGED MGO wire is available from our stock—Diam. #25 to 5/16" SEND FOR BULLETIN 1

*Servo Research*  
**INSTRUMENT COMPANY, INC.**

315 NO. ABERDEEN STREET, CHICAGO 7, ILLINOIS  
Sales Representatives throughout the United States and Canada

CIRCLE 252 ON READER-SERVICE CARD FOR MORE INFORMATION

## Oscillators

253

A 2-page bulletin has been published describing Model 3420B pulse oscillator. It produces repetition rates from 100 cps to 3.3 mc. The improved version of this instrument is useful as a clock pulse generator, for flip-flop resolving time studies, and high speed circuitry development.

Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.

## Program Computer

254

Reprints are available describing two articles on electronic analog computers. One is titled "Toggle Switch Programmed Computer," and describes the equipment made by the company. A sample problem and a solution is presented. The other article is entitled "High Power From Miniature Tubes," and discusses the circuitry used in the company's computer. Both these articles appeared originally in ELECTRONIC DESIGN, Mar. 15 and Apr. 1, 1956.

Weber Aircraft Corp., 2820 Ontario St., Burbank, Calif.

## Copper Alloy

255

A data bulletin has been issued describing an age-hardened alloy, precision rolled beryllium copper strip. This material, in thin gages and very close tolerances, is applicable to miniature relays, switches, pressure sensitive instruments and many others. Available thicknesses down to 0.0005 in., and in tolerances as close as  $\pm 0.0001$  in.

American Silver Co., 36-07 Prince St., Flushing 54, N. Y.

## Cold Heading

256

The second 4-page pamphlet has been released covering examples of how cold heading cuts costs in manufacturing small parts. Problem-solution text briefly gives the essentials of case histories, including advantages gained by making the parts by the cold heading process. One of the major objectives of the 2-color illustrated booklet is to provide designers with information on the many possibilities of cold heading.

John Hassall, Inc., Westbury, N. Y.

## Radiation Pyrometers

257

An 8-page booklet has been offered describing two new pyrometers applicable to a wide variety of industrial and laboratory measurements. They combine good spectral response, high sensitivity, and rapid response, with stability and accuracy adequate for most requirements. These factors are discussed in relation with the design of pyrometers. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

## New Vacuum Pumping Savings



NRC Rotary Gas Ballast Pump Model 100M Other units with capacities from 1/4 to 400 CFM; blank-offs down to 5 x 10<sup>-6</sup>mm. Hg.

are reported by users of NRC Rotary Gas Ballast Mechanical Vacuum Pumps. These pumps maintain their original high efficiency even when handling water and other condensable vapors. They have proved in thousands of installations that they save money three ways:

- 1. LOWER FIRST COST—**  
because no oil reclaiming equipment is needed.
- 2. LOWER OPERATING COST—**  
because cycles are shortened by ability of pumps to maintain top speed throughout cycle after cycle.
- 3. LOWER MAINTENANCE COST—**  
because labor and material costs for frequent oil changes are avoided.

Send today for 16 page Bulletin P-3.

## NRC EQUIPMENT CORPORATION Subsidiary of National Research Corporation

2810 Charlemont St., Newton Highlands, Mass.

CIRCLE 258 ON READER-SERVICE CARD FOR MORE INFORMATION

## SENIOR LEVEL ENGINEERS OR PHYSICISTS In Radar Systems Analysis

- Require M.S. in E.E. or Physics. Minimum 3 years' experience in radar systems engineering. Involves analysis of very large scale ground radars which are radically new in concept, application and technique and involves electronic scanning and automatic data processing of radar returns.

Please forward complete resume to:  
D. Crowley

**SYLVANIA**  
SYLVANIA ELECTRIC PRODUCTS INC.

100 First Avenue Waltham, Mass.

**Have you  
received your copy?**



**VALUABLE NEW  
TECHNICAL DATA  
DESIGN IDEAS  
MATERIEL INFORMATION**

Send for  
"Introduction to  
Fiberglass Fabrication"  
by  
**KOCH FIBERGLAS**

**FREE!**

**TENTH ANNIVERSARY 20-PAGE  
ILLUSTRATED MANUAL**

**Every day, Koch Fiberglass is  
filling new uses in your industry**

Koch cases for electronic equipment will not dent, are impervious to moisture, vapor, fungus, mildew and corrosion. They are shock and vibration-proof when fitted to Koch specifications with special hair-latex shock pads. Can be self-palletized for fork lift. Can be insulated by Koch with foamed-in-place plastic. Koch cases are air-tight; require no paint or outer packaging for long-range storage or overseas shipment. Re-usable, so cost amortizes through re-use. Withstand parachute drops from any height, free falls onto water or snow from 500 feet, or submersion.

For manual, write on your business letterhead to Dept. DEC.

**KOCH**  
PRONOUNCED "KOKE"  
**FIBERGLAS**

CORTE MADERA, CALIFORNIA

One of the world's largest fabricators  
of molded Fiberglass products

CIRCLE 261 ON READER-SERVICE CARD

**Microwave Catalog**

**262**

A 4-page brochure is now available providing useful microwave silicon mixer and video diode performance data and operating characteristics of pulse and CW magnetrons, TR and ATR radar switch tubes, reference cavities and narrow and broadband waveguide pressure windows. In addition, a complete list of waveguide components and test equipment conveniently arranged by function and waveguide frequency range is included.

Included in catalog 56BG are magic tees, frequency meters, standard horns, precision attenuators, directional couplers, barreters (balometers) low and high power dummy loads and a series of new TE<sub>01</sub> mode circular waveguide components. Microwave Associates, Inc., 22 Cummington St., Boston, Mass.

**Voltage Stabilizing Transformer**

**263**

Bulletin GEA 5754C has been issued giving the transformer's features and data on where to use the equipment. The 16-page, 2-color publication includes operating characteristics and specifications. The bulletin is illustrated with application pictures as well as wiring diagrams and performance graphs. General Electric Co., Schenectady 5, N. Y.

**Services and Facilities**

**264**

Two illustrated brochures have been published describing the activities of the company's Field Engineering Div. and the laboratory facilities of its Research and Development Div. The ability to furnish engineering services and personnel at all technical levels from Electronics technicians through Senior Communications engineers is emphasized. The service is world wide and is available to both industry and Government. The illustrated booklet describes the broad fields of interest covering electronic devices, transistor applications, radio-interference measurement and suppression studies, electro-mechanical, and technical and operations study and analysis.

National Scientific Laboratories Inc., 2010 Massachusetts Ave., Washington 6, D. C.

**Printed Circuit Connectors**

**265**

A 12-page brochure has been published describing an expanded line of printed circuit receptacles designed for 1/16, 3/32 and 1/8 in. printed circuit boards. Gold plated phosphor bronze spring retains tension, allows use of undersized or oversized board while maintaining low contact resistance of less than 20 mv at 5 amp. Wiring styles are eyelet, lig, solderless wire, taper tap solderless wiring, and contacts for dip soldering.

DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City, N. Y.

# CIRCUIT

INSTRUMENTS INC.

moisture-sealed

## POTENTIOMETERS

keep moisture, dust, and price in line

Once you use these Model H-MS Potentiometers, you'll see why it pays to call upon CIRCUIT INSTRUMENTS for all your requirements. CIRCUIT INSTRUMENTS is big enough to engineer the latest refinements in potentiometers. But it is small enough to keep production procedures highly flexible. This means greater ease in obtaining special features . . . greater assurance of obtaining quick deliveries.



MODEL H-750-MS  
POTENTIOMETER  
(actual size)

### EFFECTIVE SEALING . . .

The next best thing to hermetic sealing, Model H-MS more than meets JAN-R-19 moisture and humidity requirements. Its all-metal case is rolled and securely bonded at the joints. Terminals are glass sealed. The shaft is sealed by means of an "O" ring.

### WIDE CHOICE . . .

Model H-MS is yours in  $\frac{3}{4}$ ", 1" or 1 $\frac{1}{2}$ " standard case sizes . . . in 1, 5 or 10 turn design . . . with resistance values from 50 to 400,000 ohms . . . with a wide spread of tolerances . . . in 2 or 3 watts or higher . . . with many special features.

# CIRCUIT

INSTRUMENTS INC.

Subsidiary of  
INTERNATIONAL RESISTANCE COMPANY

CIRCUIT INSTRUMENTS INC.

Dept. D

P.O. Box 1438, 2801 Anvil St., North St. Petersburg 1, Florida

Send data sheets on Moisture Sealed  Hermetically Sealed   
Helical  Servo  Sub-Miniature  High Temperature   
High Precision  Potentiometers.

NAME \_\_\_\_\_

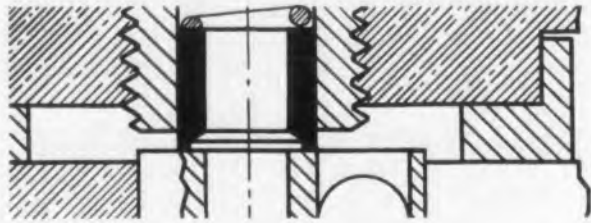
COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_

CIRCLE 266 ON READER-SERVICE CARD FOR MORE INFORMATION





## **MECHANICAL ENGINEERS**

Continually expanding programs at Northrop Aircraft are creating new opportunities for mechanical engineers in the following areas: launching and landing gear design, hydraulics and pneumatics, control systems, and equipment.

You'll enjoy the fine spirit of cooperation at Northrop. The new multi-million-dollar engineering and science center, now nearing completion, will be a great place to work in, both as to its modern architectural design and newest scientific installations. You'll be associated with a top engineering team on such notable projects as Northrop's new supersonic trainer airplane, Snark SM-62 intercontinental missile, and other advanced aircraft and missile programs.

You'll be given constantly fresh, challenging assignments. Remuneration will be substantial, with many benefits that are unexcelled in the entire industry—health and life insurance, college educational reimbursement plan, regular vacations plus extra year-end vacations with pay, and a generous retirement plan.

At Northrop, the progress of personnel is important. Initiative and ability are recognized and encouraged, and full opportunity is given to present and discuss ideas.

You will find the career opportunity you are seeking at Northrop, pioneer in the design and production of all weather and pilotless aircraft. If you qualify for one of these attractive positions, contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600- S Hawthorne, California.



# **N O R T H R O P**

NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

# Patents

## Cathode Follower Circuits

Patent No. 2,737,547. C. R. Deming. (Assigned to Hughes Aircraft Co.)

Cathode follower circuits have been designed to improve operational characteristics of this type of circuit. One such design, using a load tube in place of the cathode resistor, provides an anode resistor and connects the control grid with the anode of the follower tube to vary the conductance of the load tube in accordance with the input signal. In this circuit, the anode resistor reduces circuit efficiency as well as causes a delay in the charging of the capacity existing in the output load so that the circuit does not respond simultaneously to a steeply rising input signal. This circuit also must be operated in the linear portion of its characteristic curve.

Another circuit design also uses a load tube in place of the cathode resistor of the cathode follower tube. A pre-amplifier, however, is used which sets up two out of phase signals, one being applied to the follower tube and the other to the load tube. In this circuit, the impedance of the two tubes varies with the input signal, but it is the follower tube, only which has negative feedback. This circuit is subject to distortion and has frequency limitations.

In the circuit of the figure, a cathode load tube 14 is in series with the cathode follower tube 13. A control tube 15 has its control grid connected with the control grid of the follower tube so that the input signal is applied to both tubes. Upon receiving a negative going input signal, the current through the follower tube and the control tube decreases, the result of which is an increase



What is the **TOTAL COST**  
of a *plastic part*?

First costs often are only part of the total cost of plastic components. Poorly designed or inaccurately produced plastic parts can mean excessive inspection and assembly costs in your plant and a high failure rate, as well. American's *precision production* saves you money by eliminating these hidden cost factors and thus keeping your *total cost* per part to the barest minimum. That is why so many exacting buyers say, "We turn to American *first* for our plastic parts—because they are precision made."

American Plastics is equipped to give you full line service— injection, compression, extrusion, multiple-shot injection, and low pressure vacuum assisted forming.

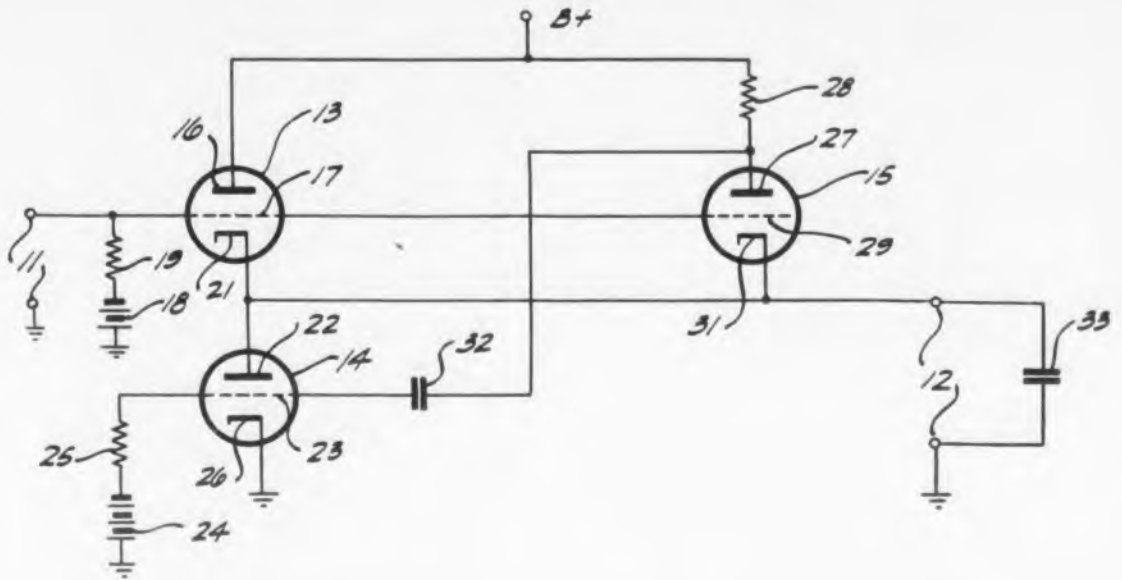
Next time you need plastic parts, try American *first*. Others have for over 50 years! Write or wire Dept. ED.



**AMERICAN PLASTICS CORPORATION**

Subsidiary of Hayden Chemical Corporation  
Executive Offices at 342 Madison Avenue  
New York N. Y.

CIRCLE 272 ON READER-SERVICE CARD FOR MORE INFORMATION



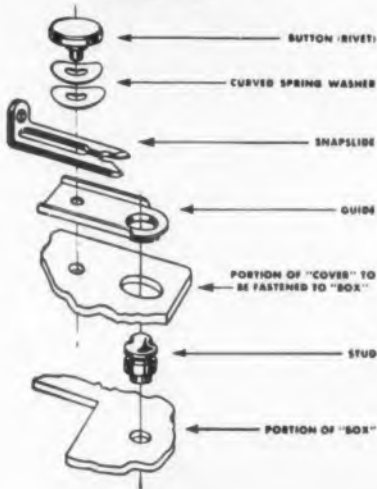
in the potential on the anode 27. This increase in potential is transmitted to the control grid 23 of the load tube 14. The conduction through the load tube is increased so that the potential at the anode of this tube and hence at the output terminals 12 decreases. The increase in the conduction of the load tube causes a rapid discharge of the output capacitance 33 so it does not effect any delay of the output signal in following the input signal. The cathode follower circuit is permitted to follow the input

signal instantaneously. Essentially, the equivalent operation occurs upon a positive going input signal.

