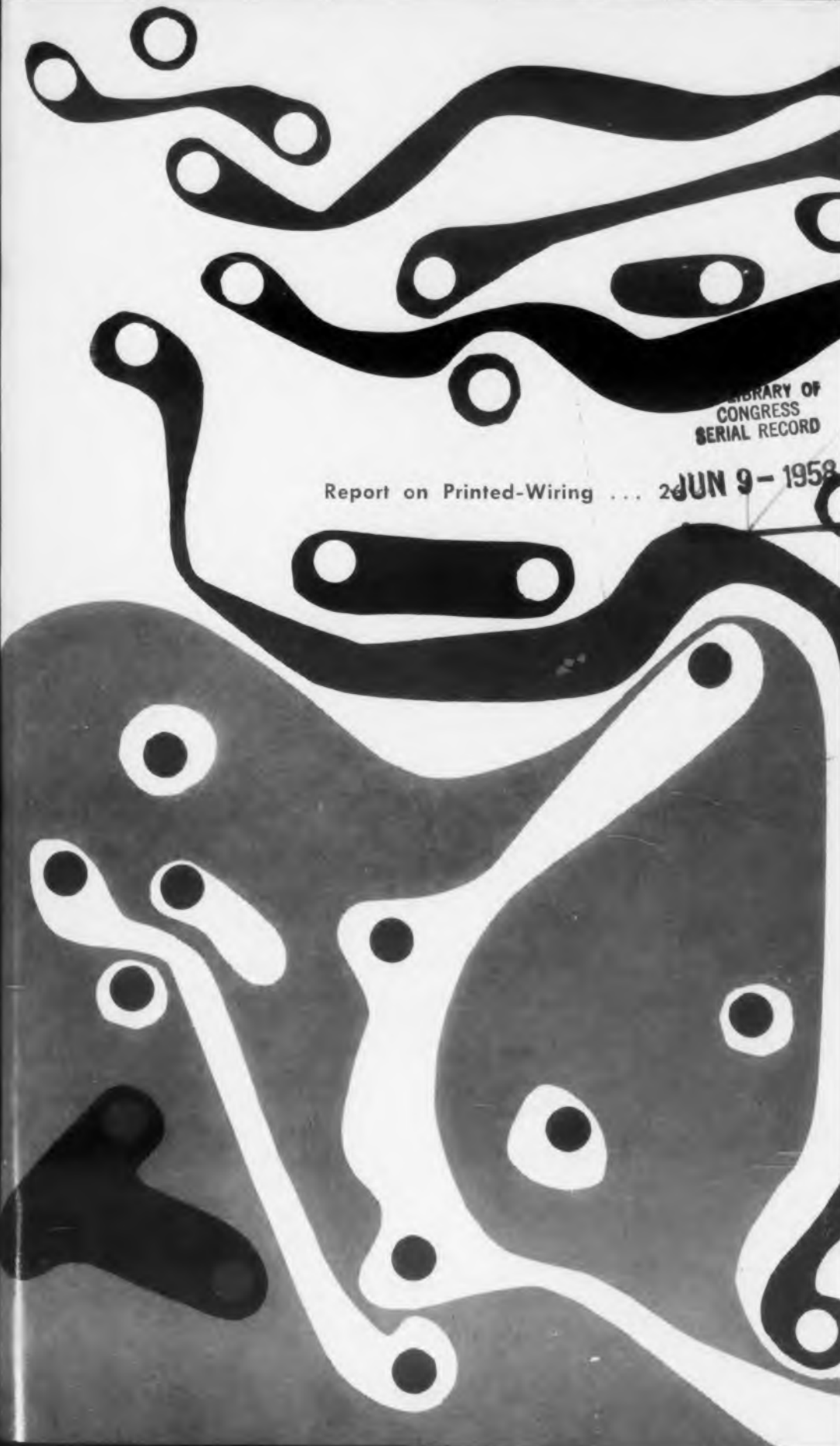


ELECTRONIC

D

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SERIAL RECORD

Report on Printed-Wiring ... 2 JUN 9 - 1958



ROUNDO
DESIGN

JUNE 11, 1960



IF YOU NEED A BATH

VITREOUS
ENAMEL
IS FINE *



* Fixed wire wound resistors are generally coated with either a cement or a vitreous enamel. The vitreous enamels employed are similar—as one reference book appropriately remarks—to those used in kitchenware and bathrooms.

But for Power Resistors you need **IRC[®] Resisteg Coating**

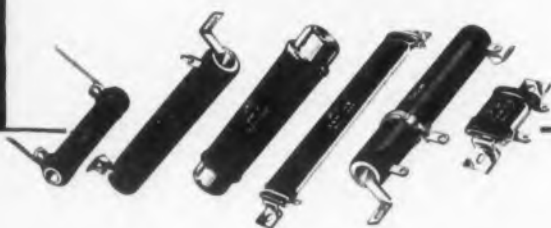
Consider the curing temperatures required for wire wound power resistor coatings and you'll readily see the advantages of IRC's exclusive RESISTEG Coating.

The low curing temperature of RESISTEG Coating is 205°F.—about the boiling point of water in many areas. Vitreous enamel must be cured at 1200°F., or higher!

IRC's low-temperature curing doesn't change the position of the wire, and winding turns do not shift together. No wire stretching, with its "work-hardening" aftereffect, is needed to prevent wire shifts.

RESULT: IRC Power Resistors have no "hot spots" from arcing-over. They offer greater stability, longer life and need no derating... even at high values.

Write for catalog of over 50 IRC Power Resistors including MIL types



—Wherever the Circuit Says—



INTERNATIONAL RESISTANCE COMPANY
Dept. 335, 401 N. Broad Street, Philadelphia 8, Pa.
CIRCLE 1 ON READER-SERVICE CARD

HIGHLIGHTS OF ISSUE



Making Printed-Wiring Reliable (Cover) 26

Several phases of printed-wiring design and fabrication contribute to reliable operation. Most important are: Standards; Board Design; Materials; Care and Handling; and Soldering. Each of these special report sections discusses the latest methods by which fabricators and users assure minimum failures. A sixth section discloses some of the newer or lesser known, but equally important forms of printed-wiring.

Printed Circuit Standardi- zation 22

One way to insure reliability is to insist on adherence to rigid standards. Arma Div. has achieved extremely reliable circuits in a missile application by working out specifications for their vendors. Every parameter that affects printed-wiring performance has been fixed at an optimum value to facilitate production without compromising quality.

Effects of Processing and Environment on Printed- Wiring Laminates 48

Only by thorough understanding of laminate characteristics can the design engineer properly use these materials. Effects of environment are important in choosing a laminate for a particular application. Processing also affects laminate characteristics. Effects of processing are important in calculations involving dimensional changes. Electrical characteristics of some laminates are adversely affected by processing and must be given careful considerations.

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|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 10 | 20 | 30 | 40 | 100 | 110 | 120 | 130 | 140 | 200 | 210 | 220 | 230 | 240 | 300 | 310 | 320 | 330 | 340 | 400 | 410 | 420 | 430 | 440 | 500 | 510 | 520 | 530 | 540 | |
| 1 | 11 | 21 | 31 | 41 | 101 | 111 | 121 | 131 | 141 | 201 | 211 | 221 | 231 | 241 | 301 | 311 | 321 | 331 | 341 | 401 | 411 | 421 | 431 | 441 | 501 | 511 | 521 | 531 | 541 |
| 2 | 12 | 22 | 32 | 42 | 102 | 112 | 122 | 132 | 142 | 202 | 212 | 222 | 232 | 242 | 302 | 312 | 322 | 332 | 342 | 402 | 412 | 422 | 432 | 442 | 502 | 512 | 522 | 532 | 542 |
| 3 | 13 | 23 | 33 | 43 | 103 | 113 | 123 | 133 | 143 | 203 | 213 | 223 | 233 | 243 | 303 | 313 | 323 | 333 | 343 | 403 | 413 | 423 | 433 | 443 | 503 | 513 | 523 | 533 | 543 |
| 4 | 14 | 24 | 34 | 44 | 104 | 114 | 124 | 134 | 144 | 204 | 214 | 224 | 234 | 244 | 304 | 314 | 324 | 334 | 344 | 404 | 414 | 424 | 434 | 444 | 504 | 514 | 524 | 534 | 544 |
| 5 | 15 | 25 | 35 | 45 | 105 | 115 | 125 | 135 | 145 | 205 | 215 | 225 | 235 | 245 | 305 | 315 | 325 | 335 | 345 | 405 | 415 | 425 | 435 | 445 | 505 | 515 | 525 | 535 | 545 |
| 6 | 16 | 26 | 36 | 46 | 106 | 116 | 126 | 136 | 146 | 206 | 216 | 226 | 236 | 246 | 306 | 316 | 326 | 336 | 346 | 406 | 416 | 426 | 436 | 446 | 506 | 516 | 526 | 536 | 546 |
| 7 | 17 | 27 | 37 | 47 | 107 | 117 | 127 | 137 | 147 | 207 | 217 | 227 | 237 | 247 | 307 | 317 | 327 | 337 | 347 | 407 | 417 | 427 | 437 | 447 | 507 | 517 | 527 | 537 | 547 |
| 8 | 18 | 28 | 38 | 48 | 108 | 118 | 128 | 138 | 148 | 208 | 218 | 228 | 238 | 248 | 308 | 318 | 328 | 338 | 348 | 408 | 418 | 428 | 438 | 448 | 508 | 518 | 528 | 538 | 548 |
| 9 | 19 | 29 | 39 | 49 | 109 | 119 | 129 | 139 | 149 | 209 | 219 | 229 | 239 | 249 | 309 | 319 | 329 | 339 | 349 | 409 | 419 | 429 | 439 | 449 | 509 | 519 | 529 | 539 | 549 |

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|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 10 | 20 | 30 | 40 | 100 | 110 | 120 | 130 | 140 | 200 | 210 | 220 | 230 | 240 | 300 | 310 | 320 | 330 | 340 | 400 | 410 | 420 | 430 | 440 | 500 | 510 | 520 | 530 | 540 | |
| 1 | 11 | 21 | 31 | 41 | 101 | 111 | 121 | 131 | 141 | 201 | 211 | 221 | 231 | 241 | 301 | 311 | 321 | 331 | 341 | 401 | 411 | 421 | 431 | 441 | 501 | 511 | 521 | 531 | 541 |
| 2 | 12 | 22 | 32 | 42 | 102 | 112 | 122 | 132 | 142 | 202 | 212 | 222 | 232 | 242 | 302 | 312 | 322 | 332 | 342 | 402 | 412 | 422 | 432 | 442 | 502 | 512 | 522 | 532 | 542 |
| 3 | 13 | 23 | 33 | 43 | 103 | 113 | 123 | 133 | 143 | 203 | 213 | 223 | 233 | 243 | 303 | 313 | 323 | 333 | 343 | 403 | 413 | 423 | 433 | 443 | 503 | 513 | 523 | 533 | 543 |
| 4 | 14 | 24 | 34 | 44 | 104 | 114 | 124 | 134 | 144 | 204 | 214 | 224 | 234 | 244 | 304 | 314 | 324 | 334 | 344 | 404 | 414 | 424 | 434 | 444 | 504 | 514 | 524 | 534 | 544 |
| 5 | 15 | 25 | 35 | 45 | 105 | 115 | 125 | 135 | 145 | 205 | 215 | 225 | 235 | 245 | 305 | 315 | 325 | 335 | 345 | 405 | 415 | 425 | 435 | 445 | 505 | 515 | 525 | 535 | 545 |
| 6 | 16 | 26 | 36 | 46 | 106 | 116 | 126 | 136 | 146 | 206 | 216 | 226 | 236 | 246 | 306 | 316 | 326 | 336 | 346 | 406 | 416 | 426 | 436 | 446 | 506 | 516 | 526 | 536 | 546 |
| 7 | 17 | 27 | 37 | 47 | 107 | 117 | 127 | 137 | 147 | 207 | 217 | 227 | 237 | 247 | 307 | 317 | 327 | 337 | 347 | 407 | 417 | 427 | 437 | 447 | 507 | 517 | 527 | 537 | 547 |
| 8 | 18 | 28 | 38 | 48 | 108 | 118 | 128 | 138 | 148 | 208 | 218 | 228 | 238 | 248 | 308 | 318 | 328 | 338 | 348 | 408 | 418 | 428 | 438 | 448 | 508 | 518 | 528 | 538 | 548 |
| 9 | 19 | 29 | 39 | 49 | 109 | 119 | 129 | 139 | 149 | 209 | 219 | 229 | 239 | 249 | 309 | 319 | 329 | 339 | 349 | 409 | 419 | 429 | 439 | 449 | 509 | 519 | 529 | 539 | 549 |

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TRANSISTORIZED DIGITAL MAGNETIC TAPE HANDLER MODEL 906

Optimum performance in virtually all tape handling applications

The advanced design of the completely transistorized Potter Model 906 Tape Handler provides improved performance in virtually any tape handling application.

Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second. Using a small vacuum loop buffer, Model 906 features:

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- 3 millisecond starts
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The 906 may be supplied with a transistorized Record-Playback Amplifier featuring a separate module for each channel. Electronic switching from record to playback function is available as an optional feature.

Other Potter products include Transistorized Frequency Time Counters, Magnetic Tape Handlers, Perforated Tape Readers, High Speed Printers, Record-Playback Amplifiers and Record-Playback Heads.



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|--------------|-----------------------------|----------------------------------|---------------------------------|---------------|-----------------------------|----------------------------------|---------------------------------|
| 1N55B | 150 | 5 | 500 at -150 | 1N128 | 40 | 3 | 10 at -10 |
| 1N66A | 60 | 5 | 50 at -10 | 1N191 | 90 | 5 | 25 at -10 |
| 1N67A | 80 | 4 | 50 at -50 | 1N198 | 80 | 5† | 75† at -10 |
| 1N68A | 100 | 3 | 625 at -100 | 1N294A | 60 | 5 | 10 at -10 |
| 1N95 | 60 | 10 | 800 at -50 | 1N297A | 80 | 3.5 | 100 at -50 |
| 1N126 | 60 | 5 | 50 at -10 | 1N298A | 70 | 30* | 250 at -40 |
| 1N127 | 100 | 3 | 25 at -10 | | | | |

*at +2 v †at 75°C

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for TV video and portable radio application;
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| TYPE | Peak Operating Voltage -65°C to +150°C Volts | Ave. Rectified Current | | Reverse Current (Max.) in μ A at Specified Voltage | | |
|--------------|--|------------------------|-------------|---|------|-------|
| | | 25°C mA | 150°C mA | Volts | 25°C | 100°C |
| 1N645 | 225 | 400 | 150 | 225 | 0.2 | 15 |
| 1N646 | 300 | 400 | 150 | 300 | 0.2 | 15 |
| 1N647 | 400 | 400 | 150 | 400 | 0.2 | 20 |
| 1N648 | 500 | 400 | 150 | 500 | 0.2 | 20 |

Silicon DIFFUSED JUNCTION RECTIFIERS

WIRE IN TYPES

| TYPE | Peak Operating Voltage -65°C to +165°C Volts | Ave. Rectified Current | | Reverse Current (Max.) at Specified PIV, 150°C mA |
|---------------|--|------------------------|-------------|--|
| | | 25°C mA | 150°C mA | |
| 1N536 | 50 | 750 | 250 | 0.40 |
| 1N537 | 100 | 750 | 250 | 0.40 |
| 1N538 | 200 | 750 | 250 | 0.30 |
| 1N539 | 300 | 750 | 250 | 0.30 |
| 1N540 | 400 | 750 | 250 | 0.30 |
| 1N1095 | 500 | 750 | 250 | 0.30 |
| 1N547† | 600 | 750 | 250 | 0.35 |

† Same as 1N1096 *to +135°C

STUD TYPES

| TYPE | Peak Operating Voltage -65°C to +165°C Volts | Ave. Rectified Current | | Reverse Current (Max.) at Specified PIV, 25°C μ A |
|--------------|--|------------------------|----------------|--|
| | | 25°C Amps. | 150°C Amps. | |
| 1N253 | 95* | 3.0 | 1.0* | 10 |
| 1N254 | 190* | 1.5 | 0.4* | 10 |
| 1N255 | 380* | 1.5 | 0.4* | 10 |
| 1N256 | 570* | 0.95 | 0.2* | 20 |
| CK846 | 100 | 3.5 | 1.0 | 2 |
| CK847 | 200 | 3.5 | 1.0 | 2 |
| CK848 | 300 | 3.5 | 1.0 | 2 |
| CK849 | 400 | 3.5 | 1.0 | 2 |
| CK850 | 500 | 3.5 | 1.0 | 2 |
| CK851 | 600 | 3.5 | 1.0 | 2 |

Ratings at 25°C unless otherwise indicated. All illustrations actual size.

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CIRCLE 3 ON READER-SERVICE CARD

ENGINEERING REVIEW

For more information on developments described in "Engineering Review," write to the address given in the individual item.

Manned Space Laboratory Within Three Years

WITHIN THREE YEARS a recoverable manned spaced laboratory may be hurtled into orbit by Northrup Aircraft, Hawthorne, Calif.

Company officials asserted that they have "developed basic design criteria for a perfectly feasible manned space laboratory." The space laboratory will be a bullet-shaped capsule, approximately 7 ft in diam and 10 ft long. The space traveler inside it would be strapped in a near-reclining position in order to withstand acceleration forces. Contemporary

rocket engines would boost the space laboratory into orbit.

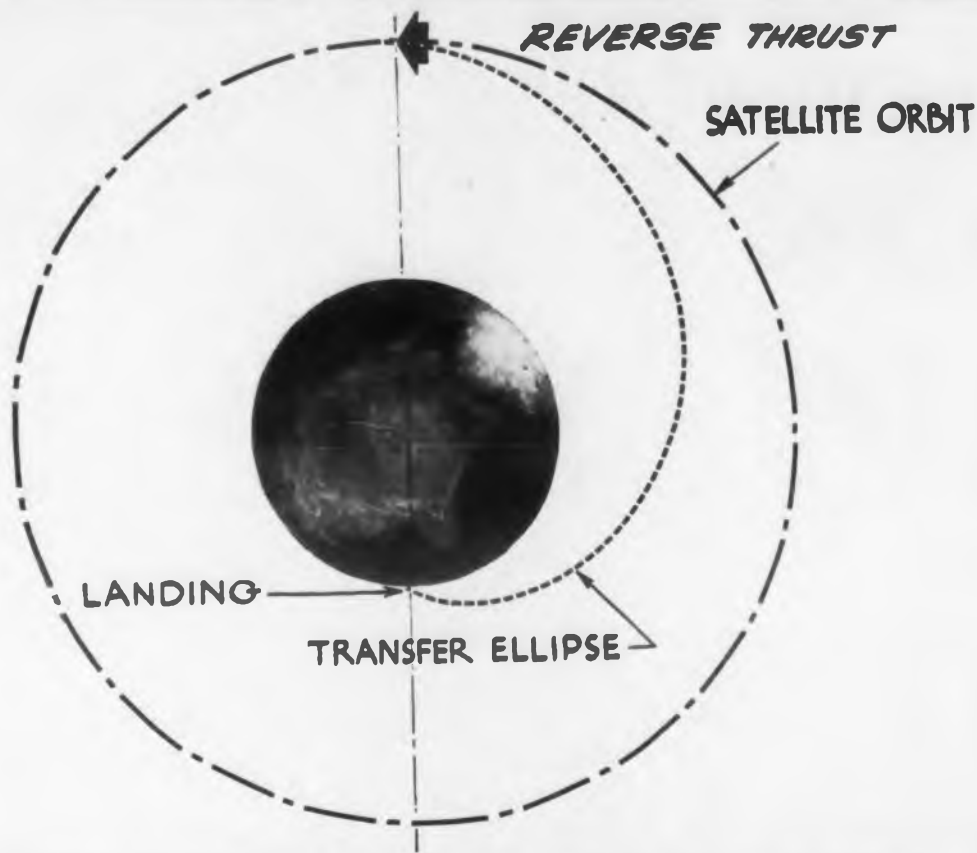
Once in orbit, it would be turned by attitude control jets so that its blunt end faced forward. This would provide a high drag to slow the capsule as it hurtled back into the earth's atmosphere.

During re-entry the vehicle would slow from 25,000 fps to 1000 fps by the time it descended to 60,000 ft altitude.

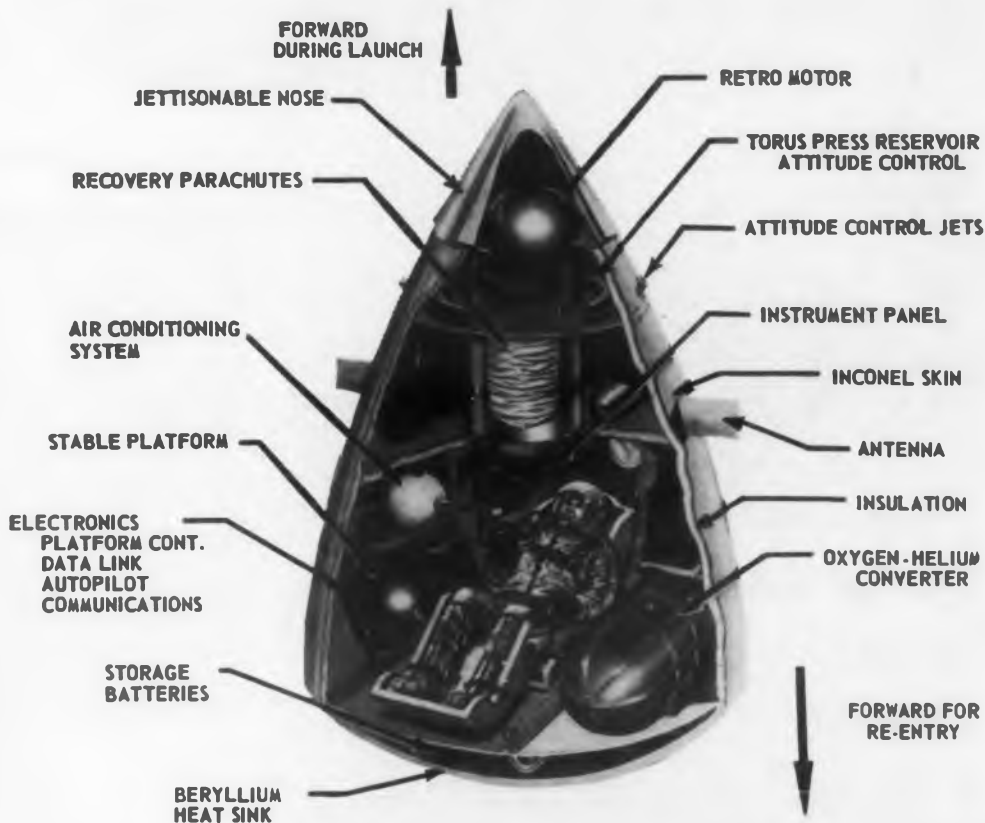
Between 20,000 and 30,000 ft, altitude parachutes would open to ease the capsule to the ground.



Many of space laboratory's preliminary design problems are being solved by COM-PADAC, an extensive computer and data handling facility. Installation includes IMB 704 which handles 4000 multiplications, or 40,000 additions per second.

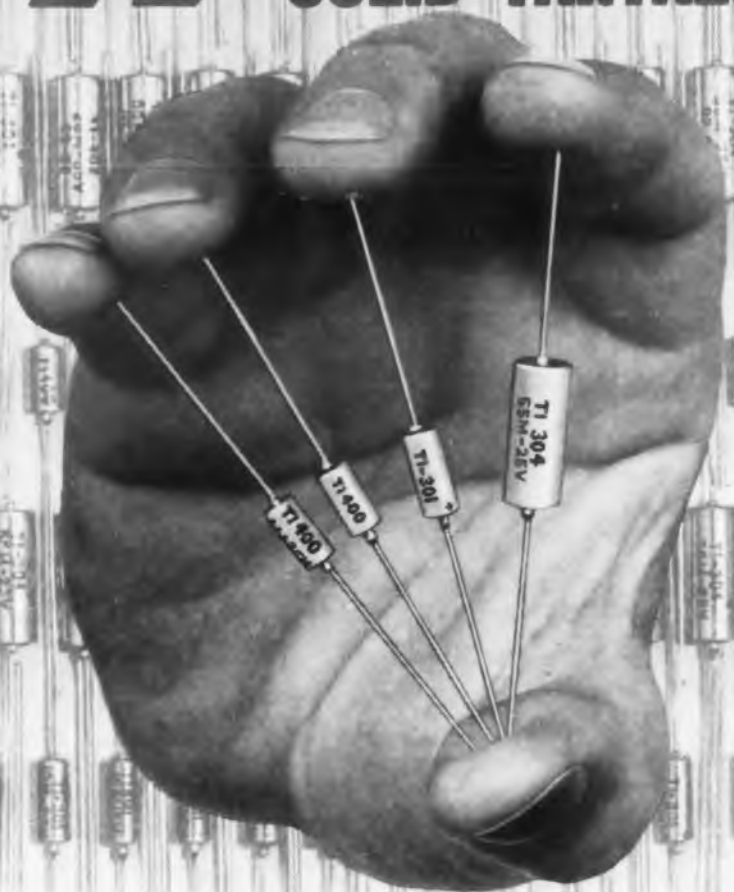


Reverse thrust rocket would be fired at a point 180 deg from the desired landing point when manned space laboratory is to be returned to earth. Velocity would be reduced so that the capsule would go into an elliptical orbit whose perigee would be the earth's surface. Capsule would reenter atmosphere at an angle of two deg from local horizontal.



Luxuriating space traveler in one ton vehicle will play host to a multitude of instrumentation. In the nose of the capsule is the reverse thrust rocket. Below it are parachutes for the final stage descent. During launching pointed end of capsule would be forward to reduce drag. Man is supported in a nearly prone position during launch and recovery so that he may withstand the effects of acceleration and deceleration. Proposed navigation system for laboratory is a star tracking system similar to the one developed for the Snark missile.

NOW *tan-TI-cap*^{*} SOLID TANTALUM CAPACITORS



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YOU get precision performance, tough mechanical construction and clean, compact design when you specify *tan-TI-cap* solid-electrolyte tantalum capacitors — available immediately in production quantities!

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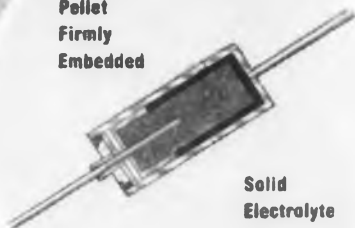
Solid, no-leak construction of *tan-TI-cap* capacitors provides pellet with a hard surrounding foundation of high temperature solder that resists high impact and vibration. You simplify printed circuit assembly with *tan-TI-cap* capacitors... firmly anchored leads can be bent sharply close to the case for easy mounting in subminiature circuits.



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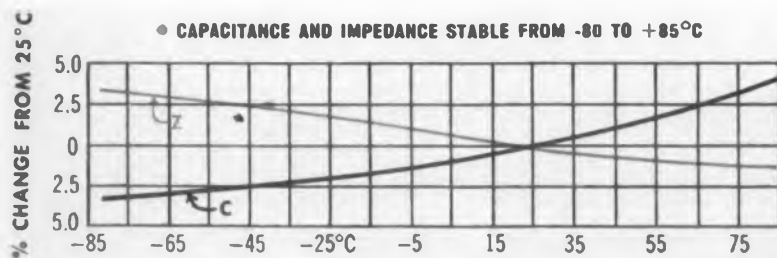
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proved
benefits!**

Tantalum
Pellet
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|---------|------------|------------|------------|------------|-------------|
| 6-Volt | 22 μ f | 33 μ f | 47 μ f | 60 μ f | 200 μ f |
| 15-Volt | 10 | 15 | 22 | 33 | 100 |
| 25-Volt | 5 | 10 | 15 | 35 | 55 |
| 35-Volt | 4 | 8 | 25 | | |



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ENGINEERING REVIEW

Continuous Process For Etching Copper

Downtime of equipment such as that used in the manufacture of printed circuits will be eliminated by a new process for continuously regenerating copper etching solutions. Developed by Dr. Paul D. Garn and Dr. Louis H. Sharpe of Bell Telephone Labs., New York, N.Y., the process will also do away with the dangers inherent in changing the corrosive spent etchants and make it possible to salvage the etched copper.

Etching solutions used in the new process are composed of cupric chloride in the presence of excess chloride ions. They can be regenerated electrolytically while etching operations continue, either on a self-regulating basis, or on a time cycle. Hydrochloric acid, sodium chloride, and ammonium chloride have all been investigated as sources of the excess chloride ions.

Highway Control System Demonstrated

Demonstration facilities of the "electronic highway of tomorrow" are now in operation at RCA, Princeton, N.J.

Cars entering the trial grounds pass over electronic loops buried in the entrance road. Transistorized detector units connected to the loops count each of the passing cars, measure the speed of each, and flash a warning sign at the roadside saying "Slower, Please" to every driver exceeding the posted speed limit. The new equipment is a transistorized variation of the comprehensive electronic vehicle control system developed earlier by RCA and demonstrated last year at Lincoln, Nebraska, in cooperation with the Nebraska Department of Roads. Detector loops in the roadway consist of rectangles of wire 6 x 20 ft in outline.

◀ CIRCLE 4 ON READER-SERVICE CARD

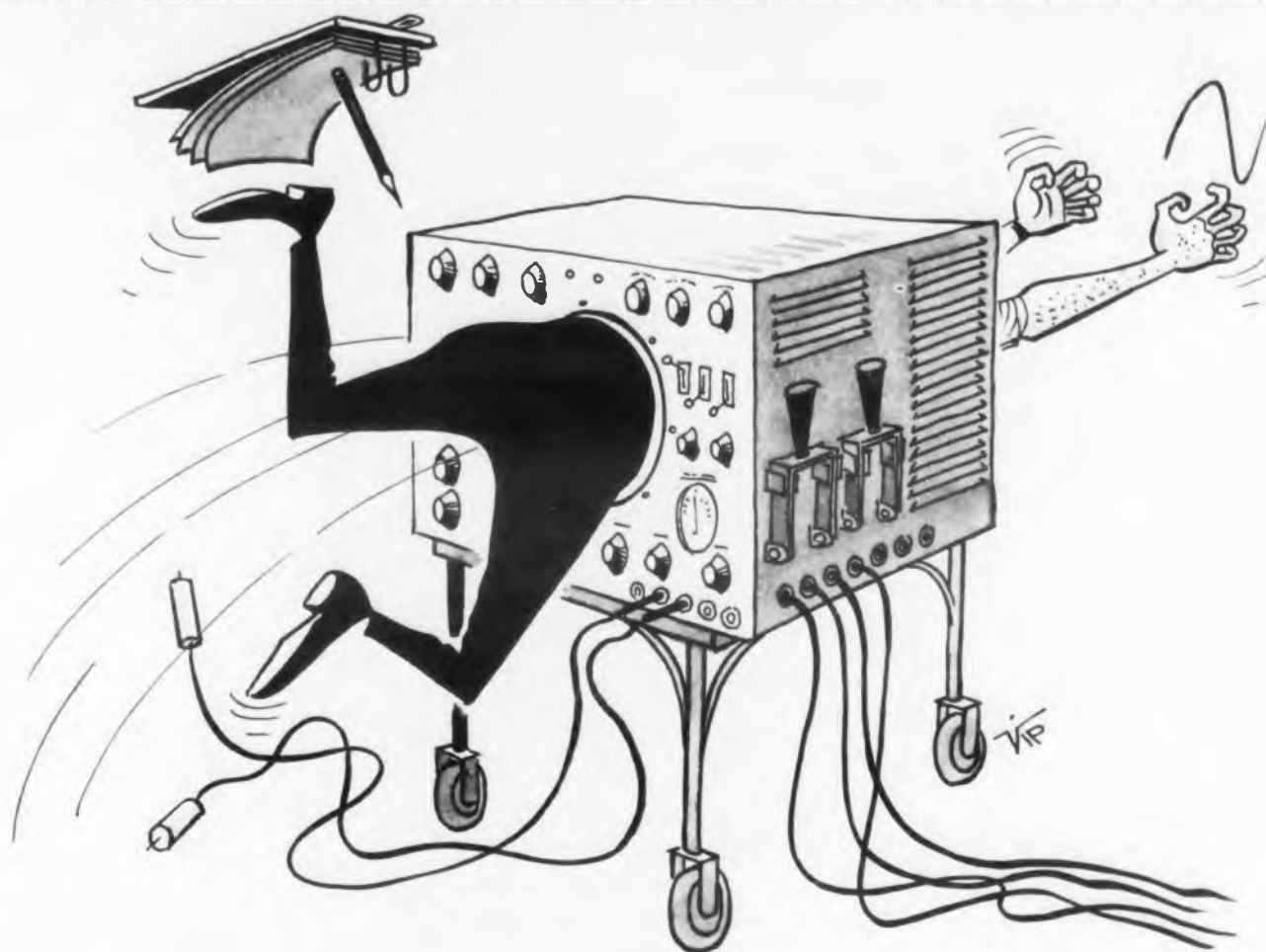
Publication Date Set For Printed Circuit Manual

Tentative publication date of the newly compiled circuit industry manual *How to Design and Specify Printed Circuits*, has been set for July according to W. J. McGinley, President of the Industry of Printed Circuitry, 27 E. Monroe, Chicago 3, Ill.

This manual, representing the combined experience of manufacturers who are members of the IPC, will include information on: engineering steps for utilizing printed circuits; mechanical considerations; characteristics of printed circuit switch plates; selection of materials; characteristics of copper-faced laminates; dimensional considerations; finishes; multiple soldering techniques; and a special section on standard tolerances. The booklet will sell for \$5.00.

The Institute is currently making plans for a special technical session for members to be held in November, 1958, in Chicago.

How to Save Man Days in Research and Testing Involving Transients — No. 7 of a series



PROBLEM: How to Capture Elusive Transients



Coiling World's Largest Inductance

This huge inductance coil, shown during assembly, supplies energy to an electric-arc tunnel for testing missiles. Coil is wound with thirty-six 850 mcm cables in parallel. It measures 119 in. in diam. Energy is stored in the coil when its field is built up by a d-c source; the arc chamber circuit is closed at this time. Contacts in series with the coil are then opened. An arc is produced in the chamber by the instantaneous collapse of the strong magnetic field in the coil. This heats the air in the arc chamber to 40,000 deg F and raises the pressure to 30,000 psi. The plastic seal vaporizes, releasing a blast of hot gas which rushes through the test section and into the vacuum chamber at a speed of 32,400 mph. It was designed and built at Westinghouse Electric Corp., Transformer Div., Sharon, Pa.



A Hughes representative will gladly demonstrate the Memo-Scope® in your company. Address requests to:

HUGHES PRODUCTS MEMO-SCOPE Oscilloscope
International Airport Station, Los Angeles 45, California

Attempting to analyze elusive non-recurring transients has sent the best of engineers "to the showers." Conventional practices for monitoring or examining spurious signals or noise factors do not permit accurate investigations. The result is a wasteful expense of your time, your nerves, and your company's money.

SOLUTION: The Hughes MEMO-SCOPE® oscilloscope freezes wave forms until intentionally erased. Selected transient information may be triggered externally or internally and retained for viewing. Successive wave forms may be written above, below or directly upon the original information.

HUGHES MEMO-SCOPE OSCILLOSCOPE

SWEEP SPEED FOR STORAGE:

10 microseconds to 10 seconds per division (0.33").

FREQUENCY RESPONSE: DC to 250 KC down 3 db.

SENSITIVITY:

10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.

APPLICATIONS:

Trouble shooting data reduction equipment... switch and relay contact study... ballistics and explosives research... ultrasonic flaw detection... physical testing—shock—stress—strain.

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CIRCLE 5 ON READER-SERVICE CARD

LIFE-LONG

POLARAD

PROVEN RELIABILITY



2 TECHNICAL ASSISTANCE:

The Polarad sales representative in your area is ready to render valuable technical assistance both at the time you purchase your Polarad Microwave instrument as well as throughout its long service life.



3 TRAINING:

Free training at our plant in the proper use, repair and maintenance of Polarad microwave instruments is available at all times.



Be sure you get Polarad's life-long service whenever you invest in complex microwave equipment.

*The equipment shown above:

1. Polarad Model R Extended Range Microwave Receiver
2. Model TSA Direct Reading Spectrum Analyzer
3. Model B Code Modulated Multiple Pulse Microwave Signal Generator
4. Model MSG-34 Ultra Broadband Microwave Signal Generator
5. Model ESG Microwave Sweep Generator

POLARAD ELECTRONICS CORPORATION

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REPRESENTATIVES: Abington, Albany, Atlanta, Baltimore, Boeing Field, Chicago, Cleveland, Dayton, Denver, Detroit, Englewood, Fort Worth, Kansas City, Los Angeles, Portland, St. Louis, Stamford, Sunnyvale, Syracuse, Washington, D.C., Westbury, Westwood, Wichita, Winston Salem. Canada: Arnprior, Ontario Resident Representatives in Principal Foreign Cities

**SERVICE
MICROWAVE
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INSTRUMENTS**

1 NEW SERVICE:

Field service is readily available when you need it — at no charge! Experienced maintenance engineers will make minor repairs at your plant, if necessary. Complete factory overhaul will be made in case of major repairs. This equipment service policy, at no charge, assures you of years of continuous use of Polarad equipment. This new service policy is in addition to the liberal Polarad parts warranty.



4 ENGINEERING:

And you are welcome to avail yourself of Polarad's free Engineering Consultation Service to help you solve any microwave instrumentation problem.



5 SATISFACTION:

Polarad is vitally interested in your satisfaction and continued use of our equipment, and takes great pride in the maintenance of this equipment throughout its life.

ENGINEERING REVIEW

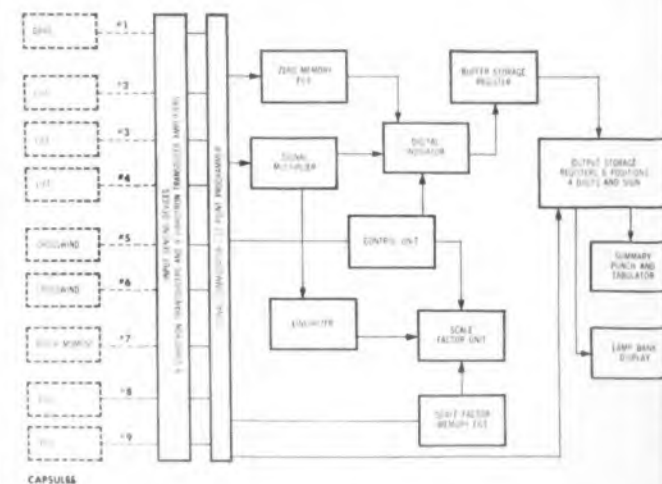
Wind Tunnel Adopts Digitizing System

A force and moment digitizing system has been selected for wind tunnel model studies at the Southern California Cooperative Wind Tunnel, Pasadena, Calif. It employs nine Vibrotron digital transducers and matched amplifiers to sense and signal hydraulic pressure variations from emery load sensing capsules directly attached to the test platform. Drag, lift and crosswind forces and pitch, yaw and roll moments are computed by the data digitizing equipment which consists of digital gating and counting circuits and relay control circuitry. A system signal commutator sequentially samples the transducer signals controlling the operation of the digitizing system to perform digitizing, totalizing and subtraction of forces and moments.

Each of the transducers basically consists of a fine hair-sized wire stretched between an anchor point and a metal diaphragm. In operation, the wire is set into vibration in a permanent magnetic field by an alternating current along the wire; wire length and tension determine the vibrating frequency.

During tunnel tests, the model is exposed to precisely controlled wind forces that subject the stand-mounted hydraulic emery capsules to variations in internal pressures, changing diaphragm displacement within each connected transducer. Subsequent wire tension change decreases or increases transducer vibrating frequency; output frequencies from the companion amplifier change accordingly, delivering a direct-signal output signal readable as a numerical indication.

Repeatability and resolution of the system from applied pressure to digital output is equal to or greater than plus or minus 0.05 per cent of full scale, based upon repetitive calibrations



Force and moment digitizing system selected for wind tunnel studies at California Institute of Technology

CIRCLE 257 ON READER-SERVICE CARD
ELECTRONIC DESIGN • June 11, 1958

% CHANGE FROM 25°C

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CIRCLE 6 ON READER-SERVICE CARD

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1958



ANALAC is a true production-line wire. This film-insulated solderable magnet wire does away with pre-stripping before soldering, lends itself to gang soldering, to iron, gun and dip soldering.

Now, just one step! Analac lets you solder without pre-stripping!

Anaconda's Analac* magnet wire saves time and money on the production line. This film-insulated, solderable magnet wire can be used just as you use Formvar or Plain Enamel—with this plus advantage . . . it is solderable without pre-stripping the insulation.

Analac cuts down labor-time where many solderable connections are to be made. It's ideal, too, where removal of the insulation is a hazard to the wire. Soldering Analac by dipping, iron or gun produces a perfect joint.

It performs well in high-speed winding! Analac has the excellent abrasion-resistance and other mechanical advantages of the enamel wire you're now using.

Distinctive red color simplifies identification . . . is highly

visible, helping operators turn out higher quality work.

Analac, 105°C (AIEE Class A) wire, is available in sizes from 15 Awg to 46 Awg.

The Man from Anaconda will be glad to give you more information. See "Anaconda" in your phone book—in most principal cities—or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

*Reg. U. S. Pat. Off. 58362

SEE THE MAN FROM **ANACONDA**[®] FOR READY-TO SOLDER ANALAC MAGNET WIRE

For details on how you can save with Analac, and for engineering data—please turn the page!

ANATHERM 155°C (AIEE Class F)
high temperature resistance

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

FORMVAR 105°C (AIEE Class A)
established dependability

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

EPOXY 130°C (AIEE Class B)
general compatibility



MAGNET WIRE DATA SHEET

from
Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

about Analac 105°C (AIEE Class A) Magnet Wire

SOLDERABILITY. Anaconda's Analac can be used to overcome high cost of insulation stripping by adapting your present system to automatic soldering techniques. Your Anaconda sales representative can arrange for cooperation from Anaconda's Research Laboratories to help you take full advantage of Analac's cost-saving possibilities.

Analac is versatile; lends itself to gang soldering, to iron, gun and dip soldering. Anaconda's Analac Booklet contains full information on soldering methods, fluxes, temperature control. Use the coupon below for your copy.

WINDABILITY. Analac is abrasion-resistant . . . has excellent lubricity and surface characteristics which make it readily adaptable to automatic high-speed winding operations. Can be used on your present equipment—no retooling is necessary to adapt solderable Analac.

COMPATIBILITY. Analac is compatible with most insulation varnishes presently being used.

TECHNICAL PROPERTIES

MECHANICAL PROPERTIES

Analac has excellent mechanical properties. The film possesses superior abrasion-resistance and flexibility under a number of varied conditions—such as heat, cold and moisture. The wire shows no cracks when elongated rapidly to the breaking point. It will also withstand 3 times diameter wrap after 20 percent elongation.

MOISTURE-RESISTANCE

Analac's moisture-resistance is excellent, particularly in size range 25 and heavier. It offers moisture-resistance superior to most other film-type insulations.



*New Analac Booklet—yours for the asking!
Latest information . . . full technical data.
Mail coupon for your copy.*

ANACONDA WIRE & CABLE COMPANY
25 BROADWAY, NEW YORK 4, NEW YORK

Please send copy of your Analac Magnet Wire Booklet. I am interested in heavy or intermediate size (15 Awg to 30 Awg)—; fine sizes (31 Awg or finer)—.

NAME & TITLE.....
COMPANY.....
ADDRESS.....
CITY, ZONE, STATE.....

ELECTRICAL PROPERTIES

Analac has superior dielectric strength both in a dry condition and after exposure to high humidity. Meets NEMA twist test requirements. Analac has unusually low dielectric losses at high frequencies, which are only slightly affected by high humidity. Thus Analac is particularly suited for electronic uses.

| | | Number of Tests Averaged | | Volts per Mil at Breakdown | | | | |
|----------------------|--|--------------------------|------|----------------------------|--|------|------|------|
| | | | | | | | | |
| Dielectric strength. | NEMA twist test, room conditions. | 145 | | 3500 | | | | |
| | NEMA twist test, dry. | 30 | | 4050 | | | | |
| | NEMA twist test after 6 hours exposure at 100F and 100% relative humidity. | 30 | | 4000 | | | | |
| | Layer test—double layer wind on 1 inch diameter mandrel, apply voltage between layers. | 30 | | 2840 | | | | |
| | | Frequency | | | Dissipation Factor—Cotangent of Angle of Lag | | | |
| | | Temperature—Deg C | | | | | | |
| | | cps | kc | mc | Room | 85 | 125 | 155 |
| Dielectric loss. | Dissipation factor at room temperature. | 100 | | | 1.00 | — | — | — |
| | | 1000 | | | 0.92 | — | — | — |
| | | | 10 | | 1.38 | — | — | — |
| | | | 100 | | 1.90 | — | — | — |
| | Dissipation factor at elevated temperature. | | 1000 | | 1.97 | — | — | — |
| | | | | 10 | 1.93 | — | — | — |
| | | | | 40 | 2.79 | — | — | — |
| | | | 100 | | — | 1.08 | 1.73 | 15.7 |
| | 1000 | | — | 1.32 | 1.48 | 11.9 | | |
| | | 10 | | — | 1.72 | 1.62 | 6.4 | |
| | | 100 | | — | 1.40 | 1.40 | 5.0 | |
| Dielectric constant. | As measured by bridge and Q meter at room temperature. | 100 | | | 3.00 | — | — | — |
| | | 1000 | | | 2.96 | — | — | — |
| | | | 10 | | 2.93 | — | — | — |
| | | | 100 | | 2.85 | — | — | — |
| | As measured by bridge and Q meter at elevated temperature. | | 1000 | | 2.54 | — | — | — |
| | | | | 10 | 2.52 | — | — | — |
| | | | | 40 | 2.90 | — | — | — |
| | | | 100 | | — | 3.63 | 3.85 | 3.66 |
| | 1000 | | — | 3.57 | 3.80 | 2.93 | | |
| | | 10 | | — | 3.51 | 3.69 | 2.49 | |
| | | 100 | | — | 3.40 | 3.63 | 2.33 | |

CHEMICAL PROPERTIES

Analac has good resistance to the action of solvents, water, and dilute acids and bases. Analac will withstand 24 hours' immersion at room temperature in most varnish solvents including naphtha, toluol, xylol, and ethyl alcohol. Shows excellent resistance to 5% sulfuric acid and 5% potassium hydroxide.

THERMAL PROPERTIES

Analac is offered as 105°C (AIEE Class A) magnet wire, although its thermal stability shows it is capable of performance at much higher temperatures. Analac's thermoplastic flow cut-through data, obtained on basis of MIL-W-583A methods, has been above 200°C.

under stable environmental conditions. Digital outputs are stored in six relay bank registers for compatible use with summary punch and lamp bank display. The facility is operated by California Institute of Technology for 5 aircraft companies: Convair, Douglas, Lockheed, McDonnell, and North America.

New Satellite Transmitter Doubles Present Efficiency

The development of a new transmitter will enable U.S. satellites to telemeter data 1-1/2 to four times as long as is presently possible.

The transmitter is a 500 milliwatt version of the Naval Research Laboratory's 100 mw satellite transmitter. Months of extensive development and testing will be required before it can be programmed into an actual satellite. The crystal controlled transmitter employs three transistors capable of operating as oscillators or amplifiers at 108 mc. The transmitter weighs less than 3 oz. and occupies less than 6 cu in. For a power output of 500 mw, it uses one-half to one-fourth the battery power needed by any other transmitter now known. The transmitter can be operated on solar batteries, with one-half to one-fourth of the rocket surface heretofore required for sun exposure, according to engineers at Dukane Corp., St. Charles, Ill., who designed the device.

The output stage of a conventional tube-type transmitter doing the same job would need 4620 mw to produce 500 mw output. By contrast, the output stage of the new transmitter needs 930 mw power to produce the same output. The corresponding efficiencies are 11 per cent and 54 per cent, respectively. The circuit operates on a single 20 to 24 v battery.