In the circuit so far described, the circuit would function properly if the instantaneous slope of the input signal is less than the discharge slope of the output capacitance. By connecting the cathode of the control tube with the output terminal and anode of the load tube, the circuit is freed from the influence of the discharge characteristic of the capacity in the output circuit.



## How can YOU use this simple, rugged **SNAPSLIDE FASTENER?**



This positive, quick-action fastener was originally developed to hold airborne equipment with security—even under severe stress and shock of carrier-based aircraft operations—and yet permit equipment replacement in a matter of seconds.

A wide variety of industrial uses has been found for the fastener. Perhaps you can use it profitably. It requires no tools; thumb and finger fasten and release. Even with repeated use no adjustments are necessary. Available in two sizes, with parts to match different thicknesses of mounting plates.

Write for details.

Dependable Airborne Electronic Equipment Since 1928

**AIRCRAFT RADIO CORPORATION**  
BOONTON, NEW JERSEY



CIRCLE 273 ON READER-SERVICE CARD FOR MORE INFORMATION

CIRCLE 274 ON READER-SERVICE CARD FOR MORE INFORMATION ➤





# 11 million operations without a miss on low-energy switching test!

## New test proves outstanding reliability of General Electric's Miniature relays

Laboratory tests using standard, production relays have confirmed the remarkable performance of General Electric Miniature relays on low-energy switching applications. These hermetically sealed relays made contact 11 million times without failure—switching 25 microamps at 50 millivolts—indicating permanent reliability.

This low-energy performance is combined with proved mechanical life. On one typical application, several of these

relays continued to function after 300 million switching operations.

A key reason for this outstanding reliability is extremely high (40 to 55 grams) tip pressure—designed into all Miniature relays. Ample wear allowance provided by G-E engineers also contributes to extra-long life.

**Description:** Available in standard, current-sensitive, and voltage-sensitive models; in 2-, 3-, or 4-pole double-throw and 6-pole normally open forms. Rated 5 amps at 28 volts DC at 85C.

### OTHER G-E RELAYS TO MEET YOUR NEEDS

**1 Micro-miniature relay:** Weighs .35 oz; rated 2 amps resistive at 28 v DC or 115 v AC. Also, current-sensitive model. Standard relays withstand ambient temp of 125C.

**2 2PDT sub-miniature relay:** 2 amps; .651 in. in diameter, 1.6 in. long; weighs one ounce. Withstands shock

tests in excess of 50Gs. Available in wide variety of coil ratings.

**3 High-speed 4PDT relay:** Especially designed for use where operation as fast as 500 microseconds is required. Ideal for applications like ground-based radar, multiplexing of electronic signals, and computer circuits.

#### MAIL TODAY FOR SEALED-RELAY DATA

General Electric Co., Sect. B792-5, Schenectady 5, N. Y.

- Miniature—Bulletin GEA-6213  
 Micro-miniature—Bulletin GEA-6346  
 2PDT sub-miniature—Bulletin GEA-6412

- High-speed 4PDT miniature—Bulletin GEA-6212  
 HAVE G-E SALES ENGINEER CALL

NAME \_\_\_\_\_ TITLE \_\_\_\_\_  
 COMPANY \_\_\_\_\_  
 ADDRESS \_\_\_\_\_  
 CITY \_\_\_\_\_ STATE \_\_\_\_\_

GENERAL  ELECTRIC

# Electronic Systems Specialists

## SYLVANIA'S

rapid growth is almost twice that of the electronics industry as a whole... think what this can mean to you in opportunity and rapid advancement. And Sylvania helps underwrite your advanced studies in leading universities in both locations... because we want you to assume greater responsibility and leadership. Here are some typical problems being solved by Sylvania engineers and physicists in our Buffalo, N. Y. and Waltham, Mass. laboratories.

### AT BUFFALO:

1. How do you design 10 similar microsecond timing circuits whose delay times can be varied over a range of 100 times by analog control voltage maintaining a tracking accuracy of  $\pm 0.1\%$  in an environment of  $-65^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  at sea level to 100,000 feet?
2. If you know which bits of a code group are in error, can you modify the hamming code to use these data to provide maximum information capacity in a noisy channel?
3. Can you design a crystal mixer to operate with latest production type crystals and having a noise figure less than 12db above KTB operating in the "S"-band?

If you believe that you can assist us in the solving of these problems, please write:

#### BUFFALO LABORATORY

E. F. Culverhouse  
175 Great Arrow Ave.  
Buffalo 7, N. Y.

### AT WALTHAM:

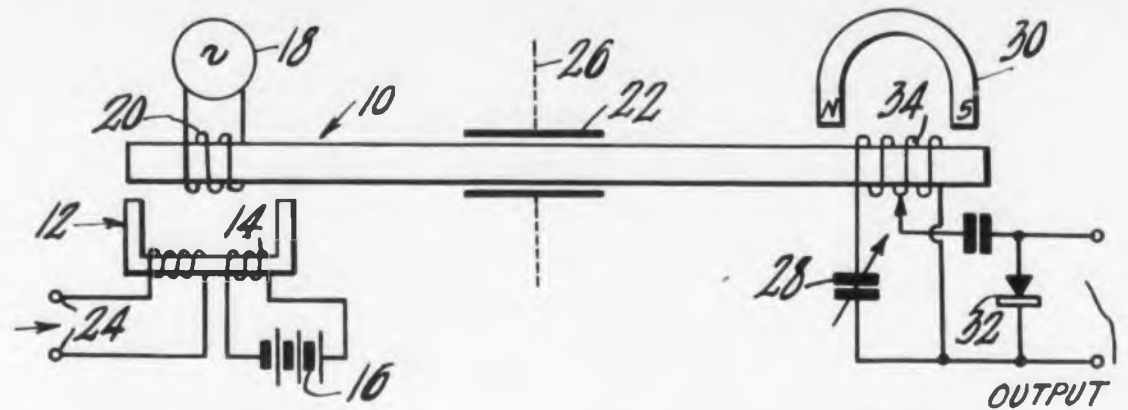
4. What are the statistical factors to be considered in calculating the detection probability of a search radar?
5. What is the effect of atmosphere turbulence on high gain antenna performance?
6. How is the sidelobe level of a radar antenna effected by random perturbations of phase and amplitude over the aperture?
7. How does the AGC bandwidth effect the accuracy of angle-tracking?

#### WALTHAM LABORATORIES

Erling Mostue  
100 First Ave.  
Waltham, Mass.

Your inquiries  
will be answered  
within 2 weeks.

 **SYLVANIA**   
SYLVANIA ELECTRIC PRODUCTS INC.



### Magnetostrictive Amplifier

Patent No. 2,738,386 W. Van B. Roberts  
(Assigned to Radio Corporation of America)

An amplifier, as disclosed in the figure, uses a circuit with a magnetostrictive element 10 by means of which signals of slowly varying magnitude can be effectively amplified. The magnetostrictive element is shown as a straight bar capable of mechanical vibration. The bar has a non-magnetostrictive section at the center, and a magnetostrictive section at each end. It is desirable for each section to have a length of one halfwave length. Shielding 22 and 26 is provided at the central section. The magnetostrictive element provides a rugged means, functioning as a sharply tuned mechanical filter.

An oscillator 18 is coupled by a coil 20.

The frequency is the same as the natural frequency of the bar. A magnetic field is set up by a battery 16 and a coil 14 around an armature 12, at the same end of the bar as that carrying the oscillator coil 20. The signal to be amplified is applied at the terminals 24 and a coil connected to the terminals controls the magnet field. Control of the field controls the magnitude of the vibration of the bar.

At the other or output end of the bar, a magnet, shown as a permanent magnet 30 adjacent to the output end of the bar, creates a field at this end. A tuned circuit is coupled to the bar and includes the condenser 28 and a coil 34 around the bar. A rectifier 32 is provided across the output terminals. This magnetostrictive amplifier secures amplification of either voltage or

## How Federal's **A.Q.\*** SHORT RUN STAMPING SERVICE saves YOU time and money...



**KNOW HOW** 30 years of Short Run Stamping  
**Engineering Skill** Experience  
**Creative Ingenuity**

1. You send us your print, sketch or sample. It undergoes a complete analysis from the standpoint of materials, men, methods, machines and delivery. An analyzed quotation is promptly submitted without obligation to you.
  2. Immediately upon receipt of your order, a Federal die is made for your stamping. Effecting a savings of up to 80% of permanent die cost.
  3. Stampings are fabricated in our modern press department.
  4. The average short run stamping order is delivered in four to five weeks' time. Orders are shipped the same day they are completed.
  5. Your dies are carefully stored and maintained for your exclusive future use at your direction.
- Be sure your next short run stampings are produced accurately, economically and quickly—send your print, sketch or sample for our...



**Analyzed Quotation**

**Federal TOOL & MFG. CO.**  
Quality Stampings in  
Small Quantities

3650 Alabama Ave., Minneapolis 16, Minn.

CIRCLE 276 ON READER-SERVICE CARD FOR MORE INFORMATION

current of the signal applied to the input terminals.

Other forms of magnetostrictive devices may be used in place of the straight rod particularly illustrated. The patent also describes two other forms of amplifiers which are modifications of the amplifier of the figure. A form of feedback circuit is also illustrated.

#### Thermal Control System

Patent No. 2,726,312. W. C. Dunlap Jr. (Assigned to General Electric Co.)

This patent discloses a temperature responsive element and circuit which is definitely responsive to a predetermined temperature and which generates a voltage difference of about 4 mv with a temperature difference of about 10°.

The control system uses as its thermal element a P-type germanium element. This type of non-conductor changes sharply from its P-type characteristic to that of an intrinsic germanium at a particular temperature. This depends upon the proportion of impurities in the non-conductor which makes it the P-type. It is convenient also in that the resistive characteristic of the germanium is a measure of its point of inversion temperature. Germanium hav-

ing a resistive characteristic of 2 ohms CM will have an inversion temperature in the neighborhood of 240°. By selection of a germanium element having a particular resistive characteristic, the inversion temperature is selected.



#### Voltage Reference Devices

Patent No. 2,739,282. William G. Evans. (Assigned to Westinghouse Electric Corp., East Pittsburgh, Pa.)

A saturable reactor voltage reference device designed to supply a constant dc voltage or current, independent of supply voltage magnitude and frequency variations. The saturable reactor is driven into saturation on each cycle so that the average voltage on the secondary winding is proportional to the frequency of the supply voltage, but independent of the magnitude. An integrating circuit is then used to eliminate the frequency dependence, and a full wave voltage rectifier and filter supply a constant output voltage. A simplified circuit is shown.



# Welwyn

leaders in the field of high  
stability deposited carbon resistors

Now Offers

## VITRICON

### Vitreous Enamelled Miniature Capacitors

#### Tolerances:

±20%, ±10%, ±5% and ±2%  
(±0.5 uufd at low values)

Max. Ambient Temperature:  
150° Centigrade

#### Values:

18 to 1000 uufd

#### Temperature Coefficient:

Substantially zero — with spread of  
±40 parts/million/degree C

Power Factor at 1 mc:  
better than 0.001

Manufactured in England and Canada

For complete data and specifications write to Dept. OK-5

**Welwyn International, Inc.**

3355 Edgecliff Terrace, Cleveland 11, Ohio

CIRCLE 277 ON READER-SERVICE CARD FOR MORE INFORMATION



# new!... Continental Connectors



## Series '18' connectors with polarizing screwlocks\*

The new Series '18' provides a large, rugged contact with the same efficient spacing used on our Series '20'. The .053" diameter solder cups can accommodate two #20 AWG wires, if necessary. 20, 27 and 50 contact units are available.

Our reverse type guide pin and guide socket arrangement provides positive polarization. To insure against accidental disconnection you can order the Series '18' with the exclusive Continental Polarizing Screwlock.

Anodized aluminum hoods with top or side openings are available for positive cable support and strain relief.



### POLARIZING SCREWLOCKS

\*PAT. NO. 2746022



### GUIDE PIN and GUIDE SOCKETS



### SERIES '18' SPECIFICATIONS

**CONTACTS:** 20, 27 and 50—plus other contacts and arrangements (9, 14, 34 will be available soon).

Contact pins (brass) and sockets (spring temper phosphor bronze) are silver and gold plated for low contact resistance.

**TERMINALS:** Solder cup or turret.

### ELECTRICAL RATINGS:

Voltage Breakdown  
At Sea Level                    2100 Volts RMS  
At 60,000 Ft.                    750 Volts RMS  
Current Rating                    5 Amps

Additional information on these connectors, and special designs requiring the use of subminiature, printed circuit, hermetic seal, pressurized, high voltage, or power connectors are available on request.

Write today for free catalog.

you're sure with

# DeJUR

ELECTRONIC SALES DIVISION  
DeJUR-Amsco Corporation  
45-01 Northern Blvd.  
Long Island City 1, N. Y.

CIRCLE 278 ON READER-SERVICE CARD FOR MORE INFORMATION

# Sometimes it's Difficult to tell...



**AGASTAT**  
Comp  
TIME  
solenoid actuator

Introduces time delay  
adjusted to provide  
five or more minutes  
The AGASTAT  
position. Dust-proo  
ating life with a mi

**AGA**  
DIVISION

**Fixed Vacuum Capacitor**  
Rated at 500 mfd



The Type VC500-10 Fixed Vacuum Capacitor is rated at 500-mmfd capacitance, 10-kv peak, and 42 amp rms. Dimensions are: 4 in. overall length x 3-1/4 in. diam, 3-1/2 in. mounting centers, and 7/8 in. contact diam. This unit features reversed copper-to-glass seals for maximum voltage path in minimum space. Low inductance, practically loss-free characteristics, and rugged construction are features of the unit, which is especially suited for medium and high power oscillators and transmitting equipment.

Dolinko & Wilkens, Inc., Dept. ED, 1907 Summit Ave., Union City, N.J.

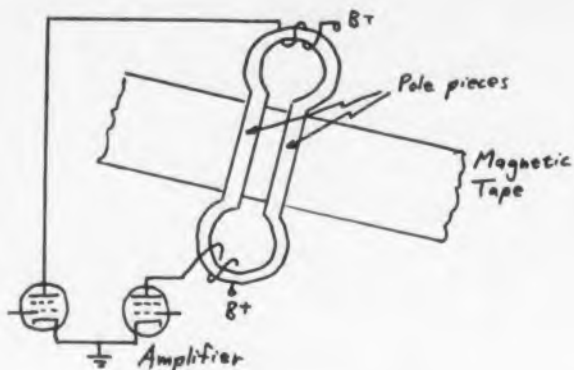
CIRCLE 55 ON READER-SERVICE CARD FOR MORE INFORMATION

**B**ecause of similarity in size, new product editorial in **ELECTRONIC DESIGN** often resembles paid advertising space. This has confused some readers in the past, so for the record we have selected two items at random and reproduced them above.

The item in front is *editorial*. It is a free, concise, write-up of a manufacturer's product, based on its newness and its relevance to the design engineer's work. Once brought to the design engineer's attention, however, it's up to the manufacturer to *remind* our readers, if he wishes, in paid advertising space.

If you have a new product, send information about it to our editors. You need not advertise in our publication in order to have your material qualify for acceptance. And, of course, there is no charge for this service.

## ELECTRONIC DESIGN



**Variable Area Magnetic Recording System**  
 Patent No. 2,743,320. Howard L. Daniels  
 and Sidney M. Rubens. (Assigned to Sperry  
 Rand Corp., New York, N. Y.)

A magnetic recording means which produces a gradient of flux concentration across the width of the tape. The figure shows a schematic diagram of the system which utilizes two electromagnets driven by a push-pull amplifier.

**Voltage Limiter**  
 Patent No. 2,732,494. O. C. Hall. (Assigned  
 to The United States of America.)

A voltage limiter ordinarily uses vacuum tubes when it is to be used for frequency shift keying in the operation of teletypes, in order to secure frequency deviation. A vacuum tube changes its gain upon any

change of either anode supply voltage or the voltage applied to the filament heaters. This change in gain effects variation of the output voltage of the tube and produces undesired frequency deviation. A voltage regulated power supply may be used to supply a stable anode voltage; however, variation in voltage for the cathode heaters presents a problem.

The voltage limiter circuit shown in the figure is unaffected by anode or cathode voltage changes and consequently there is no deviation in the output voltage. The input signal is applied to the terminals 11 and 12; however when no signal is applied, the tube 15 is non-conducting. When the tube 15 is non-conducting, the control grid of the second tube 21 which is coupled to the anode of the tube 15, carries a bias which causes tube 21 to conduct. As long as tube 21 is conducting, the anode current of this tube through the resistor 34 maintains the potential on the anode 29 of the thyatron 28 below its firing potential. If now a positive pulse is applied to the input terminals and hence to the control grid of the tube 15, this tube becomes conducting and the control grid 22 is biased by current through resistor 33 so that tube 21 becomes non-conducting. Full power supply potential,

## AN INVITATION

TO ENGINEERS

INTERESTED IN REAL ENGINEERING OPPORTUNITY

To those who wish to explore, from a study standpoint, the newest in systems or missile guidance and radar—to engineers versed in circuit development and packaging or in hydraulic servo systems development—we extend an invitation to look into a position at Sanders.

Yes, we have educational programs, fringe benefits, liberal salary scales BUT, more significant, at Sanders can also be found a breadth and depth of technical progress that will keep you on your toes and contribute much to your career.

The pace is fast, the work demands high skill and competence, but to those who qualify Sanders can offer a direct road to professional success.

We think you'll also value—as we do—the relaxed living conditions here, in the beautiful New Hampshire hill country (less than an hour from downtown Boston).

If you are an electronic or electromechanical engineer interested in real engineering opportunity, send your resume to D. H. Johnson.



NASHUA

NEW HAMPSHIRE



Therefore, is applied to the anode of the thyatron 28 so that it fires.

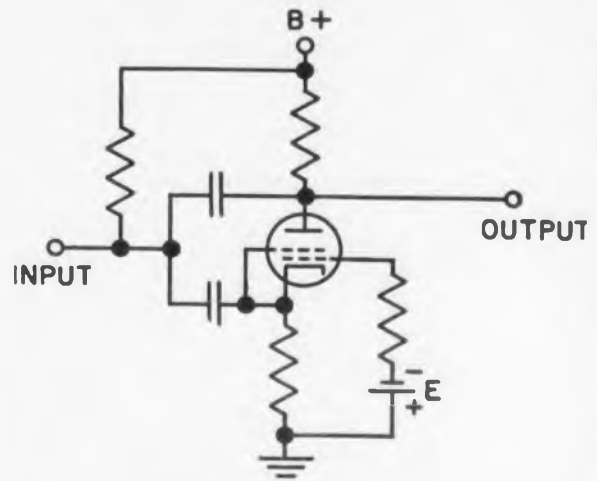
Normally the potential across the output terminals 38 and 39 is determined by the potential across the cathode resistors 36 and 37 which are in series with a resistor 35 directly connected with the power supply. When the thyatron fires, the added current through this tube and resistors 36 and 37 raises the potential across the output terminals. The output potential is maintained stable as to one level by the regulated power supply. The thyatron is of the cold cathode type which does not have a cathode heater to affect the output potential. The output potential is therefore unaffected by any variations in cathode supply voltage and is stable at both its high and low potential level.

#### Imperfection Counter

Patent No. 2,739,239. Edward J. Bernet. (Assigned to Institute of Textile Technology, Charlottesville, Va.)

An apparatus to count imperfections in material in the form of yarn and the like. The apparatus determines the yarn diameter and a differentiating circuit produces an output whenever the diameter of the

yarn changes in the order of 1/16". By adjusting a threshold level it is possible to count all imperfections larger than some present size.



#### Gas Discharge Tube Binary Device

Patent No. 2,739,235. George Vande Sande. (Assigned to General Railway Signal Co., Rochester, N. Y.)

A gas tube circuit with two stable states. An input signal is coupled simultaneously to the plate and cathode in such a manner that a negative input pulse will switch the device from its present state to the other stable state. A simplified schematic is shown.

## NOISE and FIELD INTENSITY METER Model NF-105

(Commercial Equivalent of AN/URM-7)



CONFORMS TO  
MIL-I-6181B  
MIL-I-11683  
MIL-I-16910

#### ENGINEERING DATA

- Frequency range 150 KC to 1000 MC by means of four quick-change tuning heads. At least one RF amplifier with tuned input is employed for each tuning range.
- Easy frequency scanning by means of single tuning knob.
- Built-in impulse noise calibrator flat to 1000 MC (Output externally available).
- 4 1/2" logarithmic indicating meter reads carrier or true peak.
- Aural slideback operation.
- Input VSWR better than 1.2 to 1.
- Built-in regulated "A" and "B" supply.
- Complete line of accessories available.

Write for Catalog No. N-356

edp

EMPIRE DEVICES PRODUCTS CORPORATION

38-15 BELL BOULEVARD • BAYSIDE 61, NEW YORK

MANUFACTURERS OF

Field Intensity Meters • Distortion Analyzers • Impulse Generators • Coaxial Attenuators • Crystal Mixers

CIRCLE 281 ON READER-SERVICE CARD FOR MORE INFORMATION

# DI-FORMED PAPER TUBES IMPROVE YOUR COILS ...SAVE MONEY AND PRODUCTION HEADACHES



## HERE ARE THE FACTS

Di-Formed Tubes feature a special patented Precision Paper Tube construction which produces a completely ridgeless surface, thus eliminating wire pile up and resultant coil shorts.

Side walls are straightened under pressure during the winding operation. The bow being thus controlled permits a perfect fit between mandril and tube as provided by Precision's low-cost Related Mandril Service.

Under the Related Mandril Service, Precision supplies the coil manufacturer with accurately ground steel or aluminum mandrils at a price comparable to commonly used unsatisfactory wood or undersized steel mandrils. *This is not a profit-making service.* Its sole purpose is to give the coil manufacturer these advantages:

1. *Provide proper tube support.*
2. *Facilitate stacking operations.*
3. *Prevent coil collapse.*
4. *Save machine and operator fatigue.*
5. *Permit a smaller core, thus decreasing coil size and eliminating pressing.*

Get full details on Precision Di-Formed Tubes and Related Mandril Service. Write, wire or phone today.

### Sales Representatives in:

Illinois; Indiana; Iowa; Wisconsin; Missouri; Minnesota: Chicago, Illinois, ARmitage 6-5200.

Indiana; Southern Ohio: Logansport, Indiana, Logansport 2555.

Northern Ohio: Cleveland, Ohio, ATLantic 1-1060.

New England: Framingham, Massachusetts, TRinity 3-7091.

Delaware; Washington, D. C.; Maryland; New Jersey; Metropolitan New York; Eastern Pennsylvania; Virginia: Jersey City, New Jersey, Swarthmore 5-2480.

Upper New York: Syracuse, New York, Syracuse 4-2141.

CANADA: Montreal, Quebec, Canada, Walnut 0337.

MEXICO: Mexico 6, D. F., Telephone: 35-06-18.



## PRECISION PAPER TUBE COMPANY

2055 West Charleston Street, Chicago 47, Illinois

Plant No. 2: 1 Flower Street, Hartford, Conn.

CIRCLE 282 ON READER-SERVICE CARD FOR MORE INFORMATION

# INSULATION

for electrical-  
electronic applications

**SIL-THIN-GLAS AND SIL-THIN-BESTOS**—Extra-thin high temperature insulation for wrapping armatures, fields, stators, relays, transformers and coils.

**STICK-GLASS\***: Wrapping for small coils where space is limited and holding down of wrapping is difficult. Ideal for toroidal coils. Thicknesses .005"-0.15". Dielectric strength of "A" glass (1300 vpm).

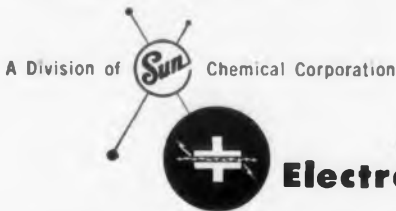
**SUN-PLI**—Asbestos paper combinations. Improved mechanical and electrical strength plus high moisture resistance.

**SIL-GLAS**—Uses: coil wrap or tape—slot cell insul.-layer insulation. Flexible 200°C heat resistance, good abrasive resistance, 2.5 Dielectric constant at 25°C. ¼" diel. breakdown 5000 V @ .003" to 10,000 V @ .010". 1% power factor. Thicknesses .003"-0.10".

**ELASTOMERIC FIBERGLAS**—Highly water repellent. Impregnated and coated with silicone rubber. Cured or uncured. Baking uncured to 360°F provides after-cure for tough, abrasive-resistant finish. Cured E-F has dielectric strength of 800 VPM @ 25°C for .007", and power factor of 0.7%.

**BI-GLAS**—Class "B"—bias woven Fiberglas tape for fast wrapping of coils, spirals, etc. Stretches and contour wraps without electrical loss, coning or air pockets.

**ACTO-GLAS**—Fiberglas cloth preimpregnated with polyester or silicone resin. In 36" rolls or tape. Dielectric strength to 700 VPM. Low moisture absorption, high impact resistance, high flexural strength. Gauges from .004" to .012".



Available from authorized distributors in principal cities or write for complete data and samples to Department E19-1069. Special problems will receive immediate attention in our modern, fully-equipped laboratories.  
\* Owens Corning Fiberglas Corp.

## Electro-Technical Products

Nutley 10, New Jersey

### DIVISIONS OF SUN CHEMICAL CORPORATION

HORN (paints, maintenance and construction materials, industrial coatings) • WARWICK (textile and industrial chemicals) • WARWICK WAX (refiners of specialty waxes) • RUTHERFORD (lithographic equipment) • SUN SUPPLY (lithographic supplies) • GENERAL PRINTING INK (Sigmund Ullman • Fuchs & Lang • Eagle • American • Kelly • Chemical Color & Supply Inks) • MORRILL (news inks) • ELECTRO-TECHNICAL PRODUCTS (coatings and plastics) • PIGMENTS DIVISION (pigments for paints, plastics, printing inks of all kinds) • OVERSEAS DIVISION (export) • A. C. HORN COMPANY, LIMITED (Canada) • GENERAL PRINTING INK CORPORATION OF CANADA, LIMITED • FUCHS & LANG de MEXICO, S. A. de C. V.

CIRCLE 283 ON READER-SERVICE CARD FOR MORE INFORMATION

# Celco

# TOROIDS

... Offered in a  
wide range of sizes

#50 wire on .062" ID  
#15 wire on 9" OD



Whether it's a complex 10 winding magnetic amplifier or a simple choke... at Celco each toroid is precision-made. New core materials are used in Toroidal magnetic amplifiers, reactors and transformers to achieve maximum performance.

At Celco, the proper matching of cores, winding, handling, impregnation, encapsulation and electrical history of the final assembly is carefully controlled to maintain the original design characteristics.

Submit your toroidal problems for our immediate attention... Call Ramsey 9-1123 — or write today.

# Celco

*Constantine Engineering Laboratories Co.*

MAHWAH, N. J.



Your plant is only hours away by the Celco Air Fleet

CIRCLE 284 ON READER-SERVICE CARD FOR MORE INFORMATION



# Books

## Pulse & Digital Circuits

Jacob Millman & Herbert Taub. McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. 687 pages; Price: \$12.50.

Response of linear networks, both active and passive, to the types of waveforms commonly encountered in pulse circuits is analyzed in the beginning of this book. Basic nonlinearities of tubes and semiconductor devices are described, and the efforts of these nonlinearities on waveform transmission are studied. Waveform generating circuits are analyzed in detail. Other fundamental circuits or components are given consideration. These basic building blocks are assembled into pulse and digital systems such as radar, television, and digital computers.

A number of illustrative examples are worked out in detail in the body of the text. Material is organized into a logical pedagogic presentation.

## International Dictionary of Physics and Electronics

D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J.

Here in one volume, are definitions of all the principal terms used in classical and modern physics, useful not only to physicists but also many more scientists and engineers in fields who have frequent need for information about terms used in physics.

Prepared by an international group of scientists and educators, this dictionary has terms from sixteen major subject divisions, over 300 illustrations, all designed to provide the exact and unambiguous definitions needed in everyday work.

The terms defined here include laws, relationships, equations, basic principles and concepts, as well as the most widely used instruments, apparatus and their components. In short, this treatment comprises the terms of pure science as well as those of its applications.

# Shasta

INSTRUMENTS

*designed for the user!*

## MODEL 101 EXPANDED SCALE VOLTMETER



### features:

- ★  $\pm 0.25\%$  accuracy
- ★ True rms reading
- ★ Easier, error-free reading
- ★ Direct connection for 1 ma recorder
- ★ Special high or low base voltages, scale expansions, panel or switchboard mountings available on order.

### brief specifications:

Accuracy:  $\pm 0.25\%$  of input voltage  
Voltage indicated: True rms  
Voltage Range: 100-500 (or 50-250)  
Frequency Range: 50-2,000 cps  
Scale Range: 12 v. (smallest div. 0.2v)  
Dimensions: 7½"W x 8½"H x 9½"D  
Price: \$360.00 f.o.b. factory

Write today for Technical Bulletin 101; please address Dept. SE 10

### OTHER SHASTA QUALITY INSTRUMENTS

Expanded Scale Frequency Meters and Voltmeters  
Audio Oscillators • AC Voltmeters • Power Supplies  
Wide Band Amplifiers  
Bridges • WWV Receivers  
Decade Inductors.

# Shasta

division

BECKMAN INSTRUMENTS INC.

P. O. Box 296, Station A, Richmond, California  
Telephone LAndscape 6-7730

S-20

CIRCLE 285 ON READER-SERVICE CARD FOR MORE INFORMATION

The units and systems of units are treated both by definitions and by a comprehensive discussion at the beginning of this book. All definitions, wherever possible, which have been established or recommended by professional groups are included. Many terms have been defined from the subject-areas bordering on physics.

#### Frequency Response

Rufus Oldenburger, *The MacMillan Co.*, 60 Fifth Ave., New York 11, N.Y. 372 pages. Price: \$7.50.

Papers and addresses presented at the 1953 ASME Frequency Response Symposium are disclosed in this book.

Featured are discussions and criticisms of each ASME paper; a complete eight-page bibliography of important works on frequency response; and 428 illustrations supporting the text material.

#### Electrical Circuits

Charles S. Siskind, *McGraw-Hill Book Co.*, 330 W. 42nd St., New York 36, N.Y. 516 pages. Price: \$6.75.

Fundamental principles of electric and magnetic circuits are featured in this book. Material is divided into two major parts:

Part 1 deals with circuits in dc systems, while Part 2 builds upon the former and deals with circuits in ac systems.

Also included are circuit diagrams, and mathematical derivations involving the use of calculus.

#### Engineering Formulas and Tables

Lefax, *Sheridan Building, Philadelphia 7, Pa.*

This is a pocket-size system of loose-leaf data sheets and blank forms. The twelve categories include Math. Tables; Measures: Materials: Gages, Screws, etc; Mechanics; Elect. & Magnet; Hydraulics; Struc. Data; Reinf. Concrete; Pipe & Fittings; Steam Tables; Math. Tables.