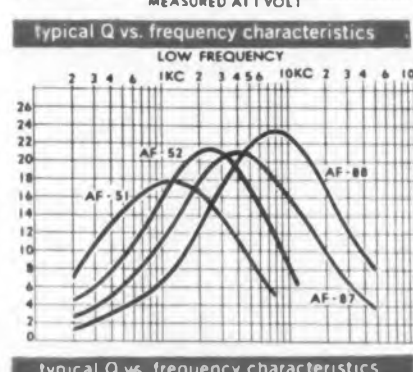
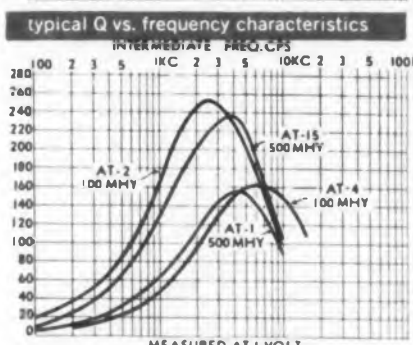
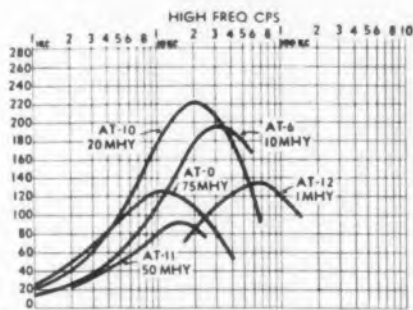
New 500 mw satellite radio transmitter weighs less than 3 oz and will broadcast 1-1/2 to 4 times as long on same battery power as any previously known.

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ELECTRONIC DESIGN • June 11, 1958

AND NOW FULLY ENCAPSULATED!

NEW SUBMINIATURE BURNELL ADJUSTOROIDS* HANDLE BIG JOBS



The new subminiature Burnell Adjustoroids utilizing an ingenious patented method of magnetic biasing cover a wide range of frequencies, occupy less space and are available at low cost.

New Burnell Adjustoroids possess all the outstanding characteristics of non-adjustable toroids including:

Precise continuous adjustment of inductance over a 10% range.
No need for external control current.

Hermetic sealing to meet Government MIL E # 15305-A specifications.

If your Adjustoroid needs can't be met from our stock catalogue, we'll be glad to manufacture to your specifications.

| Model | Length/Dia. | Width | Hgt. | Wt. | Useful Freq. Range | Max Q | Max L in hys |
|-------|-------------|--------|--------|---------|--------------------|---------|--------------|
| AT-0 | 1 1/16" | | 1" | 2 oz | 1 kc to 20 kc | 10 kc | 3 hys |
| AT-1 | 1 3/4" | 1 3/4" | 1 1/4" | 7.25 oz | 2 kc to 10 kc | 4 kc | 15 hys |
| AT-2 | 2 3/4" | 2 3/4" | 2 1/4" | 24 oz | Below 2.5 kc | 2.5 kc | 125 hys |
| AT-4 | 1 1/4" | | 1 1/4" | 4 oz | 1 kc to 16 kc | 6 kc | 15 hys |
| AT-6 | 1 1/16" | | 1" | 2 oz | 10 kc to 100 kc | 30 kc | .75 hys |
| AT-10 | 1 1/4" | | 1 1/4" | 4 oz | 3 kc to 50 kc | 20 kc | .75 hys |
| AT-11 | 4 5/8" | 4 5/8" | 3/4" | .83 oz | 2 kc to 25 kc | 15 kc | 5 hys |
| AT-12 | 4 5/8" | 4 5/8" | 3/4" | .83 oz | 15 kc to 150 kc | 60 kc | .5 hys |
| AT-15 | 1 3/32" | | 1 7/8" | 14 oz | Below 5 kc | 4 kc | 125 hys |
| AF-51 | 1 1/4" | | 2" | 5 oz | 30 cps to 500 cps | 120 cps | 1000 hys |
| AF-52 | 1 1/4" | | 2" | 5 oz | 50 cps to 1 kc | 250 cps | 1000 hys |
| AF-87 | 4 5/8" | 4 5/8" | 1 1/4" | 1.7 oz | 90 cps to 2 kc | 400 cps | 80 hys |
| AF-88 | 4 5/8" | 4 5/8" | 1 1/4" | 1.7 oz | 16 kc to 4 kc | 800 cps | 42 hys |

Burnell & Co., Inc.

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EASTERN DIVISION
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000

TELETYPE: PELHAM 3633



PACIFIC DIVISION
720 MISSION STREET
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RYAN 1-2841

TELETYPE: PASACAL 7578

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*PAT. 2,762,020



GUARANTEED FOR FIVE YEARS

New LAMBDA L-T TRANSISTORIZED POWER SUPPLIES



CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC 0-2 AMP

- Ambient 50° C at full rating.
- High efficiency radiator heat sinks.
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.
- Compact. Only 3½" panel height.
- Short-circuit proof.
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.
- All transistor. No tubes.
- Transient free.
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote DC vernier.

Introduced at the 1958 I.R.E. Show

Model LT 2095 **\$365**
Model LT 2095M (metered) **\$395**

CONDENSED DATA*

| | |
|--|---|
| Voltage Bands ... 0-8, 8-16, 16-24, 24-32 VDC | Electrical Overload Protection ... Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload. |
| Line Regulation ... Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC. | Thermal Overload Protection ... Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel. |
| Load Regulation ... Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load. | Size ... 3½" H x 19" W x 14⅞" D. |
| AC Input ... 105-125 VAC, 50-400 CPS | |

* Preliminary and tentative specifications

Send for complete LAMBDA L-T data.



LAMBDA Electronics Corp.

11-11 131 STREET • COLLEGE POINT 56, NEW YORK
INDEPENDENCE 1-8500 Cable Address: Lambdatron, New York

ENGINEERING REVIEW

Improve Midwest Telegraph Facilities

Telegraph facilities for the midwest area were greatly increased with the addition of a 557 mile microwave radio beam system that was placed in operation between Pittsburgh, Cincinnati, and Chicago. 1600 telegrams can be transmitted simultaneously at the rate of more than 100,000 words a min over the Western Union system. The beam system is virtually immune to interruption from storms and electrical interference. Failure of local commercial power along the route will not halt operation. Propane gas-driven, automatically-controlled, emergency power generators will instantly continue the electrical power at all stations without the loss of a single telegraph pulse. Passive reflectors on the 290 ft masts deflect the arriving beam to the ground stations. There the received signals are amplified in power and flashed back to another reflector on the mast which projects the beam to the next mast 20 to 37 miles away.

Utility Poles Can Be Dangerous

Pine utility poles treated with creosote can be potentially dangerous, engineers were warned. At the Middle Eastern District Meeting of the AIEE, J. H. Winters, Jr., and H. E. Ziegenfuss, of the Baltimore Gas & Electric Co., said that a number of tests indicated that electric equipment mounted on such poles "is not sufficiently insulated from ground to be safe. Linemen who consider such equipment to be isolated are under the wrong impression and perhaps lulled into a false sense of security." Investigation showed that the resistance to ground of pole mounted metal structures varies with the age of the pole and the depth of penetration of the mounting bolts or lags and is generally low enough to

◀ CIRCLE 8 ON READER-SERVICE CARD

partially ground such equipment. This effects a hazardous condition unless it is recognized and guarded against because inadvertent contact between a primary or even a secondary line and a pole mounted structure could cause a shock resulting in either a fall or possible heart fibrillation. Ungrounded metallic pole mounted equipment, such as transformers, should be regarded as partially grounded or energized, they stated.

Scientific Russian To Be Taught in Summer

Carnegie Institute of Technology will offer a summer course in Scientific Russian in answer to increasing needs of graduate students and research workers. The 18-unit course, equivalent to a full year of work, will meet two hours daily from June 16 to August 9. Carnegie president John C. Warner, stated that only a small fraction of the leading Russian technical periodicals are translated into English, and that those which do appear are generally four to eighteen months later than their originals. College libraries could afford many more journals if researchers read Russian, he added, because translations are as much as ten times more expensive. The course places stress on a quick acquisition of reading knowledge in technical literature, with speaking and writing instruction deferred to advanced courses.

Brave New World? Step in Right Direction

Reproduction engineers are now rapidly spreading themselves throughout industry. Technical function of the new professional group lie in the field of processes for making multiple or single copies of any two-dimensional material used in business.

Reproduction engineering has already blossomed to an annual volume estimated at three billion dollars.

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with the *New...*

UNIVERSAL RATIO METER



model B811A

**NOW IN ONE
COMPACT PACKAGE
TWO INSTRUMENTS**

FXR's — B811A Universal Ratiometer, combines, at less cost, the many features of a separate ratiometer and standing wave amplifier.

- Increased sensitivity for more accurate reflectometer measurements
- Two cycle precision log meter—VSWR reflectometer readings of 1.02 to ∞ on only two scales
- VSWR, DB and Γ scales eliminate conversion tables
- Built-in input transformers—no accessories required
- Expanded VSWR scales and full 70 DB standing wave amplifier operation
- Crystal and bolometer operation

Precision Microwave Equipment

FXR

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PRINTED *Circuitry*

HOW PRINTED CIRCUITRY BECAME A MAJOR PRODUCT AT CRONAME

A few short years ago circuitry was confined to our research laboratories. NOW, EVERY DAY thousands and thousands of etched and plated circuits are produced at CRONAME for America's leading radio, television, electronic, instrument, automotive and appliance manufacturers. For over 50 years CRONAME has been accepted by industry as a superior source for decorative metal and glass parts, nameplates, gages, control panels, bezels, escutcheons, jack covers, TV masks and assemblies. With the advent of Printed Circuitry, CRONAME'S vast experience in precision etching, plating, silk screening and lithographing on metal was called upon to lead the way for a new electronic era.

This experience has met the challenge. Our precision quality and service in the infant Printed Circuitry industry has brought us acceptance of our circuits exceeding many of our older products. Our new Printed Circuitry Division geared for volume production will share a major portion of our new facilities now under construction. Your acceptance of our products has made this expansion inevitable. We would like to help you improve your product now. Write for literature.



CRONAME
INCORPORATED

1741 GRACE STREET
CHICAGO 13, ILLINOIS

ENGINEERING REVIEW

Pressure Regulator For Missile Equipment

Self-destruction of electronic guidance equipment on guided missiles is being prevented by a specially developed air pressure regulator. The regulator maintains approximate sea level pressure in an electronics compartment. Without this environmental control the equipment would be subjected to destructive electrical arcing at the low pressures of high altitude. Essentially, the unit developed by The Garrett Corporation's AiResearch Mfg. Div., Los Angeles, Calif., is an outflow valve operated by a spring and bellows arrangement. The interior of the bellows is evacuated to approximately 0 pressure. As the unit is carried to higher altitudes, faster flow of gas from the compartment to the atmosphere results in lower compartment pressure on the bellows. This allows the bellows to expand with the assistance of the spring.

The resulting action positions the valve to lessen the opening that permits flow to the atmosphere. In this manner, the gaseous environment of the chamber is kept in circulation at a constant pressure.

Magnetic Thrust Engine For Space Flight Described

Thrust to maneuver the first manned satellite in outer space may be accomplished by using a magnetic field to accelerate and expel a neutral plasma of fully ionized gas. According to Dr. Richard M. Patrick of Avco Mfg. Corp., Everett, Mass., the magnetic thrust engine would be used to alter the altitude of its orbit while circling the earth or speed it on trips to the moon or other planets. A number of different propulsion systems which have been suggested for travel outside the earth's atmosphere were mentioned including: the chemical rocket; the ion rocket;

◀ CIRCLE 10 ON READER-SERVICE CARD

"sails" which reflect solar radiation to produce thrust; and propellants accelerated by heat energy from a separate source (such as a nuclear reactor) and expanded to the outside of the vehicle in a nozzle.

The magnetic propulsion system eliminates the process of separating ions which is an integral part of the ion rocket system.

Transistor Amplifier Distortion Solved

Estimates of power output and per cent distortion for single-ended class A, transistor power amplifier may be made by a new method described at the Great Lakes District Meeting of the AIEE.

J. D. Horgan of Marquette University, Milwaukee, Wisc., said the method is based on piece-wise-linear approximations of the transistor's external characteristics. Construction of the usual load line on the output characteristics is required. Two points from the dynamic input characteristics are transferred to the load line and reference is then made to a universally applicable curve.

The problem of estimating distortion, Mr. Horgan pointed out, has usually been solved by approximating the transfer characteristic with a quadratic curve and selecting parameters in the equation to fit the characteristic at the operating point.

"Such approximations," he said, "do not match the transfer characteristics well for large input signals, are restrictive in that distortion due to frequency components above the second harmonic is neglected, and are cumbersome to handle."

The new method is generally accurate enough for engineering purposes, according to Mr. Horgan.

"The errors introduced by the method," he said, "are . . . small . . . and not as significant as the discrepancies which exist between the external characteristics of a particular transistor and the manufacturer's typical characteristics with which the circuit designer works."

CIRCLE 11 ON READER-SERVICE CARD >



first from PHILCO



(shown actual size)



more transistor power in standard packages!

Philco Design Increases Power Dissipation As Much As Four Times For New 2N671 Transistor!

- Exclusive Copper-to-Glass Hermetic Sealing
- One Watt Power Dissipation
- New Higher Voltages . . . Higher Currents

Philco is proud to introduce the 2N671, a new power transistor, rated conservatively at one watt maximum dissipation in a studded version of TO-9 (JETEC 30) type package.

With collector and emitter voltage ratings of -40 V dc and a maximum current rating of 2 amps., the 2N671 is especially engineered for high powered relays, relay drivers, drum or tape writers, pulse amplifiers, communications and core switching applications.

For applications with lower power requirements the 2N670 is available, without stud mounting, at dissipations of 300 mw.

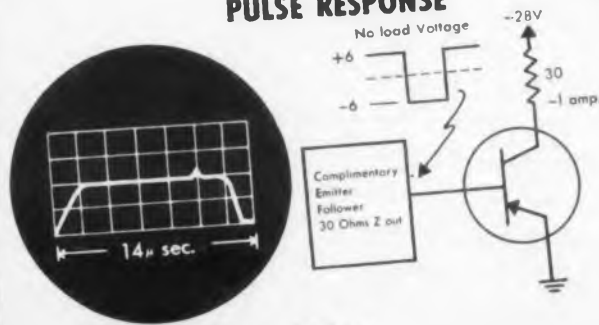
New Philco production techniques enable increases in thermal conductivity up to 8 times . . . power ratings as much as 4 times conventional ratings. These performance advantages can be applied to all classes of Philco transistors from audio frequencies through UHF.

If your application needs an optimum approach to semiconductor performance . . . more power, greater heat dissipation, or increased reliability . . . consult Philco first.

Make Philco your prime source of information for all transistor applications.

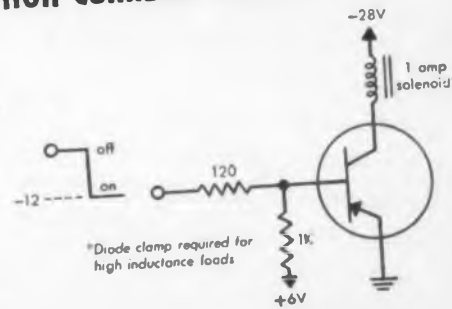
Write to Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa., Dept. ED 658

PULSE RESPONSE



† 200 mil. pin circle package TO-9-type

HIGH CURRENT SOLENOID DRIVER



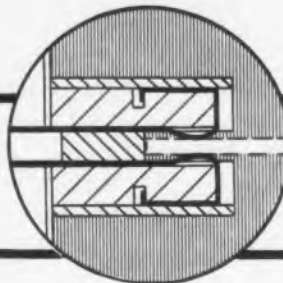
PHILCO CORPORATION
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NEW!



GORNECTORS®
and
GORNET†



*Cutaway detail shows
printed circuit board
held in place by spring-
action contact.*

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CIRCLE 12 ON READER-SERVICE CARD

ENGINEERING REVIEW

Digital Computer Multiplication

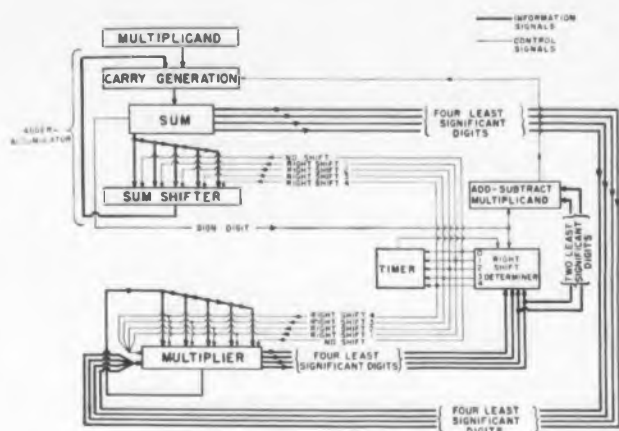
An improved multiplication method developed at the National Bureau of Standards can achieve a three-fold increase in present operation speeds. The technique can be generally applied and does not require any particular kind of digital computing components or circuitry.

The most common method of multiplying with binary digital computers is the repeated addition of the multiplicand. A one-position shift accompanies each addition, and a running sum of the partial products is maintained in an accumulator. In this process, the accumulator is cleared initially. During the first addition cycle, if the least significant digit of the multiplier is a 1 the multiplicand is added to the contents of the accumulator. If it is a 0, nothing is added. In either case, the contents of the accumulator and of the multiplier register are shifted one position to the right. Similarly, during the second addition cycle, the next most significant digit of the multiplier determines whether the multiplicand is or is not added to the contents of the multiplier. Again, in either case, the contents of the accumulator and of the multiplier register are shifted one position to the right. After each multiplier digit in turn has controlled the addition of the multiplicand to the contents of the accumulator (with the one-position shift for each cycle) the multiplication operation is complete and the final product is available in the accumulator.

The Bureau's system omits some of these steps when a sequence of several consecutive 1's or 0's appears in the multiplier. Whenever any multiplier digit is a 0 and nothing is to be added to the partial-product sum, that addition cycle could be omitted entirely, and only a shift need be performed. A sequence of 0's would allow omitting as many addition cycles as there are 0's. Similarly, if a sequence of 1's occurs in the multiplier, cycles corresponding to these 1's may also be omitted in much the same way, if subtraction of the multiplicand from the partial-product sum is provided for.

Consider a string of n consecutive 1's in the multiplier. The numerical value of just this string of binary 1's is equivalent to $2^n - 2^0$. Therefore, in computing the partial products corresponding to this string of n 1's, one subtraction of the multiplicand for the right-hand 1 and one addition of the multiplicand for the 0 to the left of the string of 1's are sufficient.

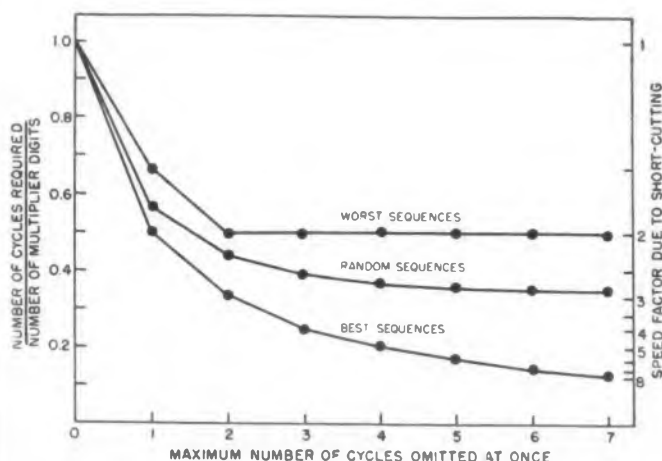
A fundamental requirement of the multiplication process is that the contents of the accumulator (and of the multiplier register) be shifted one position to the right for each digit of the multiplier, regardless of whether or not any of the cycles are omitted. Therefore, in order that



Logical diagram of high speed multiplier.

the multiplication time be shortened to the fullest extent by omitting cycles of the operation, some arrangement must be made for accomplishing multiple-position shifts as rapidly as possible. Ideally, the shifts that correspond to cycles to be omitted should be combined with the shift that accompanies the last cycle actually performed. Thus, for example, if three cycles are to be omitted, one shift of four digit positions should be executed instead of four shifts of one position each.

Some measure of the effectiveness of this shortcut multiplication technique can be determined on the basis of a purely random sequence of multiplier digits. In this case, it turns out that the number of cycles for $n = 3$ is about 40 per cent of the number of digits. In practice, multiplier digits are often not random, nor even apparently so, but experience indicates that departures from randomness usually favor sequences of similar digits. Thus, the average number of cycles required for multiplications will generally be less than the theoretical number for random sequences. If a curve were plotted for the average number of cycles required for multiplier sequences usually occurring in practice—a mixture of random digits and strings of similar digits—this curve would lie between the curve for purely random sequences and the curve for the best sequences.



Graph showing how computation speed is improved when using the high speed multiplication technique.



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| Heater Current | 0.55 amp. |
| Beam Voltage | 350 v max. |
| Beam Current | 40 ma max. |
| Reflector Voltage | 0 to -350 v |
| Heater-Cathode Voltage (peak) | 45 v |

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mode characteristics for automatic frequency control operation.

Important features include waveguide output, integral cavity and tuner, single-screw tuning covering full frequency range in only 9 turns.

Other applications for the SRU-95 are local oscillator in microwave receivers and spectrum analyzers, low-power transmitting tube, and bench oscillator. Write or phone for data sheet on the Sperry SRU-95.

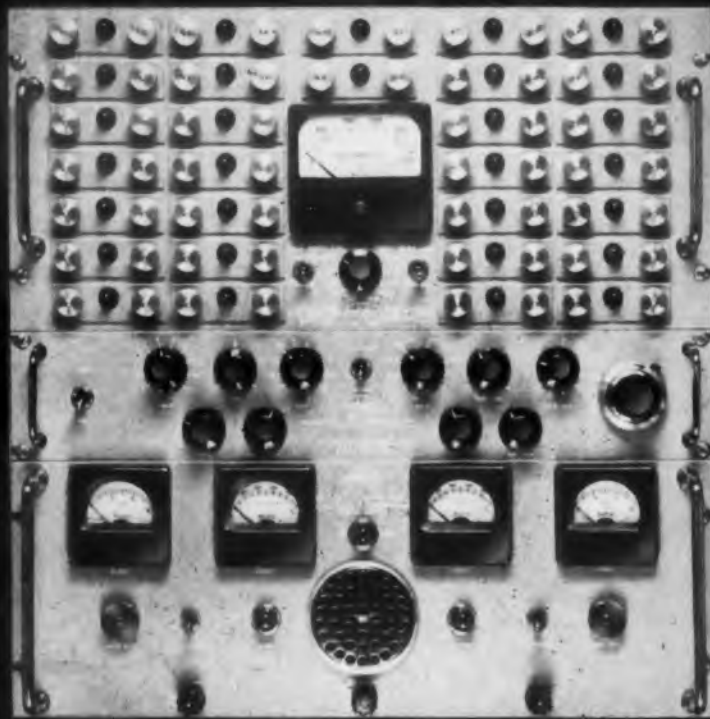
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CIRCLE 13 ON READER-SERVICE CARD

New....ARNOUX miniature DECOMMUTATOR

FOR PAM and PDM TELEMETRY SYSTEMS



The new Arnoux Model TDS30-1 Decommution System is completely self-contained within three chassis assemblies consisting of: Gating Unit (TOP), Pulse Selector (MIDDLE) and Regulated Power Supply (BOTTOM). The unit handles 28 channels of information and occupies only 19½ inches of panel height in a standard relay rack. Overall depth behind panel is 13 inches.

The Arnoux Model TDS30-1 Decommution System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D. C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within $\pm 1/2\%$ at maximum level. Long term level drift is within $\pm 1/2\%$. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
- Power required is 115 volts, 60 cps, single phase. Optional 115 volt, 400 cps, power supply available for airborne application.

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CIRCLE 14 ON READER-SERVICE CARD

WASHINGTON REPORT



Herbert H. Rosen

Ad Hoc Group on Electronic Parts Set Up by DOD

Assistant Secretaries of Defense for Supply and Logistics and for Research and Engineering have agreed to sponsor jointly an *ad hoc* group on electronic parts. Jim Bridges' Office of Electronics will administer a program aimed at setting up procedures and specifications for parts reliability. The group will review management, prepare parts and tubes specifications, and coordinate procedures and practices. The QPL and Qualifications Testing Procedures are also to be reviewed with an eye toward propriety of qualifications, adequacy of tests, and elimination of duplication.

Reliability Assurance Test Procedures are to be developed to verify compliance with the designated reliability level. A program is to be developed for obtaining technical characteristics and test data for parts. The group will, in addition, investigate the need for a document which will provide design guides rather than rigid specifications.

Navy, Air Force To Spend Four Billion in Electronics

Recent hearings before a House Appropriations Subcommittee have disclosed Navy and the Air Force hope to spend nearly four billion for electronics. Almost 10 per cent of the Navy's \$11 billion budget request and \$3 billion of the Air Force's \$19 billion will be used to buy electronic equipment and services.

More specifically, the Navy plans for electronic spending breakdowns in this manner: \$300 million in varied land, sea, and air electronics; \$500 million in aircraft; \$80 million in missile activity; \$30 million in antisubmarine warfare; \$20 million for R & D.

As for the Air Force: Missile support—ground electronics, \$878 million; general support and ECM equipment, \$747 million; command control and warning equipment, \$810 million; R & D, \$120 million; and O & M, modifications, air defense, ECM, installations, meteorology, \$328 million.

In terms of equipment, the Navy will sink its money into missiles and submarines; the

Pacific Missile Testing Center, Sonobuoys, detection and ground approach radar, ASW, modernization of communications equipment, modernization of navigation aids; data processing systems; and R & D ranging from development of communications networks to high temperature components.

A hefty chunk of Air Force money is earmarked for the operational support of SAGE (\$430 million), White Alice, DEWline, and Pinetree Line. The Ballistics Missile Early Warning System will receive an additional \$86 million. New Air Defense electronics will be researched with about \$28 million. The same amount of money will be turned over to the Army Ballistic Missile Agency for more work on the Jupiter missile.

DEWline, which is now getting eastern and western extensions, is to have new radars and associated communications equipment valued at \$44 million. Other radar improvements costing \$15 million, and high-power communications, data link, and identification equipment (at \$34 million) together are sought to strengthen the early warning system.

Reorganization Effects

While most of the headlines underscore Defense Secretary McElroy's battle over a single chief, single service, there appears to be complete unanimity on setting up a Director of Defense Research and Engineering.

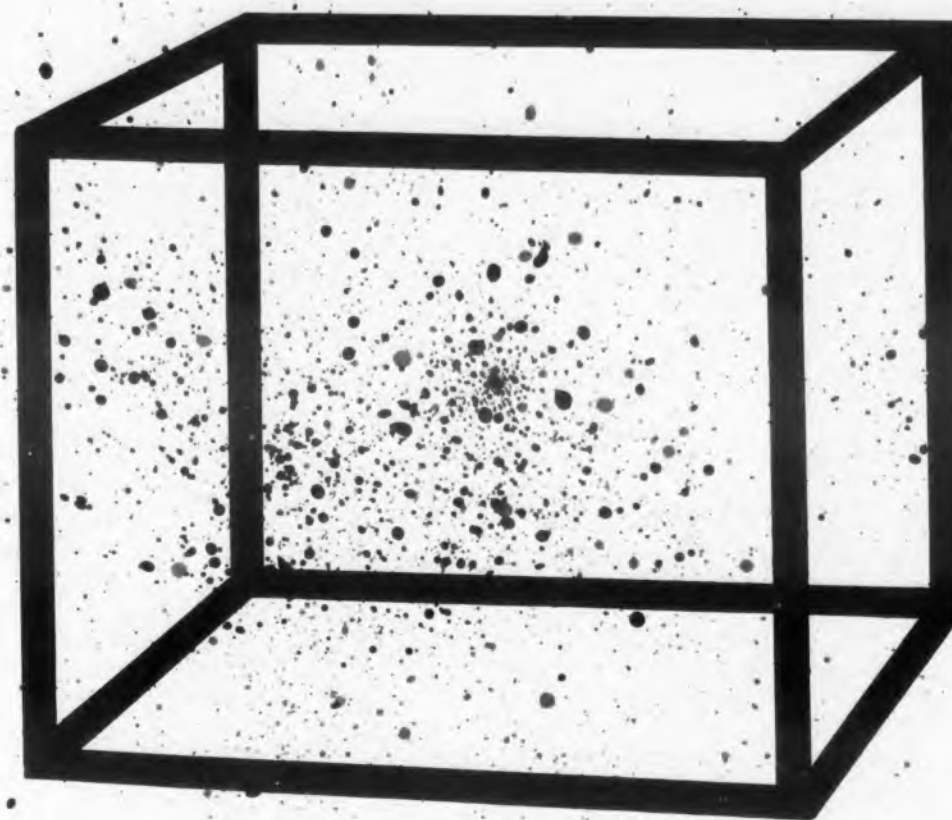
His Director will be the principal advisor on scientific and technical matters. He will supervise all R & E activities, including those of ARPA and the Office of the Director of Guided Missiles. He will also direct R & E activities that require centralized management.

Besides these broad duties, the Director of R & E will:

- plan research and development meeting military objectives;
- eliminate unnecessary duplication;
- release promising programs for development or production;
- analyze military technical programs for integration of R & D to meet the needs of each operational command.

This job is going to require a great amount of advice from staffs of experts and consultants.

A growing fear among Pentagonians is that well-known scientists and engineers from the universities will be drawn into these jobs. While they are by and large outstanding in their fields, there is doubt concerning their management capabilities. And this, in the final analysis, is the major responsibility of anyone who works for the upper echelons of the Department of Defense, and an area in which there have been noticeable deficiencies.

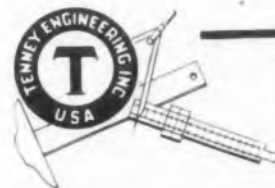


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CIRCLE 15 ON READER-SERVICE CARD

MEETINGS

July 24-25: 5th Annual Symposium on Computers and Data Processing

Albany Hotel, Denver, Colo. Sponsored by the Denver Research Institute, Electronics Div., University of Denver. Symposium will consist of technical papers on basic problems in the field of data processing, particularly in the areas of formalized analysis techniques, logical design techniques, automatic programming, systems organization, digital communications, and components and devices. Queries concerning the symposium may be addressed to C. A. Hedberg, Head, Electronics Div., Denver Research Institute, University of Denver, Denver 10, Colo.

Aug. 6-8: Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers

Hotel Statler, Los Angeles, Calif. Sponsored by AIEE. The four technical sessions will include: technological and theoretical aspects of non-linear magnetics and magnetic amplifiers; computer applications; special purpose devices and applications; and "new frontiers" in the field. Exhibits will be displayed by 40 manufacturers selected for their contributions to the industry. For more information about the conference, write AIEE, 33 West 39th St., New York 18, N.Y.

Aug. 13-15: 7th Annual Conference on Industrial Applications of X-Ray Analysis

Albany Hotel, Denver, Colo. Sponsored by University of Denver, Denver Research Institute, Metallurgy Div. For additional information write William M. Mueller, Metallurgy Div., Denver Research Institute, University of Denver, Denver 10, Colo.

Aug. 13-15: Conference on Electronic Standards and Measurements

NBS Boulder Labs., Boulder Colo. Sponsored by the Professional Group on Instrumentation of IRE, Electronic and High-Frequency Instruments Committee of AIEE, and the Radio Standards Lab. of the National Bureau of Standards. Six technical sessions will cover the following subjects: The Relationship of Standards to Physical Constants; Frequency and Time Interval Standards; Direct-Current and Low-Frequency Standards; Radio-Frequency Standards (Measurement of voltage, current, power, impedance, attenuation, phase shift, field strength); Microwave Standards (Measurement of power, impedance, attenuation, noise), and The Organization and Operation of Standards Laboratories. Write

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CIRCLE 16 ON READER-SERVICE CARD

James F. Brockman, National Bureau of Standards, Boulder Labs., Boulder, Colo.

Aug. 19-22: Western Electronic Show and Convention

Los Angeles, Calif. Details will be announced later. For more information write Western Electronic Show and Convention, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Sept. 12-14: 7th Annual High Fidelity Show

Palmer House, Chicago, Ill. Write to International Sight and Sound Exposition, Inc., One N. La Salle St., Chicago 2, Ill., for further details.

Sept. 15-19: 13th Annual Instrument-Automation Conference and Exhibit

Philadelphia Convention Hall, Philadelphia, Pa. Sponsored by ISA. Two technical sessions on the use of instruments in the nuclear field will highlight the 5-day conference. Ask Fred J. Tabery, Conference and Exhibit Manager, 3443 S. Hill St., Los Angeles, Calif., for further information.

Sept. 22-24: National Symposium on Telemetry

Americana Hotel, Miami Beach, Fla. Sponsored by PGTRC of IRE. Ken West, 1345 Indian River Dr., Eau Gallie, Fla., has additional information about the symposium.

Sept. 24-25: 7th Annual Symposium on Industrial Electronics

Rackham Memorial Auditorium, Detroit, Mich. Co-sponsored by PGIE and AIEE. Address queries to William R. Thurston, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Paper Deadlines

June 25: Deadline for papers to be presented at the 1958 National Simulation Conference. The conference, sponsored by the IRE, is planned for October 23-25 in Dallas, Tex. One hundred words abstracts and 500 word summaries of technical papers in the general field of simulation should be transmitted in duplicate to *D. J. Simmons, Rt. 8, Box 447, Ft. Worth, Tex.*

Aug. 1: Deadline for papers for the 7th Annual Meeting of the Standards Engineers Society. Papers preferably should be related to the theme of the meeting, STANDARDIZATION, A MUST FOR THE SPACE AGE. This meeting will be held on

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Sept. 22-24 at the Benjamin Franklin Hotel, Philadelphia, Pa. Send papers of 1600-2400 words in length, typed and double-spaced in quadruplicate to *E. D. Clark, c/o Standard Pressed Steel Co., Jenkintown, Pa.*

Courses—Seminars

July 7-11: Institute in Technical and Industrial Communications. Colorado State University, Ft. Collins, Colo. Further details may be obtained by writing *Herman M. Weisman, Associate Professor, Department of English and Modern Languages, Colorado State University, Ft. Collins, Colo.*

July 8-12 and July 14-18: Two Special Summer Programs on Strain Gage Techniques. Massachusetts Institute of Technology, Cambridge 39, Mass. Additional information may be obtained from *Dr. William M. Murray, Professor of Mechanical Engineering, M.I.T.*

Aug. 4-15: Special Summer Program on Microwave Ferrites. Massachusetts Institute of Technology, Cambridge 39, Mass. Topics will include Electromagnetic Theory of Fields in the Presence of Ferrites, Measurements of Ferrite Characteristics, and Linear and Non-linear Ferrite Devices: Theory and Application. Write to *Dr. Herman A. Haus, Assistant Professor, M.I.T., Department of Electrical Engineering for information.*

Aug. 4-15: Summer Study Course in Microwave Theory and Technique. Case Institute of Technology, Cleveland, Ohio. The course will be directed toward the engineer in industry who has found a growing need for training in the methods of measuring and analyzing with microwaves. Requests for additional information on the course should be directed to the *Director of Special Programs, Case Institute of Technology, 10900 Euclid Ave., Cleveland 6, Ohio.*

Aug. 11-22: 3rd Annual Statistical Methods in Industry Course. University of California, Los Angeles, Calif. Sponsored by the UCLA College of Engineering, University Extension, and the American Society for Quality Control. In addition to the above course, there will be a 3-week course in Industrial Reliability, Aug. 4-22. Address requests for information on the courses to *Edward P. Coleman, Professor, College of Engineering, University of California, Los Angeles 24, Calif.*

CIRCLE 17 ON READER-SERVICE CARD

EDITORIAL

Printed-Wiring Comes of Age

Printed-wiring is an excellent concept promising many advantages. But like many other promising developments, its reputation suffered a setback when some manufacturers tried to cut production costs at the expense of quality. Others, through ignorance, didn't realize that certain production shortcuts degraded quality and cut reliability.

Now the emphasis is again on reliability. Much effort has gone into improving laminate quality and bond strength, standardizing dimensional tolerances, and most important, improving soldered connections. Better production processes and better care and handling of printed-wiring boards have been found necessary to effect these improvements.

But these changes didn't happen overnight. An education in good processing and handling techniques has been somewhat forced upon printed-wiring makers and users. They found that printed-wiring boards used in consumer products' applications wouldn't stand up in military applications. Even in some consumer products, printed-wiring was very unsatisfactory. So as users insisted on better quality, fabricators evolved standards to guarantee fulfillment of these quality requirements. Naturally, improved quality means more reliability.

The cost of printed-wiring is high. When reliability is a must, cost is secondary. Of course, the cost of the most expensive board is low compared to the cost of a reject that is completely assembled with fifty or more mounted parts. Nevertheless, designers must be cost-conscious. Part of the cost is both engineers' and draftsmen's time in laying out a circuit for printed wiring. Time saving short cuts should be explored.

One area still to be exploited is the education of designers in new uses of printed-wiring. Engineers should freely exchange printed-wiring information at technical meetings and through technical publications. It now becomes imperative to promote printed-wiring applications to enable the industry to profit by all its advantages.

James D. Shepley

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The series 400 miniature, precision multipot line was developed for industry as a complete low-cost line of high performance potentiometers.

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CIRCLE 18 ON READER-SERVICE CARD



High Reliability is insured by . . .

Printed Circuit Standardization

S. Kramer, L. Krauss, and J. Monturo

Arma Division,
American Bosch Arma Corp.,
Garden City, N.Y.

To insure reliability and uniformity of product at the lowest possible cost, Arma established a project to set up design procurement and processing standards for printed wiring. Their efforts have resulted in highly reliable designs for the military.

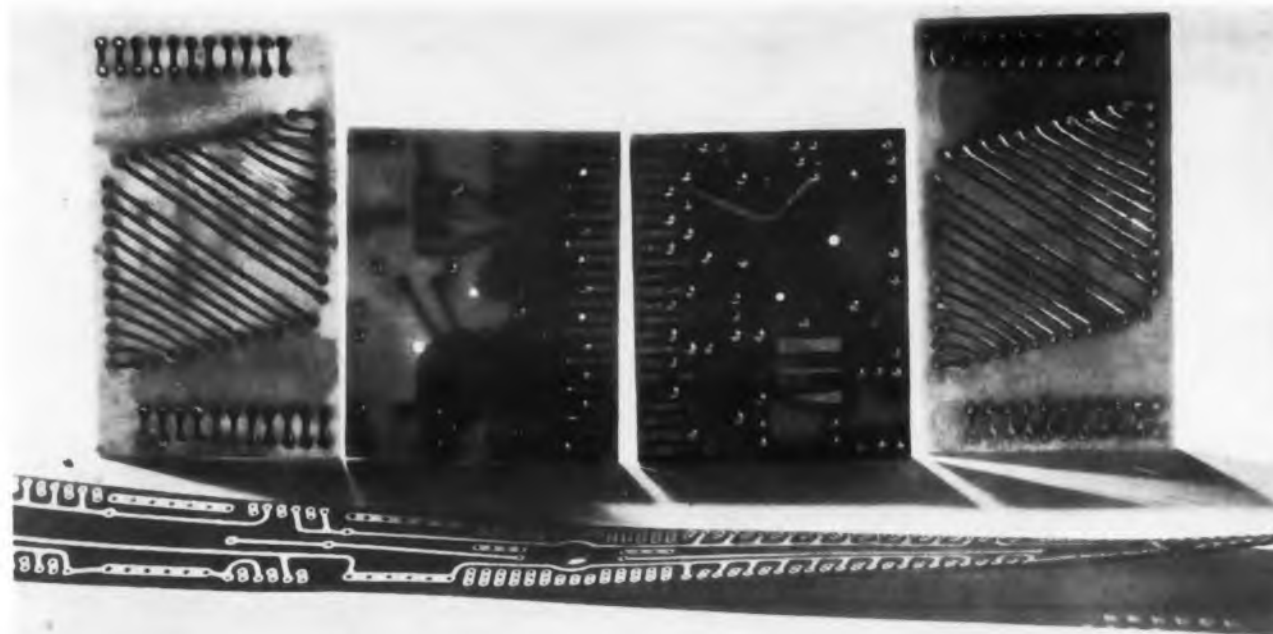


Fig. 1. Poor bond strength and interlaminar blistering (upper samples). In the foreground is an example of excessive warp and twist.

DESIGN standards must be based on commercially available production processes in lieu of specialized techniques. With this thought in mind, printed circuit design standards and related specifications established were based on Arma's requirements and the vendor's ability to consistently produce a high quality product at minimum cost. It was necessary that the design standards be sufficiently flexible for applications including missile guidance, naval navigation, and naval and airborne fire control systems.

Basic printed circuit design standards used at Arma (Table 1) were established as a result of past design experiences, laboratory evaluations, and other accumulated data.

Nominal conductor width preferred for all designs is 1/16 in. unless space and weight are a criteria. The allowable minimum is 3/64 in. providing the temperature rise due to current is acceptable. The established width was based primarily on: fabricators tolerances; pin holes in the copper foil; bond strength and current carrying capacity.

A fabricator's tolerances could reduce a given 0.032 in. conductor width, thus affecting reliability.

For example:

- 0.004 in. tolerance when 4 times artwork is reduced,
- 0.005 in. tolerance from screening process,
- 0.010 in. undercutting from etching,
- 0.019 in. total tolerance,
- 0.032 in. desired conductor width,
- 0.013 in. possible conductor after fabrication

When functional designs require conductors greater than 1/4 in. wide, for shielding or ground

Table 1. Basic design standards using epoxy glass laminate, both sides plated with 2 oz copper; plated-through holes, gold-plated conductors.

| | Nominal | Minimum |
|-----------------------|---------------|---------------|
| Conductor Width.-in. | 1/16 | 3/64 |
| Conductor Spacing-in. | 1/16 | 3/64 |
| Pad Diameter-in. | 1/8 | 0.100 |
| Hole Diameter-in. | 0.063 ± 0.007 | 0.038 ± 0.007 |

Table 2. Minimum Spacing of Adjacent conductors

| Potential Difference, peak volts | Minimum Spacing-in. |
|----------------------------------|---------------------|
| 0 to 300 | 3/64 |
| 301 to 500 | 1/8 |
| Greater than 500 | 0.0003-in. per volt |

planes, cross-hatching is required to eliminate blistering and other thermal effects from dip soldering.

Nominal conductor spacing is 1/16 in. Where space is at a premium a minimum of 3/64 in. spacing is permitted. Conductor spacing is dependent upon voltage differences. Table 2 is the guide used at Arma.

Other conductor spacing considerations: (a) 1/32 in. between conductors and edges of board or holes in the board; (b) 0.100 in. between conductors and metal hardware and/or metal-type components.

Intersections of conductors, and conductors and pads are filleted. Smooth curves are employed to change conductor directions. Fillets and curves reduce the incidence of failures which occur at conductor intersections due to screening techniques.

Mounting components directly on or across conductors is undesirable. This type of mounting permits entrapment of flux and other contaminants. In addition, some component markings, such as tolerance bands on carbon composition resistors, are relatively conductive. When components must be placed on or across conductor lines, adequate protection should be taken. Coating the contact area with an insulating varnish prior to component assembly is one solution.

Minimum pad diameters are 0.062 in. larger than their respective hole diameters in order to provide sufficient annular foil area around the hole for soldering and strength. A pad diameter of 0.100 in. is used for 0.038 in. holes and 0.125 in. pad diameters for 0.063 in. holes.

Pads are required on both sides of the board when plated-through holes are used. This is necessary to prevent etchant attack on the hole walls and provide maximum solder joint strength.

Arma uses plated-through holes rather than eyelets. Their decision is based on the requirements for mass soldering, reliable solder joints, and space considerations. Mechanical rigidity required is achieved by the capillary action of the solder during dip soldering.

Plated-through holes by themselves are not relied upon to provide electrical continuity from one side of the board to the other. When it is necessary to transfer circuitry through the board via a hole that does not contain a component lead wire, a separate piece of bus wire is secured into the hole. Diameters of plated-through holes are specified as "after plating." In order to consistently obtain adequately plated-through holes and solder joints, the hole size must be compatible with the board thickness. Table 3 shows the hole diameter as a function of the board thickness and wire size.

Pigtail type components are mounted flush with the printed circuit board. To hold the com-



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CIRCLE 19 ON READER-SERVICE CARD

Table 3. Hole Diameter vs Board Thickness

| Wire Size-in. | Plated Thru Hole Diameter-in. | Maximum Base Material Thickness-in. |
|---------------------|-------------------------------|-------------------------------------|
| Up to 0.022 diam | 0.038 to 0.007 | 1/32 |
| 0.023 to 0.045 diam | 0.063 to 0.007 | 1/16 |
| over 0.045 diam | Wire size plus 0.015 | Equal to hole diameter |

ponents securely in place prior to, and during dip-soldering, the lead wires are clinched on the solder side of the board. Components are mounted so that replacement may be easily accomplished without the use of special tools. The use of multiple-contact, flush-mounted components is avoided. When such a component must be used, the printed conductors to and from the components should be on the dip solder side of the board to insure maximum reliability.

All component leads should be straight, a minimum of 3/32 in. from the point of egress from the component body to the point of bend. Bend radii for various lead diameters are shown in Table 4.

Components fabricated with welded leads, such as tantalum capacitors, require that the leads be straight 5/32 in. minimum beyond the

Table 4. Bend Radii vs Lead Diameters

| Lead Diameter-in. | Lead Wire Bend Radius-in. |
|-------------------|---------------------------|
| up to 0.028 | 0.032 min. |
| 0.029 to 0.045 | 0.062 min. |
| 0.046 & larger | twice lead wire diam min. |

welds to prevent bending stress on the welded joint. Component leads are machine formed to provide lead support during the bending operation thereby minimizing seal failures.

Component leads are mounted to 0.100 in. grid intersections. Standardized component mounting centers assure uniform design, optimum packaging, lower tooling costs, and greater reliability. A typical example of this is shown in Table 5 for fixed composition resistors.

After basic design standards have been fixed and found acceptable, it is necessary to specify and control the material and processing parameters to assure a highly reliable end product. The basic mechanical and electrical properties required, such as flexural strength, warp, volume resistivity, surface resistivity, etc., are dictated by the design objectives. During the design

Table 5. Standard Mounting Centers For Fixed Composition Resistors

| MIL-R-11 Style | Center to Center Hole Distance-in. |
|----------------|------------------------------------|
| RC09 | 0.700 |
| RC20 | 0.700 |
| RC32 | 1.100 |
| RC42 | 1.100 |

stages these criteria dictate a choice of one of the basic laminate stocks, phenolic, epoxy, melamine, and filler (glass cloth, glass mat paper).

In seeking an answer to "What type of base material, and whose, will consistently meet the performance requirements desired?" we use:

- past experience and/or test data obtained from a related design application;
- military and/or commercial specifications;
- data available from laminators or fabricators;
- test data obtained from laboratory investigations of sample quantities.