#### Applied Electrical Measurements

Isaac F. Kinnard, *John Wiley & Sons, Inc.*, 440 Fourth Ave., New York, N. Y. 600 pages. Price: \$15.00

This book is concerned with the framework of the familiar branches of physics. The material has been chosen to apply the principles of electrical measurements in industrial practice.

The book is divided into two parts, the first concerned with the measurement of electrical quantities and the second to non-electrical quantities.

nobody  
gets  
"lost in the  
shuffle"  
at



GENERAL PRECISION LABORATORY is organized in small engineering groups where everyone has a chance to use initiative, assume responsibility, show what he can do.

Results tell the story. Just one example: GPL engineers harnessed Doppler and developed the AN/APN-66 air navigation systems that are the most accurate airborne systems in operation today.

At GPL you'll have freedom from administrative routine, and enjoy the satisfaction that comes with using facilities as up-to-date as they come. Because GPL is a member of the nationwide General Precision Equipment Group, you'll share in numerous added employment and professional benefits. And remember—you and your future will never be lost in the shuffle.

If you have the skill and imagination we need—and if you want personal recognition and opportunities to grow in your profession—send your resumé to Richard D. Hoffman, Employment Manager. Interviews can be arranged in advance at any time, including weekends. Security limits us to U. S. citizens only. We will pay the expenses of qualified applicants to come for an interview.

#### RADAR NAVIGATION AND BOMBING SYSTEMS (Doppler & Inertial)

Research • Development • Applications  
Systems Analysis • Systems Test  
Administrative Engineering • Mechanical Packaging  
Field Engineering • Technical Writing  
Production Follow-up

Computers • Servos • Microwave Techniques  
Pulse Circuitry • Transistorization

**General Precision Laboratory Incorporated**  
63 Bedford Road, Pleasantville, New York

In the heart of Westchester County

FOR FURTHER INFORMATION PLEASE CONTACT ADVERTISERS DIRECTLY

A SUBSIDIARY OF



# VERSATILE!

## Clary Numerical Data Printers

The Clary printer is now used in a wide variety of applications by famous industrial and technological firms. Typical examples of Clary's ability to solve problems are *digital voltmeter* and *shaft position conversion*. Clary is the versatile printer that may well solve a problem for you.

Gives you a permanent printed record, instead of a fleeting visual one. Both serial and parallel-type printers available. Choice of 4 models, 8 to 11 digit capacity. Designed for use with any

automation or data-processing system. Capable of taking input in various forms, manual or remote, and delivering it in equally diverse forms. And only Clary equipment is able to print, add and convert remote input to perforated tape or cards. Also a wide line of other data-handling units for industrial and scientific applications. Please write on your letterhead for facts. Clary Corporation, Dept. E106, San Gabriel, California.



### ELECTRONICS DIVISION

CLARY CORPORATION  
San Gabriel, California

*... manufacturer of business machines, electronic data-handling equipment, aircraft and missile components... for America and the World*

CIRCLE 287 ON READER-SERVICE CARD FOR MORE INFORMATION

## Electroplated WIRE

*For Many Different Applications*



Specialists in the Unusual

More and more people are turning to us for electroplated wire. We electroplate by continuous methods a wide variety of wire in a range of diameters from .035" to the smallest available. In our laboratory, Tungsten wire as small as .00015" has been electroplated with Gold . . . New applications for electroplated wires on different base materials are being developed from time to time . . .

Your inquiry is invited. Consult our staff, without obligation, about your specific wire problems.



**SIGMUND COHN MFG. CO., INC.**

121 SOUTH COLUMBUS AVENUE MOUNT VERNON, N. Y.

Write for List of Products.

CIRCLE 288 ON READER-SERVICE CARD FOR MORE INFORMATION








Centralab transistor amplifier used in Goldentone hearing aid. Four-stage unit measures only 1/2" x 1" x 1/4"

*Today's smallest complete amplifier demonstrates*  
**a new technique**  
**for packaging**  
**electronic components**

*One-, three-, and four-stage transistor amplifiers are ideal for:*

- Hearing aids*
- Small radios*
- Recorders*
- Microphones*
- Military equipment*
- Television*
- Electro-medical units*
- Other space-saving applications*

**Another first by Centralab, pioneer in miniaturization**

-  Special transistors and diodes developed by Centralab are hermetically sealed into a ceramic base plate in this unique Packaged Electronic Circuit which also includes capacitance, resistance, inductance, and wiring.
-  Not laboratory specimens — standard one-, three-, and four-stage transistor amplifiers that are being used successfully in industry on many applications. Special designs can be adapted to your requirements.
-  Complete amplifier units reduce your production costs — there are fewer individual parts to buy, inventory, assemble, and test. For example, a four-stage transistor amplifier replaces 21 parts — four transistors, five capacitors, 12 resistors, plus wiring. Soldering connections are reduced from 46 to 7.

*Write for Technical Bulletin EP-75*

**Centralab**  
Y-2656

**A DIVISION OF GLOBE-UNION INC.**

960J East Keefe Avenue • Milwaukee 1, Wisconsin  
 In Canada: 804 Mt. Pleasant Road, Toronto, Ontario



**CIRCLE 289 ON READER-SERVICE CARD FOR MORE INFORMATION**

## What The Russians are Writing

J. George Adashko

Measurement Engineering, No. 2,  
March-April 1956

**Test Setup to Check Absorption Attenuators in the 3-cm Band, E. I. Strelkova (4 pp 2 figs).**

The setup shown in Fig. 1 was developed and tested by the All-Union Scientific Research Institute for Measures. It is used to check absorption attenuators in the 3-cm (8700-9600-mc) band when a relatively high measurement accuracy is required.

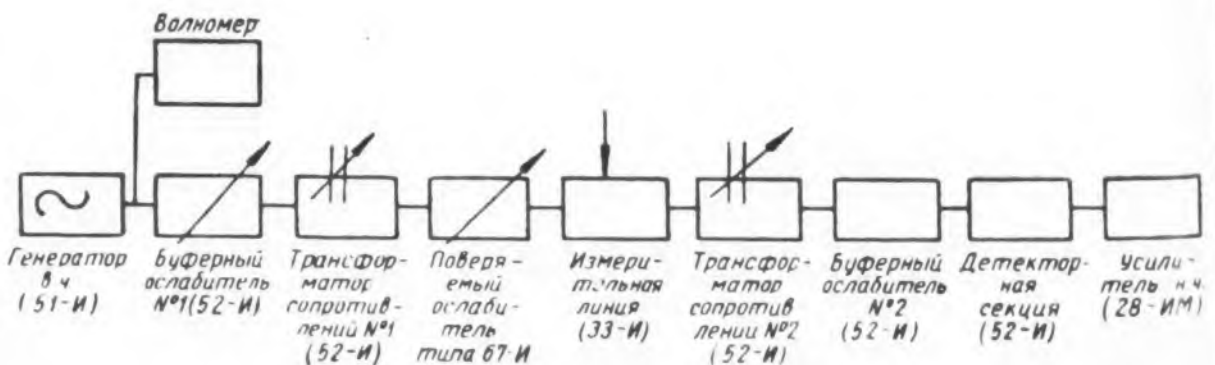
Operation of the setup is based on the low-frequency substitution method, whereby the unknown power ratio in the high-frequency channel is determined from the ratio of corresponding low-frequency voltages obtained across the load resistor in the detector circuit. A crystal detector with square-law characteristics is used.

The measurement procedure is as follows: The generator and calibrated line are tuned to the prescribed frequency. An oscillograph is used to check the waveform of the detector-output envelope. Before

connecting the unknown attenuator into the line, the impedance of the detector and generator sections are matched to the wave impedance of the line until the VSWR is less than 1.02. The detector power level is then set at a value not exceeding the upper limit of the square-law portion of its characteristic. The ratio of the If amplifier output with and without the attenuator determines the value of the attenuation.

The article contains a detailed discussion of the random and system errors inherent in such a procedure.

- 1—wavemeter,
- 2—hf generator,
- 3—buffer attenuator No. 1,
- 4—impedance matching transformer No. 1,
- 5—unknown attenuator,
- 6—calibrated line,
- 7—impedance-matching transformer No. 2,
- 8—buffer attenuator No. 2,
- 9—detector,
- 10—If amplifier.



**Inductive Recording Meter for Small Displacements, V. S. Chaman (3 pp 3 figs).**

The problem of attaining both phase and amplitude balance in an ac bridge consisting of a pair of inductances and a pair of pure resistances is solved in Fig. 1 by using a phase shift RC network. Here the unbalance voltage between point 1 and ground is compensated by the voltage between points 2 and 3. Fig. 2 shows that as the brush 2 of the rheostat moves relative to the center tap 3, the voltage between points 1 and 2 is represented by vectors  $FA$ ,  $HA$ ,  $GA$ , etc, while the respective voltages between points 2 and 3 are represented by vectors  $OF$ ,  $OH$ ,  $OG$  before the phase shift is introduced by

the RC network, and by vectors  $FM$ ,  $HL$ ,  $GM$ , etc. after the phase shift. The voltage applied to the servo amplifier is  $AF+FM$ ,  $AH+HL$ ,  $AG+GN$ , respectively, and it is evidently zero at the point  $H$ , corresponding to the minimum unbalance.

A complete circuit of the system, including the amplifier, is shown in Fig. 3. The instrument was constructed by the "Bureau on Interchangeability" of the Committee on Standards, Measures, and Measuring Instruments of the USSR. The recording error on a 200-mm strip charge at magnifications of 500 and 5000 to 1 did not exceed the error of the inductive transmitter itself. (The latter error was not specified in the article).

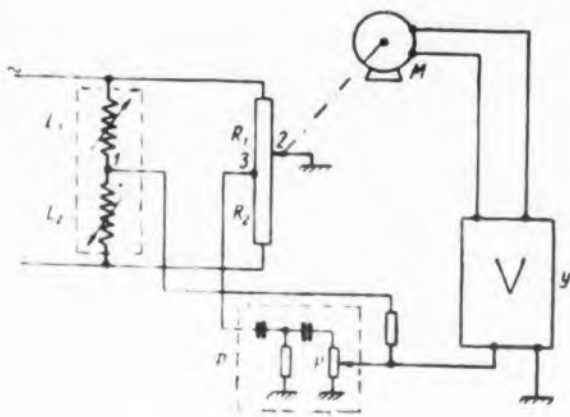


Fig. 1

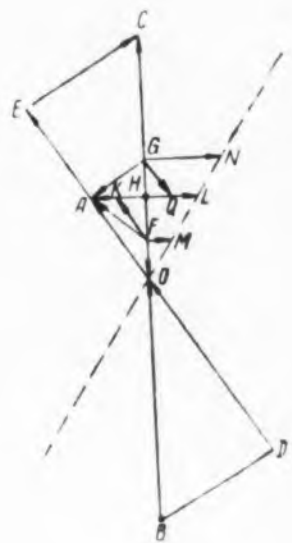


Fig. 2

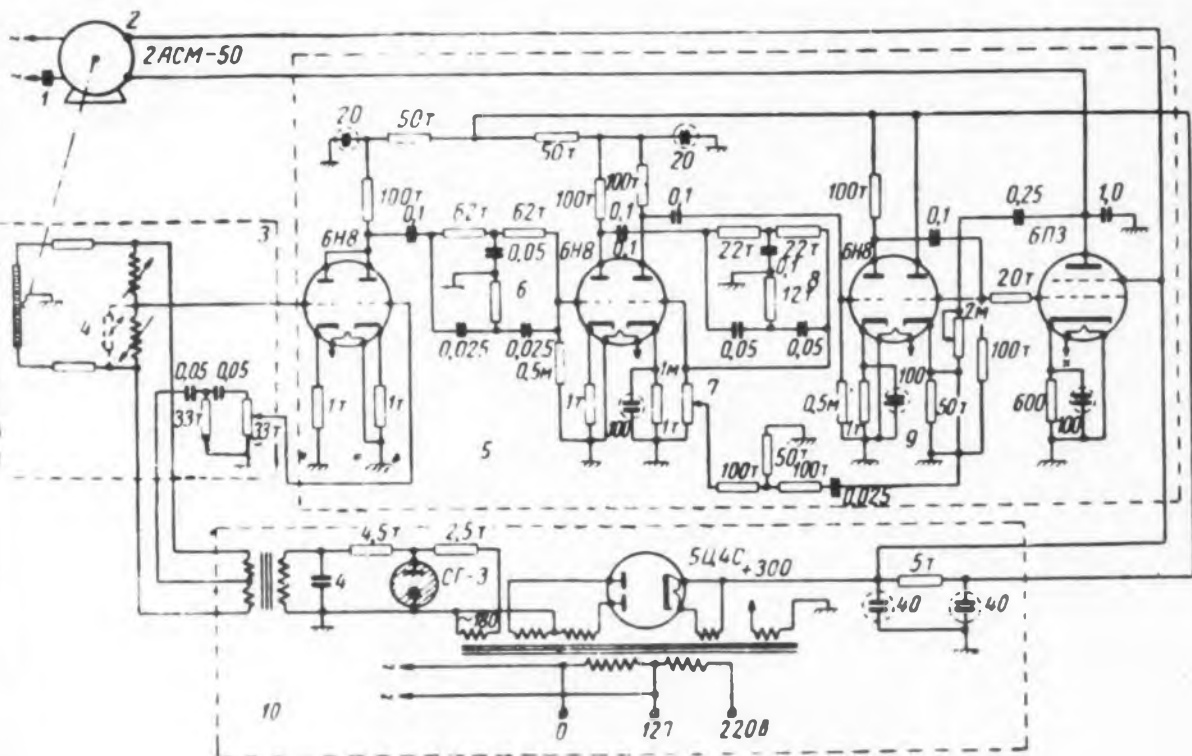


Fig. 3



# REGULATED DC POWER SUPPLIES

HI-VOLTAGE

## SERIES

Designed for powering airborne electronics equipment under the most adverse environmental conditions, Arnoux High Voltage DC Power Supplies assure the utmost in reliability. These magnetic-amplifier regulated supplies are available in the range of 108 to 450 volts DC, with current ratings from 50 ma to 800 ma. Other ratings are also available on special order.



Model 250 S 025

# ARNOUX

<b>Input Power:</b> 115 volts, 400 cps	
<b>Regulation:</b> Input (Variation)	Output (% Rated)
<b>Line Voltage:</b> $\pm 10\%$	$\pm 0.25$
<b>Line Frequency:</b> $\pm 20$ cps	$\pm 0.1$
<b>Load Current:</b> 20-100%	$\pm 0.1$
	$\pm 0.2$
	0-100%

**Ripple:** Less than 0.05% rms at full load.

**Output Adjustment:** 5% adjustment available on request at slightly higher price.

**Environmental:** Meets specification MIL-E-5272 A for acceleration, vibration, altitude, humidity and temperature operating at 20% to 100% rated load. Also meets MIL-I-6181 B.

**Connector:** AN-type connector.

**Mounting:** Stud-mounted.

(Write for Bulletin 200)

LO-VOLTAGE

## SERIES

Intended for use in precision airborne instrumentation systems, Arnoux Low-Voltage DC Power Supplies are available in both single and dual output. Ranging from 5 to 50 volts at currents up to 10 amperes, these rugged units are hermetically sealed.