These yield only typical properties and indicate solely the type of material to be used. Unfortunately available procurement specifications are inadequate because:

- Acceptance criteria are usually of a compromise nature. They reflect minimal properties for

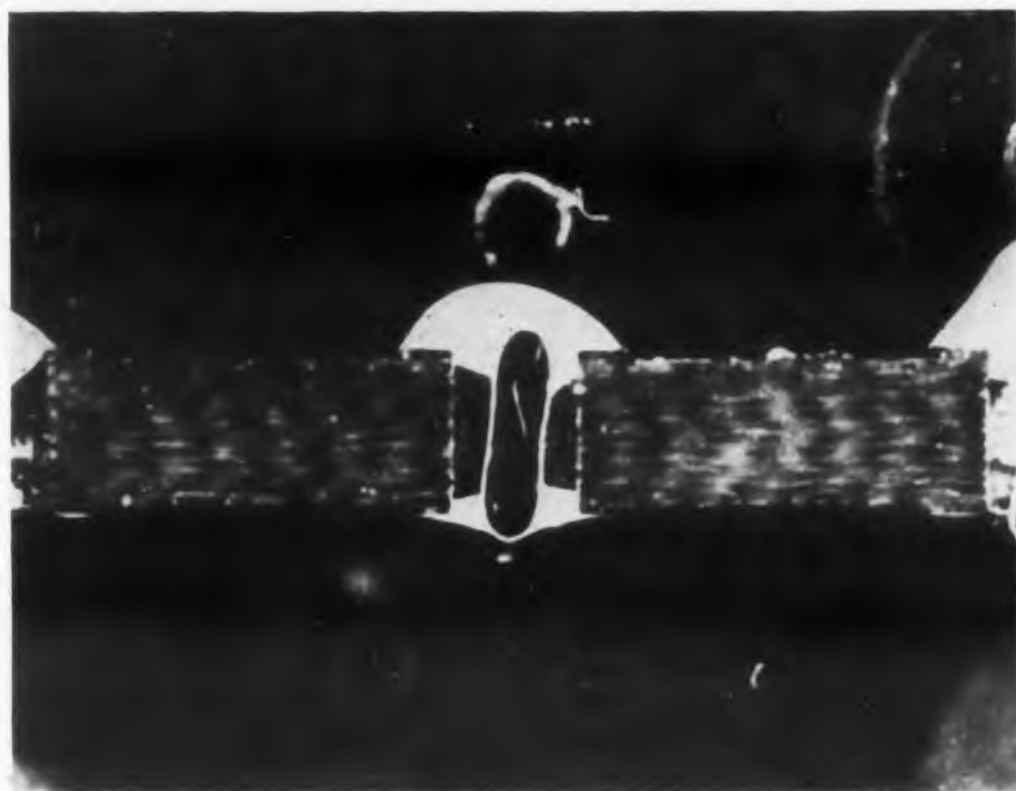


Fig. 2. How voids appear in the solder connections in plated-through holes.

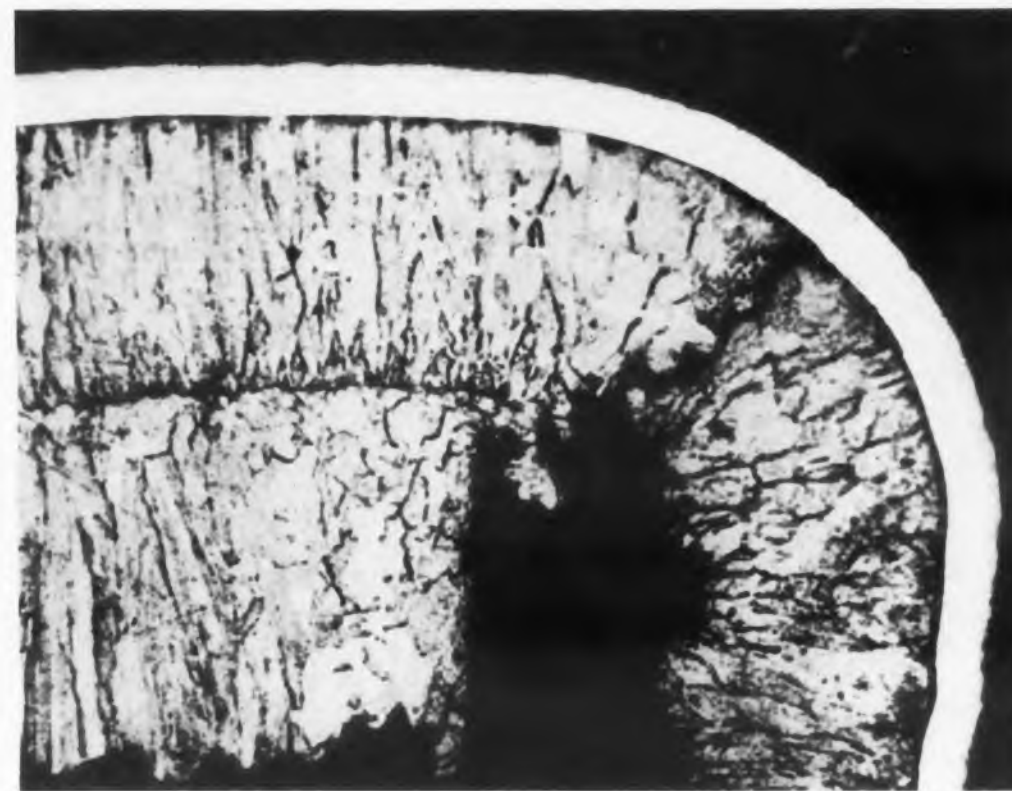


Fig. 3. Rupture of copper plating and reduced plating thickness at hole entrance.

the various types of materials. Superior materials in each of the grades are not readily detectable under a minimum requirement specification.

- Quality levels are inadequate for high reliability application. Basically the three elements of quality control that are lacking include: (1) repetitive control tests to insure consistency of product; (2) adequate sampling plans; (3) coordinated effort. Quality levels cannot be successfully maintained without coordinated control at all echelons of fabrication and manufacture.

- Test procedures are inadequate or inappropriate. For example, it is not unusual for published data to state that a particular material will withstand a hot solder bath of 500 F for 30 seconds. Based on this characteristic, dip soldering should be no problem as far as the material is concerned. In dip soldering, parameters are substantially lower. But, a check into the test procedure used for determining this published data will usually reveal that the test is conducted on small squares with the copper clad on one or both sides. The sole criteria of acceptance is usually no blistering of the foil. Most printed circuit boards are substantially larger, contain a circuit pattern, and, therefore, introduce other problems not readily detected by the hot solder test.

Major problem areas which require close surveillance and are important factors in the overall cost and reliability of printed circuits are:

- Bond Strength.** Can be reduced after subjection to the hot solder test. More realistic data is obtained by testing etched conductor lines 1/16 in. or 1/8 in. wide.

- Blistering.** Internal blistering is caused by the rapid expansion of volatile matter as a result of dip soldering. It is wise to test material for this defect after humidity conditioning.

- Platings.** If plated through holes are used, inadequate plating thickness in the holes will not permit solder flow and adequate filleting with the inserted lead on the component side of the board. Two other important problems with respect to plated through holes are: (1) insufficient etch resist will permit etching solution to attack the copper plating in the hole; and (2) plating thickness must be sufficient to allow for component replacement. Insufficient plating will not endure at least four rework cycles.

Type of circuitry, design, and environmental conditions dictate the required electrical parameters. Since the major use of printed circuits at Arma is in low impedance and low power devices, any electrical problems are minimized. In this case, electrical characteristics are used to define the product. Obviously when printed capacitors, inductors, transmission lines, or microwave antennas are employed, careful consideration must be given to any variation in dielectric constant, dissipation, and conductor spacings.

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12 1/2 WATT MINIATURE RHEOSTAT

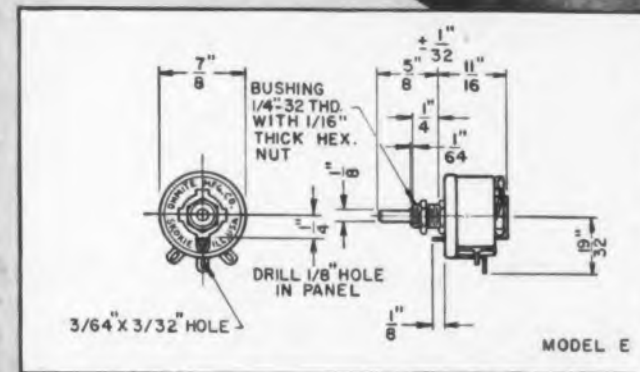
High power handling capability for small size

Newest addition to the Ohmite line of vitreous-enamelled rheostats is the new Model "E" miniature 12 1/2-watt rheostat. This new unit is smaller than many one- or two-watt potentiometers. It provides time-tested Ohmite all-ceramic and metal design features for uses where as much as 12 1/2-watt dissipation is required and space is extremely limited. Built to operate at a maximum hot spot temperature rise of 300° C at an ambient of 40° C, Model "E" is also useful for operation at high military ambients, derated linearly to zero at 340° C, attained. Rugged, lasting, power rheostat performance is thus available in such small size that new possibilities in miniaturization and dependability are afforded the apparatus designer.

Like the larger Ohmite rheostats, Model "E" has a ceramic base, and ring-shaped ceramic core. Vitreous enamel holds the turns of wire against shifting, and fastens the base and core together. Also, the Model "E" has a ceramic hub insulating the shaft; a metal-graphite contact; folded spring arm; independent compression spring; slip-ring; a stop directly connected to the shaft. The entire assembly is a miniaturized, dependable version of the time-proven Ohmite power rheostat design. Mounting is by a 1/4" — 32 threaded bushing. The shaft is 1/8" in diameter. Resistance range: up to 5,000 ohms with 23 stock values; higher values available with OHMICONE inorganic coating. Resistance tolerance: ±10%. Torque: 0.1 to 0.2 pound-inch. A small finger-grip knob, in keeping with the rheostat dimensions, is available.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.

ACTUAL SIZE
Model "E"
Only 7/8" Diameter
Weight: 0.52 Ounce



INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS



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QUALITY
Components

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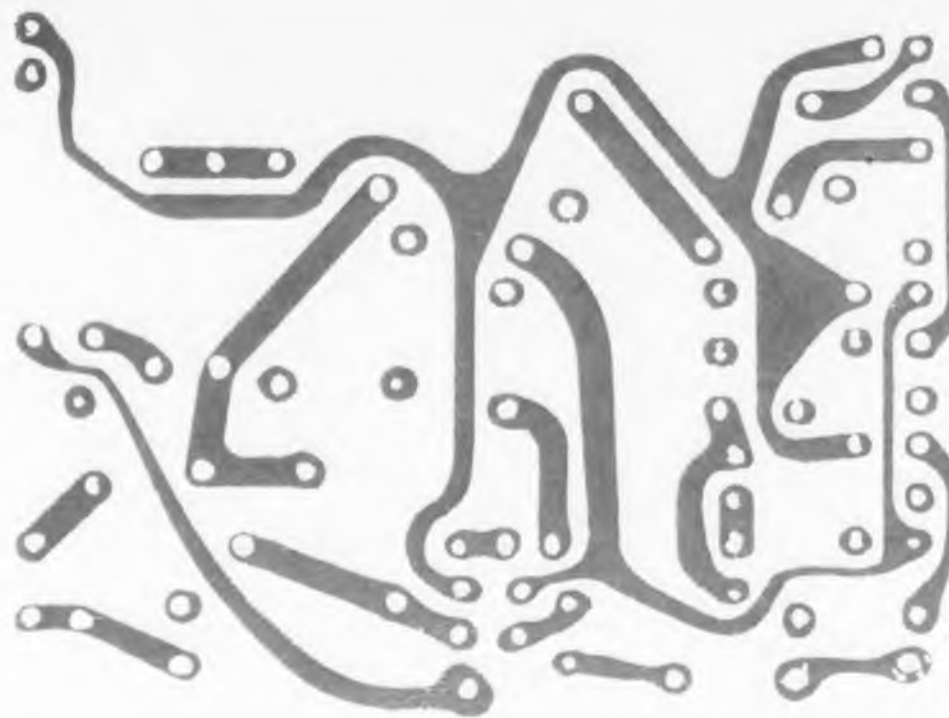
Now 11 Sizes! — 12 1/2 to 1000 Watts

All sizes available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in each of the 26 type designations.

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TAP SWITCHES TANTALUM CAPACITORS
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OHMITE MANUFACTURING COMPANY 3643 Howard Street, Skokie, Illinois

CIRCLE 20 ON READER-SERVICE CARD



Making Printed-Wiring Reliable

Laurence D. Shergalis
Associate Editor
ELECTRONIC DESIGN

Printed wiring has many advantages. It saves valuable space in electronic assemblies and permits use of automatic production techniques. But these advantages can be lost through poor reliability. With increased emphasis on reliable performance, designers of equipment using printed-wiring are concerned with avoiding faults in printed-wiring boards. In this special issue, we are presenting the latest industry practices in achieving reliable printed-wiring. And, because military equipment demands the utmost in reliable performance, our articles stress these more rigid requirements.

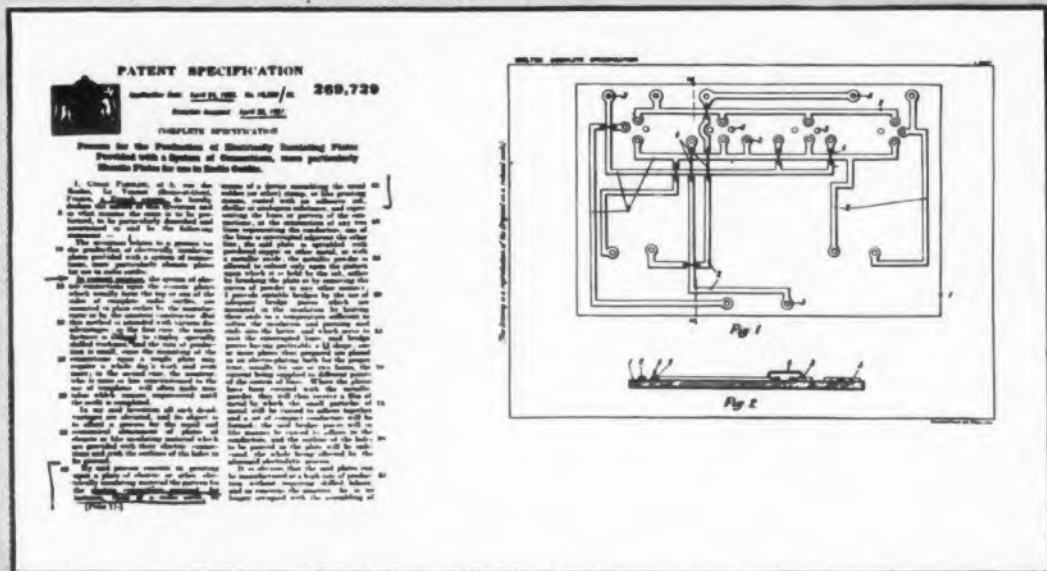
The initial survey for this report on printed-wiring disclosed that nearly all major fabricators and users

have their own standards. But many issues still remain unsettled. For example, opinion on the merits of eyelets as opposed to plated-through holes leans heavily toward eyelets. However, recent new advances in plating tend to make plated-through holes look more attractive to many manufacturers. Biggest complaint is in the care and handling of boards during and after manufacture. Because of its importance, the subject rates special attention in this report. Our survey indicated that manufacturers have acquired considerable background in the areas of processing, coatings and soldering. Techniques seem to be pretty well established. Now the emphasis will be on refinements to improve reliability.

For a free reprint, 8-1/2 x 11", of this staff report and the articles authored by engineers of Arma Div. and Formica Corp., circle 27 on Reader-Service card.

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- 1 Standards** — The starting point for reliable printed-wiring . . p 28
- 2 Board Design Techniques** — Factors to consider for reliable operation p 32
- 3 Choosing Board Materials** — Using the right laminate aids reliability p 36
- 4 Proper Care and Handling** — An often neglected aspect of reliability in printed-wiring p 40
- 5 Factors in Soldering** — Good soldering practice insures reliable connections p 44
- 6 Other Forms** — variations of well-known techniques designed for reliability p 46



Is this the First?

Printed-wiring makers still debate the date printed-wiring first came into being and was patented. Many ideas similar to present-day printed-wiring are disclosed by early U. S. patents, many dating back into the later 19th Century.

But this British patent unearthed by a leading U. S. manufacturer during a patent search in England recently, may be the first. It specifically spells out the printing and electroplating process. Invented by a Frenchman named Cesar Parolini, the method consists "of an ebonite plate for radio outfits, having an electrolytically deposited system of connections." Application date is April 24, 1926 and the patent was granted April 28, 1927. British patent number is 269,729.



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CIRCLE 22 ON READER-SERVICE CARD

1 Standards — The starting point for reliable printed-wiring



RELIABILITY depends to a great extent upon adherence to standards. And standards reflect good design criteria to enable engineers to fully exploit the advantages of printed-wiring.

Designers have started to be more standards conscious. Establishing the 0.1 in. grid pattern was a step in standardization for automatic production. Recently, the Institute of Printed Circuit manufacturers devised a set of preliminary suggested standard tolerances. Much of this is based upon standard tolerances used by Photocircuits Corp. the past few years. IPC expects to publish a working set by midsummer.

Other manufacturers and the military have also established various standards. These include standards tolerances in hole dimensions, regis-

tration, conductor size and spacing laminate thickness, plating thickness, and board size. Cleveland Metal Specialties for example, have published their own booklet entitled "Military Standards for Printed Circuits."

The Military, however, have established no dimensional tolerances. Most of their publications are good design guides including standard test procedures. Manufacturers are not differentiating between military and commercial standards. Standards are being based on price levels, and the Military may specify any standard they wish.

Several military standard specifications are applicable and are available to industry. Most noteworthy are:

- XAR-153, Printed Circuit Boards. This specification has been approved by the Bureau of Aeronautics, Dept. of the Navy and is available from the Commanding Officer, U. S. Naval Avionics Facility, Attention D/910, Indianapolis 18, Ind.
- MIL-STD-275 (Ships), Printed Wiring for Electronics Equipment. This standard has been approved by Bureau of Ships, Dept. of the Navy, available from Chief of Bureau of Ships, Dept. of the Navy, Washington 25, D.C.
- MIL-STD-429, Printed Circuit Terms and Definitions, (Standardization Division, Office of the Assistant Secretary of Defense, Supply and Logistics, Washington 25, D. C.) This standard, approved by Dept. of Defense, is mandatory for use by the Army, Navy, and Air Force. Available

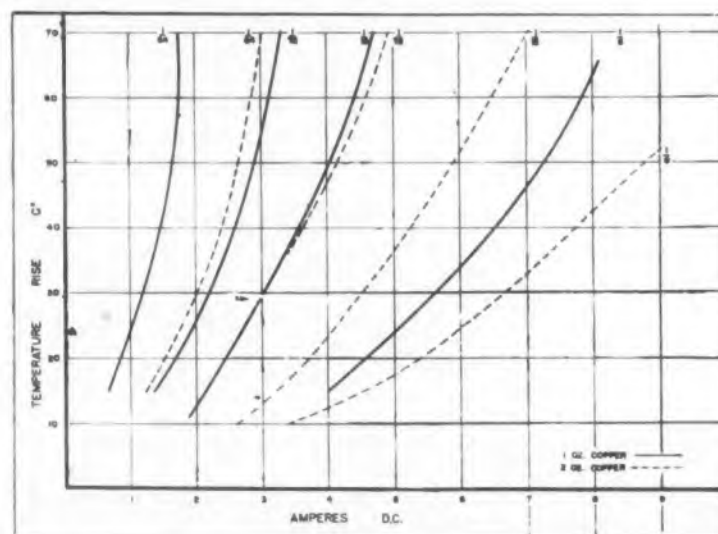


Fig. 1. Maximum allowable temperature rise vs line width.

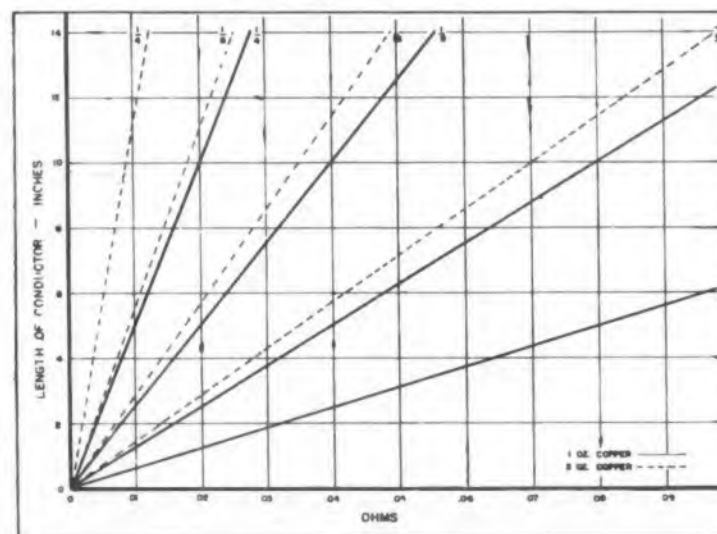


Fig. 2. Resistance of printed-wiring conductors.

Table 1. Underwriters' standards for conductors spacing based on the formula for breakdown of twice plus 1000 v.

| Spacing-in. | DC Working Voltage |
|-------------|--------------------|
| 1/16 | 500 |
| 3/32 | 750 |
| 1/8 | 1000 |
| 3/16 | 1500 |
| 1/4 | 2000 |
| 3/8 | 3000 |

Printed-wiring users—Arma, Consolidated Electrodynamics, Hughes, Motorola, Sperry are a few—have set up strict standards to insure reliability of the printed-wiring boards they buy. Many of these users require fabricators to submit samples made to special test patterns. From these pieces, purchasers make continuing quality checks on the materials they receive. Most make periodic quality checks according to a rigid schedule. These are some of the more important requirements for which users' standards have been written:

| | | |
|-----------------|----------------------------|--------------------|
| Dimensions | Solderability | High Temperature |
| Hole Spacing | Soldering Rework | Endurance |
| Conductors | Endurance | Thermal Cycling |
| Plated Holes | Compatibility with | Low Temperature |
| Eyeletted Holes | Ultrasonic Cleaning | Endurance |
| Finish | Compatibility with Coating | Humidity Endurance |
| Marking | Electrical Performance | Vibration |
| Workmanship | Bond Strength | Resolderability |

from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

■ MIL-STD-S-6872A, Soldering Process, General Specification for. This specification has been approved by the Dept. of Defense for use by the Army, Navy and Air Force. Available from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.

■ MIL-STD-105A, Sampling Procedures and Tables for Inspection by Attributes. (Munitions Board Standards Agency, Department of Defense) Available from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 45 cents.

■ SCL-6225, Design Requirements for Auto-Assembled Army Signal Electronic Equipment. Published by the Electronic Parts and Assemblies Branch, Electronic Parts and Materials Division, Components Dept., USASEL, Ft. Monmouth, N.J.

Tolerances for hole diameters, plated or unplated, depend on how the hole will be made. For unplated holes, Photocircuits Corp. and the IPC recommend a tolerance of ± 0.002 in. for drilled holes and ± 0.001 in. for reamed holes. Counterbored or flycut holes of 5/16 to 4-in. diam have a tolerance of ± 0.005 in. Tolerances of punched holes vary in accordance with laminate thickness (See Table 2).

Photocircuits Corp. gives tolerances for overall dimensions of boards, cut by different methods. For example, the overall dimensions of the board may be ± 0.025 in. for hand sawing. For regular routing, a tolerance of ± 0.015 in. is to be held. High precision routing tolerance is ± 0.005 in.

IPC standard tolerances are similar.

Generally, very close tolerances can be held if price is no object. But the proper approach should be, "How wide a tolerance can we hold without interfering with the proper functioning of the board?" For example, Arthur Ansley Mfg. Co is willing to hold overall board dimension tolerances to ± 0.005 in. if the customer is willing to pay. Pattern to edge tolerance can be held to ± 0.005 in.; registration, front to back ± 0.005 in.; line width and spacing within ± 0.003 . All for a premium price.

Most manufacturers agree that line width tolerances are not to include nicks, pinholes, or scratches as long as the line width is not reduced more than one-third. Military specifications generally state that nicks and pinholes in conductors be invisible to the unaided eye.

Conductor width, conductor spacing, and clearance between component leads and holes are also covered by standards. A copper thickness of 0.0028 in. or 2 oz per square ft is most commonly used. Plating of a coating on the copper pattern is possible to protect the circuit from corrosion, wear, and to improve solderability. A common tolerance is plus 100 per cent, minus nothing.

Manufacturers like to maintain conductor width at 1/16 in. Photocircuits Corp. recommends a minimum of 0.031 in. for reliability. Greater widths are recommended where possible for ease in dip soldering and bonding. A conductor 1/16 in. wide and 0.0027 in. thick has a maximum current carrying capacity of about 15 amp. Parameters affected by conductor width are shown in Fig. 1 and 2. (Continued on page 31)

Ungar

No. PL 338
(shown 5 times
actual size)

1"

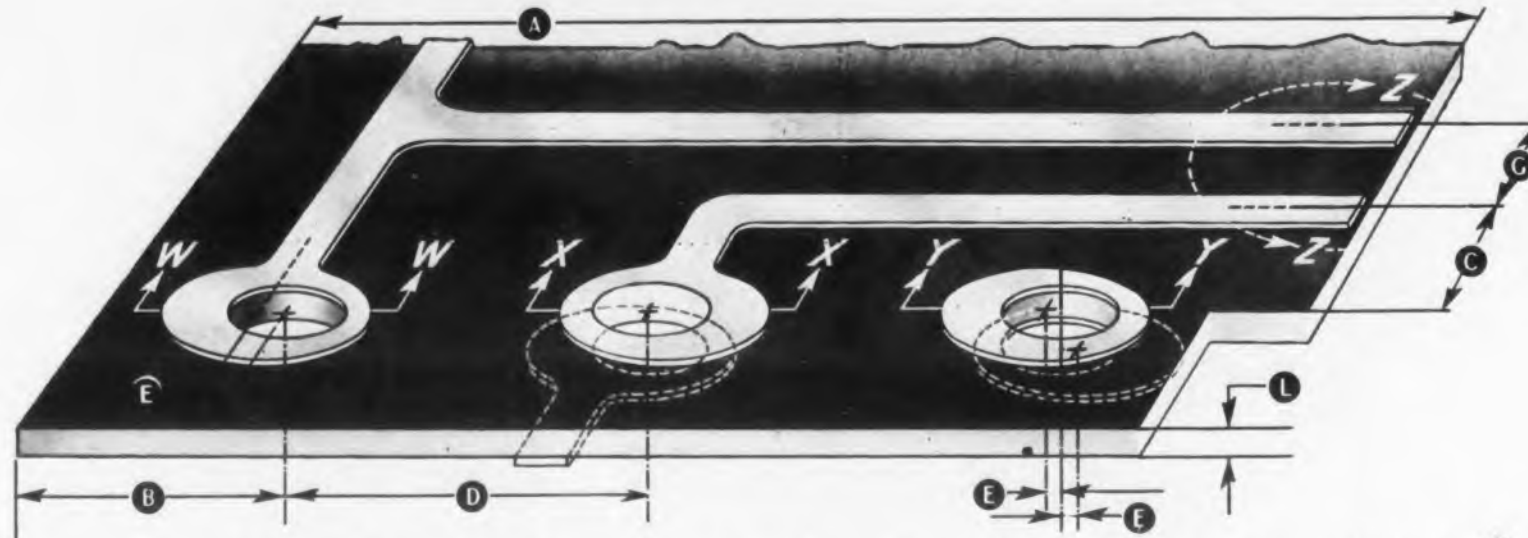
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Table 2 Typical Standard Tolerances For Printed Wiring Boards



| RELATIVE COST KEY | RELATIVE COST KEY | | | | | | | | | | | | | | | | | |
|---|-------------------|--------------|---|------------|---------|--------|-----------------|--------------|--------------|------------------------|------------------------|---------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------|------------------|------------------|
| | 2 | 3 | 1 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| | Rout—regular | Rout—premium | Saw by eye | Saw by jig | Turn | Blank | Progressive Die | Compound Die | Drill by eye | Drill by temporary jig | Drill by jig bored jig | Drill by etched steel jig | Drill by visual alignment jig | Punch by temporary template | Punch by jig bored template | Punch by tape program | Printing—regular | Printing—premium |
| A Overall dimension | ±.015" | ±.005" | ±.025" | ±.010" | ±.003" | ±.003" | ±.003" | ±.003" | | | | | | | | | | |
| B Ref. hole to edge | ±.010" | ±.005" | ±.030" | ±.015" | ±.005" | ±.010" | ±.010" | ±.005" | | | | | | | | | | |
| C Pattern to edge | ±.015" | ±.010" | ±.030" | ±.015" | Use B+F | ±.015" | ±.015" | ±.015" | | | | | | | | | | |
| D Ref. hole to hole | | | See Note #1 | | | ±.005" | ±.005" | ±.010" | ±.010" | ±.005" | ±.010" | ±.005" | ±.012" | ±.007" | ±.005" | | | |
| E Pattern to hole Either side | | | Section X-X Plated-thru holes | | | .015" | | | .015" | .020" | .015" | | .022" | .022" | .017" | | | |
| Single sided board or top side of double sided board | | | Section W-W Unplated holes | | | .015" | .015" | .010" | .015" | .015" | .015" | .005" | .015" | .015" | .015" | | | |
| Bottom side of double sided board | | | Section Y-Y Unplated holes | | | .025" | .025" | .025" | .025" | .025" | .025" | .017" | .025" | .025" | .025" | | | |
| F Pattern, side to side | | | Only considered when no holes are to be furnished in part. | | | | | | | | | | | | | .020" | .015" | |
| G Pattern to pattern, one side | | | See Note #2 | | | | | | | | | | | | | | | |

• Add .001" for every inch over 2 inches.

† These tolerances as given are based on the datum line passing through the center line of the reference hole pad.

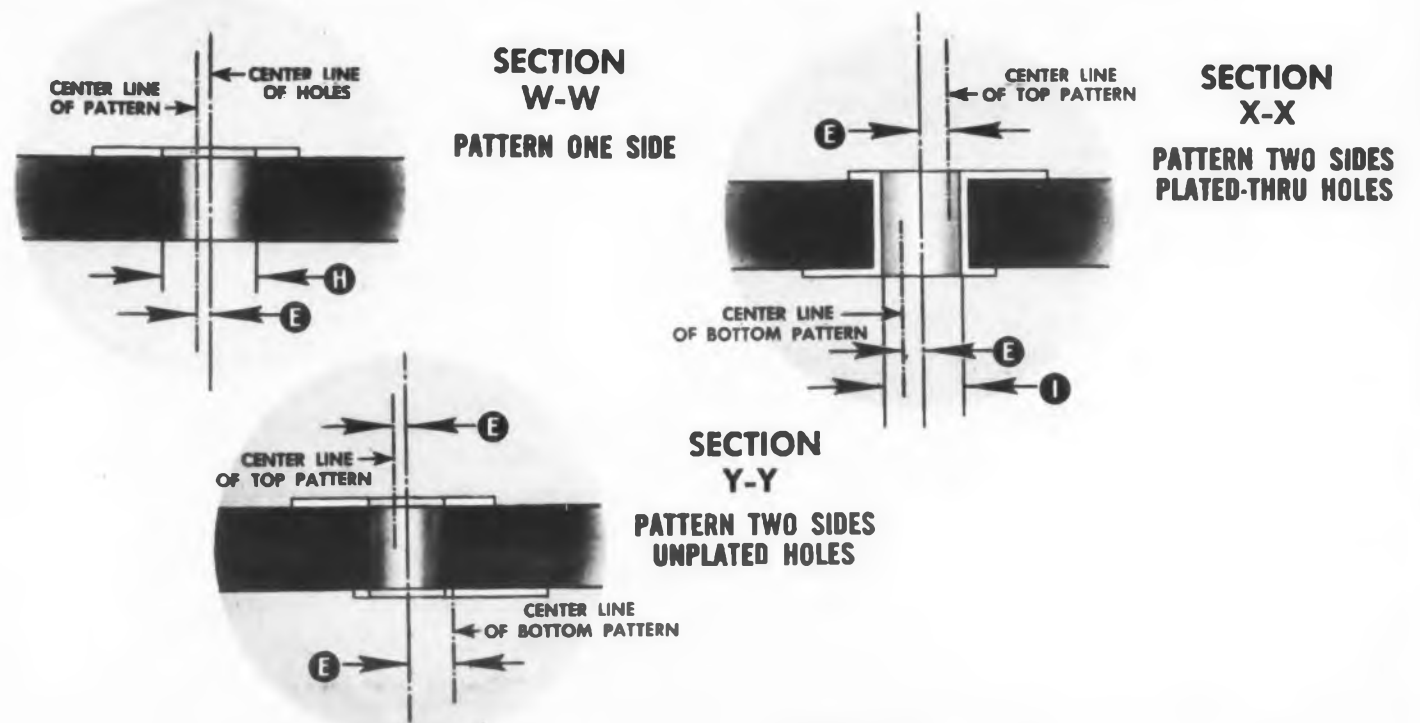
NOTE—Where no tolerance dimension is indicated, such operation is not normally performed.

RELATIVE COST KEY:

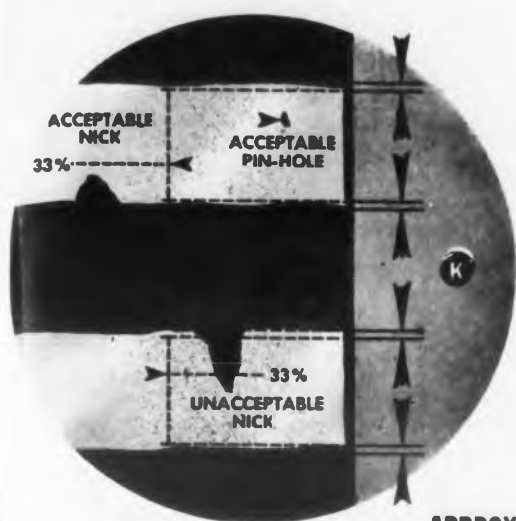
- ① Low cost operation
- ② Moderate cost operation
- ③ Premium cost operation

NOTE #1—Holes requiring relative positioning tolerances closer than ±.010" should be dimensioned as a cluster.

NOTE #2—Pattern to pattern tolerance is the accumulation of variances in the master drawing, and in printing and material stability. This tolerance is ±.005" plus .001" for each five inches based on a final size master drawing error of not greater than .003". Additional variation must be added to the tolerances when master drawing accuracy does not meet this requirement.



Photocircuits Corp.



DETAIL
Z-Z

APPROXIMATE 5X
MAGNIFICATION OF
ACTUAL CIRCUIT

At least 1/32 in., and preferably 1/16 in. of copper around each hole is preferred. Of course, less than this is possible in subminiature equipment. Arma requires that pad diameter be 0.060 greater than hole diameter.

Underwriters' Laboratories figures (Table 1) are a good guide to conductor spacing. About 250 v dc per 1/32 in. separation is considered safe. But designers are cautioned to design for peak voltages. Protective coatings may enable a decrease in conductor spacing.

Warp is defined as the deviation from the plane surface measured across the length or width of the board. It is expressed as a percentage of the length or width. Twist is defined as the deviation from the plane surface measured from one corner of the board to the opposite corner, and is expressed as a percentage of the diagonal dimension.

Tolerances for warp vary, depending on whether circuitry is on one or both sides. If the board is printed on both sides, a tolerance of 0.005 in. per lineal inch is recommended; with the pattern on one side, warp tolerance depends upon stock thickness. For example, for 1/8-in. stock thickness, tolerance is 0.012 in. per lineal inch. Methode Mfg. Co. specifies a general 0.015 in. per lineal inch tolerance.

Scratches, gouges, or pits in the laminate shall not exceed 0.005 in. in depth nor 0.010 sq. in. of area.

Almost every manufacturer has adopted the 0.1 in. grid pattern to facilitate automatic operation. General Electric's Light Military Electronic

H UNPLATED HOLES—Diameter Tolerances

| | | |
|---|------------|------------|
| Drilled | ±.002" | |
| Reamed | ±.001" | |
| Counterbored or flycut (dias. from 5/16" to 4") | ±.005" | |
| | PAPER BASE | GLASS BASE |
| Punched* (1/16" thick) Up to 1/4" dia. | ±.003" | ±.003" |
| 1/4" to 1/2" dia. | ±.003" | ±.004" |
| 1/2" to 1" dia. | ±.004" | ±.004" |
| over 1" dia. | ±.005" | |

Add ±.001" to above for thicknesses of 3/32" through 1/8"

Routed Slots and Notches up to 2"

Milled or Broached Slots and Notches up to 2"

*Punched Slots and Notches . . . use tolerances as above considering both length and width as hole diameters.

I PLATED HOLES—Diameter Tolerances

ADD the following tolerances to tolerances shown in (H) on drilled or punched holes:

| | |
|--------------------------|--------|
| Drilled, paper base..... | ±.004" |
| Drilled, glass base..... | ±.005" |
| Punched, paper base..... | ±.005" |

J HOLES TO OUTSIDE DIAMETER TOLERANCES

| | |
|-------------------------------------|--------|
| I.D. to O.D.: Regular T.I.R.* | ±.010" |
| Premium T.I.R.* | ±.003" |

*Total Indicator Runout.

K LINE WIDTH & SPACING

| | | |
|--------------------|---------|--------|
| No Plating | Regular | ±.010" |
| | Premium | ±.005" |
| With Plating | Regular | ±.015" |
| | Premium | ±.010" |

Minimum Line Width and/or Spacing..... .031 for Reliability

NOTE—Line width tolerances do not include nicks, pin holes and scratches. Such imperfections are considered acceptable provided the line is not reduced more than 33%. It is suggested that line width and spacing be specified as minimums provided the design is based on the tolerances given.

L STOCK THICKNESS (per NEMA Specifications)

M PLATING THICKNESS

All plating will be produced to a stated minimum thickness with a tolerance of plus 100% minus nothing. On boards with plated holes, plating build-up on plug-in fingers may add as much as .003" to finger thickness on each side over and above specified minimum plating thickness. Photocircuits will normally use close tolerance material (thickness) for these applications.

N WARP

The following values can be used as a guide in determining anticipated warp of copper-clad board:

| | |
|----------------------------|--------------------------|
| Pattern on ONE side: | |
| 1/16" stock thickness..... | .025" per inch of length |
| 3/32" stock thickness..... | .020" per inch of length |
| 1/8" stock thickness..... | .012" per inch of length |
| 1/4" stock thickness..... | .006" per inch of length |
| Pattern on TWO sides: | |
| All stock thicknesses..... | .005" per inch of length |

Equipment Dept. establishes a zero reference on a grid point at the left edge and lower edge of the board. Facilities for programming a piercing operation are based on the 0.1 in. spacing. Required holes that do not fall in the grid pattern must be made by other means, with an increase in costs.

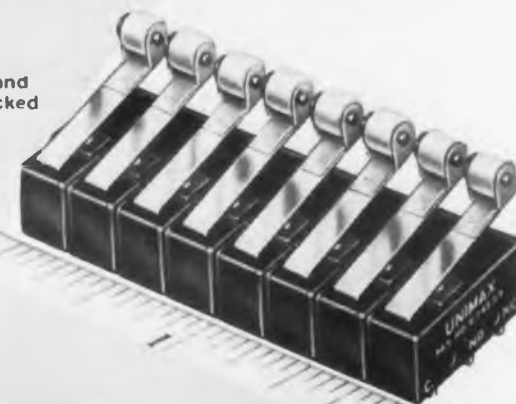
Component spacing is also basis of standards. All are based upon the 0.1 in. grid system. Some variations are allowed for special components.

Many test standards have been established. They pertain to bonding, solderability, physical, and mechanical properties. These standards are described in our discussion of quality control.

These subminiature snap-acting switches have
a BIG advantage...

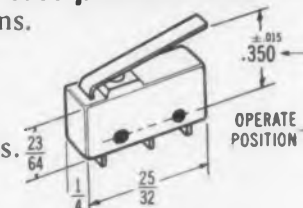
INTEGRAL ACTUATORS

The leaf or leaf-roller actuator — an integral part of the switch — is pre-adjusted and mechanically locked in the switch assembly during manufacture.



UNIMAX type USM integral-actuator switch benefits:

- **Saves space** in ganging, no build-up of thickness tolerance: stacking 4 per inch 8 in 2 inches, 12 in three inches, etc.
- **Quickly installed** in miniaturized apparatus or hard-to-get-at places: no auxiliary actuator mechanism to adjust or assemble.
- **High repeatability**, long switch life.
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UNIMAX SWITCH

Division The W. L. Maxson Corporation
IVES ROAD, WALLINGFORD, CONNECTICUT

CIRCLE 24 ON READER-SERVICE CARD

2 Board Design Techniques —

Factors to consider for reliable operation

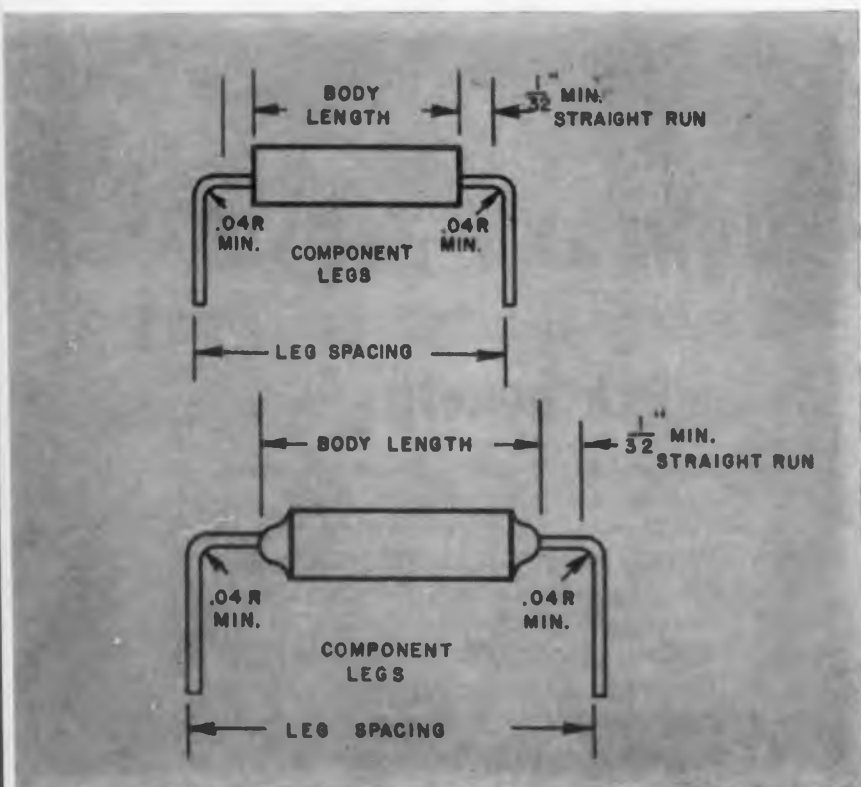


Fig. 1. Leg spacing standards devised by General Electric's Light Military Electronic Equipment Dept. for components with and without glass-bead end construction.

STARTING with his conventional wiring diagram, the printed-wiring designer must lay out his electrical circuit. His problem is to get the simplest layout with the most direct connections possible.

One Side vs Two Sides

In laying out the printed-wiring board, the designer is faced with the decision of whether to use a single-sided or double-sided board.

Two-sided printed-wiring takes on two forms. The circuitry on the two sides of the board may be different (the usual case), or, in instances where ultimate reliability is needed, the circuitry on one side of the board may be duplicated on the opposite side with through-the-board connections at numerous points.

Two-sided circuitry has an advantage over single-sided circuitry in size and weight reduction. This is of prime importance in miniaturized equipment and in airborne applications. Two-sided circuitry also tends to reduce the tendency

of board warpage during fabrication. This is particularly true where the circuitry is the same, or nearly the same, on both sides. From the standpoint of warpage effects, therefore, two-sided circuitry tends to be a factor in improved reliability. Current-carrying capacity is increased by running two conductors in parallel.

In other respects, however, two-sided circuitry adds complexity which can be a source of unreliability. For this reason many users favor single-sided wiring, even though it usually means the use of hand-inserted jumper wires and increases warpage difficulties, particularly on large boards. Generally, one-sided boards are more economical, and inherently more reliable.

The Signal Corps, in their design guide, SCL-6225, requires that printed-wiring on one-side of the base only shall be used to the maximum extent possible. This to facilitate automatic assembly, they say. It also minimizes the need for interface connections, hand soldering, and reduces registration problems.

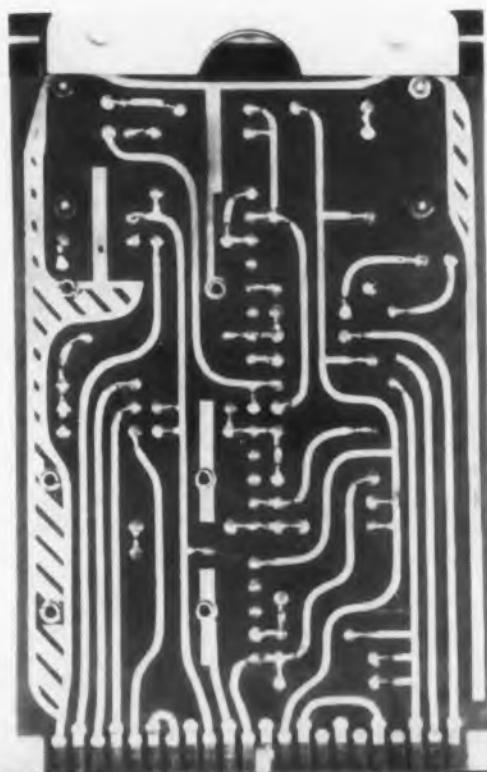
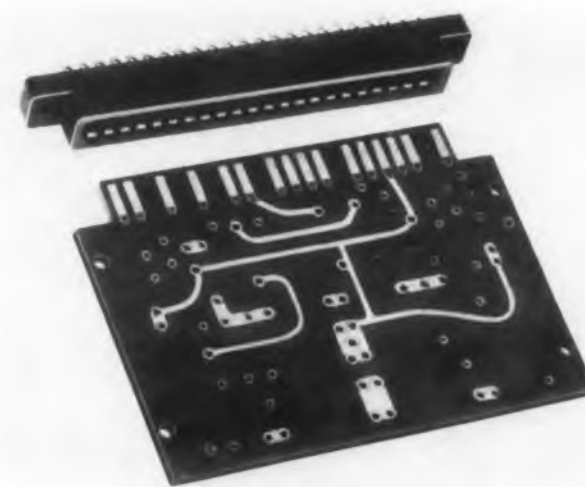


Fig. 2. Good board layout showing "free-flowing" conductors and cross-hatching of large copper areas.

Cleveland Metal Specialties Co.



DeJur-Ameco Corp.

Fig. 3. Typical printed-wiring connector application.

Some board materials must be supplied with copper on both sides to prevent excessive warpage (Choosing Board Materials, page 36. Of course, space factors, in missiles for example, may demand use of double metal boards.

How Large a Board?

Board size must be determined. For optimum ease of handling in production, and to facilitate mounting problems, many manufacturers limit the board size to 6 x 12 in. General Electric's Light Military Electronic Division limits board size to 12 x 12 in. A 6 x 6 in. card has been suggested as maximum.

In one application, Komak Inc. has fabricated boards as large as 34 x 9 x 1/16 in. Used in an electronic organ application, the boards are made of copper-clad Formica XXXP. The military, however, has placed no restrictions on printed-wiring board size.

For modular design, the Signal Corps requires the basic unit of length to be 0.025 in. This basic modular unit is to apply to all three axes of Cartesian coordinates. In equipment to be built on automatic machines, certain dimensions should be in multiples of this basic modular unit. These dimensions include: over-all board dimensions; spacing of part leads; location of holes; and test point locations.

The 0.1-in. grid pattern should be used wherever possible. For subminiature applications, a 0.05-in. grid may be used. With particularly stringent subminiature requirements, a 0.025 in. grid may also be used. Overall width and length of the board should coincide with the lines of the 0.1-in. grid pattern.

Component Mounting

Components should be oriented in both the horizontal and vertical planes. Most crossovers can be eliminated in this manner. But where crossovers are necessary to achieve a certain component layout, wires may be used. Treat the wire as a component.

Leg spacings should be to the 0.1-in. grid pattern. General Electric's Light Military Electronics Division specifies an additional 0.2-in. over the body length of axial-lead components.

Signal Corps requirements dictate that lead spacings coincide with a multiple of the 0.025-in. modular unit. Leads of axial-lead parts should remain straight for at least 0.015-in. from the end of the part.

Components should be mounted separately. Where components tie into a common lead, or are interconnected, separate mounting holes should be used. If a faulty component must be replaced, it isn't necessary to unsolder others.

Components have been developed to fit dip-solder techniques. For tubes, socket terminals

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CIRCLE 25 ON READER-SERVICE CARD

snap into holes in the base. There seems to be a need for a plug-in type i-f transformer which could be inserted into a standard tube socket. Superior reliability and ease of servicing are two advantages of this arrangement.

Several manufacturers have introduced, or are developing potentiometers and variable capacitors to meet printed-wiring requirements. Electrolytic capacitors can be simply inserted into standard spacing and dip soldering. The newer plug-in types improve reliability and reduce line repairs resulting from the broad tolerances on standard cases.