Model 5 S 10

# ARNOUX

<b>Input Power:</b> 115 volts, 400 cps	
<b>Regulation:</b> Input (Variation)	Output (% Rated)
<b>Line Voltage:</b> $\pm 15$ volts	$\pm 0.10$
<b>Line Frequency:</b> $\pm 20$ cps	$\pm 0.15$
<b>Output Load:</b> 20-100%	$\pm 0.05$
	$\pm 0.10$
	0-100%

**Temperature Stability:** 0.5% per 100°F. (-60°F. to +160°F.)

**Ripple:** Less than 0.1% rms at full load.

**Output Adjustment:** Screwdriver adjustment provides  $\pm 0.5$  volt change. Wider range of adjustment available on request.

**Connector:** Standard AN-type connector, or hermetically sealed header on request.

**Mounting:** Stud-mounted.

**Environmental:** Meets specification MIL-E-5272 A for acceleration, vibration, altitude, temperature and humidity.

(Write for Bulletin 100)

Designers and manufacturers of precision instrumentation.



11924 West Washington Blvd.  
Los Angeles 66, California

CIRCLE 290 ON READER-SERVICE CARD FOR MORE INFORMATION

# New German Tubes

Alfred Jorysz

## New Tube For Pulse Work

Many problems in pulse circuitry require a vacuum tube with the following characteristics: 1. two independent control grids, 2. two independent plates, 3. high mutual conductance  $g_m$  with optimum  $g_m/C$  ratio (required for wide frequency band amplification) and 4. high plate current with optimum current distribution between plate and screen grid. Siemens and Holske, Germany, have developed such a tube.

The design is based on the use of a fine wire structure for both control grids and the screen grid, resulting in high  $g_m$  values and low internal capacities. The fine wire grid is not self supporting but is held inside a frame around which very fine tungsten wires are wound. These wires are welded to the frame under high mechanical tension.

The use of this construction for the control grids permits a spacing of  $45 \times 10^{-4}$  cm between first grid and cathode, resulting in a mutual conductance of 13 ma/v and a good sharp cut-off. The second control grid  $g_m$  is 7.5 ma/v. To reduce the current to the first screen grid, which separates the two control grids, another fine wire structure is used. Since even a small

amount of screen grid current will produce a screen grid temperature rise and therefore expansion of the screen grid wires, the latter are mechanically pre-tensioned to such a degree that they will not shift under normal operating conditions.

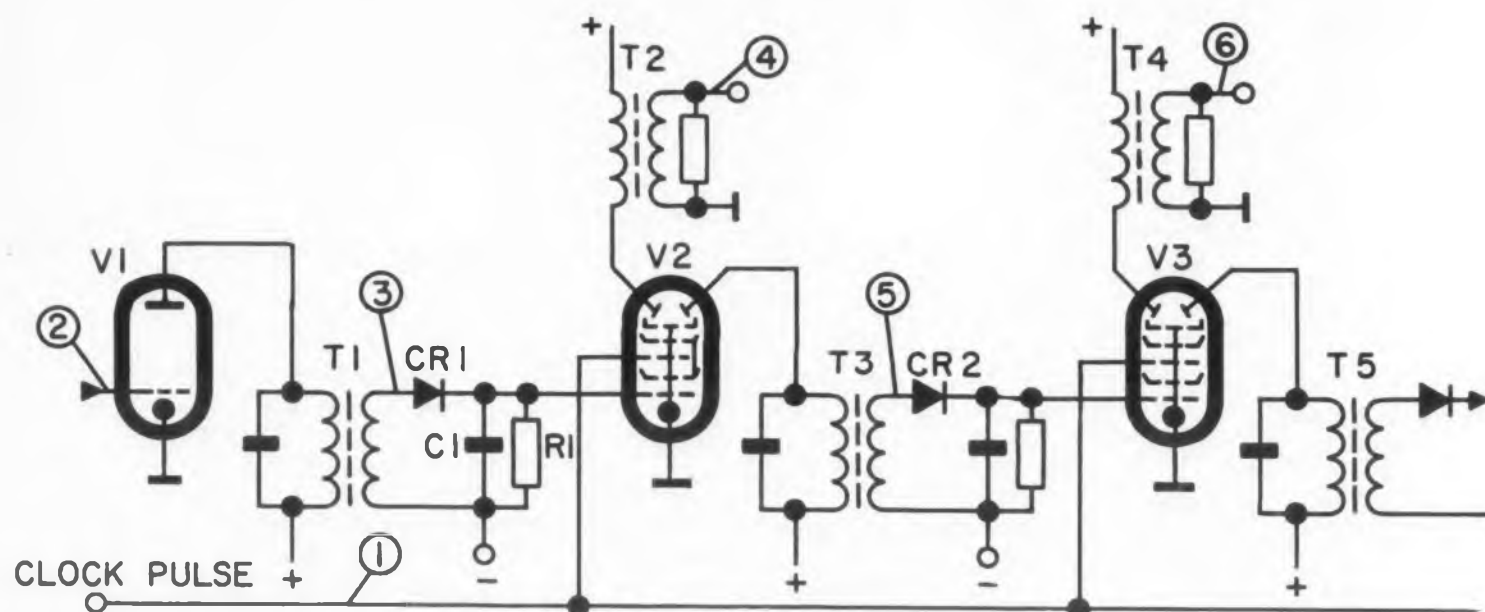
Due to the parallel and symmetrical construction of the tube, the two plates are almost completely decoupled. The mutual capacity between them is only 0.18 mmfd.

The tube has a nine-pin base and a miniature size envelope. Its characteristics are shown in the table which makes a comparison to those of a 6AS6 tube.

The use of this tube in a coincidence circuit has the advantage of almost complete decoupling between inputs, practically infinite input impedances and amplification rather than attenuation as found in diode gates. Semiconductor switching time problems due to hole storage do not exist in a tube.

A synchronized, pulse-delay circuit using the coincidence is illustrated. The input pulse to  $V_1$  excites the tuned transformer  $T_1$ , thereby charging  $C_1$  through  $CR_1$ . When  $CR_1$  is cut off,  $C_1$  discharges slowly through

$R_1$ . The time constant  $R_1C_1$  is chosen to keep the grid No. 1 of  $V_2$  open during the next clock pulse, but closed during the one following it. The clock pulses are applied to grid No. 2. A pulse appears therefore in  $T_2$  which is delayed compared to the input pulse by one period of the clock pulses. By using the second plate of the coincidence tube to excite the next transformer  $T_3$ , the voltages appearing in  $T_1$  are repeated delayed by one clock pulse period. The next coincidence tube produces then a pulse in  $T_4$ , which is delayed by two clock pulse periods. Preservation of the waveforms through a number of such steps is only possible due to the availability of two plates. In a typical circuit, the clock pulse period may be one microsecond and the pulse length 0.3 microsecond. K. Gossiau and W. Guber, "A new multi-grid tube with very high  $g_m$  and its application in pulse circuits," *Frequenz*, vol. 10, pp. 83-89; March 1956.



Basic schematic of a synchronous pulse delay circuit.

	Three fine-wire grid tube Type V108	6AS6 (5725)
Plate current	66.0	12.0 ma
Cut-off voltage:		
$U_{g1}$	-8.0	-5.0 v
$U_{g3}$	-13.0	-10.0 v
Mutual cond.:		
$g_{m1}$	13.0	3.2 ma/v
$g_{m3}$	7.5	0.5 ma/v
$g_m/C$		
Grid No. 1	1.2	0.8 ma/v/mmfd
Grid No. 3	0.58	0.18 ma/v/mmfd
Plate resistance	0.7	4.4 kilohms
Current distr.		
$\frac{I_{p0}}{I_{g20} + I_{g30}}$	1.1	1.16
Heater voltage	6.3	v
Heater current	0.37	a
Plate dissipation	2.0 max.	w
Screen dissipation	1.0 max.	w
Cathode current	20 max. dc	ma
Cathode current	250 max. pulse	ma

## Analog Multiplier Tube

A new solution of the problem of multiplication in analog computers is obtained with the aid of this electron beam tube with three electrostatic deflection systems.

The three basic requirements for an analog multiplier are: Four quadrant operation, i.e. sign of product must be determined by signs of inputs, high accuracy and high computing speed, which means no inertia and large bandwidth. An electron beam tube with a hyperbolic deflection system, Fig. 1, yields an excellent solution. Input No. 1 is applied to the standard parallel plate deflection system No. 1. It is followed by the deflection system No. 2 which produces a hyperbolic field, Fig. 2. By connecting the second input to the four deflection electrodes as shown, a hyperbolic field is produced in a plane at right angle to the tube axis. The potential is zero on both the  $x$  and  $y$  axes, but the  $y$  component of the electrostatic field is negative in the two quadrants where  $x$  is positive and positive where  $x$  is negative. This arrangement makes four quadrant operation possible. The electron beam entering the hyperbolic field is already deflected proportional to  $U_1$ . In the second system it is deflected in the  $y$  direction proportional to the product  $U_1 \times U_2$  into the quadrant corresponding to the sign of  $U_1 \times U_2$ .

The beam then traverses a feedback control system which operates as follows: The anodes are two adjacent plane electrodes. The undeflected beam strikes the dividing line between the anodes, thus producing two equal voltage drops in the resistors  $R$ . The difference between the two voltages, which is the input to the differential amplifier, is therefore zero. A deflected beam produces two different voltage drops and their difference results in an amplifier output which controls the third deflection system. The polarity of this voltage is chosen so as to return the beam to the border line between the two anodes, thus keeping

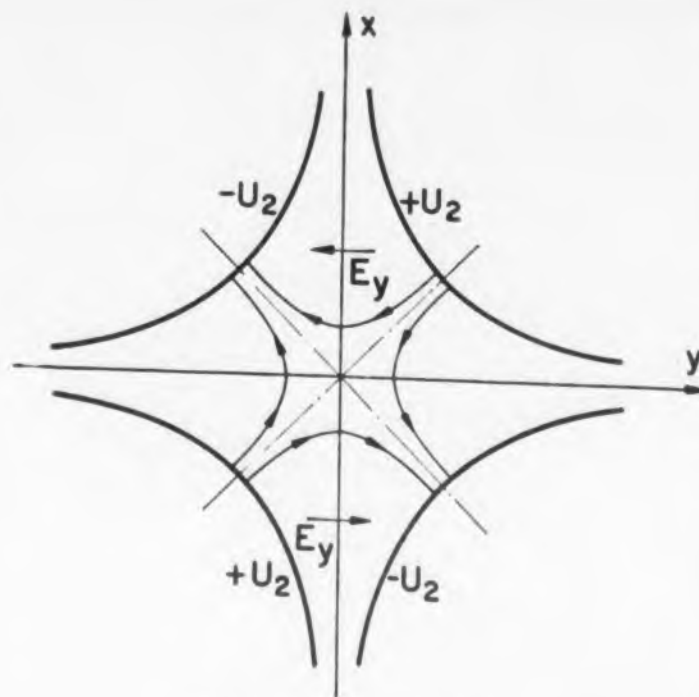


Fig. 2. Arrangement of electrodes for hyperbolic field.

the differential amplifier input almost at zero. The output voltage  $U_3$  of the feedback amplifier is at the same time output of the multiplier, since it is proportional to  $U_1 \times U_2$ .

The maximum input voltages are 25 and 50 v respectively, while the maximum product voltage is limited to 60 v. The maximum error referred to maximum output is approximately 0.5 per cent. The upper frequency limit is indicated as about 200 kc. Problems of electrode geometry, beam cross section deformation and stability of the feedback control system are also discussed. *W. Schmidt, "The hyperbolic field tube, an electron beam tube for multiplication in analog computers," Zeitschr. f. angew. Physik, vol. 8, pp. 69-75; February 1956.*

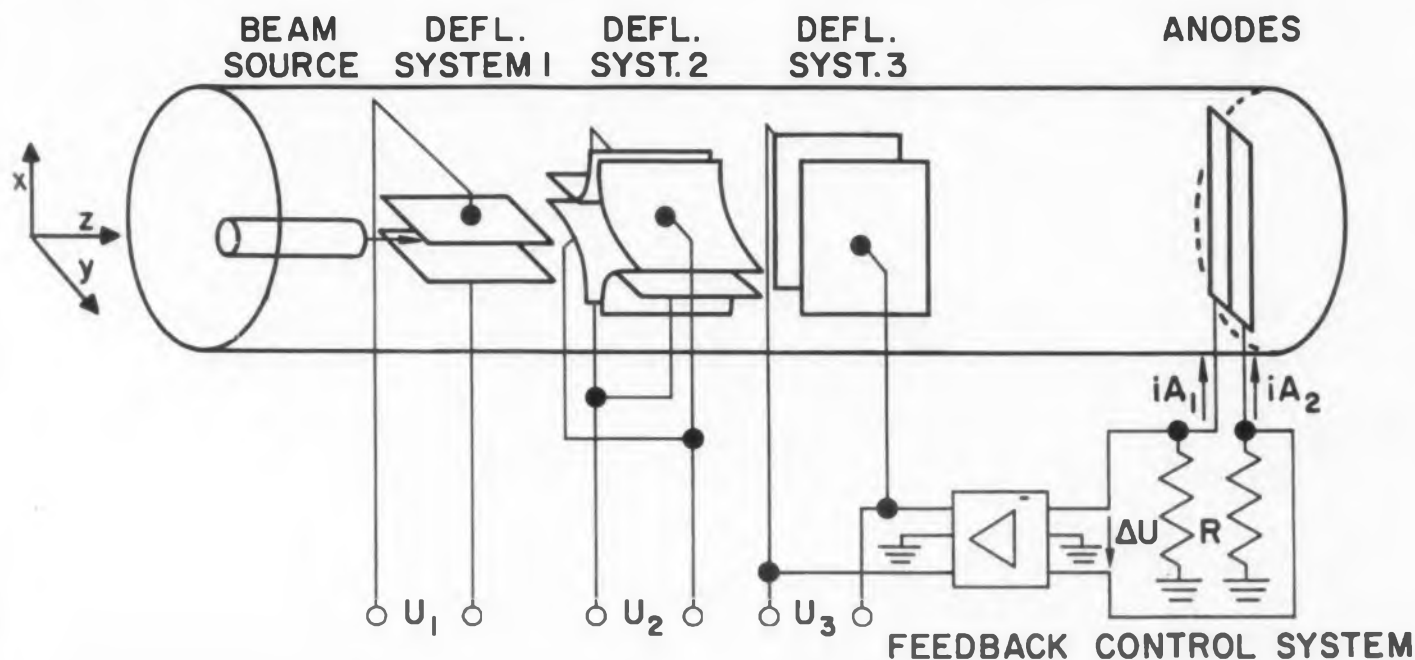


Fig. 1. Electrode arrangement of hyperbolic field multiplier.

## Here's the New

### BASIC SUB-MINIATURE SWITCH



**New** Increased Life to 200,000 Operations Guaranteed

**New** Greater Stability of Characteristics

**New** Lower Price

This Electro-Snap Sub-Miniature Basic Switch has been improved to give even better performance—and at less cost. Although no thicker than a lead pencil and only 27/32" long, 23/64" high, it does a man-sized job, handling 5 amps at 125v AC or 4 amps resistive, 2.5 amps inductive at 30v DC. Its small size plus low operating force and small movement differential make it ideal for precision control of "feather touch" devices, business machines, aircraft and instrument circuits. Positive snap action resists vibration and shock, has no dead center. Available in normally open and normally closed single-pole models and in single-pole, double-throw models.