AMP Inc. has devised a component tip to speed assembly operations. Special tips are automatically placed on component leads which in turn are placed into holes in the board. This method insures better reliability and may eliminate the need for eyelets and plated-through holes.

Connectors

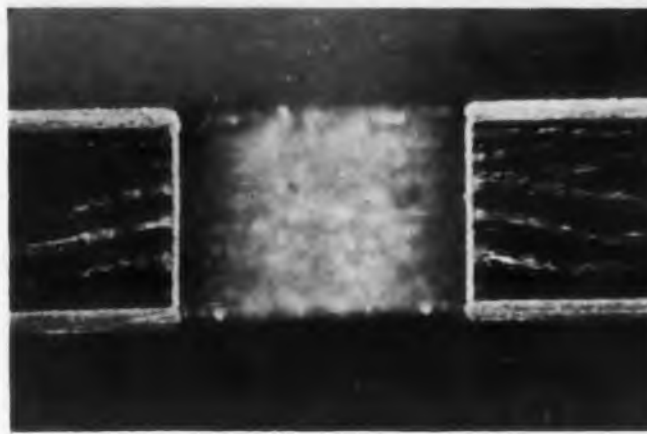
Connectors designed as receptacles for printed-wiring boards are commercially available with up to 44 contacts. These connectors enable the design of plug-in printed-wiring packages. Continental Connector Corp. has set up their own standards for printed-wiring circuit connectors. Their specifications cover mechanical, electrical, and environmental tests. Board thickness, contact size, and material are also included.

Unsatisfactory experience from the standpoint of reliability has often occurred from poor contact between printed-wiring board terminal fingers and connectors. Experience shows that high reliability can be achieved when the terminal fingers and connector inserts are plated with a noble metal such as gold, silver, or rhodium. More reliable connections are possible when rhodium is used because of its wearing properties. The Light Military Department of General Electric Co. recommends at least a 50 per cent overlap of contact area (board to socket). Tolerances should be so specified.

Chamfering of the edge of the printed-wiring board at the terminal fingers or plating around the edge of the board has been used to avoid the possibility of the terminal fingers lifting from the board upon insertion in the connectors. Recent improvements in adhesives, which hold the copper to the laminate, have just about eliminated this difficulty.

Eyelets vs Plated-Through

Biggest battle raging among printed-wiring makers is that of eyelets versus plated-through holes. Results of ELECTRONIC DESIGN's questionnaire show opinion favoring use of eyelets, but plated-through holes are gaining in favor.



Photocircuits Corp.

Fig. 4. Photomicrograph of a cross-section of a good quality plated-through hole.

Military specifications have specified eyelets in every case. But the new Signal Corps design guide, SCL-6225, section 3.4.4 states, "The use of mechanical eyelets or standoff terminals for electrical connections shall be avoided wherever possible because of difficulties in assuring reliable performance. Where frequent replacement of a particular electronic part is anticipated, suitable mechanical eyelets or plated-through holes may be used to assist in preventing delamination of the printed conductor. Mechanical eyelets for such purposes shall be of light-gage metal and



Photocircuits Corp.

Fig. 5. Cross-section showing poor eyeleted connection after temperature cycling.

shall be mechanically secured to the printed-wiring board. Their flanges shall be flared out from the printed-wiring so as to ensure the formation of an adequate solder fillet under the flange. Use of eyelets (either mechanical or plated-through types) may make replacement of the part difficult or impossible unless the part leads can be separately and individually removed from the printed-wiring board."

Section 3.4.5 of the Signal Corps publication states, "Plated-through holes shall not be used by themselves to effect interface connections. A

Here are some suggested design techniques to improve reliability:

- Use single-sided printed-wiring boards instead of double sided.
- Use etched rather than plated boards.
- Use smallest possible "card." (6-in. square or less).
- Keep card as nearly same length on all sides as possible. (square rather than rectangular).
- Use 0.1 in. grid layout as standard.
- Use "free-flowing" lines, rounded corners.
- Make conductors as short as possible.
- Avoid placing high impedance or rf circuits on printed-wiring board.
- Keep dc leads near edges.
- Avoid placing components across conductors.
- Clean component leads of wax, etc. before assembly on printed-wiring board.
- Specify tolerance for design-center conditions.
- Stick to proven design standards and tolerances.
- Keep both electrical and mechanical characteristics in mind.
- Watch out for "hot-spots" on printed-wiring board. Use heat sinks and heat shunts as required.
- Avoid eyelets altogether if equipment is subjected to vibration or shock.
- Boards 1/16 to 3/32-in. thick shall be supported at intervals of not more than 4-in. Boards thicker than 3/32-in. shall be supported at intervals of not more than 5-in.
- Holes for component leads should be spaced at least 1-1/2 times the thickness of stock apart and from outside edges and cutouts.
- Smallest hole no smaller than 2/3 stock thickness.
- Any conductor lines running near the edge should be spaced 1/16-in. from the edge of the final board or should be so laid out that the shearing or blanking edge will trim through the copper.
- The minimum spacing between conductor lines, copper pads or islands be no closer together than 0.032 in.
- That at least 0.030 in. of copper be around all holes that ultimately get soldered.
- Make conductor at least 0.040 in. wide. (Signal Corps says 0.060 in.).
- The width of any line be no smaller than 0.015 in.
- Large expanses of copper should be avoided as this tends to create a blistering condition during soldering. Any large expanse of copper should be checkered or cross-hatched to reduce possibility of blistering.
- Plate or etch the same information on both sides of the board for minimum warpage and maximum reliability.

properly formed lead shall be employed . . ."

Previously, plated-through holes were considered unsatisfactory because of failure of the plating inside the hole. As the board is dipped in hot solder, gases released by the laminate blow a hole through the plating where it is especially thin. As a result, solder was not drawn into the hole, thus effecting a poor solder joint.

Eyelets, on the other hand, have proven unreliable because of the difference in expansion and elasticity of the eyelet and the plastic laminate. The plastic base material, the eyelet, and the solder which bands the eyelet to the conductor pattern all have different coefficients of expansion and moduli of elasticity. After several temperature cycles during which the plastic expansion under heat exceeds that of the metal, the metal assumes a permanent set and breaks its contact with the solder on the surface of the board. In a plated-hole, the interlocked bond of the plating comes and goes with temperature changes. Tests show that failures have not occurred after seventy cycles of the same conditions under which eyelets began to fail after five cycles. Additional statistics will be presented in ELECTRONIC DESIGN, when available.

Chief concern with plated-holes has been replacement of components without loosening the adhesion of the conductor pad around the hole during removal of one lead and resoldering the next. Those using plated-through holes extensively found that by educating service personnel to keep the iron up on the lead and away from the pads, components can be replaced three to six times. (Resoldering twenty times has been reported.)

Funnel Type Best

One solution to the eyelet problem was to switch to the funnel-type eyelets. Construction of these permits the base material to expand without undue pressure. Circon Component Corp. has developed a line of funnel flange eyelets. No under-head flux inclusions are possible because of the open character of the eyelet.

Several new developments in plated-through hole technique promise its growing use—possibly to replace eyelets entirely. Both Printed Electronics Corp. (Narcus process) and Precision Circuits Inc. have developed new techniques for securing better plated-through holes. Photocircuits Corp. has announced their "Tuf-Plate" process, which guarantees a wall thickness of at least 0.0015 in. Its current carrying capacity is equivalent to a 2 oz copper conductor of width equivalent to the hole diameter. It is said to be implosion proof and will stand up under thermal shock of repeated solderings.

Plated-through holes, then, with proper processing technique, will provide real reliability. The real test will be time.

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| Characteristics | Two (2) Section Resonator | Three (3) Section Resonator | Four (4) Section Resonator |
|-------------------------|------------------------------------|------------------------------------|------------------------------------|
| Model No. | 27-BW | 27-CW | 27-DW |
| Type of Resonator | TE ₁₀₁ mode rectangular | TE ₁₀₁ mode rectangular | TE ₁₀₁ mode rectangular |
| Tuning Range | 2700-3150 MCS | 2700-2950 MCS | 2700-2900 MCS |
| 3 db Bandwidth | 4.5-6.5 MCS | 4.5-5.5 MCS | 4.5-5.5 MCS |
| Max 30 db Bandwidth | 36 MCS | 18 MCS | 13 MCS |
| Max Insertion Loss | .9 db | 1.3 db | 1.8 db |
| Price | \$400.00 | \$535.00 | \$670.00 |
| Model No. | 27-BC | 27-CC | 27-DC |
| Type of Resonant Cavity | $\lambda/4$ coax | $\lambda/4$ coax | $\lambda/4$ coax |
| Tuning Range | 2700-3200 MCS | 2700-3100 MCS | 2700-2950 MCS |
| 3 db Bandwidth | 8-11 MCS | 8-10 MCS | 8-9 MCS |
| Max 30 db Bandwidth | 60 MCS | 32 MCS | 21 MCS |
| Max Insertion Loss | 1.6 db | 2.4 db | 3.2 db |
| Price | \$350.00 | \$475.00 | \$600.00 |

C BAND FILTERS

| Characteristics | Two (2) Section Resonator | Three (3) Section Resonator | Four (4) Section Resonator |
|---------------------|---------------------------|-----------------------------|----------------------------|
| Model No. | 54-BC | 54-CC | 54-DC |
| Type of Resonator | $\lambda/4$ coax | $\lambda/4$ coax | $\lambda/4$ coax |
| Tuning Range | 5400-5950 MCS | 5400-5950 MCS | 5400-5750 MCS |
| 3 db Bandwidth | 8-11 MCS | 8-10 MCS | 8-9 MCS |
| Max 30 db Bandwidth | 60 MCS | 32 MCS | 21 MCS |
| Max Insertion Loss | 2 db | 3 db | 4 db |
| Price | \$360.00 | \$485.00 | \$610.00 |

L BAND FILTERS

| Characteristics | Two (2) Section Resonator | Three (3) Section Resonator | Four (4) Section Resonator |
|-------------------------|---------------------------|-----------------------------|----------------------------|
| Model No. | 96-BC | 96-CC | 96-DC |
| Type of Resonant Cavity | $\lambda/4$ coax | $\lambda/4$ coax | $\lambda/4$ coax |
| Tuning Range | 960-1150 MCS | 960-1100 MCS | 960-1050 MCS |
| 3 db Bandwidth | 8-11 MCS | 8-10 MCS | 8-9 MCS |
| Max 30 db Bandwidth | 60 MCS | 32 MCS | 21 MCS |
| Max Insertion Loss | 1.2 db | 1.8 db | 2.5 db |
| Price | \$370.00 | \$495.00 | \$620.00 |

X BAND FILTERS

| Characteristics | Two (2) Section Resonator | Three (3) Section Resonator | Four (4) Section Resonator |
|-------------------------|------------------------------------|------------------------------------|------------------------------------|
| Model No. | 75-BW | 75-CW | 75-DW |
| Type of Resonant Cavity | TE ₁₁₁ mode cylindrical | TE ₁₁₁ mode cylindrical | TE ₁₁₁ mode cylindrical |
| Tuning Range | 7500-8500 MCS | 7500-8250 MCS | 7500-8000 MCS |
| 3 db Bandwidth | 8-11 MCS | 8-10 MCS | 8-9 MCS |
| Max 30 db Bandwidth | 60 MCS | 32 MCS | 21 MCS |
| Max Insertion Loss | 1.5 db | 2.5 db | 3.5 db |
| Price | \$475.00 | \$625.00 | \$775.00 |
| Model No. | 85-BW | 85-CW | 85-DW |
| Type of Resonant Cavity | TE ₁₁₁ mode cylindrical | TE ₁₁₁ mode cylindrical | TE ₁₁₁ mode cylindrical |
| Tuning Range | 8500-9600 MCS | 8500-9300 MCS | 8500-9000 MCS |
| 3 db Bandwidth | 8-11 MCS | 8-10 MCS | 8-9 MCS |
| Max 30 db Bandwidth | 60 MCS | 32 MCS | 21 MCS |
| Max Insertion Loss | 1.5 db | 2.5 db | 3.5 db |
| Price | \$475.00 | \$625.00 | \$775.00 |

All of the above filters have Max VSWR of 1.5, and either a single shaft or counter dial for Tuning Control. Depending upon mode of operation, units are supplied with either Type N Connectors or Waveguide flanges.

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CIRCLE 26 ON READER-SERVICE CARD

3 Choosing Board Materials —

Using the right laminate aids reliability

WITH a large number of laminates now available, the design engineer is faced with the difficult task of choosing the right material. Laminated thermosetting plastics including paper base phenolics, glass base epoxy, melamine, silicone, and teflon are available. NEMA lists over two dozen standard grades.

Copper, or other metal foils are bonded to one or both sides. Aluminum, copper-clad aluminum, silver, and brass are used. Aluminum is not widely used in high-quality printed-wiring boards because its uniformity is not as good as copper. It needs special surface preparation.

Phenolic laminates with a paper base are most commonly used. Type XXXP is one of the most popular. Other popular paper-base phenolics include XX, XXP, XXX, and XXXP-IR. These grades should be punched hot. P-25 is a cold-punch paper-base laminate similar to XXXP.

National Vulcanized Fibre Co. just announced a new phenolite Grade XXXP-467-1. It is a paper-base material that combines the electrical characteristics of XXXP stock with flame resistant qualities. It also has very high insulation resistance and low moisture absorption. XXXP-467-1 is recommended for critical electrical applications where fire danger must be considered. Such applications include color TV sets because of the high voltage used, computers and telephone equipment because of the concern about loss of fire of expensive pieces of equipment, and other similar applications. XXXP-467-1 is a hot punching grade and cannot be punched cold.

Another fairly new National grade is G-11-861-1, a heat resistant epoxy glass laminate. It will retain 70 to 80 per cent of its original flexural strength when tested at 150 C after one hour conditioning at that temperature. (Conventional epoxy laminates of the G-10 type retain only 5 to 10 per cent when tested at 130 C).

Applications include military electronic circuits in rockets, missiles, and computers. It is, however, a premium price grade and does not supersede National's G-10 grade where heat resistance is not a problem.

Printed-Wiring Laminate Materials¹

| Manufacturer | Grade | NEMA Grade | MIL Spec. | Spec. No. | Material | | Notes |
|--|------------------|------------|-----------|-----------|---------------------|----------------|--|
| | | | | | Resin | Base | |
| 1. Continental Diamond Fibre Co., Newark, Del. (Dilecto) | 2350 | | | | Phenolic | Paper | Low cost, cold punching in thin sheets |
| | 16 | XXP | | | Phenolic | Paper | Warm punching, good insulation resistance |
| | 28 | XXXP | | | Phenolic | Paper | Warm punching, high insulation resistance |
| | 26 | XXXP | PBE-P | 3115 | Phenolic | Paper | Hot punching, high insulation resistance |
| | 28E ² | G-10 | GEE | 18177 | Epoxy | Glass | Medium weave glass fabric, excellent mechanical strength and dimensional stability |
| | 16E ³ | G-10 | GEE | 18177 | Epoxy | Glass | Fine weave glass fabric, suitable for thin laminates |
| | 108T | | | | Teflon ⁴ | Glass | Fine weave glass fabric, low dielectric losses |
| | 112T | | | | Teflon | Glass | Fine weave glass fabric, low dielectric losses |
| | 116T | | | | Teflon | Glass | Fine weave glass fabric, low dielectric losses |
| | 128T | | | | Teflon | Glass | Medium weave glass fabric |
| 2. Fluorocarbon Products, Camden, N. J. (Chemolec) | | | | | Teflon | | Low dielectric and UHF losses |
| | | | | | | | |
| 3. Formica Corp., Cincinnati, Ohio | CIRPRINT | XXP | PBE-P | 3115 | Phenolic | Paper | High insulation resistance, cold punching |
| | XP-47 | PC | | | Phenolic | Paper | Low cost, cold punching |
| | XXXP-36 | XXXP | PBE-P | 3115 | Phenolic | Paper | Highest insulation resistance, cold punching |
| | YN-25 | N-1 | NPG | 15047 | Phenolic | Nylon | For postforming applications |
| | CE | CE | FBG | 15035 | Phenolic | Cotton | Coarse weave cotton fabric |
| | FF-91 | G-10 | GEE | 18177 | Epoxy | Glass | High mechanical strength, excellent insulation resistance |
| | LE | LE | FBE | 15035 | Phenolic | Cotton | Fine weave cotton base |
| | FF-94 FF-95 | | | | Epoxy Epoxy | Glass Glass | Light-weight glass cloth High strength properties at elevated temperatures |
| 4. General Electric, Coshocton, Ohio (Textolite) | 11541 | XXP | PBE-P | 3115 | Phenolic | Paper | High insulation resistance, hot punching |
| | 11558 | G-10 | GEE | 18177 | Epoxy | Glass | High mechanical strength; excellent electrical properties |
| | 11574 | | | | Epoxy | Paper | Self-extinguishing, exceeds XXXP standards |
| | 11572 | XXXP | PBE-P | 3115 | Phenolic | Paper | Cold punching, solvent resistant |
| | 11570 | XXXP | PBE-P | 3115 | Phenolic | Paper | Cold punching |
| | 2053X | P | | | Phenolic | Paper | Low cost, low voltage applications |
| 5. International Resistance Co., Phila., Pa., (Fluorply) | F | | | | Fluoro-carbon | | Superior electrical properties, copper foil on fluorocarbon base |
| | E | | | | Epoxy | | Fluorocarbon sheet on glass-epoxy laminate base |
| | P | | | | Phenolic | Paper | Fluorocarbon sheet on XXXP laminate base |

Printed-Wiring Laminate Materials¹ (cont.)

| Manufacturer | Grade | NEMA Grade | MIL Spec. | Spec. No. | Material | | Notes |
|---|--------------|------------|-----------|-----------|-------------|----------------------------------|---|
| | | | | | Resin | Base | |
| 6. Mica Corp., Culver City, Calif. (Micaply) | EG-758 | G-10 | GEE | 18177 | Epoxy | Glass | Plain weave, low warp or twist |
| | EG-751 | G-10 | GEE | 18177 | Epoxy | Glass | Satin weave, high strength |
| | EG-752 | G-10 | GEE | 18177 | Epoxy | Glass | Fine weave, very thin laminates |
| 7. Mica Insulator, Div. of Minnesota Mining & Mfg. Co., Schenectady 1, N. Y. (Lamicoid) | 6008 | XXXP | PBE-P | 3115B | Phenolic | Paper | Cold punching, excellent electrical properties, low moisture absorption |
| | 6038 | G-5 | GMG | 15037B | Melamine | Glass | High arc resistance, heat and flame resistant |
| | 6096 | G-10 | GEE | 18177 | Epoxy | Glass | Very high heat distortion properties, self-extinguishing, low water absorption |
| 8. National Vulcanized Fibre Co., Wilmington, Delaware | XN-152-1 | | | | Phenolic | Paper | Low cost, low resin content, hot punching |
| | P-214-B-1 | P | | | Phenolic | Paper | Standard hot punching stock |
| | XXP-209-G-1 | XXP | | | Phenolic | Paper | Good electrical properties, hot punching |
| | XXP-239-1 | XXP | PBE-P | 3115B | Phenolic | Paper | Good electrical properties, cold punching |
| | XXXP-219-C-1 | XXXP | PBE-P | 3115B | Phenolic | Paper | Warm punching grade |
| | XXXP-455-1 | XXXP | PBE-P | 3115B | Phenolic | Paper | High insulation resistance, hot punching |
| | XXXP-470-1 | XXXP | PBE-P | 3115 | Phenolic | Paper | Cold punching grade |
| | XXXP-467-1 | XXXP | PBE-P | 3115 | Phenolic | Paper | Hot punching |
| | N-1-852-1 | N-1 | NPG | 15047-B | Phenolic | Nylon | High insulation resistance, low moisture absorption |
| | G-5-813 | G-5 | GMG | 15037-B | Melamine | Glass Cloth | Arc resistant, high mechanical strength |
| | G-10-865 | G-10 | GEE | 18177 | Epoxy | Glass Cloth | Superior insulation and dielectric properties; for high temperature and high humidity use |
| G-11-861 | G-11 | GEB | 18177 | Epoxy | Glass Cloth | Heat resistant Epoxy Glass Grade | |
| 9. New England Laminates Co., Inc., Stamford, Conn., (Nelco) | 100 | G-10 | GEE | 18177 | Epoxy | Glass | Medium weave glass fabric |
| | 100A | G-10 | GEE | 18177 | Epoxy | Glass | As grade 100 but with greater bond strength |
| | 101 | | | | Epoxy | Glass | For use with flush circuits |
| | 120 | | | | Epoxy | Glass | High resin, special weave glass fabric |
| | 125 | | | | Epoxy | Glass | Special weave |
| | 130 | | | | Epoxy | Paper | |
| | 135 | | | | Epoxy | Paper | |
| | 210 | P | | | Phenolic | Paper | Low cost |
| | 220 | XXP | | | Phenolic | Paper | |
| 230 | XXXP | PBE-P | 3115 | Phenolic | Paper | | |
| 10. Northern Plastics, La Crosse, Wisc., (Norplex) | 925 | XXXP | | | Phenolic | Paper | |
| 11. Panelyte Division, St. Regis Paper Co., Trenton, N. J. | 1603 | G-10 | GEE | 18177 | Epoxy | Glass | |
| | 1633 | G-10 | GEE | 18177 | Epoxy | Glass | Fire Retardant |
| | 1403 | G-5 | GMG | 15037 | Melamine | Glass | Glass cloth base |
| | 1803 | | | | | Teflon | Sheet base |
| | 1813 | | | | | Teflon | Tape Base |
| | 7763 | XXXP | PBE-P | 3115 | Phenolic | Paper | Hot punching |
| | 8103 | XXXP-HIR | PBE-P | 3115 | Phenolic | Paper | Cold punching, high insulation resistance |
| | 8053 | XXXP-HIR | PBE-P | 3115 | Phenolic | Paper | Hot punching, high insulation resistance |
| | 7743 | XXP | | | Phenolic | Paper | Hot punching |
| | 8203 | XXP | | | Phenolic | Paper | Warm punching, high insulation resistance |

¹ Courtesy, Allan Lytel, author of "Printed Circuitry". Instruments Publishing Co., Pittsburgh 12, Pa.

² 28EFR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 28E plus good flame and heat resistance. Meets NEMA G-10 properties.

Di-Clad 28ECR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 28E, and employs a special copper foil to laminate bond resistant to hot cyanide solutions commonly used for plating the etched printed boards with precious metals such as gold and rhodium. Meets NEMA G-10 properties.

³ 16EFR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 16E plus good flame and heat resistance. Meets NEMA G-10 properties.

Di-Clad 16ECR—Exhibits essentially the same excellent mechanical and electrical characteristics as Di-Clad 16E and employs the same special cyanide resistant bond as Di-Clad 28ECR. Meets NEMA G-10 properties.

⁴ Teflon is a DuPont trademark for their polytetrafluoroethylene resin.

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Non-pressurized at
50,000 feet . . . yet retains
100% RELIABILITY!

Extreme altitude is only one of many demanding requirements in which DALOHM RSE precision wire wound resistors offer dependable reliability.

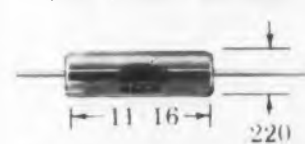
The precision resistor element is inserted in a special shock absorbent material and completely sealed in a tough metal tube. It's ready to meet demanding conditions of mechanical shock, moisture and humidity, thermal cycling and power loading.

Here are the RSE standard specifications that help you meet demanding electronic requirements:

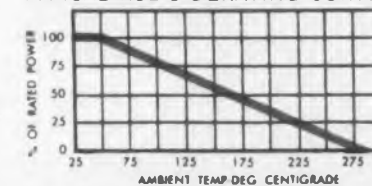
- Operating temperature range: -65° C. to 275° C.
- Precision tolerance range: 0.05%, 0.1%, 0.25%, 0.5%, 1% and 3%.
- Rated at 2, 3, 5, 7 and 10 watts.
- Resistance range from .5 ohm to 175K ohms
- Temperature coefficient: 0.00002/Degree C
- Insulation breakdown: 1000 V AC or DC.
- Seven sizes: 11/16 X .220 to 1 61/64 X .395
- Complete protection from vibration, moisture and salt spray.

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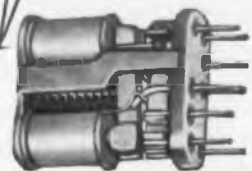
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in electromagnetic control began more than twenty-six years ago when Guardian became dedicated to the control of maximum power in minimum space. Here you see preferred standards of micro-miniature, sub-miniature and miniature control of today's aircraft, missiles and electrical industries.

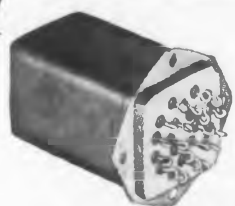


Series 1005 Micro-Miniature Control

L. 2 7/16" W. 2 5/16" D. 1 1/2"
(maximum)

3 Amp Double Pole, Double Throw. Meets or surpasses requirements for all specifications of MIL-R-25018 and MIL-R-5757C. No exceptions. Contact Rating: 3 Amps at 125° C. per MIL-R-25018; 2 Amps at 125° C. per MIL-R-5757C. Hermetically sealed. Specify plug-in or solder hooks.

\$5.90 each in lots of one thousand units
L.o.b. Chicago, Ill.



Series 2005 Sub-Miniature Control

L. 2 1/4" W. 1 7/16" D. 1 1/2"
(maximum)

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



Series 3205 Miniature Control

L. 2 1/2" W. 1 3/16" D. 1 7/16"
(maximum)

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

Write for circulars giving complete specifications

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MANUFACTURING COMPANY
1622-G W. WALNUT STREET, CHICAGO 12, ILLINOIS

CIRCLE 28 ON READER-SERVICE CARD

Printed-Wiring Laminate Materials¹ (cont.)

| Manufacturer | Grade | NEMA Grade | MIL Spec. | Spec. No. | Material | | Notes |
|--|--|------------|-----------|-------------------|----------|---|---|
| | | | | | Resin | Base | |
| 12. Rex Corp., West Acton, Mass., (Rexolite) | 2200 | | | 1422 ² | | Glass | Cold punching, excellent UHF properties, no cold flow |
| 13. Richardson Co., Melrose Park, Ill., (Insurek) | T-760 | G-10 | | | Epoxy | Glass | Hot punching |
| | T-725 | | PBE-P | 3115B | Phenolic | Paper | |
| | T-812 | | PBE-P | 3115B | Phenolic | Paper | |
| | T-610 | XP | | | Phenolic | Paper | Cold punching Cold punching |
| | T-896 | XXXP | PBE-P | 3115B | Phenolic | Paper | |
| T-903 | XXXP | | | Phenolic | Paper | | |
| 14. Rogers Corp., ³ Rogers, Conn. | RM-2035IR | XXXP | | | Phenolic | Paper | High insulation resistance |
| | RM-2034 | XXXP | | | Phenolic | Dacron | Exceptional bond strength |
| | RM-9726 | X-XXX | | | Phenolic | Paper | Good impact and flexural strength |
| | RM-4015 | | | | Phenolic | Glass-Cellulose | Exceptional impact strength |
| | RM-4100 | | | | Phenolic | Asbestos | Arc resistant; heat resistance continuous over 475° F; self-extinguishing |
| | Duroid 5600 | | | | Teflon | Inorganic | Exceptional electrical properties and heat resistance |
| | Duroid 800 | | | | Phenolic | Paper | Arc resistance, low cost |
| 15. Spaulding Fibre Co., Tonawanda, N. Y., (Spauldite) | XXXP | XXXP | PBE-P | 3115B | Phenolic | Paper | Hot punching, high insulation resistance Cold punching, high insulation resistance |
| | XXXP-690 | XXXP | PBE-P | 3115B | Phenolic | Paper | |
| | XXXP-730 | XXXP | PBE-P | 3115B | Phenolic | Paper | |
| | XXP-755 | | | | Phenolic | Paper | |
| | XP | P | | | Phenolic | Paper | |
| | XP-701 | PC | | | Phenolic | Paper | |
| | G-5-766 | G-5 | GMG | 15037 | Melamine | Glass | |
| | G-10 | G-10 | GEE | 18177 | Epoxy | Glass | Glass cloth base |
| | CS780 | | PBE-P | 3115B | Phenolic | Paper | |
| | | | | | | | |
| 16. Synthane Corp., Oaks, Pa. | XXP | XXP | | | Phenolic | Paper | Hot punching High moisture resistance, hot punching, higher insulation resistance |
| | XXXP | XXXP | | | Phenolic | Paper | |
| | XXXP-IR | | PBE-P | 3115 | Phenolic | Paper | |
| | P-10 | | | | Phenolic | Paper | Cold punching |
| | P-25 | | | | Phenolic | Paper | |
| | G-5 | G-5 | | | Melamine | Glass | Glass cloth base |
| | G-10 | G-10 | GEE | 18177 | Epoxy | Glass | |
| | G-11 | | | | Epoxy | Glass | |
| | N-1 | N-1 | NPG | 15047 | Epoxy | Nylon | |
| | 17. Taylor Fibre Co., Nerristown, Pa. | CU246 | XXP | PBE-P | 3115B | Phenolic | Paper |
| GEC | | G-10 | GEE | 18177 | Epoxy | Glass | |
| XXXP-242 | | XXXP | PBE-P | 3115B | Phenolic | Paper | High insulation resistance, cold punching Good electrical properties, warm punching Low cost |
| XXP-241 | | XXP | | | Phenolic | Paper | |
| XP-240 | XP | | | Phenolic | Paper | Superior electrical properties under high humidity, (A - with adhesive, NA - no adhesive) used for flush circuits | |
| GEC-500 | G-10 | GEE | 18177 | Epoxy | Glass | | |
| 18. Westinghouse Electric Co., Pittsburgh, Pa. | MICARTA | | | | | | Cold punching, good mechanical properties |
| | XXXPC | XXXP | | | Phenolic | Paper | |
| | MICARTA | | | | | | Warm punching Superior insulation and dielectric pro- perties; for high temperature and high humidity use. |
| | XXXP | XXXP | | | Phenolic | Paper | |
| Glass-Epoxy | | | | | Epoxy | Glass Cloth | |

² Rexolite 1422 cross-linked copolymer.

³ All grades are in moldable form, especially suitable for molded mechanical methods of producing printed wiring. All grades are cold-punching and exceptional high strength properties.

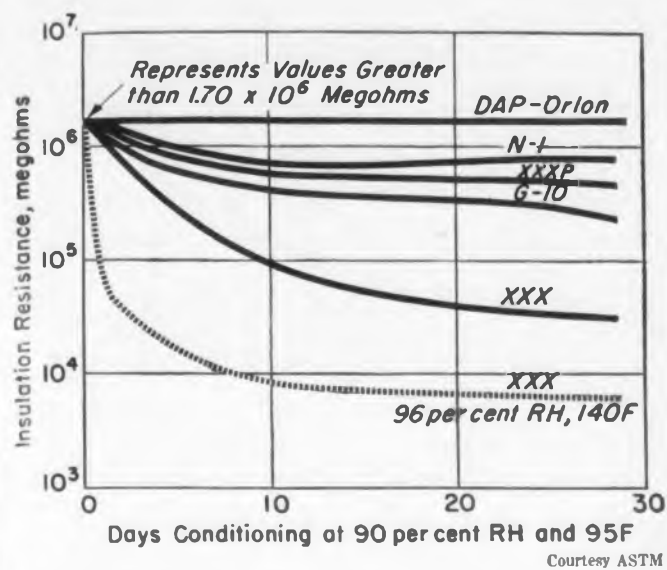


Fig. 1. How insulation resistance varies under high humidity for several copper-clad printed-wiring laminates.

Where low dimensional changes are required along with high mechanical strength, low water absorption, and fungus resistance, epoxy laminates can be specified. Base material is a continuous filament glass cloth. Two of the most commonly used grades are G-10 and G-11.

Both are continuous filament woven glass fabric grades noted especially for their electrical characteristics. G-10 retains 25 per cent of its flexural strength at 300 F; G-11 retains 50 per cent of its flexural strength at this same temperature.

Where high resistance to abrasion is desired, melamine laminates are preferred. Silicone laminates provide good resistance to heat with extreme flexibility. Teflon, because of its excellent high-frequency loss factor, is being used in microwave applications. Its cost rules it out except for the most critical applications.

Generally, paper-base phenolics offer considerable cost savings over glass fabric dielectrics. They also permit sharper definition of conductors. Also, the lower electrical grades of phenolics are less expensive than higher-rated materials.

Bond strength of copper to phenolics is better than some of the fabric and glass mat materials. However, the fabric and glass-base materials have better electrical characteristics.

Most copper-clad laminate makers use electrolytic copper foil. Further, it is specified by NEMA standards.

Synthane Corp. has developed a new adhesive with electrical properties equal to the base laminate. Minnesota Mining & Manufacturing Co. recently announced their formula XPA-220249, a liquid thermo setting type adhesive for bonding copper foil under heat and pressure. It withstands the visual 450 F solder bath for 10 sec and was found to have peel back strength of about 10 to 15 piw.

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SUB-MINIATURE IN SIZE YET ELECTRICALLY RUGGED

The 663UW has gained wide acceptance among design engineers because it SAVES VALUABLE SPACE. It can do the same for you! (See size table below.) This entire line is designed for reliable performance and it's ratings are conservative. The use of MYLAR* dielectric provides excellent stability with life and high I.R. *Du Pont trademark for Polyester film.

This thin, tough, Mylar case provides excellent moisture and abrasion resistance.

Space saving Mylar dielectric gives a rugged, yet miniature, capacitor element.



Thermo-setting epoxy seals the ends and anchors the leads securely.

APPLICATIONS: Instrumentation. Filter networks. Transistor circuitry. Amplifiers. Test equipment. Computers.

SPECIFICATIONS

Insulation Resistance: See curve reproduced below for typical performance.

Lead Pull Test: Steady force of 10 lbs. applied axially for 60 seconds.

Life Test: 250 hours at 85° C and 125% of rated voltage.

Capacity Tolerances to ± 1%.

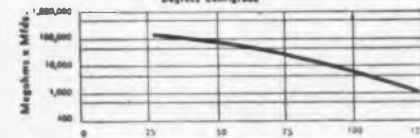
Humidity Resistance: Far exceeds requirements of RETMA Apec. REC-118-A.

Temperature Range: Operation at rated voltage from -60° C to +85° C; and to +125° C with 50% derating.

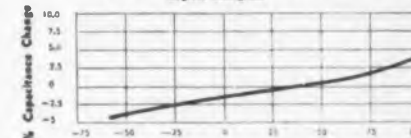
TYPICAL SIZES

| Capacity | 100 Volts | 200 Volts | 400 Volts |
|----------|--------------|--------------|--------------|
| .001 | .156 x 1/2 | .156 x 1/2 | .156 x 3/8 |
| .0047 | .156 x 1/2 | .156 x 1/2 | .186 x 3/8 |
| .01 | .156 x 1/2 | .171 x 3/8 | .250 x 3/8 |
| .047 | .234 x 3/4 | .296 x 3/4 | .343 x 7/8 |
| .1 | .281 x 7/8 | .375 x 7/8 | .421 x 1 |
| .47 | .468 x 1 1/4 | .546 x 1 1/4 | .671 x 1 3/8 |

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4 Proper Care and Handling —

An often neglected aspect of reliability in printed-wiring



Synthane Corp.

Fig. 1. Resin content and degree of polymerization of each batch of paper or fabric are tested.



Synthane Corp.

Fig. 2. Sample laminates are checked for dielectric strength.

TO INSURE reliability of printed-wiring, proper handling is necessary from preparation of the board laminate until assembly of the device has been completed. Manufacturers of laminates constantly check each step in the production process. This insures the fabricator of a good quality uniform product.

Quality checking and inspection procedures at Synthane Corp. are an example of what a manufacturer and fabricator of industrial thermosetting laminated plastics does to insure reliability.

Synthane takes these steps:

- Incoming raw materials are checked, including rolls of fabric base materials.
- Electrolytic copper is spot-checked. But Synthane relies on its vendors to check first. They pay about four times the normal price of copper for this service. Copper is checked 100 per cent for lead inclusions.
- Resins are tested. Vendors reports are checked against lots received.
- Constant checks are made of impregnating materials used in the coating machine.
- As sheets are laid up for the presses, both the laminate and copper is given a quick visual inspection.
- Press pressure is maintained at 1767 psi at 335 F. Material goes through a 2-hour cycle; cold to cold. It cools under pressure.
- Finished copper-clad sheets, are trimmed, then thickness is checked on four corners. Sometimes customers require checking at 12 points on the sheet. Greatest variation is found on the edges.
- Samples are cut for lab tests. Tests are performed to check bond strength, blistering, insulation resistance. Usually the customers own test pattern is put on the sample.
- Remainder of the sheet is polished and given a final visual inspection. If the customer requests a protective coating is applied.



Synthane Corp.

Fig. 3. Customer's test patterns are tested for effects of humidity on electrical characteristics.

■ Sheets are packed using slip sheets. Special packaging is required.

For military applications, specifications are very rigid. One aircraft manufacturer requires 100 per cent inspection and a written report on each 36 x 36-in. sheet, Synthane reports.

Most important of the tests on copper-clad laminate are:

■ Insulation resistance, including surface and volume resistivity. These tests are conducted under various humidity conditions.

■ Peel or bond strength. A special test specimen or 1-in. wide strips are used. Most tests are performed after subjecting the specimen to temperatures approximating those of soldering.

■ Blister resistance. The standard test is to float a 1-in. square specimen in a solder bath for 10 seconds at 475 F. Standard temperature for this test is still being debated. NEMA specifications to which these test results must adhere, are considered the Bible and are somewhat more rigid than most military specifications.

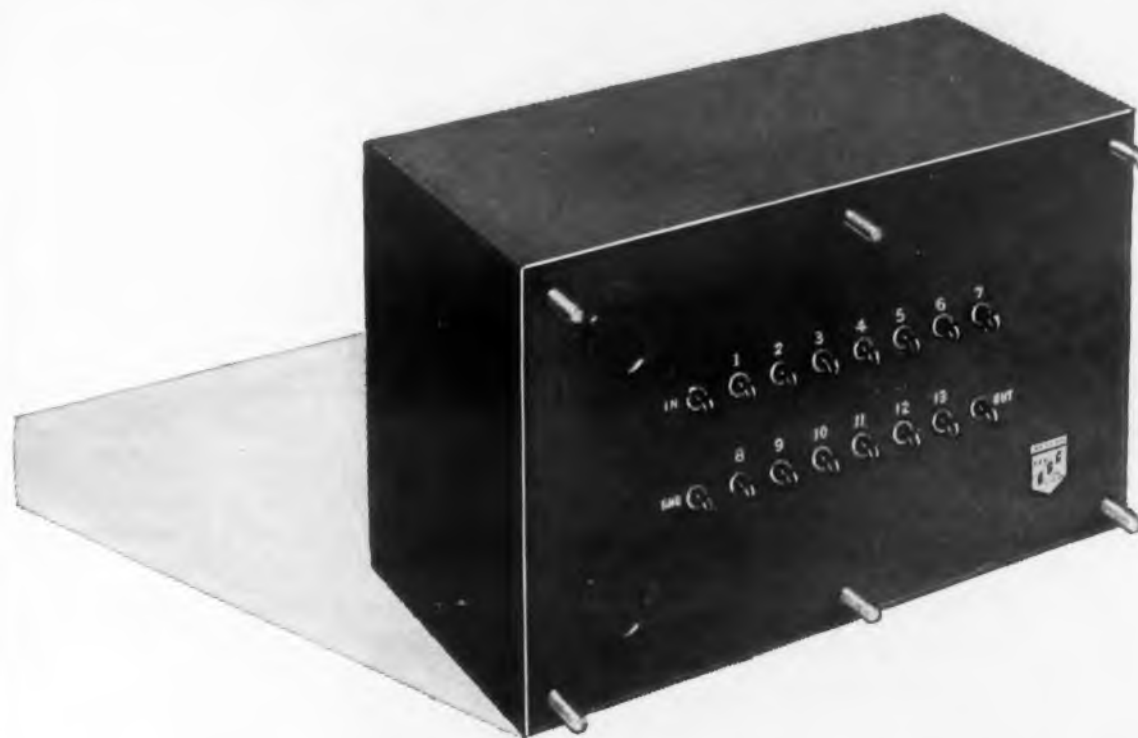
It would be impossible to list all the test specifications now being used. NEMA, ASTM and military all have standards available to printed-wiring designers. In most cases, manufacturers have set up their own standards and procedures.

After incoming inspection by the printed-wiring fabricator, the copper-clad sheets are often put in stock. In exposed storage, the copper, or solder-plated copper will oxidize. Oily or acid atmospheres will contribute to difficulty in getting good solder joints. It will also cause heavier dross to form on the surface of the solder pot.

Copper boards can be etched by several methods. But the part of the process that can contribute most to reliability is the cleaning. Cleaning is as important before etching as after. Some manufacturers scrub the board with

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| TYPE | TOTAL DELAY | RISE TIME | VOLUME, INCHES | Z ₀ OHMS | MAX. NO. PULSES | PULSES PER CU. IN. | TOTAL INSERTION LOSS | INSERTION LOSS PER PULSE | MERIT* FACTOR | MIN. PULSE LENGTH |
|--|-------------|-----------|----------------|---------------------|-----------------|--------------------|----------------------|--------------------------|---------------|-------------------|
| **Commercial Air Core Delay Line | 4.6 μs. | 0.1 μs. | 92.7 | 430 | 23 | .248 | 7 db | .304 db | 0.816 | .2 μs. |
| **Commercial Ferrite Core Delay Line | 12 μs. | 0.26 μs. | 41.2 | 500 | 23.1 | .56 | 2 db | .0866 db | 6.45 | .52 μs. |
| **Commercial Ferrite Core Delay Line | 200 μs. | 4.4 μs. | 74.4 | 500 | 22.8 | .306 | 2 db | .0876 db | 3.5 | 8.8 μs. |
| **Commercial 1350 Ohm Distributed Line | 12 μs. | 0.44 μs. | 77.7 | 1350 | 13.6 | .175 | 12.4 db | .911 db | 0.192 | .88 μs. |
| **RG 65 U | 8 μs. | 0.31 μs. | 820 | 950 | 12.9 | .0157 | 11.5 db | .892 db | 0.0176 | .62 μs. |
| ESC Delay Line Model 51-43 | 20.3 μs. | .14 μs. | 115 | 470 | 72 | .625 | 2 db | .0278 db | 22.5 | .28 μs. |

* Merit Factor = $\frac{\text{Pulses In.}^3}{\text{Insertion loss per pulse}}$

**J. R. Anderson, "Electrical Delay Lines for Digital Computer Applications" Transactions of the I.R.E.—June, 1953



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CIRCLE 31 ON READER-SERVICE CARD

PRINTED-WIRING RELIABILITY

pumice cleaner and a scrub brush before applying the acid resist.

After etching, the acid coating must be completely removed. Alcohol, acetane or various commercial cleaners may be used. Most makers blame 90 per cent of the printed-wiring problems on poor cleaning.

According to C. W. McClelland of Varian Associates, two types of contamination trouble printed-wiring—process and accidental. Production process contamination results from the etching bath and solder fluxes. Accidental contamination is a result of finger-prints and dust.

Using a ferric chloride etching process, iron and copper salts remain on the board. McClelland points out that recent research at Stanford indicates that hydrochloric acid and pluronic L62 are very effective. Other wash solutions are being tested. Ultrasonic cleaning is also satisfactory.

Printed-wiring boards should be stored in sealed plastic bags for storage. One military specification requires that, after cleaning, the board be placed in a polyethylene bag and heat sealed. Natural rubber or materials high in sulphur should not be in contact with the bag. Once the board is removed from its sealed container, it should go into production immediately.

Printed-wiring not sealed in plastic or other

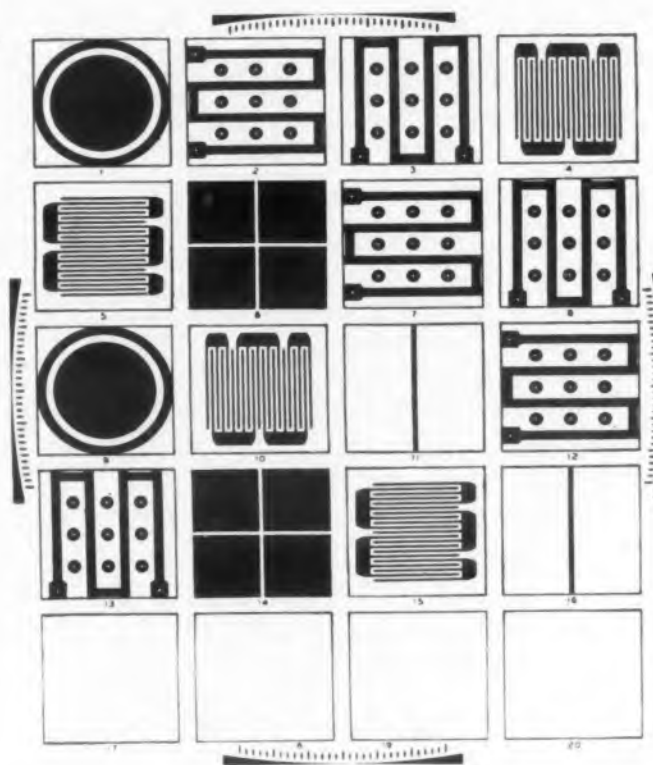


Fig. 4. Test pattern developed by American Society for Testing Materials permits checks of all important characteristics.

suitable air tight packaging should be treated as a board that has been in storage. To properly prepare a board that has been handled or stored in open air, the areas that are to be soldered should be burnished. A suitable material for burnishing is a "typewriter" eraser of the pencil type. In extreme cases 4/0 steel wool can be used. Be sure that steel "whiskers" are not entrapped or snagged under eyelets, fastenings, or pads.

Preproduction Washing

Cleveland Metal Specialties Co., in their excellent booklet, "Military Standards for Printed-Circuits" recommends preproduction washing of the printed-wiring boards in all cases where low leakage resistance and long term reliability are to be maintained. The following formula is suggested:

- 8 oz Ammonia
- 8 oz Murphy's Oil Soap
- 1 oz Swift & Co. No. 900 Solar Detergent
- 1 gallon Water

Heat water 140 F to 160 F, dissolve soap (stir slowly for minimum suds). Add ammonia; add Solar Detergent.

Use stock solution at above temperatures in cleaning printed-wiring. One gallon will treat approximately 15 sq ft of two sided printed-wiring material.

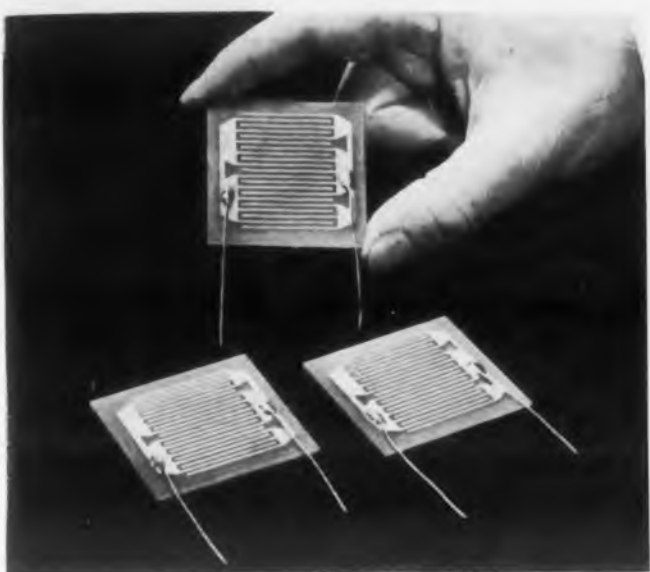
Allow circuits being washed to stand in heated solution for at least 20 sec. Using a stiff bristle brush, scrub both sides of the printed-wiring, rinse in filtered tap water, and force dry by air blast from filtered air supply.

During rinsing and drying, the board should be handled by the edges. They may be dried in lint free blotters. It is important that, during and after the production cycle, the board is to be handled by the edges.

Most resin fluxes are activated to some degree, therefore residue should be removed from the finished board when the assembly is complete. A suitable liquid flux is generally desirable in working printed-wiring boards. Where liquid flux cannot be used, use resin flux cored solders.

Upon completion of a printed-wiring assembly, flux and other residues should be removed immediately. Where possible, the entire assembly should be placed in a shallow pan of suitable flux remover such as toluol, or liquid trichloroethylene and allowed to soak. About 20 to 30 sec should be sufficient to soften and loosen the residues. The assembly can be brushed with a bristle brush to loosen residues, then redipped in flux remover. Remove the assembly and while dripping wet, use filtered compressed air blast to blow the assembly dry. Inadequate cleaning can be seen by inspecting assembly for streaks.

Suitable protective coatings such as varnishes, and sprays, are available for covering the ex-



National Vulcanized Fibre Co.

Fig. 5. Typical test boards consisting of 25 in. of conductor spaced 3/64-in.

posed conductor areas to prevent leakage, and to render the areas humidity proof.

Types of Coatings

A wide variety of moisture, fungus proofing, insulating and fire resistant coatings are available. Epoxy coatings can be obtained in air-drying or bake-drying types. Phenolic or melamine coatings can also be applied. Nearly any method of application is possible—spray, roll coating or screen printing.

Method Manufacturing Corp. suggests these finishes:

- Protective laquers, wax, thermoplastic or varnish compounds to prevent oxidation. Water-dip lacquer is the most commonly used protective finish.
- Flux Coats with or without activating agents. Slow drying characteristics defeat its purpose somewhat, however. This coating is mainly a soldering aid.
- Solder resist masks, keep solder off portions of the circuitry not to be soldered.
- Electrosolder plating aids soldering, often requires extra manufacturing costs.
- Silver Flash is useful where excellent appearance at low cost is desirable.
- Electrosilver plate used for switching and applications where good conductivity is important.
- Nickel rhodium for long-life switch uses.
- Gold for extra critical for high conductivity and resistance to oxidation is important.

Cadmium plate, nickel and silver-rhodium are also used for special applications.

All etched circuits should have a protective coating. Although no one coating fulfills all applications, one closest to meeting the necessary requirement should be chosen.



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CBS-HYTRON, Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.
CIRCLE 32 ON READER-SERVICE CARD

5 Factors in Soldering—

Good soldering practice insures reliable connections

DIP soldering presents the designer with the greatest opportunities for cost savings along with the greatest source for trouble. The method can be performed easily by relatively unskilled persons—providing proper preparations are made.

First, the base laminate must be able to withstand at least 450 F solder temperature. A suitable solder pot must be capable of holding enough solder at 475 F to handle the largest assembly. Solder is usually 60 per cent tin, 40 per cent lead, although some manufacturers use a 63-37 ratio. It must be carefully maintained at that ratio during production.

The circuit must be properly prepared to accept solder. Photocircuits Corp. makes a special protective film that can be applied to keep the pattern clean. The film decomposes at temperatures well below soldering temperature.

Other alternatives could be one of the many coatings discussed in the "Care and Handling" section. Unprotected boards must be carefully cleaned before soldering.

Choosing the flux is very important. Flux must be noncorrosive and yet extremely active in removing oxides and contaminants. A good flux can dissolve oxides at temperatures lower than the melting point of solder, is non-toxic, produces no offensive fumes, and will leave no corrosive residue.

Fig. 1. Test specimens are floated in a 475 F solder bath to determine blistering characteristics. One-inch square specimens are standard, but Synthane also uses round pieces of the same area.



Synthane Corp.

Pure resin and resin-alcohol fluxes are most common. Resin flux is probably the safest. Organic-base fluxes possess greater fluxing powers than resin fluxes, but are also slightly more corrosive. All of the residue must be decomposed to noncorrosive residues.

Some fluxes have acid chloride base salts. They are extremely corrosive and should never be used for electronic assemblies.

Flux is applied to the work by floating the assembly in a container of flux. After draining, the piece is put in the solder pot. Circuit boards should enter the solder bath at an angle of about 3 to 5 degrees to allow the flux vapors to escape. The assembly should not be moved while in the solder.

About 8 to 10 seconds is the minimum dip time. Vibrating the board removes excess solder, then the board should stand for several seconds to allow the solder to solidify. Excess flux can be washed away with liquid trichloroethylene or ethyl alcohol.

The finished dip-soldered board should have a smooth bright appearance. The solder should not have the frosty appearance of cold-solder joints.

Insufficient time in the solder pot or too low temperature cause blobs or accumulations of excess solder. If the solder doesn't take, insuffi-

cient flux or excessive dirt are usually the cause.

Often dried flux should not be removed from the assembly. Activated fluxes used in some commercial operations have very good insulation resistance in this dry state. Cleaning the flux off may be harmful unless it is thoroughly done. Any flux becomes active in solution.

Vapor degreasers are very good flux removers. But care must be taken not to remove component markings.

Many forms of dip soldering are practiced. Single dip soldering is most common. A double-dip method uses two solder pots. The second dip has a thin layer of high-temperature wax floating on top. This method permits reflow of solder that may have bridged across the printed pattern, and covers the circuit with a moisture and fungus-proof coating.

Masking keeps solder coatings off areas where it is not desired, such as component mountings. Marking tape or solder resistant varnish coatings are used.

Jig soldering is a fusion process which heats the elements to be joined and controls flow of solder to appropriate portions of the circuit. Because of considerable expense involved, the method is used only where production volume warrants.

Wave soldering, or contoured soldering is a

recent development. Instead of dipping the board into the solder pot, the level of the solder is raised to the board by pumping it up into a "wave". Several advantages are apparent, such as improved angle of insertion and withdrawal, better control of time and less heat applied to other parts of the board.

Method Manufacturing Corp. lists these important soldering considerations:

- **Solder Composition**—the eutectic solder alloy has the feature of going from solid to liquid or vice versa without a mushy stage and very quickly. To maintain the 63-37 alloy ratio, it may be necessary to add pure tin. Insufficient tin is indicated by a crystalline appearance of solder areas. The pot should be stirred before use to maintain balance between the tin and lead since the latter tends to go to the bottom during cooling. Impurities are added to the bath by the solvent action of the hot metal on components, fixtures, skimmers, etc., and periodic dumping is indicated.

- **Temperature Uniformity**—The solder reservoir should be large enough to maintain temperature at the desired level on a constant basis.

- **Gas Entrapment**—Fumes from flux if trapped between the panel and solder may impede wetting and a dip angle that allows trapped vapors to escape is suggested.

- **Pads**—Design of pattern may affect percentage of opens. Holes tangent with the edge of pads have been found on a statistical basis to tend more to opens than those centered. Ideally, each hole is a sort of focal point for its surrounding pad or portion of pad.

- **Component leads**—Metals and platings of components have contributed to many dip solder headaches. Cadmium, satisfactorily used for hand soldering electronic terminations, deteriorates too rapidly for use at dip solder temperatures. Zinc and aluminum go into solution easily and impede soldering. Resin or wax may mask solder from leads, or in liquid state form bubbles to prevent wetting action. Component leads should be carefully checked for solderability after aging.

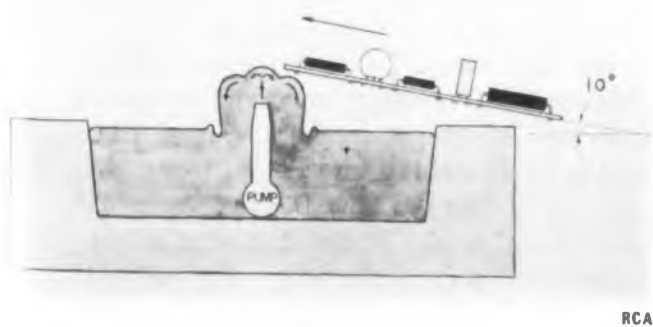
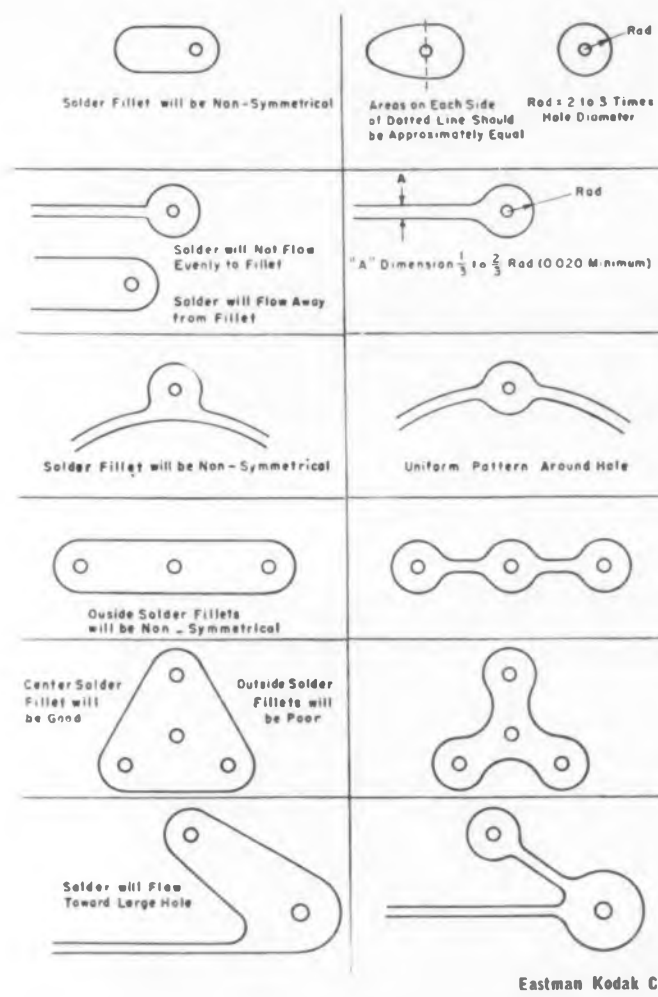


Fig. 4. Wave or fountain method of dip soldering concentrates heat on solder points.



Jefferson Electronics Products Corp.

Fig. 2. Dip soldering machine showing how board is loaded in spring loaded fingers. Dipping is controlled automatically; solder bath is covered except during dipping cycle.



Eastman Kodak Co.

Fig. 3. Wrong way (left) to design wiring terminations and how these faults may be overcome (right).

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6

Other Forms —

variations of well-known techniques

designed for

printed-wiring reliability



Fig. 1. Flush circuitry (left) and imbedded circuitry (right).

Beck's Inc.

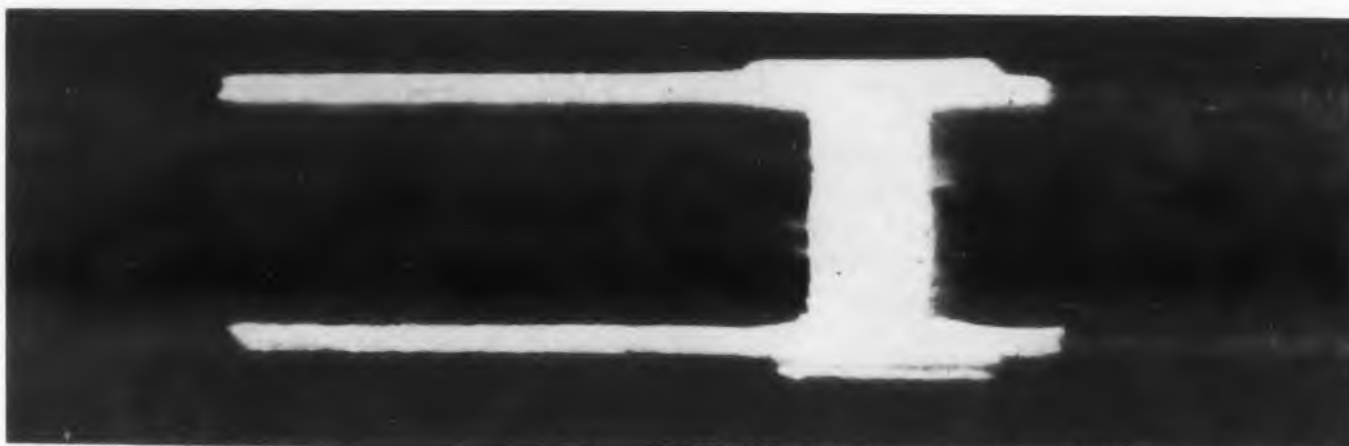


Fig. 2. Cross-section of solid copper rivet connection between two-sided board.

Beck's Inc.

PLATING is the second most popular method of fabricating printed-wiring. Etching is first. In plating, a thin conducting film, usually silver is applied to the laminate. Then, a reverse pattern is printed on the film with plating-resist ink. Electroplating follows, then an etching process to remove the ink and remaining silver.

One advantage of the plated method is its lower cost. Also, holes may be plated-through at the same time. Both sides of the base may be done at the same time.

Many other methods are less commonly used. They include embossed wiring, sprayed metal, "buried" wiring, and molded wiring. Most of these methods are expensive, but offer advantages like better insulating characteristics.

Flush Wiring

Flush wiring is commonly used for switch and commutator applications. Glass Products Co. provides an "inlaid" type. They make their boards by first plating a 0.0001-in. metal foil on a polished base. Then a photo sensitive epoxy resin is coated upon the foil, an image is photographed and the resin remains in the non-image area.

After curing the resin, the exposed foil areas or image areas are then electroplated with any metal or combination of metals desired. The plate is now laminated onto any thermoset or thermoplastic resin desired (Fig. 1).

For thermoplastic material, polystyrene is commonly used. For thermoset applications, a special high insulation resistance XXXP bakelite phenolic can be used. After lamination the supporting surface is separated from the foil and the 0.0001-in. foil is etched in a material that does not affect either the electroplated metals which form the circuit or the plastic base.

Imbedded Wiring

Another important process has been devised and patented by John Beck of St. Paul, Minn. With the Beck process, the wiring may be completely imbedded (Fig. 1) in the laminate or flush with the surface. It uses much heavier copper conductor (5, 6, or 7 oz instead of 2 oz) and uses solid copper rivets (Fig. 2) to connect both sides of the board instead of eyelets or plated through holes. All this results in relatively heavy conductors and more reliable connections.

With the Beck method, circuitry may be fabricated by etching, forming, metallic spray, or electroplating. Etching is by far the most common. But even in etching, the Beck process differs from others. Here is how Beck's "controlled selective etching" works. It can start with 0.0081-in. (6 oz) copper, stop off the terminal areas, and etch the remaining metal part way. The exact circuit pattern is next stopped off and the remaining metal etched the rest of the way. The

result is a two-level circuit with the conductors themselves only 0.0052 in. (equivalent to 4 oz) and the terminals at their original thickness.

An overlay, using the same material as the base, is then applied overall and cured to the base. Following this, the new surface is sanded down to the surfaces of the terminal pads allowing them to be exposed, but flush with the surface of the base material.

The circuit is now completely imbedded except for the terminal pads. During final assembly of these boards, it is customary that these terminal pads be coated completely with solder.

Problem of eyelets vs plated-through holes is minimized in Beck's circuitry. A solid copper rivet, the same cross-section area as the metal conductor, is inserted in a predrilled hole. The rivet is then expanded by pressure so that it tends to fill out every irregularity of the hole. It bonds itself to the metallic conductor. The fact that the "Beck Process" uses heavy conductors makes this bond an extremely good one.

Multiple-level circuitry may be made by Beck's process by building up two or more levels of laminated imbedded circuitry. The normal imbedded circuit may be produced and a second level metallic conductor may form a heat sink. This heat sink could be brought to the surface at any place in the circuitry to dissipate heat from a particular location, or from the whole board in general.

Painted and Indexed Wiring

Another departure from standard techniques is Samuel Wein's "Copperoid" process. It is a chemical process for deposition of copper on glass, ceramics, plastics or rubber. No special

equipment is needed other than trays or tanks.

Copperoid compound is a water-soluble compound and is applied at slightly elevated temperatures. Its present applications include depositing a copper film on ceramic wafers and for connections between printed-wiring boards.

J. Frank Motson Co. are producers of wiring printed on varied shapes. Circuitry can be printed on tubes, cones, and curved base material. Motson uses special silver inks which vary in printed thickness from 0.0002 to 0.0018 in. Teflon epoxies, melamines, phenolics, and the like are used as base materials. Applications include rotors, commutators, and wave guides.

Flexible Wiring

Flexible printed-wiring offers many advantages, especially for wiring harnesses. Sanders Assoc. Inc., has introduced a new material called "Flexprint." It consists of etched patterns of electrodeposited or rolled copper foil bonded between thin sheets of insulating plastics. It is available in single or multilayers.

Some of the insulating plastics include vinyls, polyesters, silicone, Kel-F, and Teflon. Its flexibility allows for irregular shapes and contours. For example, bending radius for 0.005 in. plastic is 1/16 in.

Applications include use with moving devices such as computer search carriages or reciprocating machine heads to reduce cable loading.

Ceramic Boards

Fotoceram, a process developed by Corning Glass Works, converts a special photo-sensitive glass into a ceramic printed-wiring base. Holes in the glass are etched in with hydrofluoric acid.

Then firing converts the glass into a ceramic. As a ceramic, the material will not warp or sag and does not absorb water.

After processing, copper is electroplated onto the base and through the holes. A resist is used to protect the insulating areas. Holes cannot be easily added after the material is processed.

Flexural strength is 25,000 psi, but the ceramic is brittle. Thus, added precautions must be observed in mounting. But the biggest advantage is in its resolderability. Removing and resoldering of a component up to 50 times has been accomplished with no sign of damage.

Fotoceram is competitive in price with high-quality epoxy base laminates. The material is intended mainly for use in missiles and radar equipment, where high reliability is necessary.

Molded Circuits

Printed-wiring boards may also be molded. Channels for the conductors can be molded on one or both sides. Circuitry is electrodeposited about 0.015 in. below the surface of the board. Conductors are thus protected against damage.

Any material that can be transfer molded may be used. Resin used by Die Form Circuits Inc., developers of this process, is electrical grade phenol resin. Bakelite Co. supplies the resin.

A standard transfer molding press is used for molding the panels. All holes for feed-through wiring are molded in. Thus, the use of punch presses are not required. Holes have an "hour-glass" cross section which assures uniform copper plating inside the hole.

Panel thickness has been standardized at 0.093 in. With conductors depressed about 0.015 in., base thickness between sides is 1/16 in. Maximum panel size so far is about 10 x 6-1/2 in.

Cost is expected to be considerably less than etched boards. Production of molded boards is inherently less complicated than processing of etched boards.

Rogers Corp. has developed a variation of Die Form's molded circuits. Rogers uses a laminate as its base material instead of resin.

Printed-wiring is die blanked and molded into a laminated board of any NEMA grade. Standard stamping and compression molding machines can be used.

Copper scrap from the blanking process can be reused. Circuitry can be either raised or depressed. Rogers has developed their own laminate which meets NEMA XXXP specifications, but has better dielectric characteristics.

Although the Rogers method involves die-blanking, other forms of fabrication may be used. Copper may be deposited on the board by electroplating or etching. But where high currents must be carried, die-blanked conductors can be made heavy enough to carry 70 amp.

The editors of **ELECTRONIC DESIGN** gratefully acknowledge the kind cooperation of these firms in the preparation of this staff report:

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Air Arm Div.

Effects of Processing and Environment On Printed-Wiring Laminates

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Nearly all printed circuit boards are made from high-pressure laminates that use a paper-phenolic laminate or glass fabric-epoxy laminate. This article describes the process and environmental effects on the important electrical and physical properties of these two types of laminate.

IMPORTANT laminate properties that concern printed circuit boards fall into three categories:

- Electrically, there is insulation resistance, surface resistivity, dielectric strength, dielectric constant, and arc resistance.
- Physically, there is flexural strength, impact strength, cold flow, and machinability.
- Chemically, there is the resistance of the laminate to the various processing solutions used in the manufacture of printed circuits.

The chart (Tab. 1) indicates "as received" values of various properties of paper-phenolic and glass fabric-epoxy laminates.

Of course, where high physical properties, such as flexural and impact strength are important, glass-base material is superior to a paper-base laminate. Better dimensional stability is also a characteristic of a glass base laminate as compared to paper. However, a paper-phenolic laminate having good electrical characteristics does satisfy a majority of printed circuit applications.

Effects of Environment

Before examining process effects on laminates, it would be in order to point out what happens to various properties as a function of temperature and humidity. These characteristics as well as "as received" properties will influence the choice of laminate for the particular printed circuit application.

Effect of temperature on power factor, dielectric constant, and dissipation factor is shown in Fig. 1.

Insulation resistance (Fig. 2) varies with temperature for a hot strength epoxy-glass laminate and a paper-phenolic XXXP grade.

Tab. 2 shows insulation resistance after exposure to high humidity for different types of
(Continued on page 50)

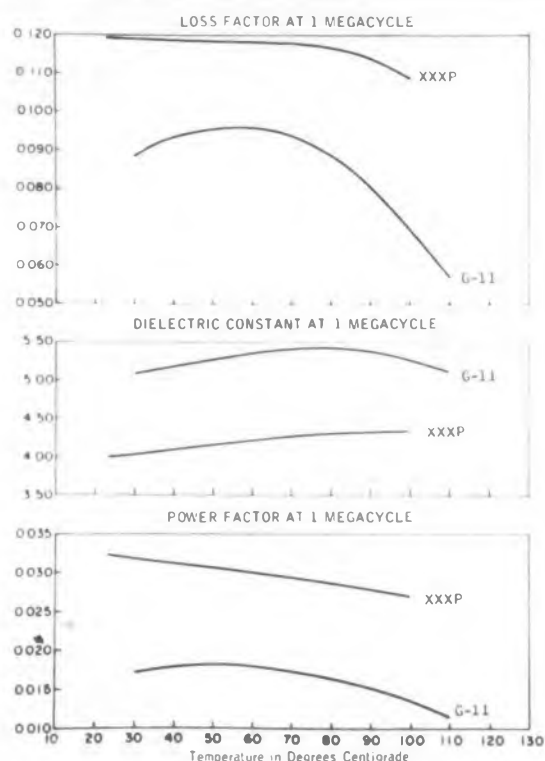


Fig. 1. Electrical properties on NEMA grades XXXP and G-11 vs temperature.

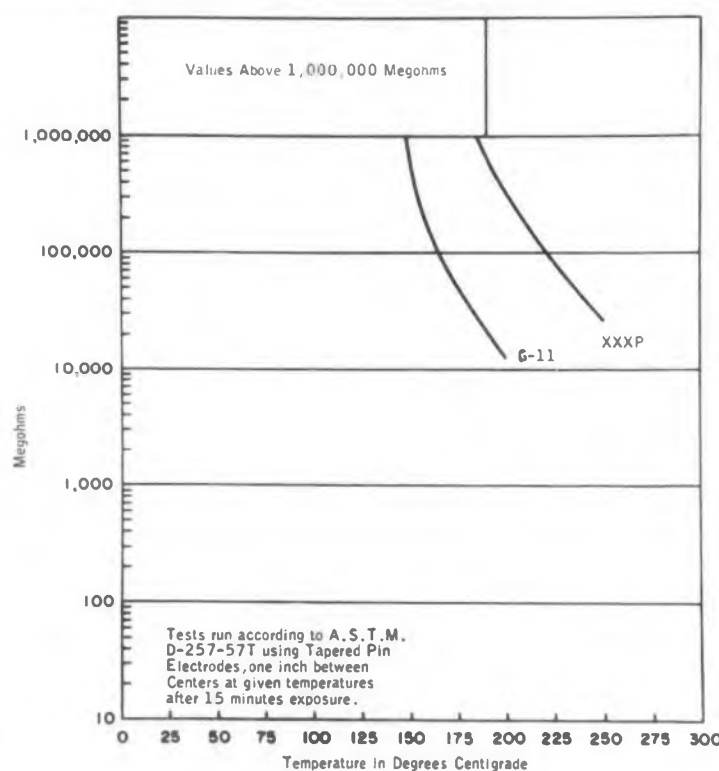


Fig. 2. Insulation resistance of NEMA grades XXXP and G-11 vs temperature.

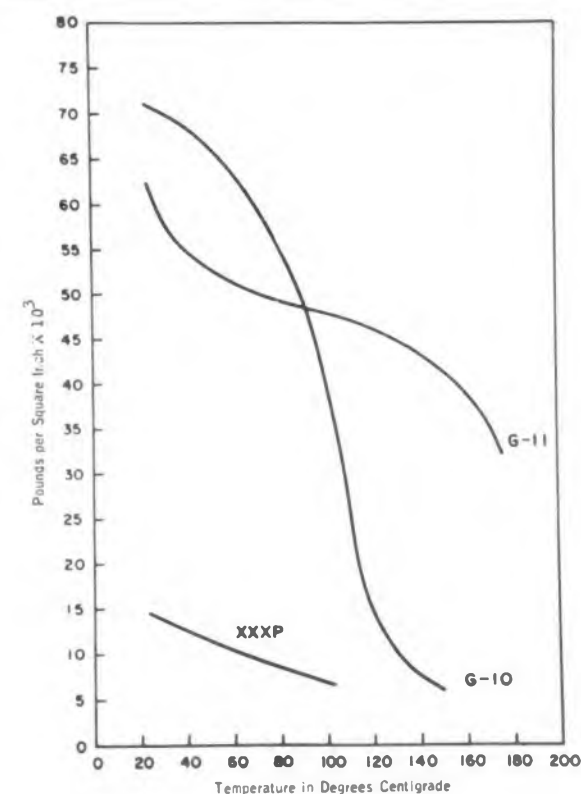


Fig. 3. Flexural strengths of NEMA grades XXXP, G-10, and G-11 vs temperature.

Table 1. Typical values of physical and electrical properties of paper-phenolic (XXXP) and glass-epoxy (G-10) laminates:

| Properties | XXXP | G-10 |
|--|----------------------|----------------------|
| Flexural Strength, Flatwise, PSI | 15,000 | 60,000 |
| Mod Impact, Edgewise, ft. lbs/in notch | .40 | 10.0 |
| Water Absorption, % (1 x 3 -24 hr. immersion) 1/16" | .60 | .25 |
| Dissipation Factor (Powder Factor) | | |
| As Received | .032 | .020 |
| D 48/50 | .041 | .038 |
| Dielectric Constant | | |
| As Received | 4.3 | 4.8 |
| D 48/50 | 4.9 | 5.2 |
| Dielectric Strength, Perpendicular to Lam. 1/16" VPM | | |
| Short time | 650 | 800 |
| Step by step | 450 | 575 |
| Insulation Resistance, Meg-ohms | | |
| C 96/35/90 | 100,000 | 100,000 |
| Arc Resistance (ASTM D-495) Seconds | — | 130 |
| Coefficient of Thermal Expansion (in. per in. per degree C.) | | |
| Lengthwise | 1.7×10^{-5} | 1.1×10^{-5} |
| Crosswise | 3.3×10^{-5} | 1.1×10^{-5} |

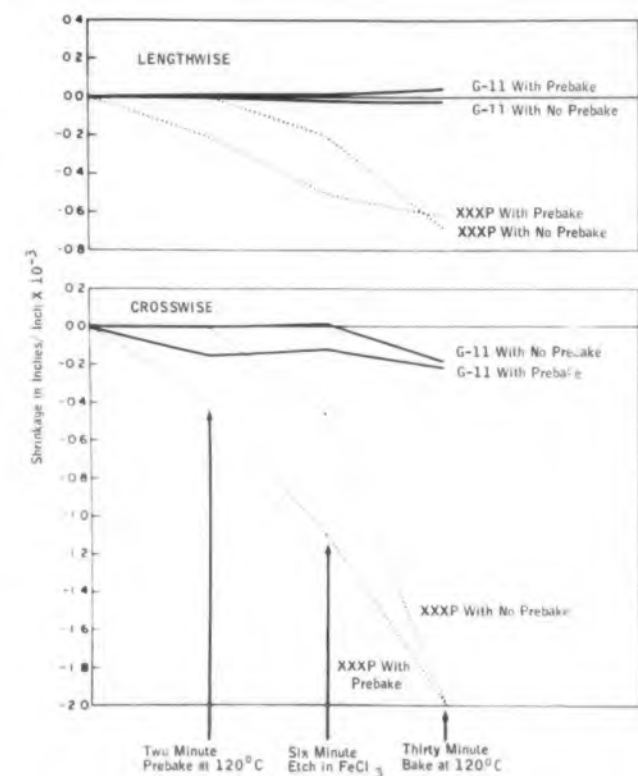
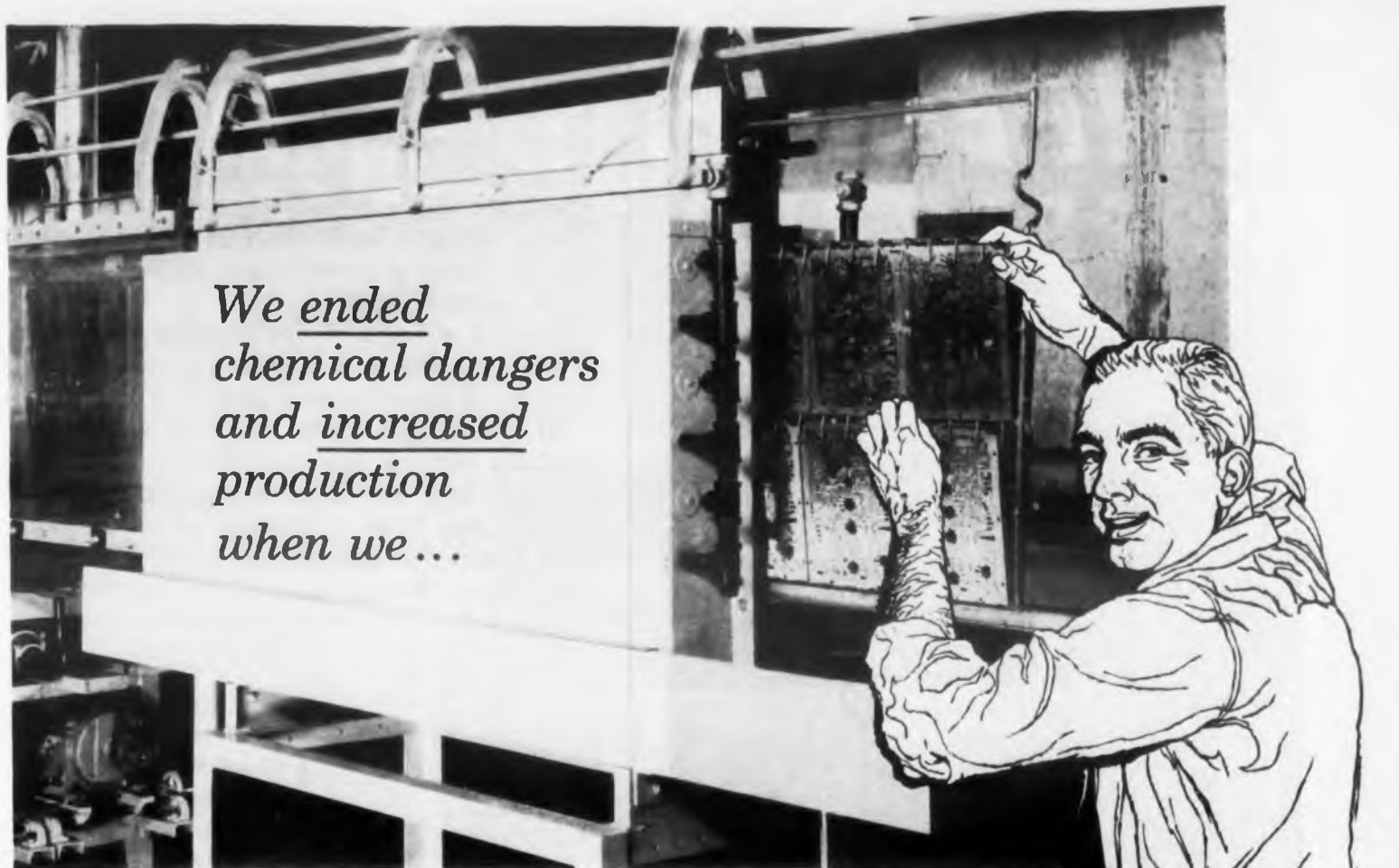


Fig. 4. Shrinkage characteristics of NEMA grades XXXP and G-11.



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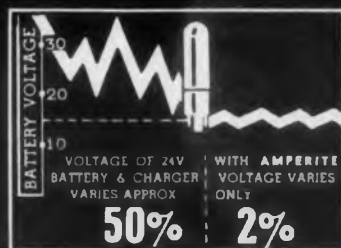


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paper-phenolic laminates. An important fact is
that it isn't the amount of resin in the paper that
affects the insulation resistance under high hu-
midity conditions, but rather the manner in
which the paper fibers have been saturated. A
sizing treatment is definitely necessary in addi-
tion to the proper application of the electrical
grade phenolic resin.

Flexural strength of two types of epoxy-glass
fabric laminates and a phenolic laminate as a
function of temperature is plotted in Fig. 3.

Of course, "as received" values of a glass-base
laminate are much higher than a paper-base
laminate. It is interesting to note the difference
between two types of epoxy resin on the same
glass fabric. The hot strength epoxy resin lami-
nates retain 60 per cent of its "as received"

| Grade | Insulation Resistance After C 96/35/90 | Water Absorp- tion 1/16" Thick D 24/23 |
|---|---|--|
| XXXP (Ave. Resin Content 60%) (Proper Sizing Treatment) | 1,000,000 Meg. | .35% |
| XXP (Ave. Resin Content 52%) (Proper Sizing Treatment) | 1,000,000 Meg. | .45% |
| XXP (Ave. Resin Content 52%) (No Sizing Treatment) | 600 Meg. | 1.65% |

Table 2. Insulation resistance for various grades of
paper-phenolic laminates.

| Rinsing Procedure on Sample Test Pattern | Insulation Resistance After C 96/35/90 |
|--|---|
| 1 Rinsed 30 seconds immediately after etching. | 200,000 |
| 2 Rinsed 1 minute immediately after etching. | 500,000 |
| 3 Rinsed 10 minutes immediately after etching. | over 1,000,000 |
| 5 Air dried, no rinse. | 3 |
| 4 Air dried for 1 hour followed by 10 minute rinse. | 55 |

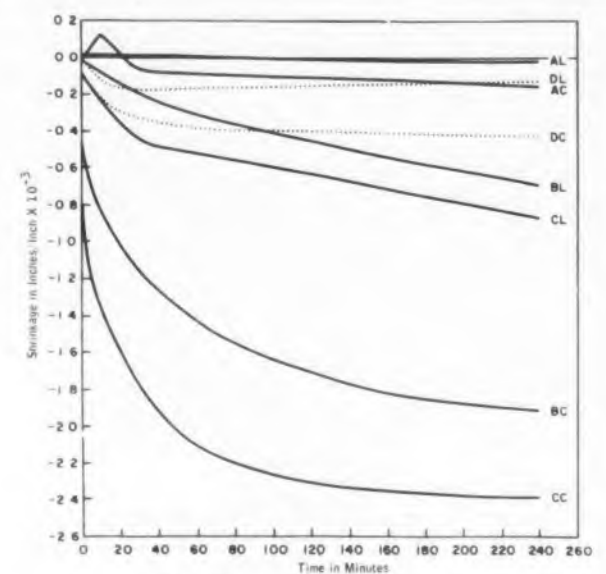
Table 3. Effect of ferric chlo-
ride on insulation resistance
(surface resistivity) of XXXP
with various rinsing cycles.

flexural strength at 300 F (150 C), whereas, the
normal epoxy has dropped to less than 10 per
cent of its "as received" value.

Effects of Processing

Dimensional changes can be expected in sev-
eral process operations that are employed in the
manufacture of printed circuits. Specifically,
Fig. 4 shows shrinkage of a XXXP board that
occurs when a baking or heating operation pre-
cedes or follows the etching operation. It also
shows the shrinkage that is simply a result of
removing the copper during the etching cycle.
The G-11, epoxy-glass laminate, shows little or
no change.

Ultimate shrinkage that can be expected from
extended exposure to various temperatures is



AL XXXP LENGTHWISE BAKED AT 50° C
AC XXXP CROSSWISE BAKED AT 50° C
BL XXXP LENGTHWISE BAKED AT 100° C
BC XXXP CROSSWISE BAKED AT 100° C
CL XXXP LENGTHWISE BAKED AT 150° C
CC XXXP CROSSWISE BAKED AT 150° C
DL G-11 LENGTHWISE BAKED AT 150° C
DC G-11 CROSSWISE BAKED AT 150° C

Fig. 5. Dimensional change of NEMA grades
XXXP and G-11 due to heat exposure.

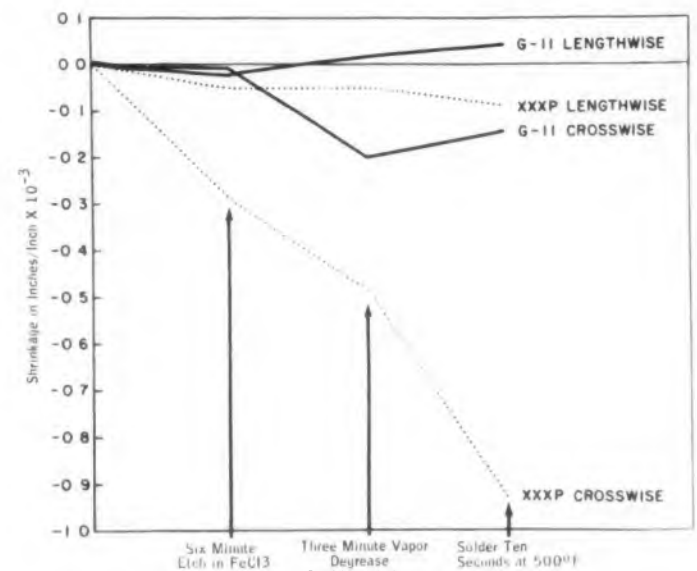


Fig. 6. Shrinkage characteristics of NEMA grades XXXP
and G-11.

shown in Fig. 5. Certain solder mask coating requires up to 2 hrs at 150 C to set up properly, so this chart indicates the degree of dimensional change that can be expected.

Shrinkage, (Fig. 6) once again on XXXP laminates, occurs as a result of etching, degreasing, and dip soldering. Basic points that should be taken into consideration when designing tolerances on dimensions and registration of printed circuits are:

- Dimensional changes as a result of processing are considerably greater with a phenolic-paper laminate than an epoxy-glass laminate.
- Dimensional changes as a result of processing a phenolic-paper laminate are considerably greater in the crosswise direction of the material than the lengthwise direction.
- Dimensional changes occur on a phenolic-paper laminate as a result of removing copper during the etching operation. This change occurs even though a room temperature etching solution may be used.

From these three points, it is apparent that, for the ultimate in tolerances on dimensions and registration, an epoxy-glass laminate should be used. In many cases, however, when highest physical properties are not necessary, economy dictates the use of a phenolic-paper, XXXP type, material. In order to obtain best results with a XXXP material, as far as accuracy of registration is concerned, it is suggested that all machining be performed prior to etching. If tolerances on machined or punched dimensions are paramount, then hole fabrication should be performed at room temperature as a final process operation, and critical dimensions should be located in the lengthwise direction of the material.

Processing operations affect the electrical properties, particularly insulation resistance of a laminate. Insulation resistance is materially deteriorated (Tab. 3) by improper rinsing after etching. The important point to stress is that any residual etching solution must be thoroughly rinsed off immediately after removal from the etching tank.

Investigation of the effect of dip soldering on the properties of phenolic-paper and epoxy-glass laminates show that there is no appreciable effect on the physical and electrical properties of the laminate.

Any new printed circuit material should be evaluated from both a processing and environmental standpoint. Consideration must be given to not only what happens to a material under various temperature and humidity conditions, but also what happens under various process operations to which the material is subjected.

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CIRCLE 37 ON READER-SERVICE CARD

Using Transistors In Demodulator Circuits

Part 2

Albert N. DeSautels

Minneapolis-Honeywell Regulator Co.
Minneapolis, Minn.

Part 1 of this two-part series discussed half-wave and full-wave phase discriminators using transistors.

This article analyzes operating characteristics, power considerations and limitations.

TRANSISTORS, when used as phase discriminators, display some of the characteristics of both switching and Class B operation. As a discriminator, the npn transistor conducts when both the base and the collector are positive. This condition occurs during one half-cycle. During the negative half-cycle, the transistor is cut off. Fig. 1 shows part of a phase-discriminator circuit.

The reference voltage, which provides the collector voltage, varies sinusoidally and is equal to $V_R \sin \omega t$. For a given load, the load line superimposed on the transistor common emitter collector characteristics (Fig. 2) will be a series of lines with constant slope; however, perpendicular distance to the origin will be related to the

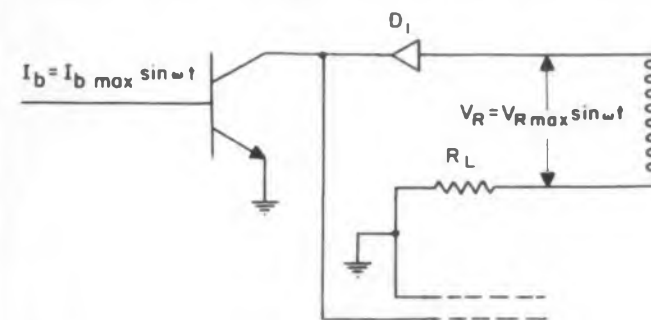


Fig. 1. Basic phase-discriminator circuit used to determine operating characteristics.

sinusoidally varying reference voltage V_R . In other words, the load line will be a series of instantaneous load lines.

For example, taking $V_{R\max} = 41.5$ v and $R_L = 1$ kilohm (neglecting, for convenience, the diode drop): 30 deg after start of the cycle, $V_R = 20.7$ v and the load line intersects the x and y axes at 20.7 ma and 20.7 v respectively; 60 deg after start of the cycle, $V_R = 35.9$ v and the load line intersects the x and y axes at 35.9 ma and 35.9 v.

The input current I_b is sinusoidal and equals $I_{b\max} \sin \omega t$. This indicates that at the start of the transistor's conducting half-cycle, $V_R = I_b = I_c = V_c = 0$.

Referring again to Fig. 2, $I_b = V_c = I_c = 0$ at the start of the cycle; therefore, the start of the ac load line will be at the origin. As the driving current I_b increases sinusoidally, the various time values of current will progress along a line comprising intersections with load lines related to corresponding time values of reference voltage. This line will terminate where the base current associated with the peak value of the base current drive intersects the load line related to the peak value of the reference voltage.

A separate line would be obtained for different

peak values of driving current. If the current gain were constant for all values of driving current, a family of straight lines radiating from the origin would be obtained. However, since current gain decreases at large signals, the response lines related to large-amplitude drive will be nonlinear, as shown by curves C, D, and E.

The transistor operates in the discriminator circuitry in a manner which enables it to handle load power well in excess of maximum effective collector dissipation ratings. The primary power output limiting consideration appears to be the maximum current and voltage rating of the transistor insofar as these ratings contribute to the maximum collector dissipation rating.

As an example of effective power dissipation per transistor, take a value of reference voltage, $V_R = 30$ v rms and $R_L = 1$ kilohm. The transistor conducts for one-half cycle and is cut off for the other half-cycle. For an effective differential or load current of 20 milliamperes for the full-wave discriminator, the current furnished by each transistor during its conducting half-cycle would be 20 ma effective or a peak current of 28.28 ma. During the conducting half-cycle,

(Continued on following page)

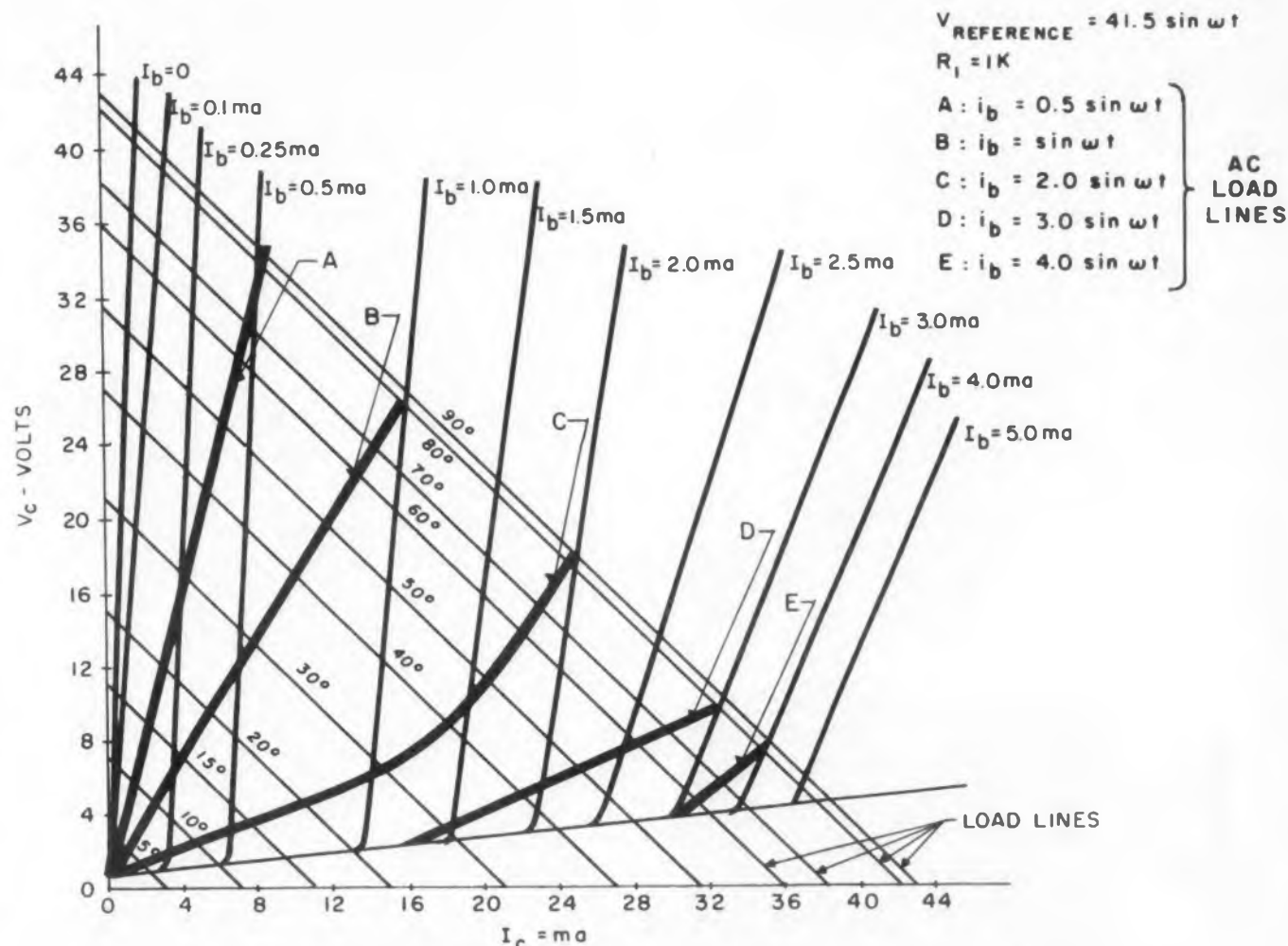


Fig. 2. Characteristics of a common emitter transistor as a half-wave discriminator.