WRITE FOR DETAILS IN DATA SHEET ES-10



**ELECTRO-SNAP  
SWITCH & MFG. COMPANY**

4216 West Lake Street  
Chicago 24, Illinois

CIRCLE 291 ON READER-SERVICE CARD FOR MORE INFORMATION

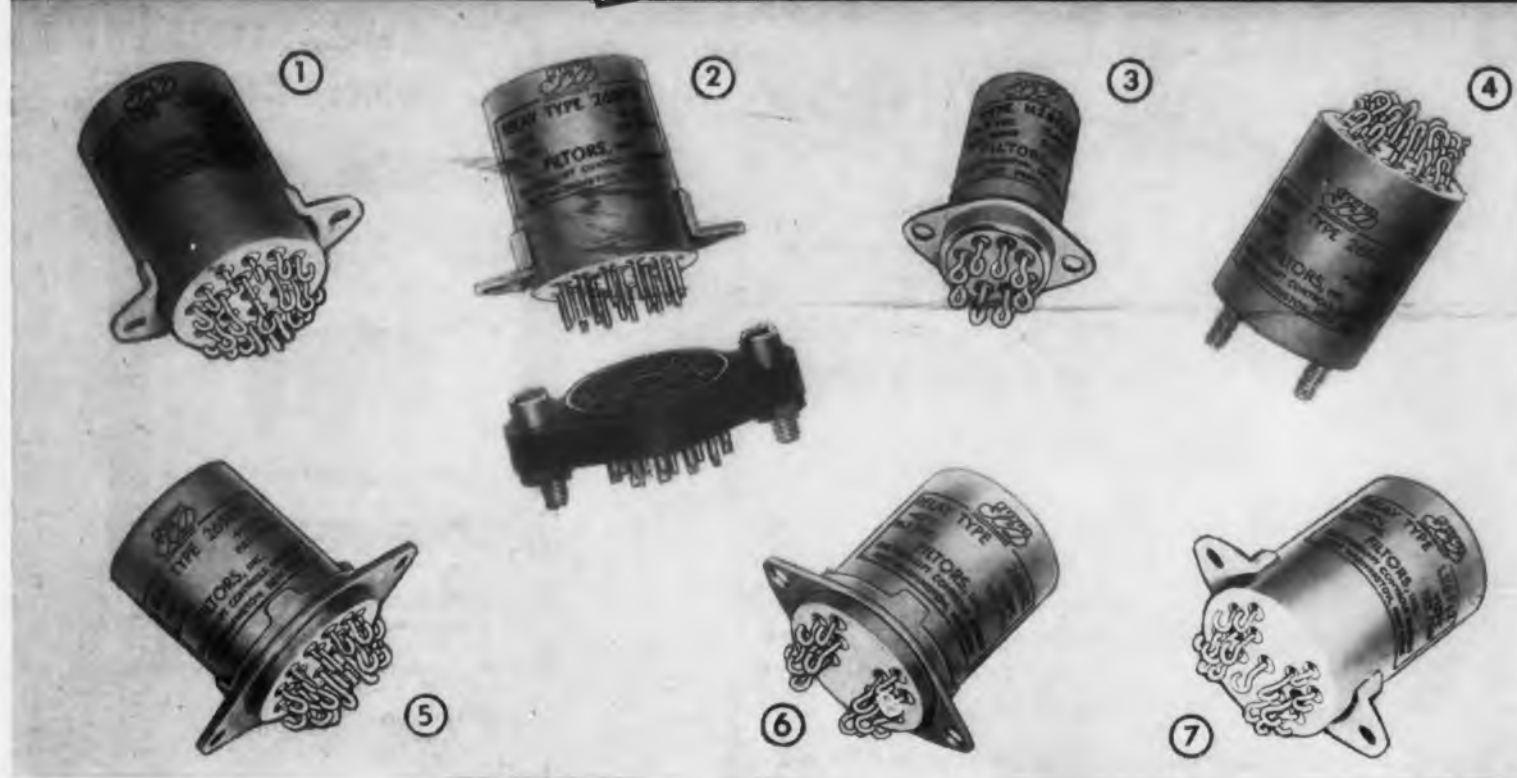
grid  
but  
ulses  
efore  
pulse  
cond  
rans-  
eated  
incipi-  
s de-  
of the  
only  
In a  
one  
cond.  
with  
uits."

/mmfd  
/mmfd  
ms

r  
1  
v  
N  
a  
a



# FILTORS SUB-MINIATURE RELAYS



Modern Fireproof Plant



Assembly Wing

Reliability Testing

## OUR MODERN PRODUCTION FACILITIES AND PRECISION TEST EQUIPMENT mean **QUANTITY + RELIABILITY**

More than 1000 relays a day are being shipped to the largest manufacturers of military equipment in the United States. Constant testing of sample lots from production runs (100% testing in the case of low level relays) has given Filtors relays a reliability rating second to none.

Below is a brief description of the relays pictured above. For complete information regarding these types and other types manufactured by Filtors write for catalog today.

	①	②	③	④	⑤	⑥	⑦
CONTACT ARRANGEMENT.....	6PDT	6PDT	2PDT	6PDT	6PDT	4PDT	4PDT
CONTACT RATING..... (AMPS. RES. at 26.5 VDC or 115 VAC)	3	3	2	3	3	3	3
NOMINAL COIL VOLTAGE..... (VOLTS D.C.)	26.5	26.5	26.5	26.5	26.5	26.5	26.5
HOUSING DIAMETER.....	1"	1"	.635"	1"	1"	1"	1"
MOUNTING CENTERS.....	1.406	1.406	.875	.625	1.562	1.406	1.406
SHOCK (11 millisecc).....	50G	50G	50G	50G	50G	50G	50G
VIBRATION at 10G.....	5 to 500	5 to 500	5 to 2000	5 to 500	5 to 500	5 to 500	5 to 500
MAX. OPERATE AND RELEASE TIME AT... NOMINAL VOLTAGE (in milliseconds)	10	10	10	10	10	10	10
RELAY TYPE.....	L26F18	26SP18	M26FC6	26SC18	26SE18	26SR12	L26F12

FOR DRY CIRCUIT (LOW LEVEL) RELAYS ADD THE LETTER "S" AT THE END OF THE TYPE DESIGNATION. EXAMPLE: TYPE 26SP18S

All made to MIL-R-5757 and MIL-R-25018 (USAF)

**FILTORS, INC.**

30 SAGAMORE HILL DRIVE, PORT WASHINGTON, L. I., N. Y., Tel. PORT WASHINGTON 7-3850

CIRCLE 292 ON READER-SERVICE CARD FOR MORE INFORMATION

Govt. Abstract

## Crystal Diodes—

Three types of crystal diodes are most common. They are; general purpose germanium and silicon diodes, power silicon diodes, and forward and reverse high-frequency silicon diodes. The last are commonly called mixer crystals.

Germanium diodes, such as the IN34A or IN69, are used for fairly low frequency applications such as video, audio, and pulse circuits. Many are used as detectors in radio and television equipment, and as mixers at frequencies up to 900 mc.

Silicon power diodes offer higher voltage and current outputs than the germanium type. They will operate at much higher ambient temperatures.

Mixer crystals, such as the IN21 or IN23, are designed for microwave detection and mixing. These are very carefully made with low-loss ceramic barrels and gold-plated brass tips and bases for close fits in waveguide and coaxial fittings.

Mixer crystals are available for use with frequencies of from 1000 to 35,000 mc. Those for use of 1000 to 10,000 mc will usually be of the cartridge type. Diodes for 10,000 mc and above are usually the coaxial type.

In the cartridge type, the active crystal is attached to a threaded end plug. The latter is then inserted into the end cap and the whole assembly fastened to the ceramic body. The opposite end of the body carries a contact pin, to which is attached a catwhisker of especially formed and tempered wire. The diameter and shape of the catwhisker are designed to provide correct contact pressure against the crystal of the silicon.

In the coaxial type of crystal, the silicon crystal is fastened to a metal end plug that is fitted to the external sleeve. The center conductor is mounted coaxially with the external sleeve, and is supported by an insulating bead, accurately machined to insure concentricity. One end of the catwhisker is welded to the center conductor.

Reverse mixer crystals, such as the IN21CR or IN23CR, are identical in characteristics to the ordinary type whose number they carry. Thus, a IN23CR is electrically identical to a IN23C except for the reversal of polarity. The crystal in the reverse type is fastened to the tip, making the tip the anode and the base the cathode.

## Forward and Reverse Types

Reverse type crystals were developed because the construction of most microwave crystal holders makes it impossible to use an ordinary or forward type of diode inserted in a reverse direction.

Another common usage is in certain types of balanced mixers. To obtain the cancellation of rf signals and reinforcement of the intermediate frequency, one of the crystals must be of reversed polarity. Most types of mixer crystals are available in both forward and reverse polarity.

Most radar receivers use balanced mixers, which provide a much better noise figure than the older single-ended mixers. Most balanced mixers require that the two crystals and holders have identical characteristics. Crystal pairs are matched for leakage, rectified current, and minimum noise in a precision magic-tee fitting, or equivalent balance mixer, with identical crystal holders. Maximum leakage power is 10% of input.

Matching of the rectified crystal current insures balance of the individual rf impedances and conversion loss values. The maximum rectified current unbalance permitted in matched pairs is 10 per cent of the smaller crystal current at 0.5  $\mu$ amp.

Mixer crystals are subject to burnout either by very short pulses (0.1  $\mu$ sec) of sufficient total energy, or by longer pulses (1  $\mu$ sec) of sufficient peak power.

It should be noticed that deterioration of mixer crystals will occur at levels below that required for complete burnout. Deterioration is caused by slight fusing of the pointed metallic contact catwhisker. This increases the contact area, thereby increasing the shunt capacitance of the rectifier.

The increased capacitance in turn adversely affects the conversion loss and noise characteristics of the crystal. A good test for deterioration, when suitable test equipment for these characteristics is not avail-

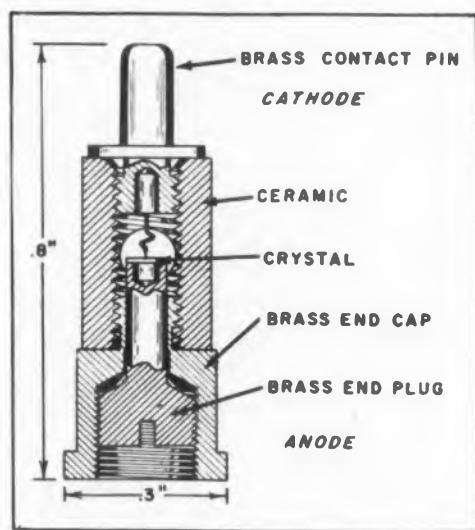
Sectional view of a germanium crystal diode.

able, is a measurement of the forward and reverse dc resistance with a sensitive meter. The ratio, at 1 v, of reverse to forward resistance that is to be measured should be at least 10 to 1.

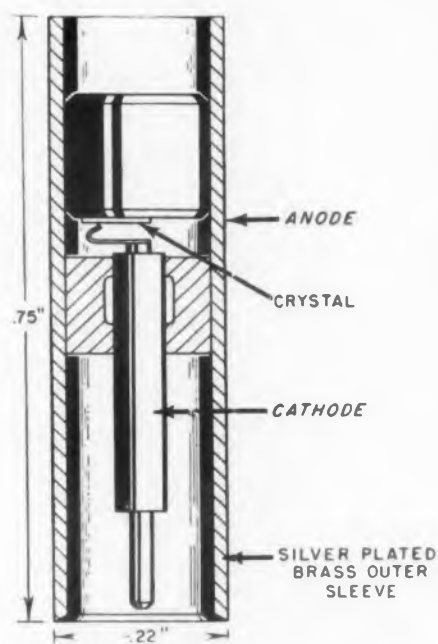
Performance of mixer crystals is not affected by orientation. However, care should be taken to avoid mechanical strain on the body of the contact pin. Soldered connections are not recommended. Spring contacts of beryllium copper are most frequently used.

In mixer applications, performance is a function of local oscillator injection. The local oscillator current is most easily determined by measurement of rectified current, the optimum value of which will generally lie between 0.5 and 1.0 ma. Current in excess of 5.0 ma may cause permanent damage to the crystal.

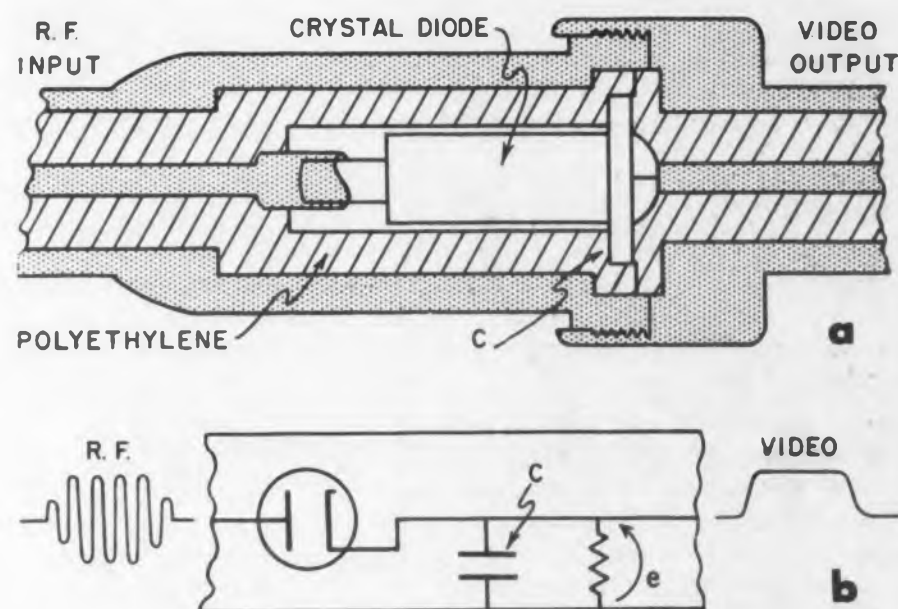
*Abstracted from Crystal Diodes—Forward and Reverse Types, Bureau of Ships Journal, July 1956, page 29.*



Cartridge type of silicon crystal diode.



Coaxial type of silicon crystal diode.



Reverse diode mounted in a coaxial line crystal holder, a. In the schematic, b, capacitance C represents capacitance from the crystal diode base to the shell.



Mr. P. Argyle Wigglesby, Board Chairman of Conglomerated Figleaf Enterprises, seen examining new SIGMA CDS PHOTORELAY. Although almost speechless, Mr. W. did finally manage the comment, "This is just great!"

and right you are, Mr. Wigglesby!

Now that commercial development of cadmium sulfide photocells has settled down a little and production lots arrive accompanied only by the less troublesome types of bugs, it seems reasonable to think about the useful applications these cells may have. To help such thinking and thinkers, Sigma has put together a 41 relay and a CdS cell in a neat, manageable and low-cost package. The CdS Photorelay—Model 1, now in production, offers these specs:

**Operate:** 5 foot-candles (max.); drop-out 0.1 f-c (min.)

**Speed:** 2 operations per sec., guaranteed minimum

**Coil voltage:** 115 AC

**Temperature range:**  $-40^{\circ}$  C. to  $+95^{\circ}$  C.

**Mounting & enclosure:** 5-pin base, dust-can cover.

**Price:** \$12.00 each (quan. 1-19); \$7.20 each (1000 and up).



The Series 41 relay used in this device was hailed (by us) about a year ago as "probably the best, low cost AC relay available with sufficient sensitivity (0.10-0.15 v-a) for such use." To date we haven't seen any reason to alter our ego concerning the 41.

So far Photorelays have been shipped only in limited numbers to various interested manufacturers, but repeat orders seem to indicate we may really have something (or more accurately, *they* have something that needs the Photorelay).

\* Pinball machines

Likely prospects include, in addition to Mr. Wigglesby, manufacturers of furnace flame-out controls, pinball machines\*, elevators, conveyors, weighing equipment, etc. The Photorelay has already been incorporated in automatic bottle washing and bagging equipment designs. (Special models are pending, awaiting further word from Conglomerated Figleaf.)

The easiest way to see how you might use such a compact, low-cost, AC photoelectric control in your equipment, is to buy a sample and try it.

**SIGMA INSTRUMENTS, INC.**

91 Pearl Street, So. Braintree, Boston 85, Mass.

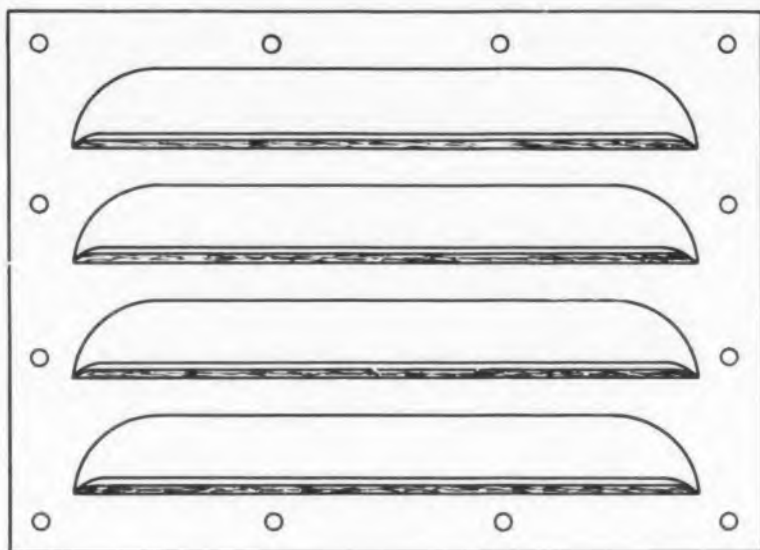
CIRCLE 293 ON READER-SERVICE CARD FOR MORE INFORMATION



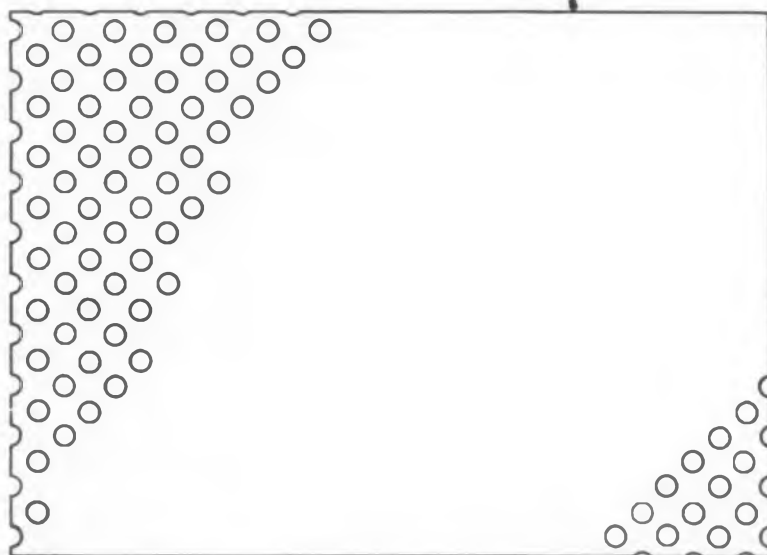
# Making Electronic Chassis Splashproof

Several simple methods of improving splash resistance of louvers have been suggested by J. W. Sampsell and K. W. Wyckoff of the U. S. Navy Electronics Laboratory, San Diego, Calif. Drawings here are cross sections of configurations of several degrees of splash proofing. These configurations provide protection ranging from a slight improvement in splash resistance over that given by standard louvers, to complete splash-proofing.

*Abstracted from Bureau of Ships Journal, July 1956, page 34.*



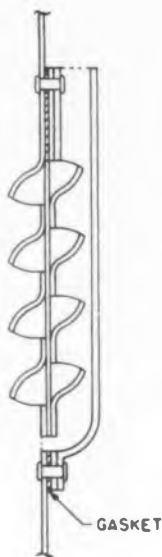
Front and side views of a standard louver of an electronic equipment cabinet.



Addition of the perforated plate, left, to the back-to-back louvers, right, gives additional splash protection.



Some improvement in splash resistance over the standard louver is achieved by mounting louvers back-to-back.



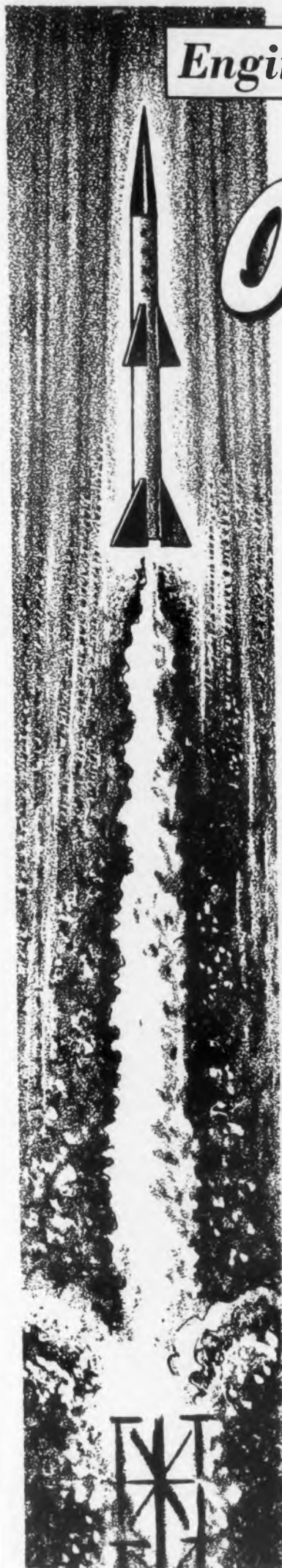
For complete splashproofing, a box-like arrangement was added to the double louvers. This arrangement is for an inside installation.



Complete splashproofing of an outdoor installation is obtained by modifying the box attachment used in the indoor installation.

Engineers • Physicists

# On The Way UP!



● Planned progress is the key to success for an individual as well as a business.

● Here at BURROUGHS we know where we are going . . . our course is charted and, like such advanced Intercontinental Ballistic Missiles as ATLAS and TITAN, we too are on the way up!

*More than 1,600 people and in excess of 200,000 square feet of working space in our four centers, located in the Paoli area, testify to our progress since 1954.*

● If YOU are an Engineer or Physicist . . . ON THE WAY UP . . . why not make the ascent with us in the creation and development of the advanced new computer techniques which will be required to control the course, speed and altitude of such Intercontinental Ballistic Missiles as ATLAS and TITAN as they are propelled out into space beyond the earth's atmosphere?

● Sage . . . ICBM . . . are just a few of the many government projects under way at BURROUGHS RESEARCH CENTER where, and equally important, untold time and creative effort is also being spent by our scientists on new and better ways to improve the business machines which have given BURROUGHS the right to use the slogan:

## THE Foremost Name IN COMPUTATION

### To Meet Tomorrow's Challenges Today

*Burroughs Invites Inquiries from Those Qualified As:*

- ELECTRICAL ENGINEERS
- MECHANICAL ENGINEERS
- MATHEMATICIANS
- ELECTROMECHANICAL ENGINEERS
- MECHANICAL DESIGN ENGINEERS
- PHYSICISTS

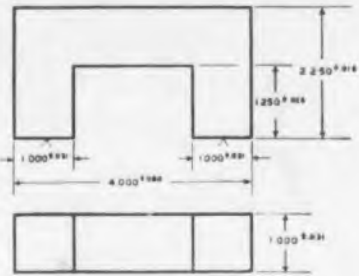
*. . . in the following fields — Control Computers, Pulse Circuitry, Digital Computers, Optical Devices, High Speed Mechanisms, Guided Missiles, Solid State Circuitry, Electronic Packaging, Electrographic Recording Devices, Printed Circuit Development.*

Write or Telephone M. E. JENKINS, Placement Manager



Near Historic Valley Forge

# HIGHER EFFICIENCY H-F POWER TRANSFORMERS



THIS IS A TYPICAL FERROXCUBE  
MAGNETIC CORE DESIGN

Smaller, lighter and less costly H-F power transformers of outstanding efficiency are being designed around Ferroxcube magnetic cores. The unique advantages of Ferroxcube are particularly marked in transformers required to handle up to 2 kilowatts of power in the frequency range from 2 kilocycles to 2 megacycles.

Ferroxcube-cored transformers are being used successfully in ap-

plications as diverse as ultrasonic power generators and rectifier power packs operating from an aircraft's normal a-c supply. In the latter application, the low leakage field of Ferroxcube eliminates the need for external shielding — for further reduction in transformer size and weight.

Ferroxcube cores are designed and produced to specifications. Our engineering department offers a complete, prompt service to assist in the design of Ferroxcube cores for specific applications. Your inquiry will receive immediate attention. ★ ★ ★ ★ ★



## Standards and Specs

Sherman H. Hubelbank

This department surveys new issues, revisions, and amendments, covering military and industry standards and specifications. Our sources of information include the Armed Services Electro-Standards Agency (ASESA), the cumulative indexes to Military Specifications, Vols. II, IV, American Standards Association (ASA) and other standards societies.

### Standards Proposal-Request for Comment

The RETMA Engineering Office, 11 W. 42nd St., New York 36, N.Y., requests industry comments on the following proposed standards. Send for proposal number as indicated. (Although the official comment period may have expired, you are encouraged to comment if you are vitally interested.)

SP 504, EMERGENCY STAND-BY POWER GENERATOR AND ACCESSORIES FOR MICROWAVE SYSTEMS . . . Definitions and minimum requirements for engine driven generator sets used for providing emergency stand-by power to microwave communications systems are established by this standard. Covered in this standard are permanently installed engine driven generator sets of not over 25 kw.

SP-505, ADDITION TO RETMA STANDARD ET-109A, MEASUREMENT OF DIRECT INTERELECTRODE CAPACITANCES OF ELECTRON TUBES OF T2 x 3 SHIELD . . . Fig. 10 has been added to the material previously submitted in SP-430. In publication, this shield will be known as No. 319.

SP-506, NOMENCLATURE OF TUBE TESTERS . . . Tube testers are divided into four numbered groups by this proposed standard. These groups are described and illustrated in this proposal, so that assignment of any tube tester to one of these groups will be simple and certain.

### Electrical Conductors

ASTM STANDARDS ON METALLIC ELECTRICAL CONDUCTORS, 1955 . . . This 300-page compilation includes in their latest form 52 ASTM standards, consisting of 43 specs, 7 test methods, 1 recommended practice, and 1 classification of coppers. The standards cover: (1) copper, copper alloy and copper covered steel; wire; stranded conductors; rods, bars, and shapes; pipes and tubes; (2) aluminum: wire; stranded conductors; rods and bars; and (3) galvanized steel core wire; and galvanized iron and steel guy, messenger, span, overhead ground, and line wire. Of the material contained in this book, 20 of the specs have been revised and one of the standards is new since the previous edition. Copies of this book can be obtained from American Society for Testing Materials Headquarters, 1916 Race St., Philadelphia 3, Pa., for \$3.50 each.

## FERROXCUBE CORPORATION OF AMERICA

• A Joint Affiliate of Sprague Electric Co. and Philips Industries, Managed by Sprague •

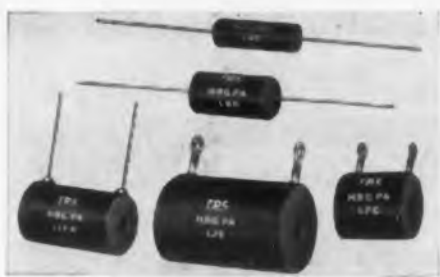
347 BRIDGE STREET • SAUGERTIES, NEW YORK

CIRCLE 295 ON READER-SERVICE CARD FOR MORE INFORMATION



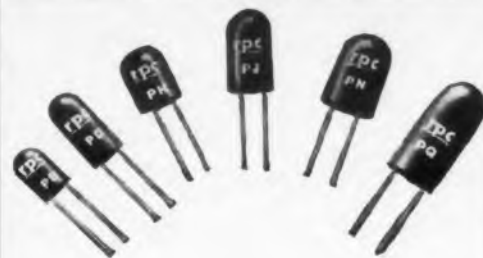
# RESISTORS

PRECISION WIRE WOUND • HIGH VOLTAGE • HIGH MEGOHM • HIGH FREQUENCY



Encapsulated Precision  
Wire Wound Resistors

RPC Type L Encapsulated Resistors will withstand temperature and humidity cycling, salt water immersion and extremes of altitude, humidity, corrosion and shock without electrical or mechanical deterioration. Type L resistors are available in many sizes and styles ranging from sub-miniature to standard with lug terminals, axial or radial wire leads. Available for operation at 105° C. or 125° C. ambient temperatures. These resistors will meet all applicable requirements of MIL-R-93A, Amdt. 3. Type L can be furnished with all resistance alloys and resistance tolerances from 1% to .02%.



NEW Printed Circuit  
Precision Resistors

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 3. Available in 6 sizes, rated from 1/10 watt to .4 watt. 1/4" diameter by 3/16" long to 3/8" diameter by 1/4" long. Resistance values to 3 megohms. Tolerances from 1% to 0.05%.



High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a 1 watt resistor 1 inch long x 3/8 inch diameter rated at 3500 volts, to a 10 watt resistor 6 1/2 inches long x 3/8 inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.

## RESISTANCE PRODUCTS COMPANY

914 SOUTH 13TH STREET,

HARRISBURG, PENNA.

SPECIALIZING IN  
THE MANUFACTURE  
OF QUALITY RESISTORS  
IN ANY AMOUNT

CIRCLE 296 ON READER-SERVICE CARD FOR MORE INFORMATION



### Nameplates

MIL-N-25076 (ASG), NAMEPLATE, IDENTIFICATION, METALLIC FOIL, ADHESIVE-BACKED, 30 MARCH 1956 . . . Design and testing requirements for adhesive-backed aluminum-foil nameplates intended for identification and other marking information on aircraft equipment and accessories are established by this spec. Aluminum-foil nameplates may be furnished as either pressure sensitive with a water-removable cellophane backing or as an adhesive-backed solvent-activated film.

### Switches

MIL-S-9419B (ASG), SWITCH, TOGGLE, MOMENTARY, FOUR-POSITION ON, CENTER OFF, 10 APRIL 1956 . . . A minimum envelope, four-position, momentary on, center off, positive action, free return toggle switch which shall ensure good contact and positive current-carrying capacity when operated under conditions of aircraft service is covered in this spec.

### Missile Specs Amended

MIL-D-8684 (AER), DESIGN DATA CONTACT REQUIREMENTS FOR GUIDED MISSILE WEAPON SYSTEM, AMENDMENT 1, 6 APRIL 1956 . . . Specs MIL-W-3947, Weight and Balance Control Data for Guided Missiles and MIL-M-18872, Microfilming Engineering Drawings and Related Data, Requirements For, have been added to the list of applicable specs. The five Bureau of Aeronautic "SR" type specs have been replaced by specs MIL-T-18847, MIL-I18802, MIL-D-18300, and MIL-T-18306. Instructions regarding the distribution of the structural design and test data reports have been added.

### Tech Manual Standardization Proceedings Published

Proceedings of the 1955 Symposium on Standardization of Technical Manuals, sponsored by the Technical Publishing Society, are now available. The Technical Publishing Society is a California non-profit corporation organized to serve the technical communications profession. Copies of the Symposium may be obtained from the Technical Publishing Society, P.O. Box 607, Tarzana, Calif. for \$1.00 per copy.