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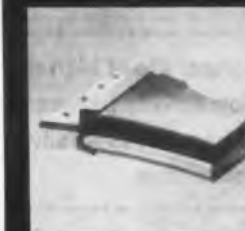
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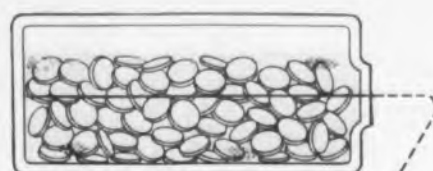
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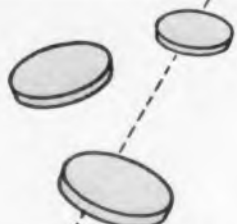
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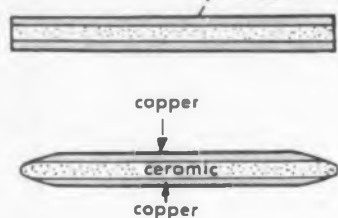
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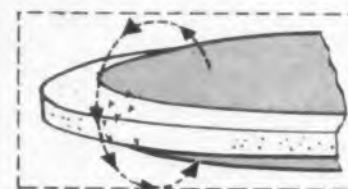
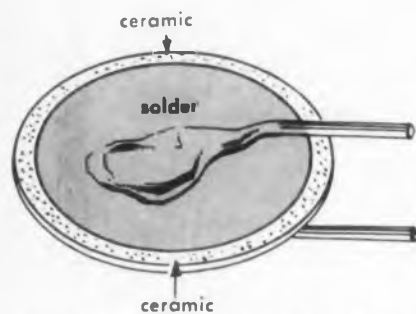
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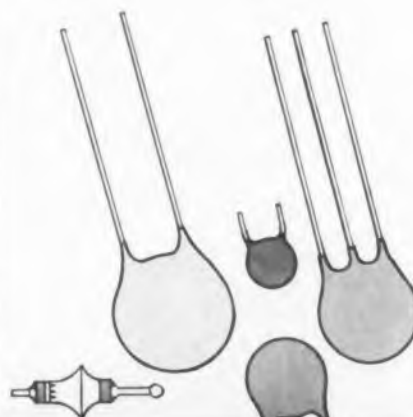
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therefore, there would be dissipated in the transistor an effective power equal to the product of the effective current and the rms collector voltage V_c where $V_c = V_{ref} rms - V_{diode} - I_{L,eff} R_L$. Considering $V_{diode} = 1$ v for this example, $V = 30 - 1 - (0.020)(1000) = 9$ vrms; and the effective transistor power dissipated during the conducting half-cycle $P_{T,eff} = (0.020)(9) = 180$ mw. Averaging over a full cycle produces for the transistor an effective dissipation of 90 milliwatts. The peak power dissipated in the transistor would equal $(\sqrt{2} I_{eff} \times \sqrt{2} V_c) = 360$ mw for an output power per transistor of $\frac{(0.02)^2 (1000)}{2}$ or 200 mw.

Thus, the following relationship between effective power dissipated in the transistor over one full cycle and the effective load current can be stated for the full-wave discriminator.

$$P_T = \frac{I_L (V_R - V_D - I_L R_L)}{2} = \frac{P_{pk}}{4} = \frac{1}{2} \left(\frac{I_{L,pk}}{\sqrt{2}} \right) \left(\frac{V_{c,pk}}{\sqrt{2}} \right) \quad (1)$$

where

I_L = effective differential or load current

V_R = rms reference volts

V_D = forward diode drop

R_L = load resistance

P_T = effective dissipation per transistor averaged over a full cycle

P_{pk} = peak power dissipated per transistor during conducting half-cycle

$I_{L,pk}$ = peak load current during conducting half-cycle

$V_{c,pk}$ = peak collector voltage during conducting half-cycle

Analysis of Equation (1) brings out that:

1. For increased load powers (i.e., increasing I_L and R_L and V_R constant, or increasing R_L with I_L and V_R constant), there is lower transistor dissipation;
2. For a given reference voltage and load resistance, maximum transistor dissipation will occur at a load current value approximately midway between the maximum and minimum possible load current values.

Rearranging Equation (1) in quadratic form and solving for I_L produces

$$I_L = \frac{(V_R - V_D) \pm \sqrt{(V_R - V_D)^2 - 8 P_T R_L}}{2 R_L} \quad (2)$$

Assuming V_D to be negligible simplifies Equation (2) to

$$I_L = \frac{V_R \pm \sqrt{V_R^2 - 8 P_T R_L}}{2 R_L} \quad (3)$$

Equation (3) shows that for a given load resistance and reference voltage, maximum transistor dissipation will occur when the term under

the radical equals zero or

$$V_R^2 = 8 P_T R_L \quad (4)$$

Equation (3) also indicates that the effective load current related to this maximum dissipation point is

$$I_L = \frac{V_R}{2R_L} \quad (5)$$

Solving Equation (4) for P_T brings out that the value of the maximum transistor dissipation can be determined quickly for any combination of values for V_R and R_L . Use of Equation (5) will establish the load current at which the maximum transistor dissipation will occur.

For most efficient operation of the discriminator with three-terminal or split load, it is essential that the input signal be in phase or 180 deg out of phase with and at the same frequency as the power supply. If the input signal were at some other frequency or at some other intermediate phase angle with respect to the power input, then there would tend to be current flowing in both arms of the load at the same time. Since it is the difference between the two arm currents which is utilized, it is obvious that, with respect to a given signal amplitude, currents flowing in both arms will result in less differential than current flowing in just one arm.

Using diode-controlled base bias, the temperature stability of the transistorized discriminator has been found to be extremely good. Using silicon transistors can result in essentially constant gain from -55 to 125 C.

The units described can operate with as low as 10 mv of signal and produce output currents limited only by the current rating of the transistors.

The full-wave unit is found to be a high-sensitivity, temperature-stable device capable of utilization in automatic control systems and a variety of other control applications. Conversion of the full-wave discriminator with three-terminal (or split) load to two-terminal load results in a considerable loss of useful power due to use of bleeder resistors which dissipate 5/6 of the total power output. However, a respectable useful power output can be obtained with the two-terminal load depending upon the maximum ratings of the transistors. The manner in which the transistor is operating in the full-wave circuitry permits power outputs many times the maximum effective power dissipated per transistor.

References

1. Decker, R. O., "Transistor Demodulator for High-Performance Mag-Amps," Technical Paper 55-67, 1955 AIEE Winter General Meeting.
2. DeSautels, A. N., "Transistorized Phase Discriminators," Technical Paper 57-31, 1957 AIEE Winter General Meeting.

MICROWAVE AND SPECIAL TUBE NEWS

from SYLVANIA

Counter Tubes Set Life Records

Field experience indicates a minimum life expectancy of 10,000 hours and a capability of 20,000 hours for Sylvania counter tubes



Quality Control inspector examines destructive life test tubes, the oldest of which has been counting continuously since July 2, 1955—a total of over 21,000 hours

UNDER ACTUAL operating conditions in the field, Sylvania counter tubes are achieving new records in reliability and life. Field reports show a life of 10,000 hours in a wide range of applications, while Sylvania life tests indicate a capability for continuous operation in excess of 20,000 hours.

These outstanding records of reliability have been achieved because of qualities inherent in the design of these cold cathode tubes, and extremely close control and testing during manufacture. Some of the in-

process steps are: high degree of component treatment at elevated temperatures to remove material impurities and foreign gases; precise control of gas mixture and pressure to assure reliable and repeatable operation; exacting exhaust and sealing techniques to retain cleanliness of parts and gas; 100% test of all electrical parameters; two 100% aging and stand-by tests; and further mechanical, electrical and life testing by the Quality Control department of Sylvania.

Portable Scaler Uses Counter Tubes

Nuclear-Chicago's new d/M-Gauge, a completely portable scaler, makes possible fast, accurate density and moisture measurements directly in the field. The new scaler uses five Sylvania counter tubes that can accumulate up to 99,999 counts. It illustrates how Sylvania counter tubes

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| 6910 | 100 KC | 10 | Duo Decal | 400 V. | 1.2 ma |
| 6476 | 4 KC | 10 | Duo Decal | 400 V. | 0.6 ma |
| 6879 | 5 KC | 3(0,8,9) | 7-pin | 320 V. | 0.8 ma |
| 7155 | 100 KC | 3(0,8,9) | 7-pin | 425 V. | 1.2 ma |



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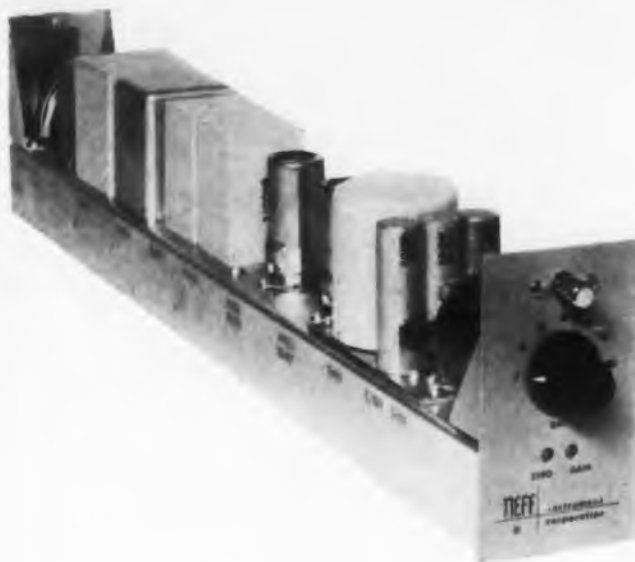
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Neff Unit

The amplifier, developed by the Neff Instrument Corp., 2211 East Foothill Blvd., Pasadena, Calif., is basically a carrier type utilizing an electromechanical chopper as an input modulator. Thus a 400-cycle square wave is produced with an amplitude proportional to the magnitude of the dc input signal.

To achieve isolation, the resultant ac signal is transformer coupled to a four-stage R-C amplifier, and the output is again transformer coupled to two identical ring-demodulators. These demodulators reconstitute two high-level dc signals from the ac output signal.

Since the demodulators are transformer coupled, the final dc outputs are floating. One of the outputs is passed through an output filter into an internal load and presented to the connector without being grounded. The other demodulator output is passed through a feedback filter and

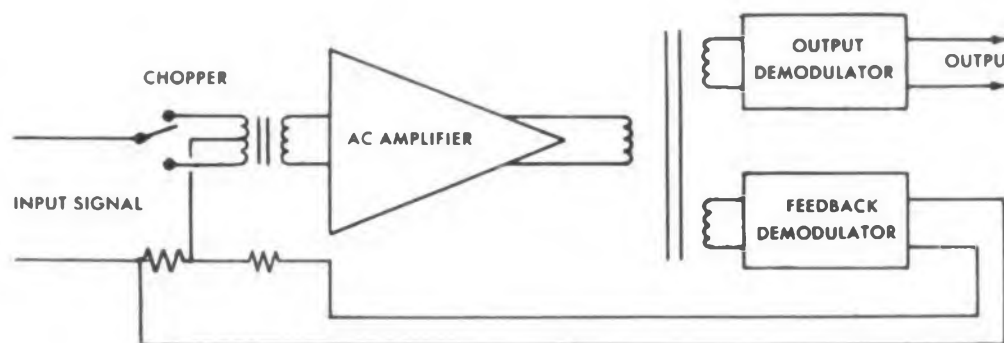
Floating Input and Output DC Amplifiers

attenuator, and is inserted in series with the input signal. Because the feedback signal is isolated from the output signal and the input signal is transformer coupled after being modulated, the input is truly floating.

Over-all feedback is provided from output to input with the exception of the output demodulator, which is identical to the feedback demodulator and consists of wire-wound resistors and low-impedance diodes. These stable components are the only ones outside of the feedback loop, thus assuring maximum stability.

The amplifier accepts inputs of 0-5 mv and produces an output of 0.5 v into a 100-ohm load. Linearity is 0.05% of full scale. Long-term stability is $\pm 0.2\%$ of full scale, and long-term drift is less than $\pm 5 \mu\text{v}$ referred to the input. Noise level is less than $5 \mu\text{v}$ peak-to-peak referred to the input.

For further information on the Neff dc amplifier circle 42 on the Reader-Service card.



Block diagram illustrates the true floating input feature of the new amplifiers, with input and output isolated from each other and from ground.

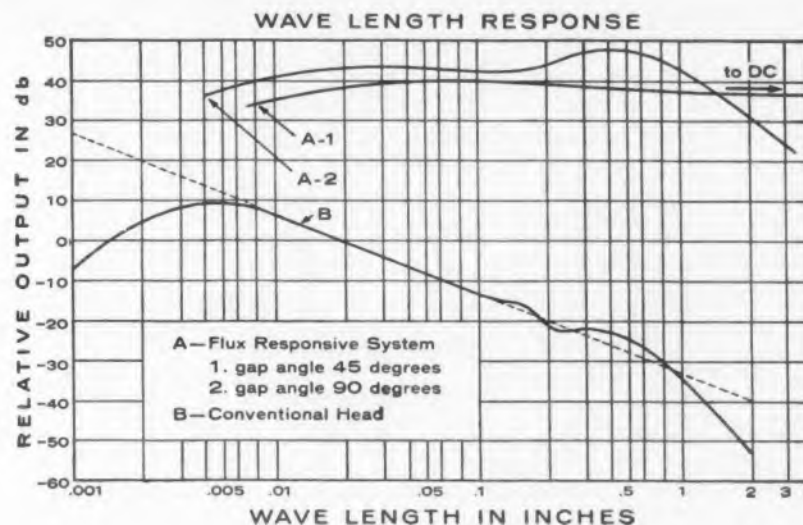
CLEVITE 'BRUSH' Flux-Responsive Magnetic Heads

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Clevite "Brush" Flux-Responsive Heads respond to the magnitude of signal flux instead of the rate of flux change. Output of flux heads is independent of tape or drum speed and, therefore, independent of frequency or pulse repetition rate. The signal reproduced by the flux-responsive head is an accurate facsimile of the recorded flux pattern and of the original recorded information.

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Special flux-responsive heads have been developed by Clevite to meet specific customer applications. They are now commercially available in 1 to 32 channel form in a variety of mechanical configurations. These designs, slightly modified, may fit your present requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.



Typical Clevite multi-channel flux-responsive head, with .032 in. track and .070 in. spacing.

Clevite 'Brush' Flux-Responsive Heads for low speed or static read-out of digital information • reproduction of high frequency analog recording at low tape speeds • extended-period process control • reproduction of low frequency recording • measurement of low angular or low linear velocities and recorded transients • position control

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CIRCLE 44 ON READER-SERVICE CARD

TRUE FLOATING input means the user can amplify minute voltages from thermocouples, strain-gage bridges, and resistance-bridge transducers. The input is isolated to prevent ground loops in thermocouple circuits, and to prevent paralleling active arms of bridge transducers. Two manufacturers are offering similar units. The Neff amplifier described is an early model and latest specs show a greater output.

Kin Tel Unit

The Kin Tel 114A unit includes an output amplifier to isolate the demodulator output from the load. This permits the use of demodulator circuits which are identical insofar as output filter characteristics are concerned, since the output impedance is unaffected by their operation and the output stage furnishes a constant load for the signal demodulator.

To adequately control a diode demodulator more power is required than is necessary to drive the output load. Transistor demodulators are used in this amplifier since considerably less power is required to control them. More important, the use of demodulator filters with similar characteristics allows overshoot to be held within 3 per cent.

The latest Kin Tel units are completely transistorized. Total power consumption is less than 10 w. The use of an emitter-follower transistorized output stage results in an output impedance of less than 1 ohm, as compared to the usual 50 to 60 ohm output impedance. Because of this low value of output impedance it is possible to drive loads of 20 ohms and capacities of 0.5 μ fd with satisfactory results.

The Kin Tel amplifier has an output of 10 v peak at peak output current of 10 ma. Gain is in fixed steps of 10, 30, 100, 300, 1000. There is vernier control of X0.1 to X1 for variation between fixed steps.

Bandwidth is rated at down 3 db at 15 cycles or greater.

For more information on this Kin Tel unit, turn to the Reader-Service card and circle 43.

Pitfalls in Precision AC Measurements

Dr. H. A. Poehler
Section Head
General Precision Lab., Inc.
Pleasantville, N. Y.

Part 2

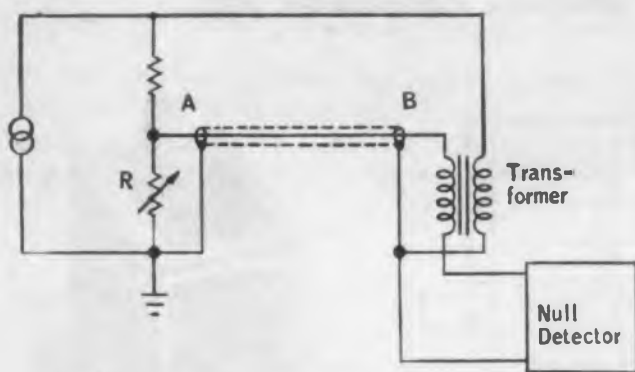


Fig. 1. The circuit illustrates errors introduced by cable capacity and the use of the shield as a conductor.

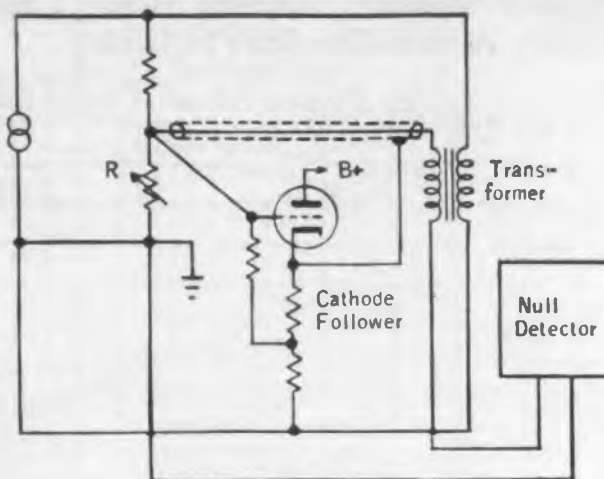


Fig. 2. Cable capacity errors, and the error resulting from the use of a cable shield as a conductor have been eliminated.

All-too-common neglect of the techniques for high precision ac measurements, have often resulted in substantial errors. The first article of this two-part series investigated those errors introduced by ground loops, loading effects, and harmonics in the null. This article discusses three other frequent error sources.

AMONG the common errors encountered in precision measurements are: improper connection of cable shields; calibration at an impedance different from that used in the measurement; and cancellation of errors in systems measurements. These errors are examined here in conjunction with the precautions to be observed for avoiding their appearance.

Improper Connection of Cable Shields

Two errors are often made in connecting cable shields because:

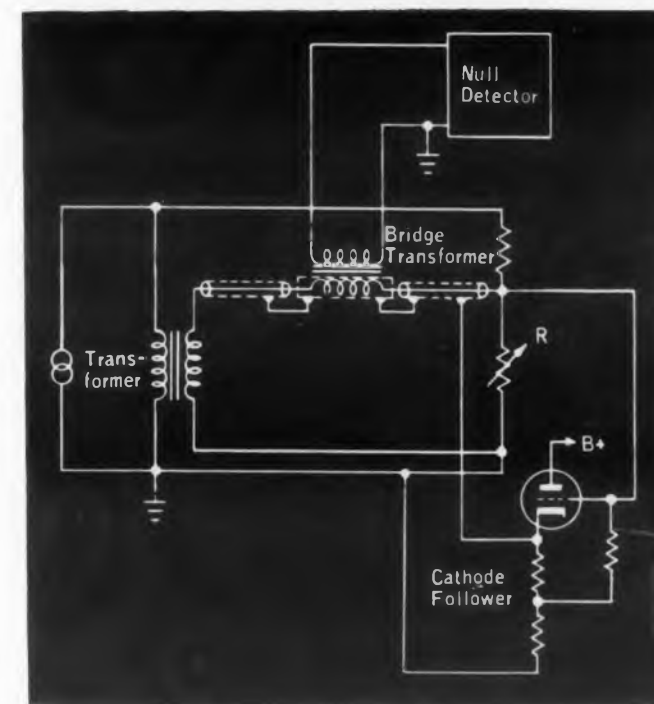
- the cable capacity is not considered as an element in the circuit;
- the cable shield is used as a conductor.

Both errors are illustrated in the circuit of Fig. 1, which is used to measure the transformation ratio of a transformer. Since the transformer is at some distance from the resistance divider, a shielded cable is employed. The cable capacity effectively shunts R and causes the voltage at A to have a lagging phase shift. The capacity of C of the cable cannot be neglected unless the reactance $1/\omega C$ is sufficiently larger than R at the operating frequency.

It is poor practice to ground both ends of a shielded cable in a measuring circuit since cable shields should **not** be intended for use as current-carrying elements. Only one side of the cable should be connected, and the circuit completed by an additional wire.

It was suggested in the previous article, that a disturbing impedance can be eliminated in a measurement circuit by arranging the circuit so

Fig. 3. (below) Bridge method measurement of transformer transformation ratio where capacity loading errors have been eliminated using a cathode follower to drive the shield.



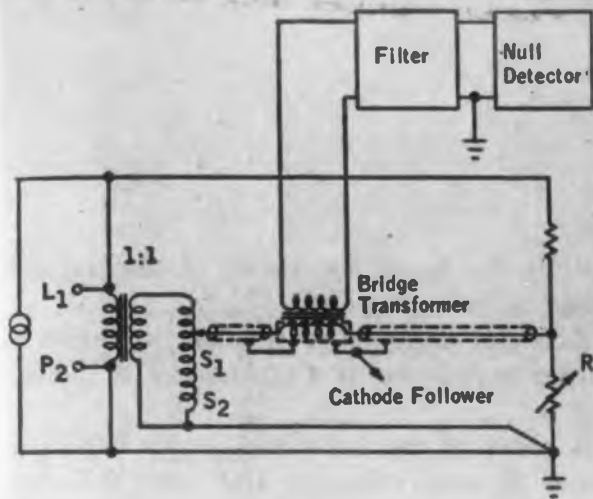


Fig. 4. Errors result from the difference in impedance levels of the calibrating device and tachometer which the circuit is designed to measure.

that the voltage across this impedance is zero at the null.

Excellent application of this principle can be made by using a cathode follower to drive the shield at the potential of the inner conductor as in Fig. 2. The voltage across the cable capacity will be reduced to a very small value, and this capacity can be considered nullified. Moreover, the shield does not serve as a conductor.

The same procedure is often helpful in minimizing the capacitance effects in bridge circuits. Consider the bridge circuit of Fig. 3. With a cathode follower gain of 0.98, the capacitance loading of the bridge transformer, and associated cable shields is reduced to 2 per cent. With high gain and feedback, the capacitance effects can be kept at any desirable low.

Calibration Errors

Since calibration equipment is generally operated at very low impedances, appreciable errors can result when this equipment is used to calibrate a test set that normally operates at a high impedance level.

In Fig. 4 the known voltage of a Gertsch voltage divider (accuracy 0.02 per cent) has been substituted in place of the unknown output voltage of the tachometer. In this case, the calibration equipment has a higher input impedance and a lower output impedance than the tachometer that the circuit is designed to measure. As indicated in Fig. 5 errors arise from:

- the internal resistance R_i of the leads feeding the input terminals L_1 and P_2 of the tachometer;
- the impedance loading of the tachometer out-



VA-210B

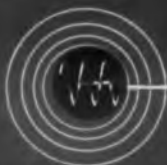
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CIRCLE 46 ON READER-SERVICE CARD

put by the input impedance of the test cable which is connected at S_1 .

A circuit designed to simulate the input and output impedance of a tachometer is shown in Fig. 6.

A check of the impedance errors can be obtained by connecting the 1000 ohm, 0.31 henry impedance branch in shunt at terminals L_1 and P_2 , in Fig. 5, and by connecting the 680 ohm, 0.54 henry impedance in series with the test lead at S_1 . The insertion of either one should not cause any change in the reading. The former measures the series resistance R_i in the lines feeding L_1 and P_2 . In this example, the tachometer draws 100 ma, and as little as 0.01 ohm in the lines leading to L_1 and P_2 will cause a 1 mv error.

The second impedance at S_1 measures the loading effect of the capacity C_c of the measuring lead. In a typical case, a cable capacity of 100 μf has caused as much as a 2 mv error.

Neither of the errors above are apparent in the calibration circuit of Fig. 4, which neglects the difference in the impedance levels.

Experience has shown that test sets which were designed to measure to within 0.5 mv were found to be in error by as much as 6 mv when tested by a method which made allowance for the difference in impedance levels between the measuring and calibrating circuits.

Cancellation of Errors

By accepting component performance in a system as the only criterion for evaluating the com-

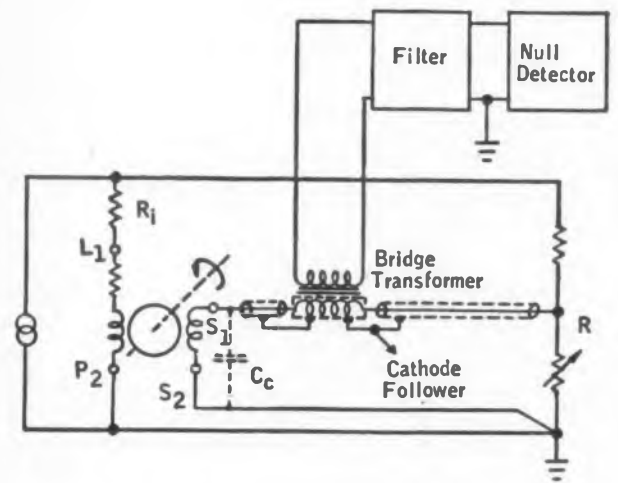


Fig. 5. Errors are produced by resistor R_i and capacitor C_c when calibration is attempted at an impedance level differing from that used in the measurement.

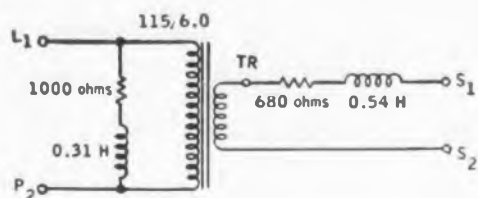


Fig. 6. This circuit simulates the input and output impedance of a tachometer.

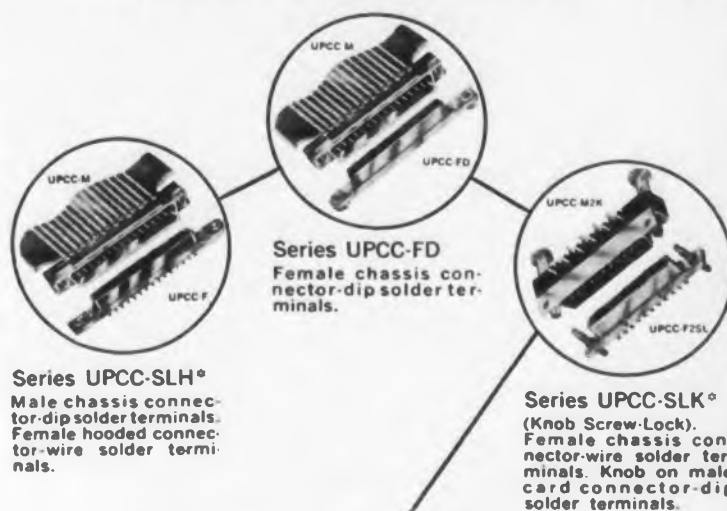
ponent, one may be a victim of error cancellations within the system. Often it is assumed that cancellation of errors is so rare an event that it may safely be neglected. In precision measurements, this assumption is not valid.

A few examples uncovered by the author in certifying the accuracy of vendors' test equipment are cited to point up this potential source of error.

Linearity Measurement of Tachometers: Manufacturer A preferred to measure the performance of his tachometer by observing its behavior in an integrator loop. Careful measurements of linearity repeatedly gave values of less than 0.05 per cent. Measurement of tachometer linearity on a direct basis (not in a loop) gave values of 0.12 per cent. A check of the integrator loop was eventually made and revealed non-linearities in the integrator loop were cancelling tachometer non-linearities. The manufacturer now advertises a linearity of 0.12 per cent.

Loading Errors: The network of Fig. 6 was designed to test the circuit of Fig. 5 for possible loading effects of the test lead. The network is excited at terminals $L_1 - P_2$ and the output is measured at terminals $S_1 - S_2$ using the circuit of Fig. 5. To check for loading errors of the test leads, the output is measured at terminal TR. Any loading error of the test cable will become evident by a difference in reading at terminals TR and S_1 of Fig. 6. No difference was obtained by Manufacturer B in readings at these terminals. However, the existence of a cancelling error was suspected because a presumably identical network gave a different answer. On investigation it developed that the 0.54 henry toroid had just the required magnetic coupling with respect to the 115/6 transformer to supply a voltage equal and opposite to the loading error of the test cable. When the coupling was removed, the loading effect of the test cable was revealed.

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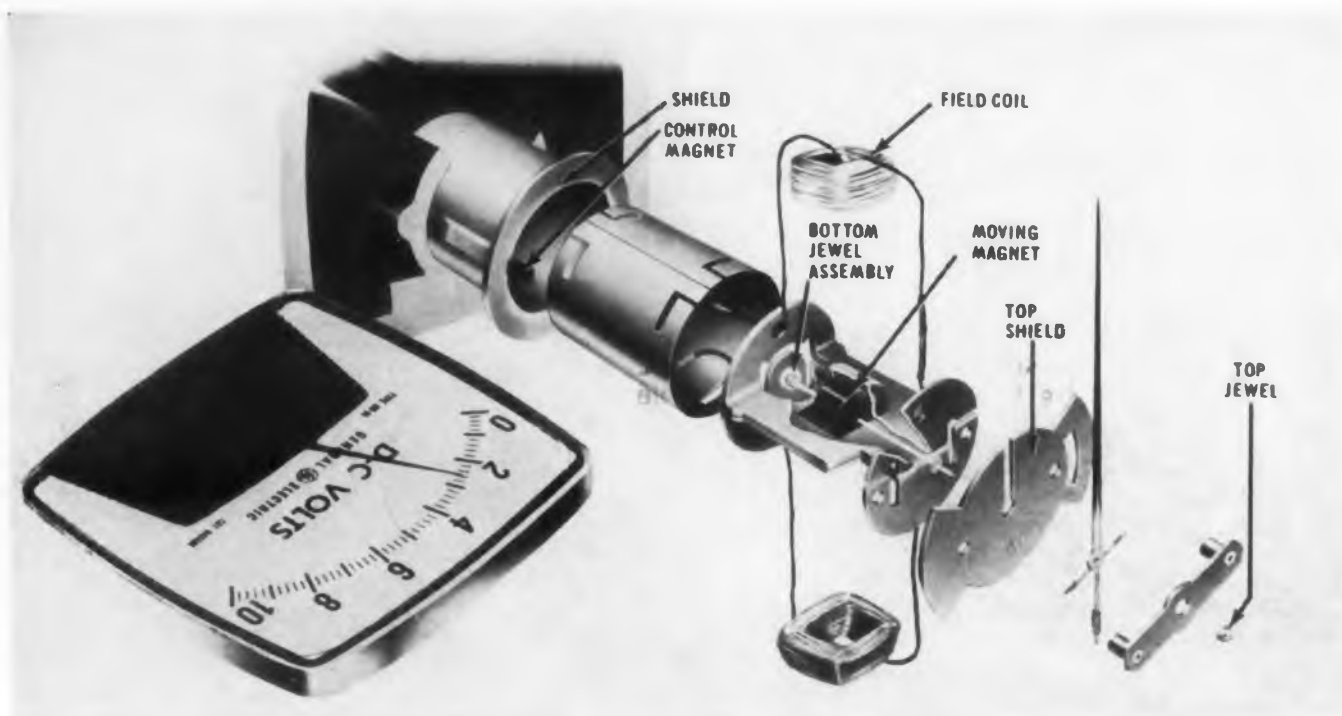


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NEW PRODUCTS

To provide a complete coverage of ALL new products generally specified when designing electronic original equipment, the New Product section has been extended. To include the larger number of items, products which are best suited to a brief description have been noted at the end of the section.



PANEL METERS

Zero set has been eliminated on several dc types of a series of ac and dc panel meters recently made available. Using a moving magnet design, all dc meters with sensitivities below 5 ma are equipped with a control magnet instead of a spring. When no current is passing through the meter, the moving magnet, along with the attached pointer, is aligned by the control magnet at the zero point. Meters with higher sensitivities use the company's standard movement. All the meters in this series feature longer scales, in standard 2-1/2 and 3-1/2 in. sizes, larger numerals, and self-shielding. Accuracy is 2 per cent for all types.

General Electric Co., Instrument Dept., Dept. ED, Schenectady 5, N.Y.

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SAMPLING SWITCH

Less than 15 μ v of total contact noise is achieved in this data sampling switch. Operation is based on the successive depression of metal reeds against a common ring by a freely revolving non-metallic wheel. No wipe is required and there is no motion between the reed and the common ring during the conduction period. Speeds of 3000 contacts per sec and up to 200 contacts per revolution can be provided. Contact arrangement can be either make-before-break or break-before-make.

Genisco, Inc., Dept. ED, 2233 Federal Ave., Los Angeles 64, Calif.

CIRCLE 49 ON READER-SERVICE CARD



TRI-AXIAL ACCELEROMETER

By measuring shock and vibration in three mutually perpendicular directions simultaneously, this accelerometer saves space in tests normally requiring three accelerometers. The standard 400-TX series and miniature 500-TX series employ piezoelectric ceramics in compression for the sensing element. Sensitivities up to 27 mv/g are available to provide an acceleration response from 0.03 to 40,000 g.

Columbia Research Labs., Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

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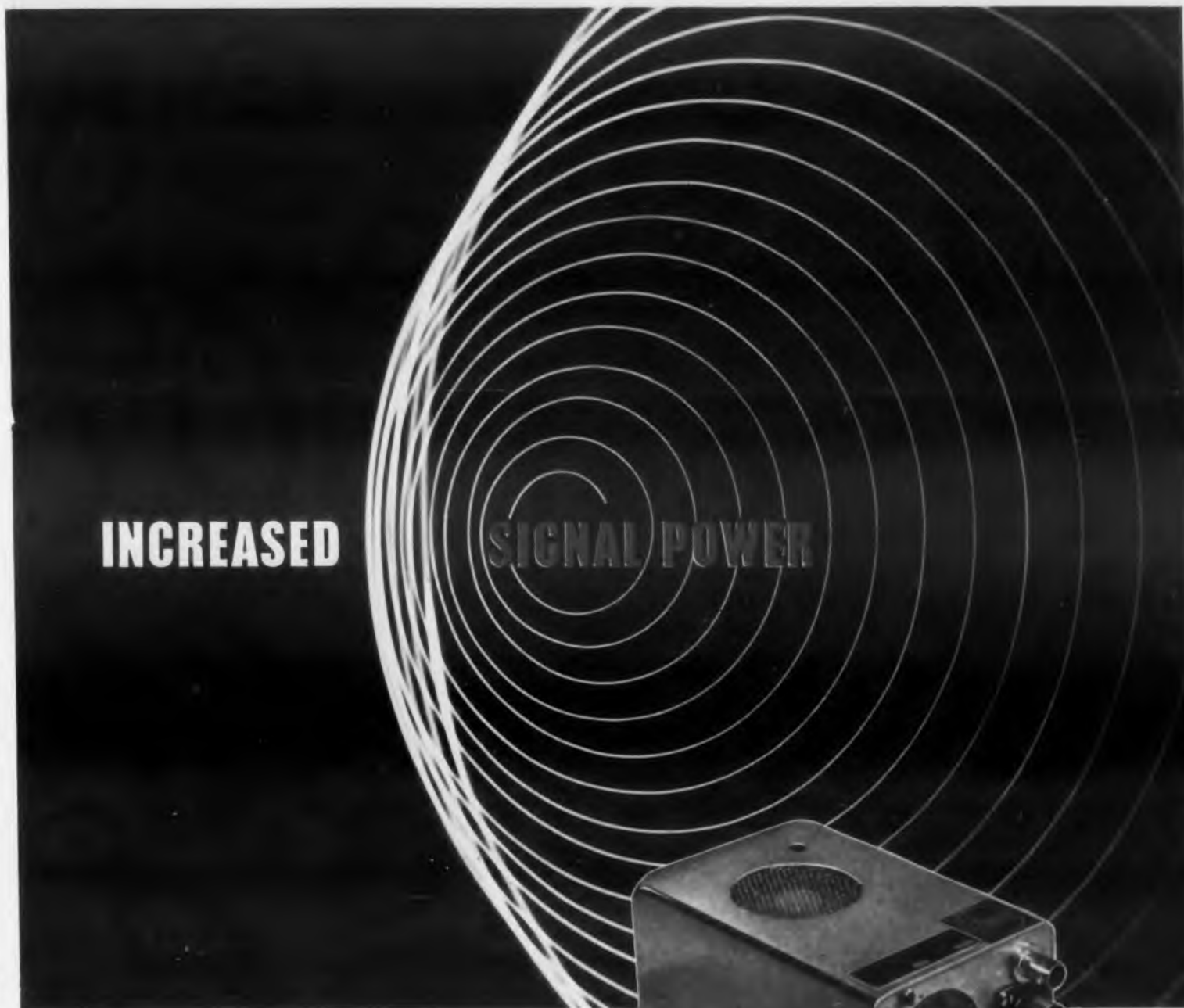


AMPLIFIER

Used to increase the output voltage and power of continuous wave generators and sweep generators, the VS-102A post-amplifier makes possible alignment of amplifier output stages at their true high operating signal level. The unit has a gain of 300, a frequency response of 20 cps to 10 mc and a maximum output of 28 v peak-to-peak. Output impedance is adjustable between 35 and 130 ohms.

Millivac Instruments Div., Cohu Electronics, Inc., Dept. ED, P.O. Box 997, Schenectady, N.Y.

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For further information please contact Rheem Electronics marketing department direct.



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Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 54 ON READER-SERVICE CARD

X-Band Magnetrons

For short range doppler radars



The MA-213 series of fixed-tuned magnetrons are lightweight, integral magnet tubes which are particularly useful in short range pulsed doppler radars. The MA-213

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series may be used as cw local oscillators when a high degree of frequency stability is unnecessary. In such applications the new tubes normally replace klystrons which operate at lower operating efficiency.

Typical pulsed rf output power is 5 w or 1 w cw, with a 450-500 v anode supply. Six frequency ranges from 8800 to 10,000 mc are available. A UG-40 A/U choke flange terminates the waveguide output. Approximate weight of the MA-213 units is 14 oz.

Microwave Associates, Inc., Dept. ED, Burlington, Mass.

CIRCLE 55 ON READER-SERVICE CARD

Magnetic Amplifier

Low error instrument type



These amplifiers for instruments and automatic controls have initial standoff errors of less than about one part in twenty thousand of full power output. The units operate directly from 115 v 60 cps line and require no bias or compensating supply. Fluctuations in operating conditions change null by less than about two parts in ten thousand of full power output. This precision and stability is obtained by using a push-pull magnetic amplifier with the two half amplifiers in each pair accurately matched to each other. Such units amplify polarity-reversible dc and low-frequency signals from thermocouples, strain gauges, and similar low-impedance sources. The amplifiers have linear response to at least ± 7.5 dc v output into 1000-ohm loads.

Airpax Products Co., Dept. ED, Middle River, Baltimore 20, Md.

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Micro Gee Products, Inc., Dept. ED, 6319 W. Slauson Ave., Culver City, Calif.

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Connectors

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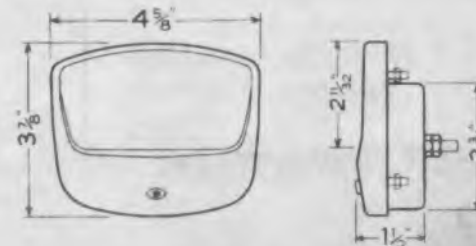


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NEW PRODUCTS

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Transistor application



These miniature transformers are designed for transistor application, including transformers for interstate, driver and output service.

James Vibrapowr Co., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

CIRCLE 62 ON READER-SERVICE CARD

Half Loop Antenna

Horizontally polarized type



Type DM N4-2 electrically balanced loop antenna is designed for use with AN/ARN-14 equipments. The antenna may be installed on the vertical tail or the sides of an aircraft fuselage to provide substantially omnidirectional sensitivity to horizontally polarized radiation in the band of 108 to 122 mc. A high degree of discrimination against vertically polarized signals is achieved assuring more accurate bearing information. The loop shells are of welded steel construction. The center gap is supported with a heavy wall fiberglass tube, and all internal spaces are foam-filled to exclude moisture. This type meets the environmental requirements of MIL-T-5422C and is capable of withstanding severe ice loads. Weight is approximately 2 lb 3 oz.

Dorne & Margolin, Inc., Dept. ED, 29 New York Ave., Westbury, N.Y.

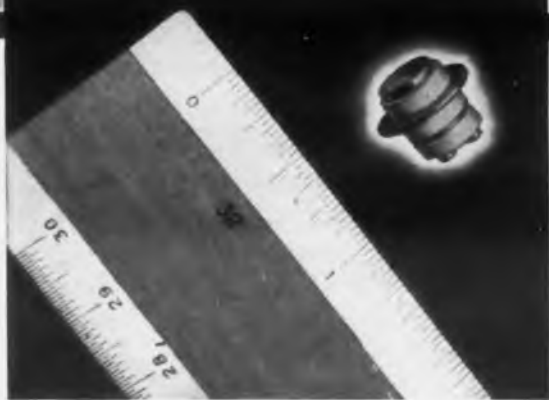
CIRCLE 63 ON READER-SERVICE CARD



CERAMIC TUBES MEAN GENERAL ELECTRIC!

A G-E technician is weighing the ceramic spacers of the 7077 triode before firing, to check their density—one of a whole series of special methods developed by General Electric to make practical the use...in tubes...of tough, heat-resistant ceramics.

NEW G-E MILITARY



SHOWN ACTUAL SIZE. The 7077 is so small (only .44" long and .48" wide) that the tube can be used in compact circuitry or miniaturized equipment.

◀ Advanced UHF systems had critical need for this tube in radar, communications, navigation. General Electric designed and built it.



CATHODE ASSEMBLY BY MICROSCOPE! The G-E production worker above is welding the nickel cap on a tantalum cathode sleeve only 1/10 inch in diameter. Note the white Dacron lint-free dress and rubber finger cots! These help protect 7077's from dust and lint—the most common causes of short-circuits.






ONLY ITS COUNTERPARTS CAN NOISE-TEST A 7077! Evidence of Type 7077's low-noise, high-gain performance, is the use of five more of these General Electric triodes in a specially-developed multi-stage test amplifier that provides 90 db total gain. *Every 7077 built* receives this noise test!

7077 TRIODE TOPS ALL TUBES IN UHF-AMPLIFIER ADVANTAGES!

- High gain: 14.5 db
- Low noise: 5.5 db
- Low capacitance
- Low inductance
- Low power input
- Light weight
- Small size
- Ceramic ruggedness

This low-price tube is in regular production *now*. Compare the 7077 with other tubes A and B, which you can obtain for efficient high-gain, low-noise amplifier service at 450 megacycles! (See chart at right)

| | 7077 | Tube "A" | Tube "B" |
|---------------|---|---|---|
| PRICE | \$\$ | \$\$\$\$\$ | \$\$\$\$\$\$ |
| RELATIVE SIZE |  |  |  |
| WEIGHT | 1.6 grams | 4.5 grams | 23 grams |
| POWER INPUT | 2.5 watts | 4.2 watts | 13.4 watts |

No tube like this existed. The industry asked for a UHF amplifier tube for new and critical military applications in radar, communication, and navigation systems. General Electric creative design took it from there. Working with a list of "musts"—such as small size, light weight, top performance, and initial and operating economy—General Electric tube engineers developed new materials and processes that made possible new design approaches.

Now the 7077 is ready—electrically, mechanically and life-tested—coming from a factory in volume production. It meets full design specifications for performance. The 7077 is built for rugged operation up to 100,000 feet altitude, and up to 300 C envelope temperature. No forced-air cooling is required.

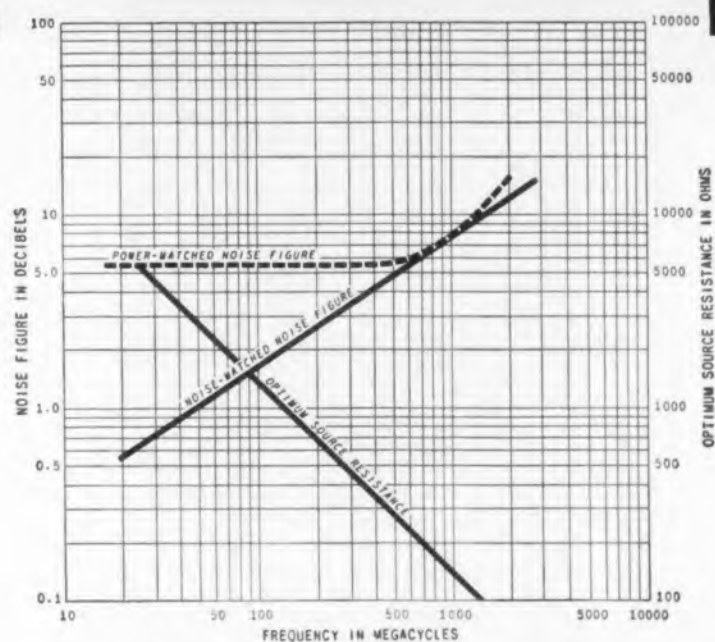
Phone your nearest General Electric Receiving Tube Department office listed below for further information about this newest, smallest, best-performing UHF triode...including the low price.

| EASTERN REGION | CENTRAL REGION | WESTERN REGION |
|------------------------------|------------------------|------------------------|
| 200 Main Ave., Clifton, N.J. | 3800 N. Milwaukee Ave. | 11840 W. Olympic Blvd. |
| Phones: | Chicago 41, Illinois | Los Angeles 64, Cal. |
| (Clifton) GRegory 3-6387 | Phone: SPring 7-1600 | Phones: GRanite 9-7765 |
| (N.Y.C.) WI. 7-4065, 6, 7, 8 | | BRadshaw 2-8566 |

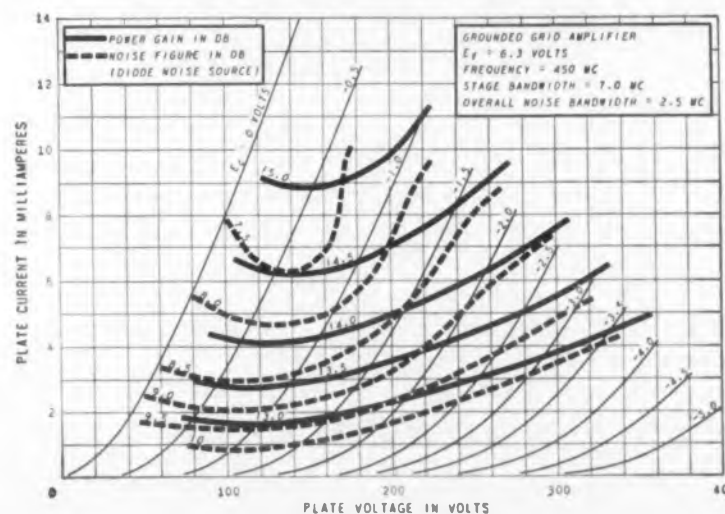
Progress Is Our Most Important Product

GENERAL  ELECTRIC

12-11-203



Wide range of 7077 performance, 30 to 1,000 mc, is shown by the noise figures above, under power-matched and noise-matched conditions, using an argon noise source. Noise contours are similar to those below with a diode noise source. Contours below plot noise figure and gain for 450 megacycles at various tube operating points.



CIRCLE 64 ON READER-SERVICE CARD

Speed Control

Detects multiple speeds

Up to eight separate speed sensing switches can be incorporated into a compact housing measuring 5 in. in diam x 4 in. deep. The multi-speed switch is particularly suited for control of multiple speeds on machine tools, control of inter-related speeds in automated systems, and synchronization of separate drives.

Torq Engineered Products, Inc., Dept. ED, 32 W. Monroe St., Bedford, Ohio.

CIRCLE 65 ON READER-SERVICE CARD

Computer Translator

Adapts different type computers



Rapid interchange of data is made possible between different types of computers and data processing equipment by means of this computer language translator model ZA-100. Magnetic tapes recorded in the format of one computer can be translated and recorded on another magnetic tape directly useable by a different computer. The computer translator can also convert punched cards or punched paper tape to magnetic tape. Data recorded on magnetic tape can be converted to punched cards, paper tape, or line printer. The needs of a particular system are met by providing the proper combination of available modules. Internal parity checking, marginal checking, and error control features are provided throughout the system. The equipment is available on outright purchase and lease.

Electronic Engineering Co. of California, Sales Dept., Dept. ED, 1601 East Chestnut, Santa Ana, Calif.

CIRCLE 66 ON READER-SERVICE CARD



Capacitors

Life expectancy of
1000 operations

NRG-200 series of fast discharge, energy-storage capacitors for thermonuclear equipment and similar applications, have a life expectancy of 1000 operations. They can be discharged into a very low-impedance load with complete safety and can be operated at ambient temperatures up to 40 C. Maximum permissible reversal voltage is 90 per cent.

Tobe Deutschmann Corp., Dept. ED, Providence Hwy., Norwood, Mass.

CIRCLE 67 ON READER-SERVICE CARD

Connectors

Eliminates turning or twisting



To connect unit, index the pins and push on. A click assures you that unit is connected. To disconnect, pull an actuating ring. Connector adapts to AN3100, 3101 and 3102 receptacle and AN3106 and 3108 plug in types A, C and E.

E. B. Wiggins Oil Tool Co., Inc., Dept. ED, 3424 E. Olympic Blvd., Los Angeles 23, Calif.

CIRCLE 68 ON READER-SERVICE CARD

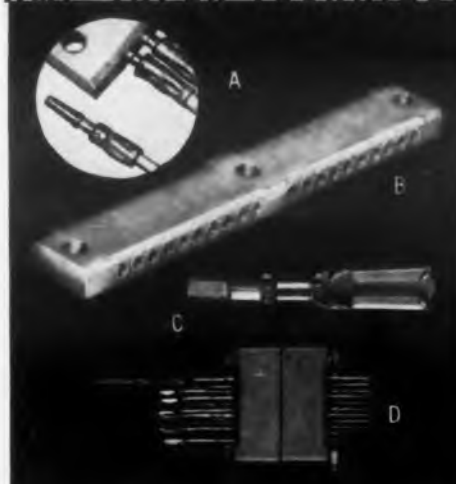
Silicon Rectifiers

Peak inverse ratings of 100 to 400 v

One of the two families of diffused junction industrial silicon power rectifiers, the pigtail version, 1N1569 through 1N1572, carries peak inverse ratings of 100 through 400 v respectively. This family is rated at 1 a dc at room ambient temperatures and has high 70 a surge rating. The

FOR BETTER WIRE TERMINATING

AMP TAPER TECHNIQUE



(A) A-MP "53" SERIES TAPER PINS

...insulated solid, screw machined or uninsulated formed pins to mate with tapered receptacles. Both types provide noise-free, low resistance electrical characteristics.

(B) A-MP "53" SERIES TAPER BLOCKS

... are available in either solid blocks or two piece blocks ... 10 or 20 cavity series ... single or dual insert.

(C) A-MP TAPER TAB RECEPTACLES

... accommodate flat tabs employing the taper key principle ... feature standardized tapered section to fit relays, stepping switches, multiple connectors and other electronic components.

(D) A-MP MINIATURE TAPER PIN RECEPTACLES

... eliminate tedious and costly operations of soldering leads to miniature connectors ... use A-MP "37" Series Pins.

Bulletin Number 77

AMP PATCHBOARD TECHNIQUE



A-MP PATCHCORD PROGRAMMING

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

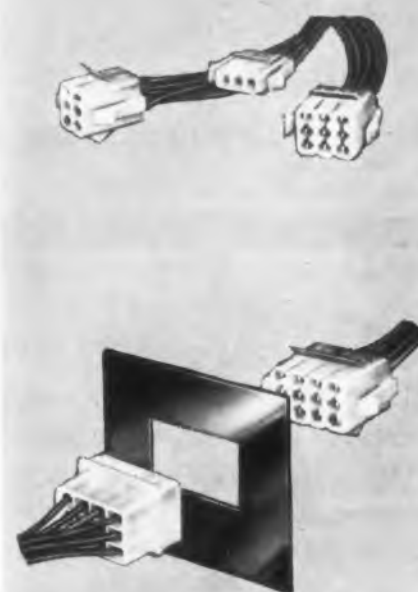
A-MP "240" SYSTEMS ... offer complete reprogramming in seconds in airborne applications. The compact "240" System weighs 3¼ pounds and features 240 patchcord receptacles for maximum program combinations. It, too, features the exclusive wiping action to assure optimum electrical contact at all times.

Bulletin Number 58

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

AMP

AMP-Lok MULTIPLE CONNECTORS



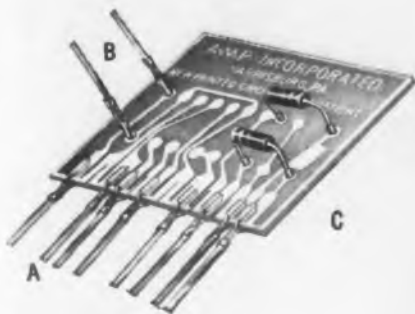
AMP-LOK CONNECTORS ... are made in 3, 6, 9, or 12 circuit units ... the most versatile multiple connectors available to the electronics industry. Self anchoring units require no extra mounting parts for through-panel applications. All contacts are identical and self cleaning ... recessed for safety.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

Bulletin Number 45

AMP INCORPORATED
GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

TECHNIQUES . . . SPECIFY **A-MP**

PRINTED CIRCUIT TECHNIQUE



(A) **AMP-EDGE TERMINALS** . . . assure excellent electrical contact with friction grippage and positive wiping action . . . apply easily to any section of the perimeter of the printed circuit board . . . reduce cost of application to wire conductor and to board.

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

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

Bulletin Number 81

SHIELDED WIRE PRODUCTS



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

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

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

Bulletin Number 24

TERMINALS AND SPLICES



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

(B) **CERTI-SEAL MOISTURE PROOF WINDOW SPLICES** . . . seal out vapors and fluids even at altitude to assure dry splice . . . accommodate over 100 insulation thicknesses . . . resist heavy vibration and shock.

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

Bulletin Number 37

stud mounted version, 1N1575 through 1N1578, has peak inverse ratings of 100 through 400 v respectively. This family is rated for 3.5 a dc at room ambient and also carries the high surge rating of 70 a.

Motorola, Inc., Semiconductor Products Div., Dept. ED, 4501 Augusta Blvd., Chicago 51, Ill.

CIRCLE 70 ON READER-SERVICE CARD

Potentiometers

Only 1/4 in. diam by 11/32 in. long



These microminiature trimmer potentiometers are available as the model MS-1 for stud mounting and as the model MS-2 for lead mounting on printed wiring boards using 0.1 in. grid spacing. Rated at 1/4 w, these units measure 1/4 in. diam by less than 11/32 in. in body length. The units weigh only 0.03 oz.

Miniature Electronic Components Corp., Dept. ED, Plymouth St., Holbrook, Mass.

CIRCLE 71 ON READER-SERVICE CARD



AC Millivoltmeter

300 μ v to 1 kc

MV-32A ac vacuum tube voltmeter employs vacuum thermo-couple as its rms-responsive meter-rectifier. Accuracy within the basic frequency range of the instrument (50 cps-5 kc) is better than 1/2 per cent, at other frequencies 2 per cent. Total frequency range is 10 cps to 500 kc and total voltage range from 300 μ v to 1 kv. Calibrator accuracy is 0.1 per cent.

Millivac Instruments, Div. of Coahu Electronics, Inc., Dept. ED, 2315 Second Ave., Carman, Schenectady 3, N.Y.

CIRCLE 453 ON READER-SERVICE CARD

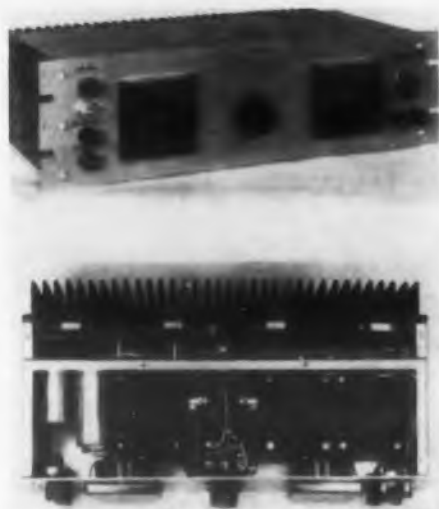
A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

CIRCLE 69 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply

Rated from 0 to 5 a



Model HC-4 5-a power supply is designed for 105-135 v ac input, 60 cps. Line regulation is within ± 0.2 per cent. Load regulation is within ± 0.2 per cent (10 per cent to 100 per cent FL). Ripple is less than 0.1 per cent or 15 mv.

Semcon, Dept. ED, 262 E. 16th St., Paterson 4, N.J.

CIRCLE 72 ON READER-SERVICE CARD

Relays

Weight but a fraction of an ounce



Designated as series R600 (dpdt) and series RS600 (spdt), these micro-miniature relays will withstand shocks of 50 g and vibration up to 2000 cps at 20 g. Contacts are rated at 2 a resistive, 28 v dc or 115 v ac. Continuous operation is possible throughout a temperature range from -65 to $+125$ C. The current-sensitive model requires a nominal operating power of only 135 mw for the single pole version and 200 mw for the double pole. The complete relay weighs but a fraction of an ounce.

Iron Firemen Manufacturing Co., Electronics Div., Dept. ED, 2838 S.E. 9th Ave., Portland 2, Ore.

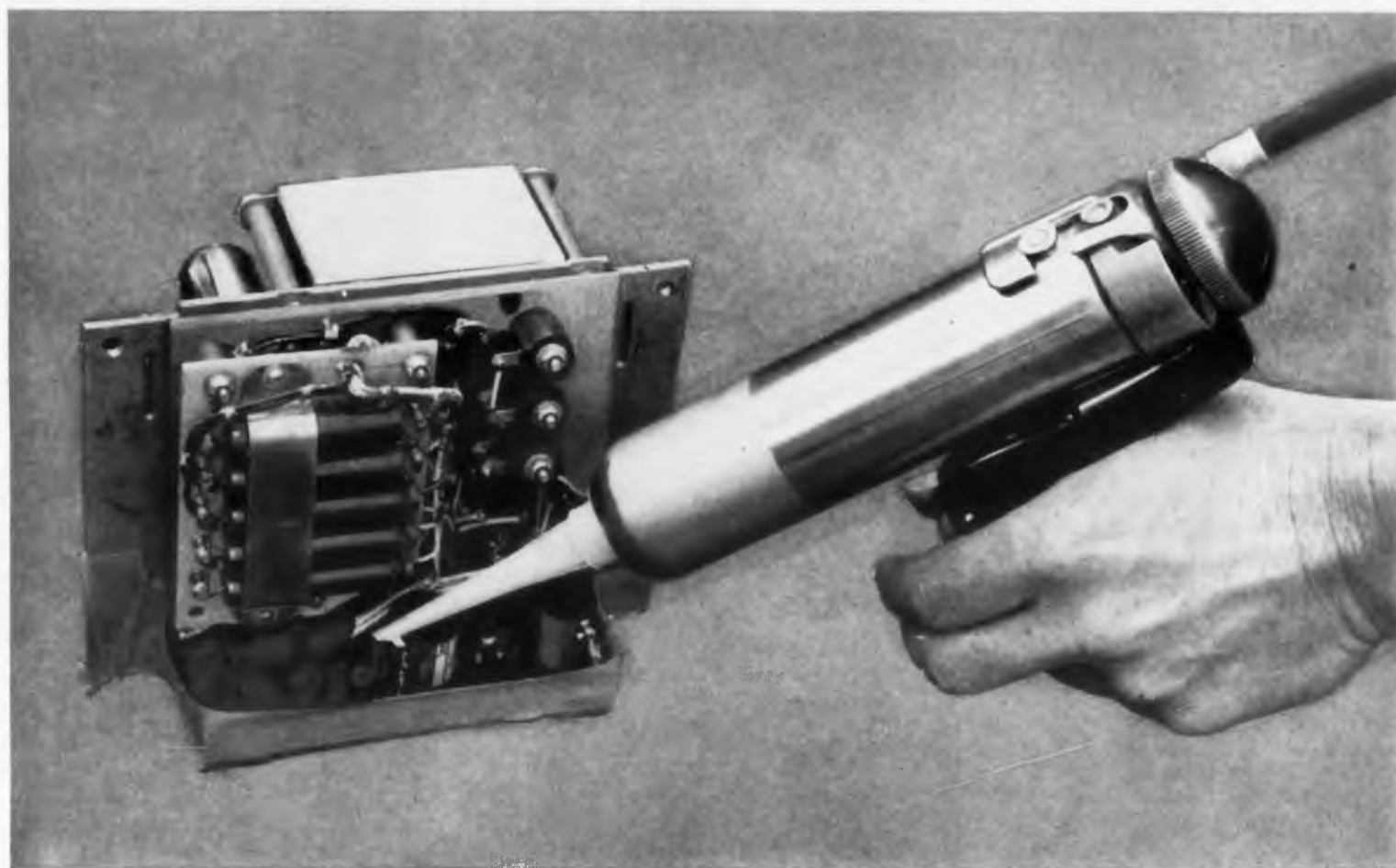
CIRCLE 73 ON READER-SERVICE CARD

Design better products with

SILASTIC RTV

SILICONE RUBBER

... seals and cushions delicate circuits



High impedance circuits in Northrop's Snark missile are coated with Silastic RTV for protection against moisture and vibration at temperature extremes. Silastic RTV is easy to apply . . . vulcanizes at room temperature.

TYPICAL PROPERTIES OF SILASTIC RTV

| | |
|---|----------------------|
| Temperature range, °C . . . | -70 to 260 C |
| Dielectric strength, volts/mil . . . | 300 to 500 |
| Surface resistivity at 50% Relative humidity, ohms . . . | 2.8×10^{13} |
| Dielectric constant, 10^5 cycles per second | 2.5 |
| Dissipation factor, 10^5 cycles per second | 0.003 |

Sensitive electronic components are sealed against moisture and cushioned against vibration with a coating of Silastic* RTV, the Dow Corning silicone rubber. Silastic RTV forms a rubbery silicone solid in 24 hours at room temperature. Stays resilient from -70 to 260 C. This "do-it-yourself" material is used for a wide range of encapsulating, potting and caulking applications. Write for free sample and complete information.

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC.

*T.M. REG. U.S. PAT. OFF.



Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics



Stromberg-Carlson telephone switch insulator

SILICONE-GLASS LAMINATES INCREASE LIFE AND DEPENDABILITY

Laminates made by bonding glass cloth with Dow Corning silicone resins have high arc resistance, low loss factor, low moisture absorption, excellent retention of dielectric properties at high temperatures. Strong, lightweight—produced by leading laminators.

SILICONE FLUIDS PROTECT ASSEMBLIES FROM MOISTURE



Southwestern Industrial Electronics seismographs

A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

SILICONE COMPOUND PREVENTS ARCS, GROUNDS, SHORTS

Nonmelting, nongumming Dow Corning 3 Compound stays in place . . . provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure . . . have a serviceable temperature range of -40 to 205 C. Free sample available.



AN Connector Terminals, Navy Helicopter

Transformer Provided with 90 db shielding



This transformer has a ratio accuracy of 0.01 per cent with a phase angle error not exceeding 2 min. Output voltages range from 7.2 to 230 v, maintained for any condition of loading. In some combinations of loading, currents of over 2 a may be drawn. First tested at 1500 v for dielectric strength, actual breakdown occurred at 3500 to 5000 v rms.

Osborne Electronics Corp., Dept. ED, 712 S. E. Hawthorne Blvd., Portland, Ore.

CIRCLE 75 ON READER-SERVICE CARD

Digital Voltmeter

Range from 0.001 to 1000 v dc



Model 801 is a portable digital voltmeter that measures dc voltages from 0.001 to 1000 v with 0.1 per cent accuracy. Display time is adjustable from 1/10th sec to infinity. Model 801 employs a successive approximation (trial voltage comparison) circuit. Input impedance of the unit is 20,000 ohm per volt.

Kin Tel, Div. of Coahu Electronics, Inc., Dept. ED, 5725 Kearny Villa Rd., Box 623, San Diego, Calif.

CIRCLE 76 ON READER-SERVICE CARD

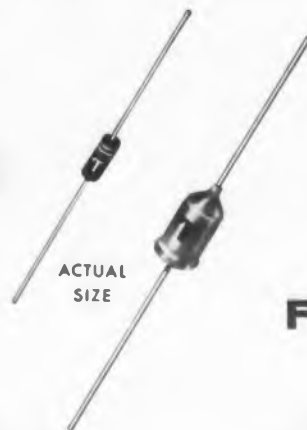
For further information on these products write Dept. 166
CIRCLE 74 ON READER-SERVICE CARD

Transitron

SILICON RECTIFIERS

Big Performance

600 volts • 450ma



IN
SMALL
PACKAGES

Higher voltage and current ratings are now yours in two compact packages. These hermetically sealed axial lead units are easily mounted in terminal or printed board assemblies, offering real design versatility. They are ideal for a wide range of limited-space applications.

Subminiature Glass Types

Transitron's Subminiature Glass Silicon Rectifiers now pack ratings to 600 volts and 400ma (150ma at 150°C). Rugged and reliable at temperatures to 175°C, these units are thoroughly tested under the most severe operating conditions. They give excellent service in subminiature power supplies, D.C. blocking, high voltage series strings and other applications where space is at a premium.

| Type | Peak Recurrent Inverse Operating Voltage (volts) | Maximum Average Forward Current @ 150°C (ma) | Maximum Average Forward Current @ 25°C (ma) | Maximum Inverse Current @ 150°C (ma) |
|-------|--|--|---|--------------------------------------|
| 1N689 | 600 | 150 | 400 | .2 |
| 1N649 | 600 | 150 | 400 | |
| 1N684 | 400 | 150 | 400 | .2 |
| 1N647 | 400 | 150 | 400 | |
| 1N679 | 200 | 150 | 400 | .2 |
| 1N677 | 100 | 150 | 400 | .2 |

Miniature Types

Ratings of 600 volts and 450ma (200ma at 150°C) are now available in the economical Miniature package — constructed without the wide flange that often interferes with compact mounting in printed circuits. These Miniature types serve well in blocking circuits, power supplies, and such critical applications as magnetic amplifiers, where low inverse leakage is essential.

| Type | Peak Recurrent Inverse Operating Voltage (volts) | Maximum Average Forward Current @ 150°C (ma) | Maximum Average Forward Current @ 25°C (ma) | Maximum Inverse Current @ 150°C (ma) |
|-------|--|--|---|--------------------------------------|
| TJ60A | 600 | 200 | 450 | .5 |
| TJ40A | 400 | 200 | 450 | .5 |
| TJ30A | 300 | 200 | 450 | .5 |
| TJ20A | 200 | 200 | 450 | .5 |
| TJ10A | 100 | 200 | 450 | .5 |

SEND FOR BULLETIN TE-1351

Transitron

electronic corporation • wakefield, massachusetts



Transistors



Diodes



Regulators



Rectifiers



T

NEW PRODUCTS

Antenna Selector

Improved model smaller in size



This instrument eliminates the effects of antenna shading in aircraft and makes possible uninterrupted inflight communications by automatically selecting exposed antennas. The S7B antenna selector, shown, is an improvement over the S7A produced early in 1957. The principal changes include an overall size reduction approximating 50 per cent, resulting in a 64 cu-in. model, as compared with a 120 cu-in. first model. This was made possible mainly by the elimination of the need for external shock mounts. An improved connector also results in better environmental capability. The instrument's memory function has been extended to provide improved performance when used in connection with the Tacan navigation system.

North American Aviation, Inc., Autonetics Div., Dept. ED, 9150 E. Imperial Hwy., Downey, Calif.

CIRCLE 78 ON READER-SERVICE CARD

Relay

Measures 0.23 cu in.

This subminiature relay is equipped with a single operating winding and two change-over contacts. It has been designed for operation from a standard 28 v regulated dc supply. Its size, excluding connection pins, is approximately 0.77 x 0.55 x 0.55 in., corresponding to a volume of 0.23 cu in. Weight is 12.5 gram.

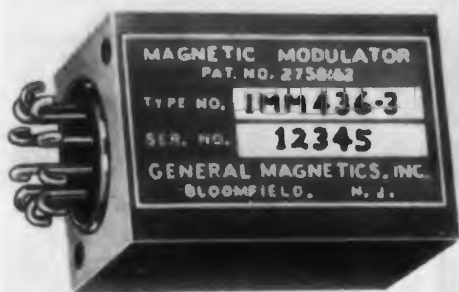
Standard Telephones & Cables, Ltd., Radio Div., Dept. ED, Oakleigh Rd., New Southgate, London, N. 11, Eng.

CIRCLE 79 ON READER-SERVICE CARD

← CIRCLE 77 ON READER-SERVICE CARD

Magnetic Modulators

Low millisecond time constant



The Mag Mod magnetic modulator delivers a phase reversing fundamental frequency amplitude modulated envelope proportional to the polarity and amplitude of an input dc or low frequency signal. Hysteresis amplitude is less than ± 0.5 per cent of full scale signal input. Null or zero drift is less than ± 0.5 per cent for ambient temperature range of -65 to $+135$ C.

General Magnetics, Inc., Dept. ED, 135 Bloomfield Ave., Bloomfield, N.J.

CIRCLE 80 ON READER-SERVICE CARD

Selenium Rectifiers

Rated from 2.5 to 25 ma

Three selenium rectifiers, 50 per cent smaller, are rated at 2.5, 8, and 25 ma. All three models are available in ratings of from 37 to 378 v piv. These rectifiers will operate at temperatures ranging up to 110 C.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

CIRCLE 81 ON READER-SERVICE CARD

Oscillator

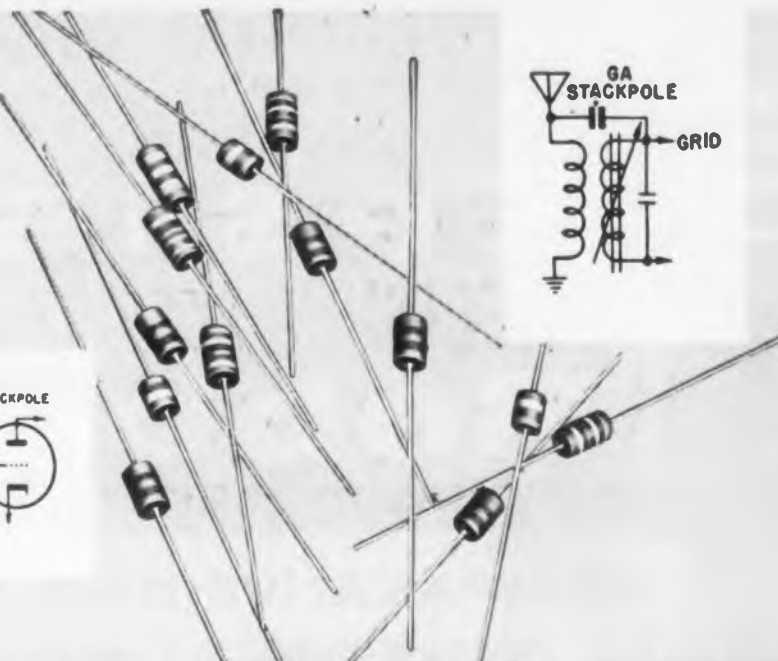
Measures one cubic inch



Model 0-22 voltage-controlled subcarrier telemetering oscillators, little over a one inch cube, draws a total of only 25 mw. One volt gives $7\frac{1}{2}$ per cent frequency change. Input is 1/2 meg and output up to several volts on RDB channels. Resistance to vibration and shock up to 20 g and 2000 cps is specified for most units.

Dorsett Labs., Inc., Dept. ED, 401 E. Boyd St., Box 862, Norman, Okla.

CIRCLE 251 ON READER-SERVICE CARD



CONVENIENT CIRCUIT COUPLING and BYPASSING... with the simplest, most inexpensive capacitor design yet produced

Pioneered by Stackpole, these sturdy little units make ideal low-cost coupling, bypass and neutralizing capacitors for TV, radio and military electronic equipment.

Insulated bodies, dielectrics and electrodes are integrally molded for maximum stability and durability. Securely anchored leads are treated for easy soldering. Ranging in size from

only 0.330" to 0.170" in length, Stackpole GA Capacitors have adequate stability and T.C. characteristics for a host of TV, radio and military electronic equipment uses.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pennsylvania

46 E.I.A.

"preferred" values

0.10 TO 10.0 μf

5%, 10% or 20% tolerances.

Standard 3- or 4-band color code.

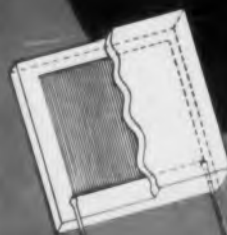


STACKPOLE
"GA"
FIXED COMPOSITION
CAPACITORS

Coldite 70+[®] fixed composition resistors • Snap and Slide Switches • Ceramag[®] ferromagnetic cores • Variable composition resistors • Ceramagnet[®] ceramic magnets • Fixed composition capacitors • Iron cores • Brushes for all rotating electrical equipment • Electrical contacts • Hundreds of related carbon, graphite and metal powder products.

CIRCLE 82 ON READER-SERVICE CARD

CTS



New "Floating" Element

PERMANENTLY STABLE, 100% TESTED Resistors PRECISION WIRE FIXED Bobbinless

FAR EXCEED PROPOSED MIL-R-93B*

Burton Browne Advertising

COMPARATIVE DATA REPORT

Note Exceptional Stability. Note extent that MIL-R-93B is exceeded.

| MIL-R-93B (proposed) Tests | MIL Requirement | CTS Maximum | CTS Average |
|--|-----------------|-----------------|-------------|
| Short Time Overload | 0.5% | .05% | .02% |
| Temperature Cycling | 0.2% | .05% | .02% |
| Moisture Resistance | 100 megs | 1000 megs (min) | --- |
| | 1.0% | .1% | .05% |
| Salt Water Immersion Cycling | 0.5% | .03% | .015% |
| Load Life at 125°C or 85°C (500 hours) | 0.5% | .15% | .05% |
| Temperature Coefficient | | | |
| Less than 2000 ohms | Up to 75 PPM/°C | 30 PPM/°C | --- |
| 2000 ohms and over | 30 PPM/°C | 20 PPM/°C | --- |
| Low Temperature Storage | 1.0% | .01% | .005% |
| Low Temperature Operation | 1.0% | .05% | .02% |
| High Temperature Exposure (145°C) | 1.0% | .05% | .02% |
| Acceleration | 0.1% | .02% | .008% |
| Shock | 0.1% | .02% | .008% |
| Vibration | 0.1% | .02% | .008% |

- No Wire Strain. Unique CTS "floating element" needs no bobbin or winding form . . . permits resistance elements and contacts to be firmly embedded in epoxy resin . . . forming a monolithic mass with a smaller space factor.
- Permanent Stability—Less than .05% average change under most environmental conditions and shelf life.
- 5PPM/°C Temperature Coefficient available.
- 100% Tested—High temperature exposure and short time overload tests are run on all resistors before shipment.
- Guaranteed Close Tolerance — Resistors guaranteed to be in tolerance under normal conditions of measurement. Tolerances down to $\pm 0.05\%$ available in standard sizes depending upon resistance value. Closer tolerances and/or matched multiples available.
- Low Inductance and Low Capacitance Characteristics with reproducible uniform frequency response.
- Withstands extreme vibration and shock due to unique construction and encapsulation method.
- Modular—Design flexibility permits grouping many resistors in a single unit.

Available in a wide variety of tubular, rectangular or square shapes. Special dimensions, tolerances, wattage ratings, resistances, etc. can be made to your precise requirement. Either axial or radial leads available.

For help in solving your fixed resistor problems, phone or write your nearest CTS office today.

*MIL-R-93B (proposed) soon to be issued, superseding MIL-R-93A.

Type FC

Type CB

Type FA

Type JD

Type F3B

Type H3C

Type H3F

All resistors shown $\frac{1}{2}$ actual size

Type L3H
SPL

FOUNDED



1896

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TWX LA 1108

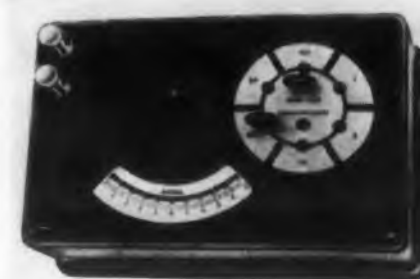
EAST COAST OFFICE
8 Haddon Avenue
Haddonfield, New Jersey
Phone: Haddonfield 8-8812
TWX No. Haddonfield 883
Phila. Phone: Market 7-3128

CANADIAN SUBSIDIARY
C. C. Meredith & Co., Ltd.
Streetsville, Ontario
Phone: Taylor 8-1141

NEW PRODUCTS

Ammeter

100 amp range, 0.2 per cent accuracy



Model CHC dc ammeter has an accuracy of 0.2 per cent and plug-in ranges to 100 amp. The double-diamond pivoted, permanent magnet type ammeter has a 6.3 in. hand-drawn, mirrored scale. Sensitivity is 50 mv, temperature coefficient is negligible between 20 and 30 C, and period is 1 sec.

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

CIRCLE 84 ON READER-SERVICE CARD

Branching Amplifier

Provides six output branches



This Branching Amplifier makes possible the connection of several communications receivers to a single antenna without objectionable interaction or degradation of individual circuit performance. The amplifier is designed to terminate properly a 75 ohm coaxial transmission line over the band of frequencies extending from 2 to 32 mc; produce a gain over this band of between 6 and 12 db; exhibit a noise figure of four; limit the amplitude of any spuriously generated signal component to a level not in excess of 60 db below a 10 mv input reference level.

CIRCLE 83 ON READER-SERVICE CARD

In addition, the branch-to-branch isolation is such that any leakage from the local oscillators of the associated receivers is attenuated by at least 35 db at the highest frequency in the useable band. Six output branches are provided each capable of feeding a 75 ohm resistive load. A high-pass filter in the input circuit attenuates all components in the region below 1.8 mc by at least 30 db.

Siegler Corp., Hallamore Electronics Div., Dept. ED, Anaheim, Calif.

CIRCLE 85 ON READER-SERVICE CARD

Circuit Interruptor

Bimetal strip construction

This line of medium-lag fractional amperage circuit interruptors, called Guardsets, can be used for loads up to 5 amp, 250 v or less. A built-in visual indication of a broken circuit, a pop-up button, as well as provision for additional visual or auditory alarms are provided. Reset is manual.

Littelfuse, Inc., Dept. ED, Des Plaines, Ill.

CIRCLE 86 ON READER-SERVICE CARD

Multiplexer

For airborne applications



This series of Minimultiplexers uses transistors, diodes and ferritic elements in such a way that a unit is asynchronous with any sampling rate from 0 to 20,000 samples per second, if one channel is being used, while ± 0.1 per cent of full scale transfer accuracy is maintained. A 40 channel combination will operate with a maximum frame rate of 500 frames per second.

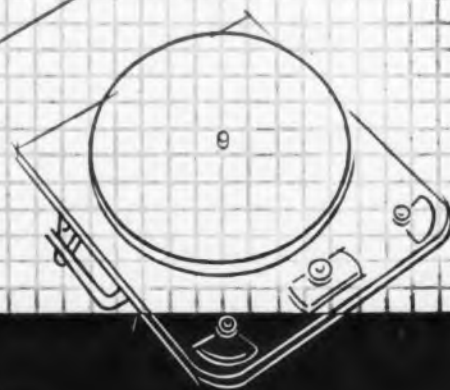
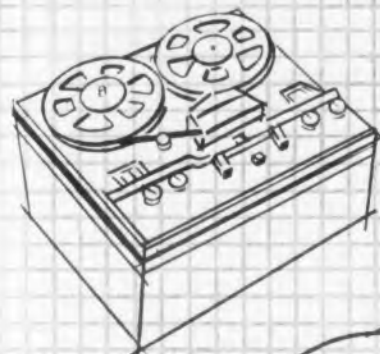
Epsco, Inc., Dept. ED, 588 Commonwealth Ave., Boston 15, Mass.

CIRCLE 87 ON READER-SERVICE CARD

CIRCLE 88 ON READER-SERVICE CARD ➤

A new standard in

HYSTERESIS MOTOR DESIGN



imc

- Uniform Speed To Meet Exacting Requirements.
- Low Noise Level approaching Inaudibility.
- High Starting Torque for instantaneous efficient operation.

SPECIFICATIONS*

| | WC2913H Turntable | WC2913H-1** Tape Recorder |
|------------------|----------------------|------------------------------|
| Volts | 115 | 115 |
| CPS | 60 | 60 |
| Watts Input | 21 | 24 |
| Amperes | .25 | .22 |
| Number of Poles | 4 | 4 |
| RPM | 1800 | 1800 |
| H.P. | 1/150 | 1/125 |
| T.P.I. (oz. in.) | 3.0 | 4.5 |
| T.P.O. (oz. in.) | 3.5 | 5.0 |
| T.ST. (oz. in.) | 2.3 | 4.0 |
| Capacitor (mfd) | 1 | 2.5 |
| 220 Volts A. C. | 1 | 2.5 |
| Weight | 1 lb. | 1 lb. |

*All specifications are relative to frame size. The hysteresis series is available in seven frame sizes from 1/4" diameter to 4 1/2".

**Can be supplied with magnetic shielding (Mu-Metal)

A new era of electronic enterprise continues to place greater and greater emphasis upon engineering design and creative production. New tape recorder and turntable applications have required hysteresis motors unusually precise in their performance, rugged construction to withstand continued use, built within smaller and smaller frames... all this to meet the competitive price requirements of the end product.

A large order— but Induction Motors has done just that in its line of hysteresis motors—compact in size, precision manufacture with assured reliability. Typical of these design achievements are the types which today find themselves in such fine recorders as those made by Ampex.

Induction Motor's reputation of quality has been proven over the years in their manufacture of a complete line of precision sub-fractional horsepower motors.

For complete information on IMC hysteresis and torque motors for tape recorders and turntables, write for catalogue HT.



Induction Motors Corp.

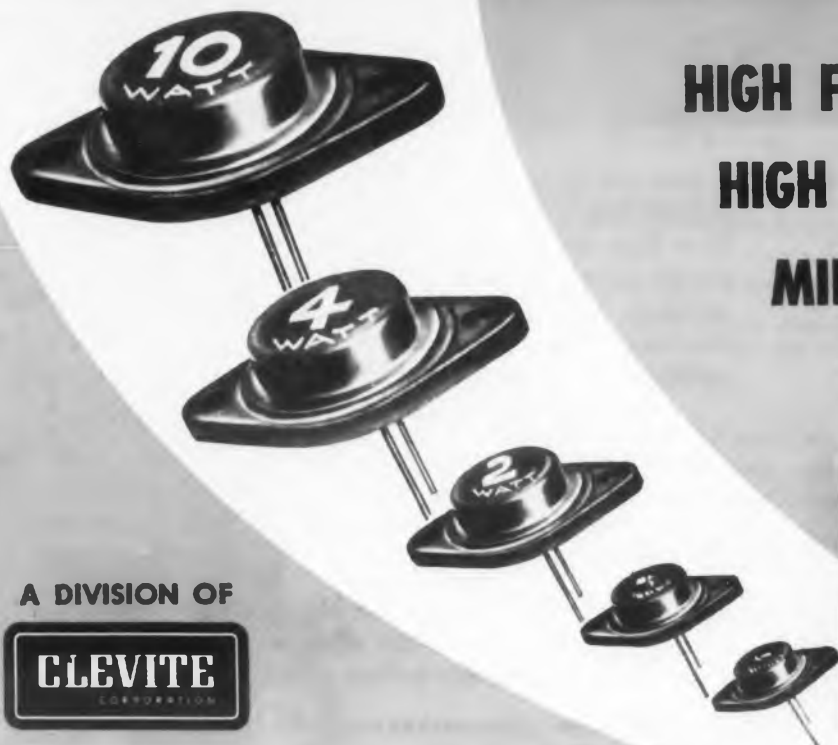
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with **PROVEN RELIABILITY...**



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GLASS DIODES and **POWER TRANSISTORS**



HIGH FREQUENCY AUDIO
HIGH SPEED SWITCHING
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10 WATT & 4 WATT

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CIRCLE 89 ON READER-SERVICE CARD

NEW PRODUCTS

Test Set

Low waveform distortion



K series of high voltage test set are available in ranges from 5 to 150 kv. Some of the features include high power capacity, low waveform distortion and metering directly at high voltage output.

Peschel Electronics, Inc., Dept. ED, Towners Patterson, N.Y.

CIRCLE 90 ON READER-SERVICE CARD

Mercury Switch

Resists shock, chemical splash

This nylon-enclosed mercury switch designated 7 MPI-2, has a small operating force and the ability to repeat operation at the same angle of tilt assures precision performance. Dependable switching is offered from -32 to 200 F. Contact arrangement is single-pole single-throw. The switch position, as mounted, determines whether the circuit is to be normally open or normally closed. The switch is rated electrically at 3 a, 115 v dc, resistive load.

Minneapolis-Honeywell Regulator Co., Micro-switch Div., Dept. ED, Freeport, Ill.

CIRCLE 91 ON READER-SERVICE CARD

Clutch-Brake

Clutch torque range of 100 oz-in.



This magnetically set clutch has a torque range of 100 oz-in. The torque of the brake is 8 oz-in. The unit weighs 15-1/4 oz and can be wound for any dc voltage up to and including 28 v dc.

Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee 2, Wis.

CIRCLE 252 ON READER-SERVICE CARD

Silicon Rectifier

Easily assembled



The A750 expandable rectifier can be used singly, or assembled instantly into series chains for higher voltage applications. The individual unit is sealed and threaded at each end, so that it can be screwed into bushings or a chassis heat sink, or plugged into a clip holder.

Each unit is one in. long with an inverse voltage rating of 400 v and maximum forward current of 750 ma. To produce a high-voltage rectifier in a matter of minutes, a number of the units are connected end-to-end with the bushings to form a series chain. Threaded units with current ratings up to 5 a may also be had for similar assembly.

Audio Devices, Inc., Dept. ED,
620 E. Dyer Rd., Santa Ana, Calif.

CIRCLE 92 ON READER-SERVICE CARD

Galvanometer Analyzer

Features turnover case for ± 1 g static balance test



GA-101 portable galvanometer analyzer features a complete check of all galvanometer parameters, including damping, frequency response, static balance, and dc sensitivity.

North Atlantic Industries, Inc.,
Dept. ED, 603 Main St., Westbury,
N.Y.

CIRCLE 93 ON READER-SERVICE CARD

CIRCLE 94 ON READER-SERVICE CARD >

THREE steps forward in rectifier design by **Amperex**[®]

designers and manufacturers of the world's most complete line of rectifiers

1

THE NEW 7136 single-anode, high-voltage mercury-vapor rectifier. A plug-in replacement for the 575A, surpassing it in capacity and dependability, with higher peak inverse voltage. Offers trouble-free operation in induction and dielectric heaters.

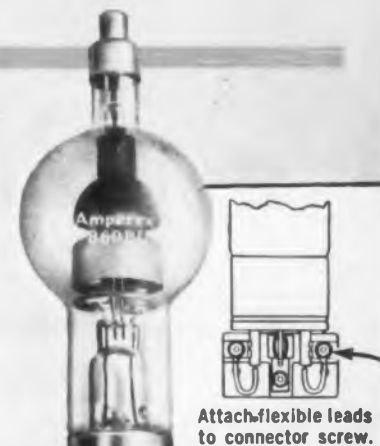
Peak Inverse Voltage: 15 kv
Average Anode Current: 3 amps



2

THE NEW 869 B1 heavy-duty mercury-vapor rectifier. Uses short, flexible filament leads to eliminate possibility of high contact resistance. This prevents under-emission and tube damage, and insures proper voltage drop across the filament at all times. Preferred by equipment manufacturers and users for broadcasting, induction and dielectric heating equipment.

Peak Inverse Voltage: 15 kv
Average Anode Current: 5 amps



Attach flexible leads to connector screw.

3

THE 6786 super-power, grid-controlled, mercury-vapor rectifier. Guarantees precise electronic control for industrial oscillators up to and in excess of 100 kw output. Proven long life in actual field tests.

Peak Inverse Voltage: 15 kv
Average Anode Current: 10 amps continuous;
15 amps intermittent

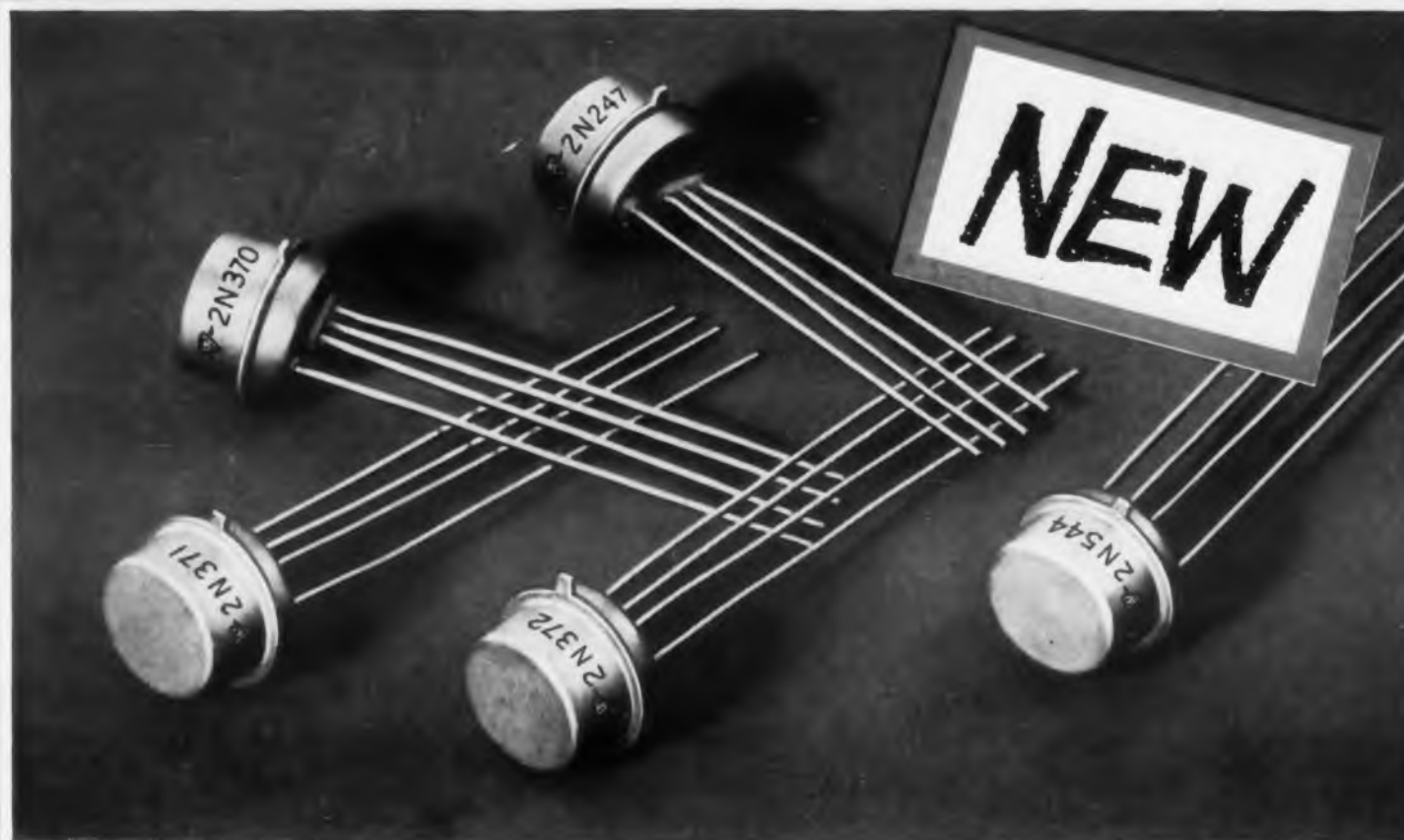


ask **Amperex**

about mercury-vapor, inert gas
and grid-controlled rectifiers
for communications and industry

AMPEREX ELECTRONIC CORP., 230 DUFFY AVENUE, HICKSVILLE, LONG ISLAND, N. Y.

In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17, Ont.



Sylvania **RF-IF** Transistors

Five new PNP Drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544, for radio frequency amplifier service

Sylvania's new PNP Germanium Drift transistors feature high output resistance for increased gain at 1.5 mc to 20 mc, low feedback capacitance and high alpha cutoff frequency.

Designed for RF-IF circuits, they open the door to more transistorized electronic equipment operating from the broadcast band to the higher frequencies.

The new Sylvania drift transistors incorporate a diffused base on an intrinsic germanium layer for improved control over base thickness, more uniform base region, lower base resistance and reduced collector capacitance. The end result is superior performance at higher frequencies.

The new PNP drift transistors feature Sylvania welded hermetic seal construction for maximum protection in rugged environments. They are encased in a modified JETEC class 30 case with four flexible in-line leads. The additional cen-

ter lead is connected to the metal case providing a complete unit shield and interlead shield. Coupling to adjacent circuit components is reduced to a minimum.

Call your Sylvania Sales Representative or write direct for information on new Sylvania PNP drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544.

| | ELECTRICAL CHARACTERISTICS (25°C) | | | | | Unit |
|---|--|-------|----------------------------|-------|--|------|
| | 2N247 | 2N370 | 2N371 | 2N372 | 2N544 | |
| Power Gain, P _g V _{CE} = 8, I _C = 1 ma, Freq. = 20.0 mc | | | | | | db |
| Minimum | 24 | 10 | 12 | 10 | 30.5 | |
| Typical | 27 | — | — | — | 37.5 | |
| Maximum | 31.5 | 17 | 17 | 17 | — | |
| | (V _{CE} = -9 Freq. = 1.5 mc) | | | | (V _{CE} = -9) (Freq. = 1.5 mc) (R _L = 750 ohms) (Neutralized) | |
| Reverse Biased Collector Voltage, V _{CB} V _{EB} = 0.5, I _C = 50 ua | | | | | | V |
| Minimum | -40 | -20 | -20 | -20 | -20 | |
| Typical | — | — | — | — | — | |
| Maximum | — | — | (I _C = 0.50 ma) | — | — | |
| Collector Base Capacitance, C _{ob} V _{CB} = 12, I _C = 0, Freq. = 1.5 mc | | | | | | uuf |
| Minimum | — | — | — | — | — | |
| Typical | 1.5 | — | — | — | — | |
| Maximum | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | |
| | (V _{CB} = -9) | | | | | |



SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY
CIRCLE 95 ON READER-SERVICE CARD

NEW PRODUCTS

Delay Line

Features a mechanical driving system



This variable ultrasonic delay line employs a fused quartz as the delay medium. The unit features a mechanical driving system. The unit has been designed for special purpose use, including target simulator applications and all operations in which control in setting the delay time is vital and bandwidth is required.

Andersen Labs., Inc., Dept. ED, 501 New Park Ave., West Hartford, Conn.

CIRCLE 96 ON READER-SERVICE CARD

Power Transistors

For converter and switching circuits



These transistors have a 5 a maximum current rating and can switch power up to 250 w. Current gain ranges are 15 to 30, 20 to 40 and 30 to 60 at a collector current of 3 a. The transistors have collector-to-emitter breakdown voltage ratings of 40, 70 and 80 v.

Bendix Aviation Corp., Semiconductor Prod., Dept. ED, Long Branch, N.J.

CIRCLE 97 ON READER-SERVICE CARD

Multiplex System

Unitized construction

Multiplex system, model FMC consists of an exciter unit, model FME-1, one or two sub-carrier generators, model FMX-1, a power supply for the multiplex exciter, model PS-11, and a separate power supply for each sub-carrier generator.

ator model PS-12. Unitized construction is one of the features of this equipment. Each section consists of individual 5-1/4 x 19 in. panels.

General Electronic Labs., Inc., Dept. ED, 18 Ames St., Cambridge 42, Mass.

CIRCLE 98 ON READER-SERVICE CARD

Drafting Kit

Saves 50 per cent drafting time



Tech-Tac is a drafting aid in which pre-printed symbols on clear acetate are affixed by pressure applied dry adhesive to drawings. In the typical schematic, regardless of complexity, 95 per cent of the drawing can be made simply by using the appropriate Tech-Tac symbols or combination of symbols and connecting them together with straight lines. Drawings so made are permanent.

Tech-Tac, Inc., Dept. ED, 727 West Seventh St., Los Angeles 17, Calif.

CIRCLE 99 ON READER-SERVICE CARD

Flip-flop Module

For use in digital shift registers



Transistorized flip-flop model SF 101 is designed for use in digital shift registers and does not require the use of additional components or circuitry in such applications. The model SF 101 is intended for slow speed shift register applications. Maximum shift rate is 2 kc. Power requirements are 5 ma at +20 v and 0.5 ma at -90 v.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 454 ON READER-SERVICE CARD

"How would YOU measure RF power accurately...reliably?"