### Terminal Boards

MIL-T-16784A (SHIPS), TERMINAL BOARDS, 21 MARCH 1956 . . . Terminal boards used for connections in electrical and electronic circuits are covered by this spec. A typical type designation for a terminal board covered by this spec is 6TB10. A listing of standard terminal boards is included in this spec.

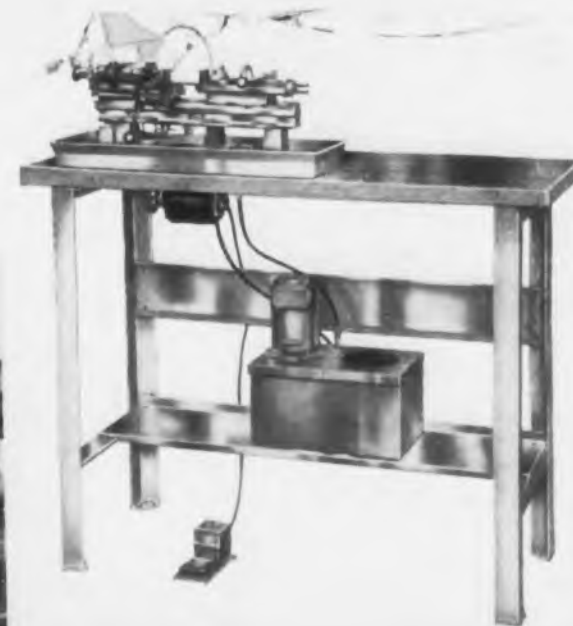
### Filters

MIL-F-18344A (SHIPS), FILTERS, RADIO INTERFERENCE, NAVAL SHIP AND SHORE USE, AMENDMENT 1, 17 FEBRUARY 1956

A vibration test setup with full load current and voltage applied for ac and dc filters has been added by this amendment.

## YOU CAN PRODUCE SMALL INSTRUMENT PARTS WITH MORE ACCURACY • ECONOMY and SPEED

A small precision turret lathe for second operations and production of instrument parts. Available in two collet capacities, 5/16" or 3/16". The 6 position turret is self indexing and has hardened ways. Turret holes are 1/2" diameter. Turret travel 1-5/8".



## LEVIN® TURRET LATHES

The cross slide has a swivel slide at one end and a rigid tool block at the other. Lever collet closer provides quick opening and closing. A variety of turret tools with 1/2" shanks is available.

Send for catalog M describing complete line of instrument lathes, micro-drilling equipment and accessories.

LOUIS LEVIN & SON, INC.

3610 South Broadway

Los Angeles 7, California

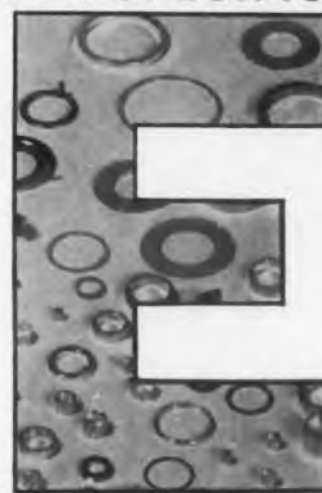
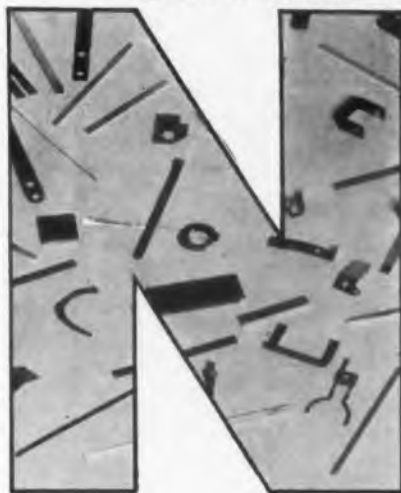
CIRCLE 297 ON READER-SERVICE CARD FOR MORE INFORMATION



NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION

## ENGINEERED CONTACTS, SLIP RINGS & ALLOYS

SUPPLIED TO YOUR SPECIFICATIONS BY . . .



Ney offers wide experience in the development of sliding contacts, slip rings and assemblies, commutator segments and assemblies, brush and brush holder assemblies, and precious metal resistance wire. Call or write the Ney Engineering Department for consultation on any problem involving the use of precious metals to improve your products.

THE J. M. NEY COMPANY, P. O. BOX 990, DEPT. D, HARTFORD 1, CONN.

Specialists in Precious Metal Metallurgy since 1812

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS • NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION  
CIRCLE 298 ON READER-SERVICE CARD FOR MORE INFORMATION

A TYPE FOR EVERY KNOWN APPLICATION . . .

## BOMAC gas switching tubes . . .

*Bomac* designs and manufactures the most complete line of gas switching tubes available anywhere today — TR, ATR, pre-TR, dual or triple TR tubes . . . from 150–70,000 mc . . . fixed-tuned or tunable . . . standard or highly specialized types. Whatever your requirements, *Bomac* can meet them. And here's a point to remember about *Bomac* reliability — every *Bomac* tube and component is 100% tested before it leaves our plant.



# Bomac Laboratories, Inc.

DEPT. ED-10, BEVERLY, MASSACHUSETTS

Cities in major cities — Chicago — Kansas City — Los Angeles — Dallas — Dayton — Washington — Seattle — San Francisco — Toronto

**WANT MORE INFORMATION?**  
Write for *Bomac's* 6-page, 16-page folder containing details and specifications on more than 300 different microwave tubes and components.

Circle 299 on Reader-Service Card

## ADVERTISING INDEX

October 1, 1956

Advertiser	Page
Ace Engineering & Machine	47
Aero-Research Instrument Co.	86
AGA Div. of Elastic Stop Nut Corp.	84
Aircraft Radio Corp.	89
Alladin Radio Industries, Inc.	19
Allied Radio Corp.	84
American Plastics Corp.	88
Amersil Co. Inc.	64
Amphenol Electronics Corp.	74
Arnoux Corp.	97
Assembly Products Inc.	84
Bendix Aviation Corp., Pacific Div.	57
Benson-Lehner Corp.	17
Bomac Laboratories	106
Bradley Laboratories	45
Bristol Company	66
Bruno-New York Industries Corp.	75
Burgess Battery Co.	78
Burdy Engineering Co.	84
Burnell & Co., Inc.	26
Burroughs Corp., Research Center	103
Cambridge Thermionic Corp.	80
Celco Constantine Engineering Laboratories	94
Centralab, Div. of Globe Union	96
Ciba Co. Inc.	9
Circuit Instruments Inc.	87
Clare, C. P. & Co.	80
Clary Corp.	95
Clifton Precision Products	15
Cohn, Sigmund, Mfg. Co., Inc.	95
Commercial Plastics Co.	82
Communication Accessories	81
Connecticut Hard Rubber Co.	77
Convair-Div. of General Dynamics	73
Daystrom Pacific Corp.	36
DeJur Amsco Corp.	91
Dow Chemical Co., The	55
Dynac Inc.	80
Electro-Instruments	107
Electro Snap Switch & Mfg.	99
Electronic Measurements Co.	78
Empire Devices Products Corp.	93
Faber-Castell, A. W. Co., Inc.	83
Fafnir Bearing Co.	42
Federal Tool & Mfg. Co.	90
Fenwal, Inc.	85
Filtors, Inc.	100
Firestone Tire & Rubber Co.	31
Fusite Corp., The	13
Gamewell Co.	76
General Electric Co., Apparatus Div.	8, 89
General Electric Co., Electronics Div.	50, 51
General Motors, AC Spark Plug Div.	27
General Precision Laboratory Inc.	95
General Radio Co.	79
Graphite Metallizing Corp.	61
Hartwell Aviation Supply Co.	85
Heinemann Electric Co.	20
Heli-Coil Corp.	43
Heyman Mfg. Co.	78
Hoffman Semiconductor Div.	21
Holtzer-Cabot Div.	54
Hughes Aircraft Co.	25, 55
Hughes Research & Development	58
Ideal Industries, Inc.	77
International Nickel Co.	85
Jet Propulsion Laboratory	48

◀ CIRCLE 299 ON READER-SERVICE CARD



Advertiser	Page
Boch, H. & Sons	87
Johnson-Hite Instrument Co.	77
Math Laboratories Inc.	61
App Insulator Co., Inc.	54
Beach Corp.	29
Beland, G. H. Inc.	83
Levin, Louis & Son	105
Inde Air Products Co.	84
Magnetics, Inc.	62
Narconi Instrument Co.	56
Micro Switch Div.	68
Millivac Instrument Corp.	76
Minnesota Rubber & Gasket Co.	75
Moloney Electric Co.	6
Mullard Ltd.	59
National Research	86
New Hermes Engraving Machine Co.	82
Ney, J. M. Co.	105
North American Aviation, Inc.	52, 74
North Electric Co.	70
Northrop Aircraft, Inc.	88
Oak Mfg. Co.	12
Perkin Engineering Corp.	7
Phillips Control Corp.	28
Polarad Electronic Corp.	10, 11, 49
Potter Instrument Co.	3
Precision Paper Tube Co.	93
Radio Condenser Co.	46
Radio Corp. of America	108
Radio Receptor Co.	69
Raytheon Mfg. Co.	63, 81
Raytheon Mfg. Co., Semi-Conductor Div.	4
Resistance Products Co.	104
Sanders Associates, Inc.	92
Sarkes Tarzian Inc.	71
Servo Corp. of America	60
Servo-Tek Products Co., Inc.	65
Shasta, Div. of Beckman Instruments Inc.	94
Shell Chemical Corp.	2
Sigma Instruments Inc.	102
Sprague Electric Co., Ferroxcube Div.	104
Stackpole Carbon Co., Jobbing Div.	57
Staedtler, J. S. Inc.	65
Standard Pressed Steel Co.	76
Stevens-Arnold, Inc.	81
Stoddart Aircraft Radio	64
Sun Chemical Corp.-Electro Technical Products	94
Sylvania Electric Products, Buffalo Labs Div.	90
Sylvania Electric Products, Public Relations Dept.	67
Sylvania Electric Products, Waltham Labs. Div.	86
Synthane Corp.	72
Technicraft Laboratories, Inc.	56
Tektronix, Inc.	16
Thermal American Fused Quartz Co.	71
Torrington Co., The	79
Triad Transformer Corp.	30
United Electronics Corp.	14
United States Gasket Co.	60
University Loudspeakers, Inc.	79
Universal Electronics	82
Vector Electronic Co.	85
Welwyn International	91
Whiso, Inc.	70
Zep Manufacturing	86

NOW E-I OFFERS  
THE COMPLETE GRAPHIC DATA  
HANDLING LINE...

## 3 NEW *x-y recorders*

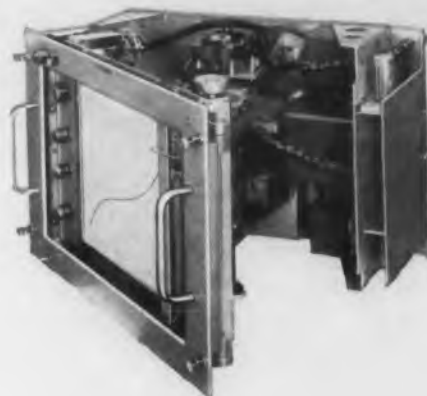
plus a COMPLETE line  
of ACCESSORIES!

Every operating convenience possible has been built into these new E-I X-Y Recorders to provide maximum simplicity of control and ease of maintenance.

In addition, numerous performance features such as freedom from jitter, isolated inputs, automatic pen lift, vacuum hold-down, high-performance servos, and sensitivities from 0.5 mv per inch to 50 volts per inch provide performance excellence found in no other recorders.

Models are available for general-purpose recording, data handling, and analog computer recording and function generations. Ask your E-I representative for the complete story.

All models available for standard rack mounting. 11x17" instruments may be used in standard cabinet or rack mounted — without changing metalwork!



Accessories include: Curve follower (Model 210), Card-Tape Converter (Model 150), Keyboard (Model 175), and Symbol Generator (Model 250).



**model 100**

8½ x 11", flatbed, or rack mounted  
0.25% accuracy  
½-second full scale pen speed  
11 scale ranges, 5 mv to 500 v full scale  
200,000 ohms-per-volt input impedance



**model 200**

11 x 17", flatbed  
±0.15% of full scale accuracy  
20" per second slewing pen speed  
3 scales; 0.1 v, 1.0 v, 10 v per inch  
scale and zero potentiometers  
with in-line dials  
1 megohm input resistance

Shown with Keyboard (Model 175)  
and Symbol Generator (Model 250)  
10-key keyboard  
six electrically selected characters  
complete operational controls

**model 225**

11 x 17", flatbed  
±0.2 full scale accuracy  
20" per second slewing pen speed  
built-in electronic reference  
16 scale ranges, 0.5 mv to 50 v per inch  
200,000 ohms-per-volt input impedance

**ELECTRO  
INSTRUMENTS  
INC.**

3794 Rosecrans Street, San Diego 10, California



Another RCA first

# DRIFT

## TRANSISTOR

TYPE 2N247



### New Concept in Transistor Design for High-Frequency Applications in Military and Commercial Equipment, and Entertainment-type Receivers

Designed to provide a "built-in" accelerating field in the base region that propels charge carriers from emitter to collector, RCA-2N247—a germanium p-n-p type transistor—begins a new era in transistor operation at radio frequencies extending from the Standard AM Broadcast band well up into the short-wave bands.

Here is a design that makes possible a significant reduction in base resistance and collector capacitance—substantially increases voltage- and current-handling capability, provides shielding between base and collector leads to minimize interlead capacitance and coupling to adjacent components. The resultant benefits to designers are: (1) high input circuit efficiency, (2) excellent operating stability, (3) good automatic-gain-control capabilities over wide input-signal variations, and (4) good signal-to-noise ratio.

In addition to its major application as a radio-frequency amplifier, RCA-2N247 is also well suited as a mixer-oscillator (converter) and intermediate-frequency amplifier in entertainment-type receivers.

Adaptable to mass-production techniques, RCA-2N247 can provide for the expanding needs of high-frequency commercial and military applications. It is one more example of RCA's intensive development program in semiconductor techniques to provide high-quality transistors—in quantity. For more data on Drift Transistor, Type-2N247, write RCA, Commercial Engineering. Or call your RCA Field Representative.

#### TYPICAL OPERATION AS CLASS A RF AMPLIFIER

Common-Emitter Circuit Base Input Ambient  
Temperature = 25°C

	1.5 Mc	10.7 Mc
DC Collector-to-Emitter Volts	-9	-9 volts
DC Base-to-Emitter Volts	-0.2	-0.2 volt
DC Collector Current	-1	-1 ma
Collector-to-Base Feedback Capacitance	1.7	1.7 μuf
Input Resistance	1350	170 ohms
Output Resistance	75000	4500 ohms
Power Gain <sup>Δ</sup>	45	24 db

<sup>Δ</sup>Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer insertion losses not included).

#### RCA Field Offices

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

**MIDWEST:** WHitehall 4-2900  
Suite 1181,  
Merchandise Mart Plaza  
Chicago 54, Ill.

**WEST:** RAymond 3-8361  
6355 East Washington Blvd.,  
Los Angeles 22, Calif.



**RADIO CORPORATION OF AMERICA**  
Semiconductor Division Somerville, N. J.

HAYDEN PUBLISHING COMPANY, INC.  
19 East 62nd Street, New York 21, N. Y.

ELECTRONIC  
DESIGN