...Lou G. Dameson,
Chief Design Engineer, Cubic Corporation



Designed to meet the requirements of the Military and Industry

Manufacturers of radar and other high frequency pulse equipment have long felt the need for a primary standard laboratory instrument to measure RF power in the microwave region. The Cubic Calorimetric Wattmeter, Model MC-1B, was designed particularly to provide you with a highly precise instrument of this type, and one with simple and fundamental instrumentation methods to establish long calibration life.

For example, precision thermometers are used, since they are far more stable and reliable than thermocouple or thermistor temperature-indicating circuits. The high accuracy of the MC-1B is maintained without frequent calibration.

Our Calorimetric Wattmeter consists of two units—a liquid circulator and a water load termination. The circulator unit controls the flow of metered amounts of distilled water through the termination, where RF output is converted to heat by means of a water load. Heat absorbed by the distilled water calorimetric fluid is measured on precision thermometers. A power scale on the termination permits direct, precise power readings in watts.

Distilled water is used as calorimetric fluid because of its

high dielectric loss characteristics above 1000 mcs. The circulator permits visual monitoring of the fluid flow rate at all times. All parts of the circulator are designed and fabricated to prevent fluid contamination.

Through the use of RF adapters, a match better than 1:15 in VSWR from 2600 to 26,500 mcs is achieved without problems associated with the excitation and propagation of higher order waveguide modes.

Metered fluid flow, precision temperature readings and well designed control of heat transfer permit extreme accuracies of power measurement.

Cubic Calorimetric Wattmeters are being used extensively by industrial and government laboratories. For example, RCA has over 30 of these instruments in use to check out and calibrate magnatrons and radar systems. Hughes Aircraft Company uses the Calorimetric Wattmeter in its laboratories.

Cubic's Calorimetric Wattmeter will prove its accuracy—as no other wattmeter can—in your laboratories, in your plant, or in the field.

For a prove-it-yourself demonstration of how you can obtain consistent, repetitive results in RF measurement, telephone or write...



CUBIC CORPORATION

5575 Kearny Villa Road, San Diego 11, California

CIRCLE 100 ON READER-SERVICE CARD

Now...

DIALCO Pilot Lights

with **Built-in Resistor** (18,000 ohms)
(a patented DIALCO feature)

and the **NEW High Brightness Neon Glow Lamp NE-51H**



A New Advance in Pilot Light Design by DIALCO:

Three basic advantages are incorporated in this series of DIALCO assemblies: (1) *Built-in resistor* for direct use on 125 to 250 volt circuits... (2) *New plastic lens* designed to give attractive "halo" effect... (3) *New High Brightness Neon Glow Lamp NE-51H*. This lamp may be operated at about 3 times the level of current that may be applied to the standard lamp, and it will produce 8 times as much light—with long life! Very low power is required, less than 1 watt on 250 volt circuit. Recommended for AC service only.

In the DIALCO assembly, the built-in current limiting (ballast) resistor (18,000 ohms) is completely insulated in moulded bakelite and sealed in metal (U. S. Patent No. 2,421,321)... Small space required—units are available for mounting in 9/16" or 11/16" clearance holes... A wide choice of optional features includes lens styles, shapes, and colors; terminal types; metal finishes, etc... Meet applicable MIL Spec and UL and CSA requirements.

All Assemblies Are Available Complete with Lamp
SAMPLES ON REQUEST—AT ONCE—NO CHARGE

DIALIGHT CORP., 46 Stewart Ave., Brooklyn 37, N. Y.

Send brochures on Pilot Lights for NE-51H Neon lamp Sub-Miniatures Oil-Tight

Name Position

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Address

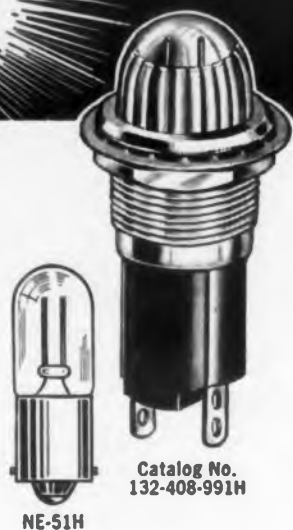
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CIRCLE 101 ON READER-SERVICE CARD



NE-51H

Catalog No.
132-408-991H

One-Cycle Response

Voltage Regulator

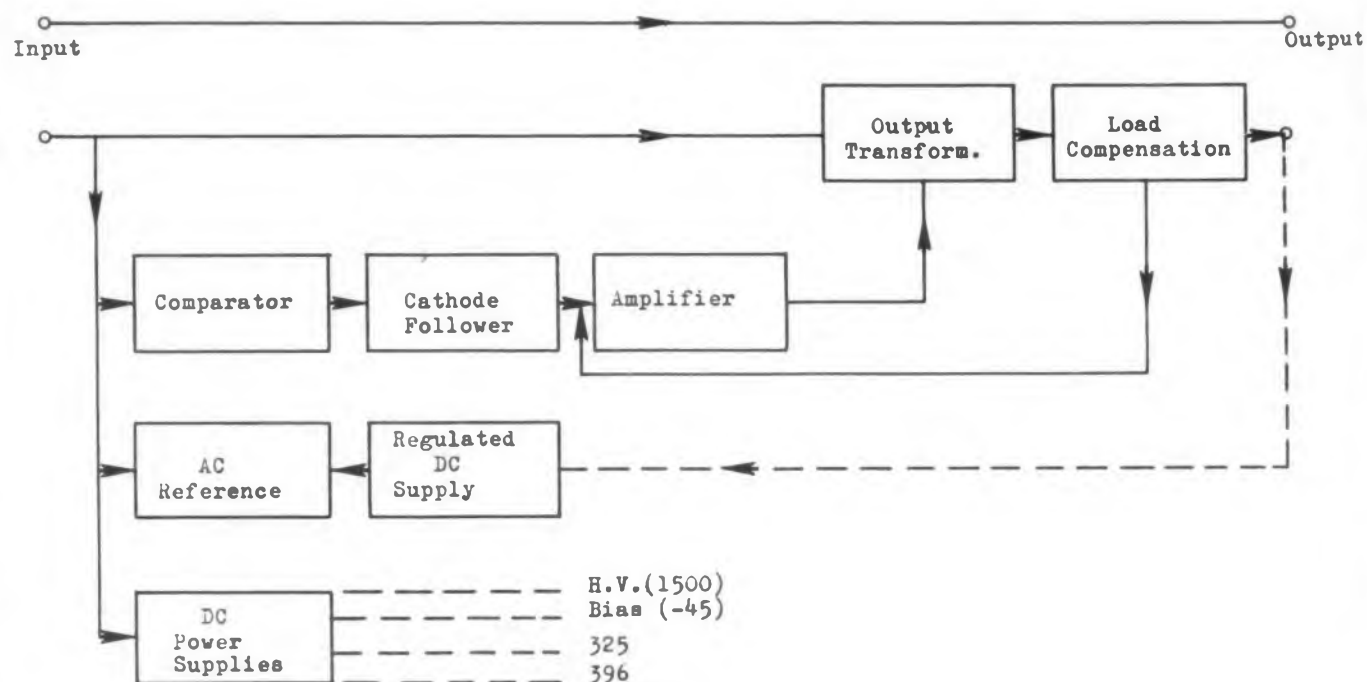
FEED A 10-VOLT line drop into this voltage regulator and the 1.2-volt deviation at the output will be corrected before one cycle, or 0.02 seconds, can elapse. In other words, input line surge is reduced by a factor of about 8:1, and the resulting output surge is out of the ± 0.25 per cent regulation band for no longer than the one-cycle response time.

Besides response time, the FRLD750 regulator, manufactured by Sorensen & Co., South Norwalk, Conn., provides an unusual amount of distortion attenuation. Unlike many regulators which often add to input line distortion, this

instrument maintains a distortion reduction equal to the transient attenuation of 8:1.

How distortion attenuation and regulation are achieved simultaneously can be seen in the block diagram. First, the input voltage is compared to a fixed ac voltage reference signal. The resulting difference is amplified by the power amplifier and added in series with the input. This difference signal is composed of a waveform of all harmonics present in the input line, plus some fundamental voltage necessary for regulation. The fundamental voltage is then added either in phase or out of phase to the input, depending

Block Diagram



Regulation and distortion attenuation are provided simultaneously by the regulator. The error signal from the amplifier is added to the input either in phase or out of phase, but the harmonic content of the signal is always subtracted from the input.



upon a negative or positive variation in the input voltage. A null point is chosen at the center of the range at which the signal is pure distortion. The distortion is always subtracted from the input voltage. Load regulation is achieved by means of feedback through the driver transformer and the power amplifier.

The ac reference circuit provides a fixed, distortion free ac voltage. This is accomplished by taking a portion of the input voltage and changing it to a pure ac signal. The circuit consists of a phasing network to adjust the signal 180 deg. out of phase with the input line, a limiter network which clips the incoming wave form to a fixed level, a filter circuit which eliminates all harmonics, and an amplifier stage to obtain the proper amplitude.

The amplifier in this regulator is a Class B audio type possessing a high degree of negative feedback. The purpose of the amplifier is solely to bring the difference error signal to the proper power level to achieve voltage regulation and distortion reduction.

The secondary of the output transformer is connected in series 180 deg out of phase with the input line. The action of this transformer either bucks or boosts the input line to achieve regulation. By being out of phase with the input, the amplified difference signal which is fed into this transformer is always subtracted from the input, thus attenuating its distortion.

The ± 0.25 per cent regulation of the FRLD750 voltage regulation is defined for any combination of load and line changes within load and line limits. These consist of 105-125 v ac input for the 750 va output range and 110-120 v ac for the 1200 va range. In conditions of high input distortion, (2.5 per cent to 10 per cent), regulation accuracy is given as 0.5 per cent over these same ranges.

For more information on this voltage regulator, circle 102 on the Reader-Service card.



show stopper



PHOTOS TAKEN AT I.R.E. CONVENTION, NEW YORK CITY, MAR. 24-27, 1958

THOUSANDS SAY "THERE'S NO ROOM FOR DOUBT!"

What a reaction to the Mark II Thinslide in action!

Never before so many features in one slide. Continuous ball bearing action... installation without cabinet modification (only $\frac{3}{8}$ " side space required)... will easily support 100 lb. loads... extruded aluminum shapes with stainless steel balls... locking and tilting mechanisms available... in lengths from 12" to 24"... and prices so modest as to make *all* of your

equipment more accessible for servicing and maintenance.

Grant is prepared to give you the facts on the Mark II Thinslide—write for complete information on the newest, most exciting Grant Slide—the Mark II!

If the question is accessibility... the answer is Grant.



GRANT PULLEY & HARDWARE CORPORATION

21 High Street, West Nyack, New York • 944 Long Beach Avenue, Los Angeles 21, California
CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducer

Capable of withstanding 50 g shock



This transducer, measuring only 2.85 by 1.91 by 1.06 in., can provide pressure altitude, true angle of yaw or attack, jump angle, dynamic, or other pressure data to missile autopilot or navigation systems. The low range, 50 psi units are designed for accuracy under high humidity, and in temperatures ranging from -65 to 165 F. Vibrations of 2000 cps at 15 g register less than 1 per cent full scale transducer error. These transducers are able of mechanically amplifying motion 2.8 to 8 times.

The Garrett Corp., AiResearch Mfg. Div., Dept. ED, 402 S. 36th St., Phoenix, Ariz.

CIRCLE 104 ON READER-SERVICE CARD

Event Recorder

Permits 500 signal changes per sec



Model RE 3610 00 permits recording of 100 channels of sequential or operational information simultaneously. A record of events, their duration and their time relationship to each other, appears on a chart less than 1 msec after the electrical current is switched through the stylus. Rapid response permits up to 500 signal changes per sec. Instantaneous electric selection of eight standard chart speeds with on site or remote operation and a chart speed accuracy within 0.25 per cent of established speed at constant line frequency are featured.

Clevite Corp., Brush Instruments Div., Dept. ED, 3405 Perkins Ave., Cleveland 14, Ohio.

CIRCLE 105 ON READER-SERVICE CARD

TRAINING A BIRD



TO NEST IN THE SAND

They try to "make life difficult"

The brittle cold of the stratosphere . . . the heat of air-skin friction . . . the acceleration and vibration of launch and flight . . . the unfavorable conditions inherent to storage and handling . . . all these factors can play havoc with a guided missile.

Hughes Research and Development engineers have designed the Falcon air-to-air guided missile to operate under the most severe conditions. Environmental testing (see Sand & Dust Test at left) subjects missiles to extremes in temperature, shock and other trouble-making conditions.

The Falcon missiles, with either infrared and radar guidance systems, measure only about 6½ inches in diameter. Complex guidance, control and auxiliary systems of each missile are installed in a space no bigger than a stovepipe.

The research and development skill required to successfully engineer the Falcons typifies the challenge present today in other Hughes guided missile assignments of a more



Collapsing the time between missile development and its effective tactical use is a project assigned to the Hughes Tucson Engineering Laboratories.

classified nature. A few of the areas being emphasized by the Hughes Research and Development Laboratories include missile launchers and power plants, guidance systems, reliability, product design, microwaves, aerodynamics, field test and telemetering, stress analysis and related areas.

High orders of engineering skill are also manifest in other Hughes activities. The commercial area, Hughes Products, has recently announced the development of a numerical control system which will automate a complete and integrated line of machine tools. The Hughes Ground Systems Division has developed a radar antenna which provides three-dimensional target data from a single antenna, transmitter and receiving channel.

Apart from the diversity of activity and the highly rewarding type of work, prospective employees may have confidence in the fact that Hughes will retain its leadership in the field of advanced electronics.



So advanced is the test equipment being designed by Hughes engineers in the El Segundo Manufacturing Plant that the test equipment is often as complex as the advanced systems being tested.

An immediate need now exists for engineers in the following areas:

| | |
|----------------|----------------------|
| Circuit Design | Computer Engineering |
| Reliability | Crystal Filters |
| Communications | Microwaves |
| Environmental | Field Engineering |
| Vacuum Tubes | Aerodynamics |

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 6-E, Culver City, California.

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Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton and Los Angeles, California
Tucson, Arizona

CIRCLE 550 ON READER-SERVICE CARD

Motor Generator

Has tuning fork speed control



Model 2615 15 k va motor generator set has a 400 cps ± 0.1 per cent frequency regulation. A tuning fork speed control regulates an electromagnetic clutch between a 60 cps induction drive motor and a 400 cps generator.

Varo Mfg. Co., Inc., Dept. ED, 2201 Walnut St., Garland, Tex.

CIRCLE 106 ON READER-SERVICE CARD

Phase-Lock Discriminator

Eliminates suppression of signals by noise

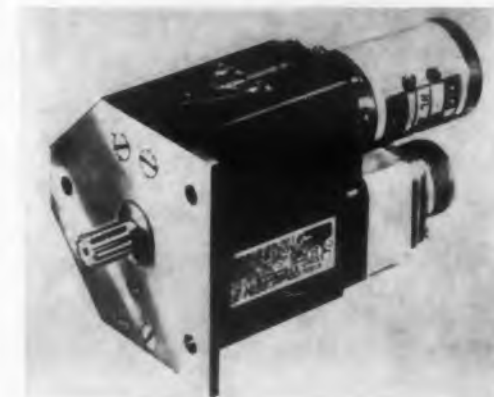
Phase-lock discriminator HEC-0162 eliminates suppression of signals by noise, non-linearities introduced by filtering, and thresholding at low signal-to-noise levels. Standard models include all IRIG channels, including the optional wide band (15 per cent deviation) channels.

Hallamore Electronics Co., Dept. ED, Anaheim, Calif.

CIRCLE 107 ON READER-SERVICE CARD

Rotary Actuators

Load ratings to 100 psi



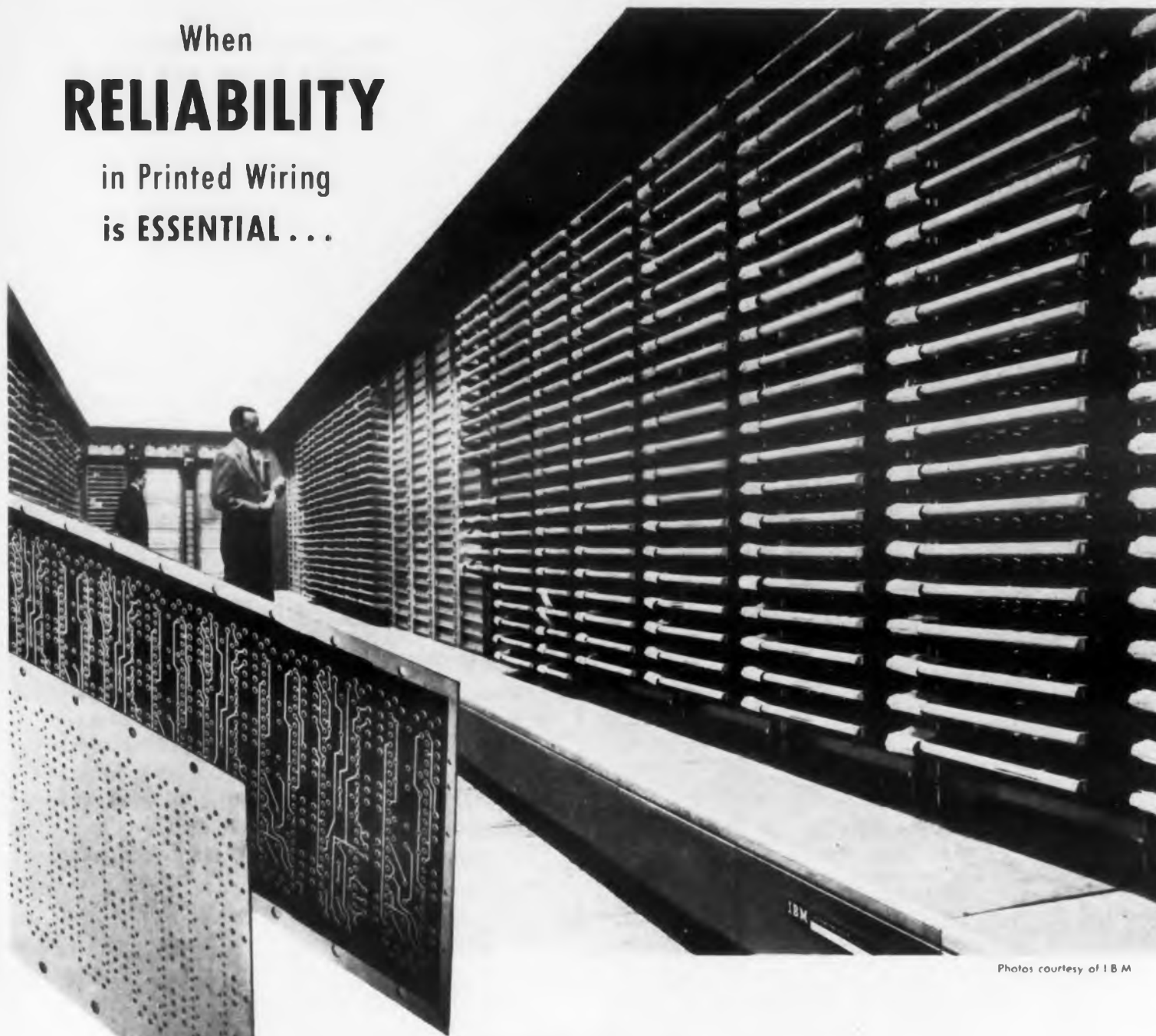
Designated R-12, this line of aircraft rotary actuators combines 12 standard interchangeable components to provide 40 different units in load ratings to 100 psi and speeds from 0.5 through 50 rpm. Units are available for 115 v, 400 cps ac, or 26 v dc. On either current, maximum operating load is 100 in.-lb, ultimate static load up to 200 in.-lb. Actuator weights are approximately 0.9 lb for the dc unit, 1.1 lb for the ac.

Airborne Accessories Corp., Dept. ED, 1414 Chestnut Ave., Hillside, N.J.

CIRCLE 108 ON READER-SERVICE CARD

When
RELIABILITY

in Printed Wiring
is **ESSENTIAL . . .**



Photos courtesy of IBM

DSP is the answer

One of the most important advantages to users of the Dry Screen Process in producing printed wiring boards is this method's uncanny ability to consistently turn out thousands of panels that need no retouching or reworking. With DSP rejects are practically nil.

DSP's thermoplastic resist is deposited so thoroughly that pinholing, distortion and broken lines are rarely encountered.

Our engineering staff can design and lay out for you a complete system for your specific requirements, incorporating The Dry Screen Process in such a way as to realize its maximum effectiveness in reliability, flexibility, and capacity at low unit cost. Single source responsibility for both design and equipment such as we offer will result in a system made up of matched units—all at a savings in capital outlay.

See our demonstration at the Second National Conference on Production Techniques, New Yorker Hotel, New York, June 4-6.

Printed Wiring Engineering and Equipment Division of:

D R Y

SCREEN PROCESS, INC.

1020 MADISON AVENUE • PITTSBURGH 12, PA.

West Coast Office: 9121 Long Beach Blvd. South Gate, Los Angeles, California, Phone LOrain 9-6547

CIRCLE 109 ON READER-SERVICE CARD

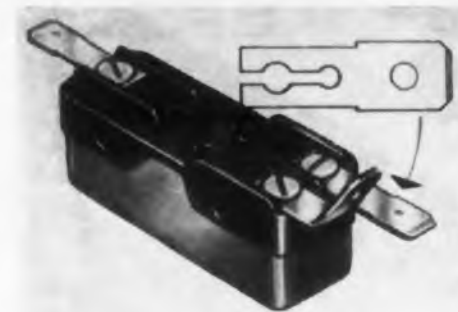


Thousands of printed wiring boards used in the SAGE computer were dry screened at the Kingston, N. Y. plant of I.B.M.'s Military Products Division.

Photos show panel before and after dry screening, and a section of the computer.

NEW PRODUCTS

Terminals For snap-acting switches



These male quick-connect terminals are 1/4 in. wide, made of 0.032 in. half-hard brass, and are indented for tight connection on switches. They are furnished for straight-on or up to 90 deg angle connection, and fit standard female quick-connect terminals.

W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Wallingford, Conn.

CIRCLE 110 ON READER-SERVICE CARD

Relay For 30 a contactor applications



Loads up to 30 a at 30 v dc are switched by the dual coil magnetic latching KG11DG relay. A high shock and vibration relay, it operates on 2.6 w, 12 msec pulses. The contacts transfer in two μ sec. The relay operates in ambient temperatures from -65 to $+125$ C.

Potter & Brumfield, Inc., Dept. ED, Princeton, Ind.

CIRCLE 111 ON READER-SERVICE CARD

Semiconductor Diodes

Utilize unusual materials

The availability of two semiconductor diodes utilizing materials with unusual environmental characteristics has been announced. The first type, FR-1426, employs an internal crystal of aluminum antimonide and has been assigned EIA type no 1N1549. The second type, FR-1731 assigned EIA listing 1N1550, employs indium antimonide as the crystal material. This is the first listing of semiconductors using these materials with the EIA.

Although no other technical details on these diodes were available, the company stated that in addition to time switching applications, these diodes will find wide application where variation in temperature effect must be held to a minimum and where high temperature conditions are encountered making it impossible to use presently available diode types.

Fretco Inc., Dept. ED, 406 N. Craig St., Pittsburgh 13, Pa.

CIRCLE 112 ON READER-SERVICE CARD

Magnetic Shift Registers

For digital computers



Known as type 92Z, this shift register is intended for use with printed wiring boards in commercial digital electronic equipment. The shift register is protected by a heavy dip coat of a moisture-resistant resin.

Sprague Electric Co., Dept. ED, North Adams, Mass.

CIRCLE 113 ON READER-SERVICE CARD

Servo Motor

Size 8, measuring 1 in. long



The 700 series size 8 servo motors feature short length with high-torque-to-inertia ratio. Length is 1.062 in. and diameter is 0.750 in. Inputs range from 6 to 57 v and the units operate in an ambient range of -55 to $+125$ C. Frequency is 400 cps; stall torque, 0.3 oz; inertia, 0.65 gm cm²; maximum power output, 0.45 w; theoretical acceleration (measured at stall), 32,600 rad/sec². Weighs 1.6 oz.

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

CIRCLE 114 ON READER-SERVICE CARD

A Wide Range of Ratings . . . Choice of Mounting
High Efficiency . . . Low Cost . . . Prompt Delivery

Tarzian SILICON RECTIFIERS

Offer These Advantages — and Many More!



SPECIFICATIONS

D. C. Current
Range . . 1.5A(J-1)—10A(J-2)
Peak Inverse
Voltage Range 100V to 400V
Approx. Rectifier
Voltage Drop 1.25V
Approx. Weight
(Ounces)2 oz.



SPECIFICATIONS

D. C. Current
Range 1.5A(L)—5A(LF)
Peak Inverse
Voltage Range 100V to 400V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces)35 oz.



SPECIFICATIONS

D. C. Current
Range 20A to 200A
Peak Inverse
Voltage Range 50V to 400V
Approx. Rectifier
Voltage Drop 1.25V
Approx. Weight
(Ounces) . . 1.3 oz. to 7.0 oz.



SPECIFICATIONS

D. C. Current
Range . . .25A(HW)—.75A(FW)
Peak Inverse
Voltage Range 1600V to 4500V
Approx. Rectifier
Voltage Drop 8V to 10V
Approx. Weight
(Ounces) 4 oz. to 8 oz.



LOW CURRENT SERIES

SPECIFICATIONS

D. C. Current
Range15A(M)—.2A(K)
Peak Inverse
Voltage Range 360V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces)2 oz.



K SERIES M SERIES

SPECIFICATIONS

D. C. Current
Range5A(M)—.75A(K)
Peak Inverse
Voltage Range 100V to 600V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces)2 oz.



HERMETICALLY SEALED SERIES

SPECIFICATIONS

D. C. Current
Range5A to 15A
Peak Inverse
Voltage Range . . 50V to 600V
Approx. Rectifier
Voltage Drop 1.5V
Approx. Weight
(Ounces) . . .15 oz. to 1.5 oz.



SM SERIES

SPECIFICATIONS

D. C. Current
Range325A to .45A
Peak Inverse
Voltage Range 800V to 2800V
Approx. Rectifier
Voltage Drop 2V to 15V
Approx. Weight
(Ounces)3 oz. to .9 oz.

Write, wire or phone for complete information

SARKES TARZIAN, INC., RECTIFIER DIV., Dept. C-3, 415 N. College, Bloomington, Ind.

In Canada: 700 Weston Rd., Toronto 9, Tel. Rogers 2-7535 • Export: Ad Auriema, Inc., New York City

CIRCLE 115 ON READER-SERVICE CARD



FOTOCERAM circuit board blanks are made photographically. All holes and shapes are produced by simple exposure to light, heat, and an etching operation.

This is a FOTOCERAM printed circuit ... an unusual new type of printed circuit board

Reliable through-plate holes • The good adhesion of the circuit runs applies also to the through-plate holes because both are produced with one plating operation.

Excellent resolderability • We have removed and resoldered components over twenty times on a FOTOCERAM board without damage to circuit runs or through-plate holes. And this is *without* using adhesives to bond the copper to the board.

Dimensional stability • Rigid structure of FOTOCERAM prevents unusual design

considerations—eliminates problem of warp and twist.

Good adhesion • It takes 12-25 pounds to peel a one-inch copper strip from a FOTOCERAM board.

Exceptional pull strength • 1400 pounds per square inch.

No water absorption • FOTOCERAM'S nonporous—zero water absorption.

Non-flammable

No blisters • FOTOCERAM never blisters. We put it through repeated 15-second

cycles of copper metallizing at 500°F. and could not find a single blister or sign of peeling or failure.

Other properties:

| | | |
|---------------------|--------------|-------|
| Dissipation factor | | |
| | 1mc @ 20°C. | 0.006 |
| | @ 200°C. | 0.014 |
| Dielectric constant | | |
| | 1 mc @ 20°C. | 5.6 |
| | @ 200°C. | 6.3 |
| Loss factor | 1mc @ 20°C. | 0.034 |
| | @ 200°C. | 0.088 |

For more information, write for our Data Sheet on FOTOCERAM.

Corning means research in Glass



CORNING GLASS WORKS, Bradford, Pa.

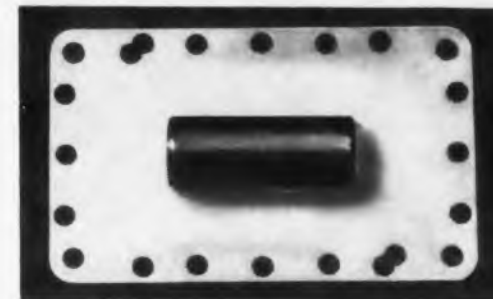
Electronic Components Sales Department

CIRCLE 116 ON READER-SERVICE CARD

NEW PRODUCTS

Duplexing Element

Low arc loss



Known as the Attenutron, this duplexing element has been successfully tested at 40 mw peak, 80 kw average, and has a very low arc loss. Design and performance characteristics are: recovery time of 3 to 40 μ sec; broad band; high level attenuation of 30-35 db; and low Q. The Attenutron is available in single or dual gas switching tubes, in all wave guide sizes greater than RG 52.

Bomac Laboratories, Inc., Dept. ED, Salem Rd., Beverly, Mass.

CIRCLE 117 ON READER-SERVICE CARD

Krypton

In rare gas mixtures

Krypton 85 as an additive to non-radioactive rare gases such as argon, helium, neon, krypton and xenon individually or as mixtures is now available. Kr-85 is not available in pure or concentrated form. The other rare or inert gases, with Kr-85 added, will be available only in Atomic Energy Commission-approved especially marked cylinders.

Linde Co., Div. of Union Carbide Corp., Dept. ED, 30 E. 42nd St., New York 17, N.Y.

CIRCLE 118 ON READER-SERVICE CARD

Control

Utilizes radioactive material



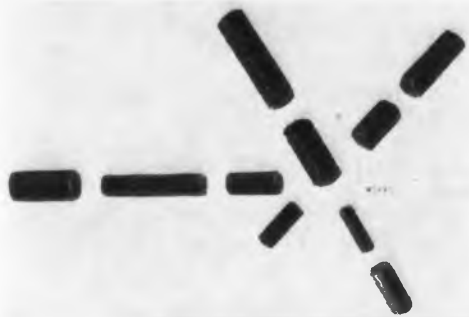
Betatrol, a liquid level sensor which utilizes a radioactive material in the sensing element, has been designed to provide an actuating signal to control or indicate a predetermined level.

Robertshaw-Fulton Controls Co., Dept. ED, 401 N. Manchester, Anaheim, Calif.

CIRCLE 119 ON READER-SERVICE CARD

Slugs

High Q and high permeability



These threaded ferrite slugs are designed for permeability tuning of inductors, filters and transformers used over the frequency range of 1 kc to several megacycles. These cores are designed for use where a high Q, high permeability core is desired and space is at a premium.

Ferroxcube Corporation of America, Dept. ED,
50 E. Bridge St., Saugerties, N.Y.

CIRCLE 120 ON READER-SERVICE CARD

Relays

Features temperature compensation

Type MTRH time delay relays are available from 10 msec to 120 sec. The relays feature temperature compensation and for special applications, voltage compensation and high speed recovery. Overall dimensions are approximately $7/8 \times 1-1/2 \times 1-3/4$ in., and the relay weighs 3 to 4 oz.

Branson Corp., Dept. ED, S. Jefferson Rd.,
Boonton, N.J.

CIRCLE 121 ON READER-SERVICE CARD

Pulse Generator

Produces 1 μ sec pulses



This transistorized pulse generator 1015A produces 0.1 μ sec pulses of 30 v amplitude, when triggered by external voltage transients. The output amplitude is variable from zero to 30 v, and in both positive and negative polarities. The input is ac coupled and may be triggered by any negative transient of at least 1 μ sec per 1 v.

Navigation Computer Corp., Dept. ED, 1621
Snyder Ave., Philadelphia 45, Pa.

CIRCLE 122 ON READER-SERVICE CARD



A plane's best friend is Reliability

Almost anyone who flies spells "Reliability" with a capital "R". Which is one reason why the aviation industry is a good customer for Synthane laminated plastics. There are other reasons.

Synthane is a material with many useful properties in combination. It's light in weight (half the weight of aluminum). It's an insulator with high dielectric strength, low dielectric losses, excellent insulation resistance. It's easily machined and resistant to chemicals. You'll go far to find one material with all these desirable characteristics.

But Synthane is more than a material. It is an investment in reliability. Quality control from the raw materials to the finished product assures you of uniformity and rigid compliance with your most exacting requirements.

CIRCLE 123 ON READER-SERVICE CARD

Synthane is people. People who have grown up with our company and take pride in turning out a first-class job. People to whom promises of delivery mean something. People who are specialists in working with laminated plastics. In short, people you can count on. What does all this cost you? Little or no more than you are now paying for other plastic laminates.

If you are interested in a reliable source of laminated plastics, you might remember that after "R" for Reliability comes "S" for Synthane . . . and Service.



Aircraft parts of Synthane laminated plastics combine light weight, strength and electrical insulating properties.

SYNTHANE
S

SYNTHANE CORPORATION, 42 RIVER ROAD, OAKS, PA.

PRINTED CIRCUIT MANUFACTURERS

...are you plagued with these problems?

1. LACK OF SKILLED PERSONNEL
2. PHOTO-RESIST TOO EXPENSIVE, NOT ADAPTABLE FOR PRODUCTION
3. ETCHING TIME TOO SLOW FOR EFFICIENT PRODUCTION RUNS
4. OXIDATION OF CIRCUIT BOARD PREVENTING PROPER DIP SOLDERING
5. UNDERCUTTING OF COPPER LAMINATES, PREVENTING PRODUCTION OF CIRCUIT BOARDS WITH CRITICAL DEFINITION
6. REJECTION RATE OF MORE THAN 5%

N O W . . . NORTHEAST WILL SHOW YOU HOW TO ELIMINATE THESE PROBLEMS AT NO COST TO YOUR ORGANIZATION!

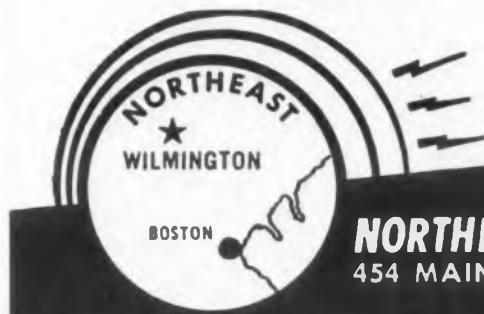
NORTHEAST CIRCUIT LABS CORP. DOES NOT MANUFACTURE PRINTED CIRCUITS, BUT DOES HAVE 32 YEARS' EXPERIENCE IN THE METAL ETCHING TRADE.

NORTHEAST IS NOW OFFERING TO THE ELECTRONIC TRADE A COMPLETE LINE OF ETCHING SOLUTIONS, PHOTO-RESISTS, COPPER CLEANING COMPOUNDS, ETC., WHICH HAVE BEEN MAINTAINED AS TRADE SECRETS FOR OVER 3 DECADES.

- NECLA GOLD STAR® PHOTO-RESIST
- NECLA BLUCITE® COPPER SCRUBBING COMPOUND
- NECLA INOXITE® OXIDE PREVENTER
- NECLA PRE-ETCH® SOLUTION
- NECLA PLASTIC PHOTO-APPLICAY® FOR TRANSFERRING AN IMAGE TO PLASTIC
- NECLA SPEED ETCH®

MANUFACTURERS' REPRESENTATIVES AND JOBBERS URGENTLY NEEDED NATIONWIDE. POSITIONS OPEN FOR QUALIFIED PHOTO-ENGRAVERS.

NORTHEAST CIRCUIT LAB'S PRODUCTS ARE SOLD UNDER THE NECLA® TRADEMARK.



NORTHEAST CIRCUIT LABS CORP.
454 MAIN STREET • WILMINGTON, MASS.
PHONE OLIVER 8-2024

NECLA® PRODUCTS DO NOT REQUIRE THE USE OF SKILLED PERSONNEL

CIRCLE 124 ON READER-SERVICE CARD

NEW PRODUCTS

Toroids

Tolerances from 5 to 1 per cent



Toroid sizes range from 7/8 to 3 in. with frequencies from 1000 cps to 200 kc. They are available with inductance and Q values to specification. Tolerances range from 5 per cent to 1 per cent.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Pa.

CIRCLE 125 ON READER-SERVICE CARD

Event Recorder

68 or 44 recorder channels



This recorder is a multi-channel instrument for recording occurrences of an on-off nature. Two recorder sizes are available, either 68 or 44 recording channels.

Lindly & Co., Inc., Dept. ED, 248 Herricks Rd., Mineola, N.Y.

CIRCLE 126 ON READER-SERVICE CARD

Test Systems

Modular units for automatic systems

The purpose of the series 1000 automatic test system is to perform go-no-go tests of electrical or electromechanical equipment on an automatically programmed basis. It supplies control and data signals to the equipment under test, converts the equipment's response signals to a form suitable for evaluation, and evaluates the con-

verted responses for presentation to go-no-go display devices or recording equipment. Applicable modules may be assembled into test sets for specific purposes permitting flexibility and interchangeability. Included in the system are translator modules, selector modules, programming and control modules, display devices, and power sources and standards.

Associated Missile Products Co., Dept. ED, 2709 N. Garey Ave., Pomona, Calif.

CIRCLE 127 ON READER-SERVICE CARD

Jack Inserts

Locks self permanently into chassis



Pushlock molded nylon tip jack requires no threads, nuts or lock washers. When the fluted nylon body is pushed through a 1/4 in. cabinet or chassis hole by drill press, arbor press or other mechanical means, the flutes compress, then expand to provide positive holding action that requires approximately 50 lb pull to release.

Whitso, Inc., Dept. ED, 9330 Byron St., Shiller Park, Ill.

CIRCLE 128 ON READER-SERVICE CARD

Duplexer

Frequency range of 9.2 to 9.4 kmc



Model W163-1C-1 rotation duplexer weighs only 7 oz, offers a frequency range of 9.2 to 9.4 kmc with isolation at 20 db min and insertion loss of .5 db max. It permits both transmission and reception. Other features include: vswr of 1.25 max; maximum power absorbed in load at 12 w and peak power at 10 kw. Exact size is: 2-3/4 x 3.037 x 2-3/4 in.

Kearfott Co., Western Div., Dept. ED, 14844 Oxnard St., Van Nuys, Calif.

CIRCLE 129 ON READER-SERVICE CARD

**you get fast delivery
on these**

BROWN COMPONENTS

for instrument, servo or control circuits



**NEW!
Brown
Motors***

for chart drives, servos, balancing circuits

These newly-designed synchronous and two-phase Brown motors have many maintenance saving features: new, sectioned die-cast housing . . . new wicking to prevent oil leakage . . . printed circuits . . . ball bearings to reduce friction. You can replace any part in two minutes, usually without disconnecting the leads from your installation.

TWO-PHASE INDUCTION

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

SYNCHRONOUS

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

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

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



BROWN *Electronik* AMPLIFIERS*

Amplify a d-c or a-c microvolt input signal sufficiently to drive one field of a two-phase balancing motor. Brown amplifiers have extremely low stray pickup, excellent stability, adjustable sensitivity and fast response. Proved in thousands of *Electronik* instruments.

SELECT FROM THESE BASIC MODELS

| Nominal Gain | Sensitivity (Microvolts) | Nominal Input Impedance (Ohms) |
|----------------------|--------------------------|--------------------------------|
| 1 x 10 ⁴ | 4.0 | 370, 1400, 50,000 |
| 4 x 10 ⁴ | 1.0 | 370, 2500 |
| 12 x 10 ⁴ | 0.4 | 2500 |
| 40 x 10 ⁴ | 0.1 | 1400 |

POWER SUPPLY

115 v., 60 cycles (fused power line)

OUTPUT

2 to 18 ma. into 12,000 ohm load

SENSITIVITY

Continuously variable screwdriver adjustment. Recessed slot protects setting

MOUNTING

Operation unaffected by mounting position

OPTIONAL FEATURES

(a) thermocouple burn-out protection, (b) without desensitizing adjustment, (c) parallel T feedback, (d) velocity damping, (e) special connecting cables and plugs, (f) without tubes, shields, and converter, (g) for 25 cycles, (h) 220-110 volt transformers.

*The sale of this device does not carry with it a license under any of our combination patents covering apparatus in which this device may be used.

For additional details, call your nearby Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR Co., Industrial Division, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell



First in Controls

CIRCLE 130 ON READER-SERVICE CARD

UAP COLD PLATE controls TRANSISTOR junction temperature!



minimizes transistor derating for thermal conditions . . .

UAP cold plate U-521330, designed for Collins Radio Company, dissipates heat generated by power transistors used in ground and airborne electronic circuits. The heat is transferred across a pressure thermal contact to cooling air. The cold plate controls the transistor junction temperature within operating limits compatible with the installation. Therefore, transistor derating is minimized.

The cooling air, which is forced through the cold plate, can be ducted from an air cycle refrigeration system; a ram air supply; an air manifold within

the electronic compartment or a pressurized equipment package.

The aluminum cold plates are bonded by UAP's dip braze method which produces extremely lightweight assemblies with maximum heat transfer area within the core. Cold plates can be used individually or assembled in manifolded banks.

DESIGN PERFORMANCE CHARACTERISTICS OF U-521330 COLD PLATE

Air flow: 7 lbs. per hr.
Air pressure drop: 0.25" H₂O corrected to .0765 density
Temperature drop in cold plate: 1.5°C per watt dissipated
Weight: Approximately 1 oz.
Performance characteristics can be modified to requirements.

For complete information call the nearest UAP Contractual Engineering Office

CALIFORNIA..... 1101 Chestnut St., Burbank Calif., VI 9-4236
NEW YORK..... 50 E. 42nd St., New York 17, N. Y., MU 7-1283
OHIO..... 1116 Bolander Ave., Dayton, Ohio, BA 4-3841
CANADA..... United Aircraft Products, Ltd., 5257 Queen Mary Road,
Montreal, Canada, ELwood 4131



a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.

1116 BOLANDER AVENUE, DAYTON, OHIO

CIRCLE 131 ON READER-SERVICE CARD

NEW PRODUCTS

Clutch
Minimum torque of 7 in.-lb.



Magnetic clutch model SAC 181 has a flexible membrane pole shoe assembly, which provides a torsionally rigid unit having zero backlash and zero residual drag and allows an angular misalignment up to 3 deg between the driving and driven shafts. The overall diameter of the clutch is 1-13/16 in., and the axial length, including mounting hubs, is 1-15/16 in. Rated to deliver a torque of 7 in.-lb at full power, its power consumption is under 4 w.

Dial Products Co., Dept. ED, 9 Avenue E, Bayonne, N.J.

CIRCLE 132 ON READER-SERVICE CARD

Accelerometer

Ranges of ± 1 g to ± 70 g



Three miniature linear accelerometers are accurately oriented to measure acceleration in three different directions. Only one input is required to all three units. The accelerometers are available in ranges from ± 1 g to ± 70 g, or unsymmetrical ranges are available in any combination desired. Output potentiometers can be provided with from 500 to 5000 ohm resistance. Accuracy is from 1 to 2 per cent, depending on range. Total weight is about 1 lb.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

CIRCLE 133 ON READER-SERVICE CARD
CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958



BORG

STANDARD BORG COMPONENTS TO MEET YOUR SPECIAL DESIGN NEEDS

MICROPOTS — Precision Potentiometers

1-turn, 3-turn, 10-turn, single or ganged, with or without rear shaft extension, single or double servo mount or bushing mount to meet your special design needs. Complete line of Trimming Micropots.

MICRODIALS — Precision Turn-Counting Dials

Direct-reading dials in 10-turn, 100-turn and 1,000-turn models. Concentric scale 10-turn dials.

BORG-MOTORS — Precision Instrument Motors

Synchronous or induction, with or without gear-trains, 2-pole or 4-pole for your precision equipment.

SEE FOLLOWING PAGES FOR DETAILS
ON THESE BORG COMPONENTS



BORG EQUIPMENT DIVISION

THE GEORGE W. BORG CORPORATION

120 SOUTH MAIN STREET • JANESVILLE, WISCONSIN



Built by Borg

MOTORS
MICROPOTS
MICRODIALS

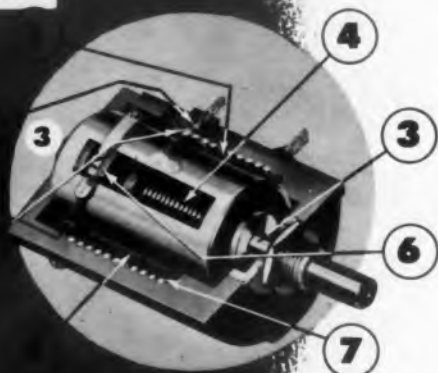
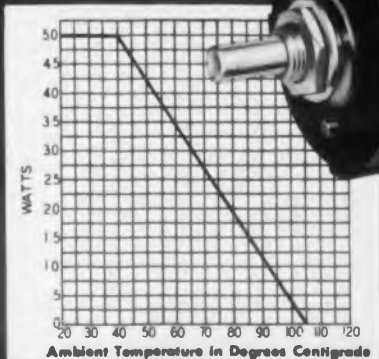
STANDARD BORG MICROPOTS TO MEET YOUR SPECIAL DESIGN NEEDS

A QUALITY MICROPOT* WITH MANY ADVANTAGES

BORG 205 SERIES, 10-TURN MICROPOTS

Borg's 205 Series 10-Turn Micropots have proved themselves exceptionally rugged and dependable through years of service in many different mobile and stationary applications. The Borg 205 Series is designed to meet more exacting electrical and environmental specifications for both commercial and military applications. Study the advantages of Borg 205 Series 10-Turn Micropots . . .

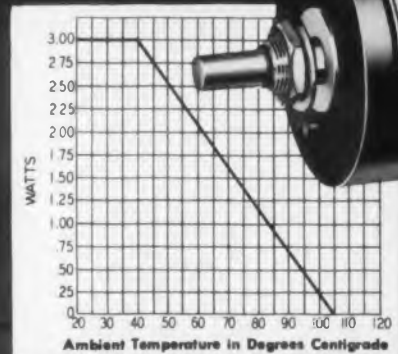
1. Permanent accuracy because resistance wire is precision positioned and moulded integrally with housing . . . it's locked in place.
2. Terminals are exceptionally rigid because they too are moulded integrally with housing.
3. Two bearings support rotor assembly assuring precise positioning of moving contact.
4. Permanently accurate settings due to double thread, precision lead-screw guiding the moving contact.
5. Terminals are soldered to ends of resistance element before moulding.
6. Anti-backlash spring in contact guide gives accurate setting and resetting.
7. Fine resolution because of $43\frac{1}{2}$ " Kohlrusch winding in helical element.
8. Each Micropot is machine tested for linearity at 100 points.



A PRECISION MICROPOT AT A COMPETITIVE PRICE

BORG 1100 SERIES, 10-TURN MICROPOTS

Borg 1100 Series, 10-Turn Micropots enable you to mass-produce precision equipment with greater price advantage in your markets. High quality commercial Micropots at competitive prices. Reduce your production costs with Borg 1100 Series Micropots!



TRIMMING MICROPOTS FOR SUBMINIATURE CIRCUITS

990 SERIES

Borg 990 Series Trimming Micropots provide accurate voltage adjustments in critical electronic circuits. Extremely small, they fit readily into subminiature circuits. They are wire wound and adjustable . . . permanently sealed against dust or salt laden air. Can be mounted individually or stacked to give designers the greatest possible latitude.

SUBMINIATURE . . . PRECISE RESOLUTION . . . STABLE UNDER ADVERSE ENVIRONMENTS

1. Screw-driver adjusts complete range in 40 turns.
2. Contact carrier assembly drive prevents damage when either end of linear excursion is reached.
3. Wide range of resistance values from 10 to 50,000 ohms. Other values on special order.



**BORG 900 SERIES MICROPOTS
PROVIDE A FLEXIBILITY TO
MEET SPECIAL DESIGNS
Single-Turn, 3-Turn, 10-Turn Models**

Borg 900 Series Micropots have long been preferred for many applications in aircraft instruments, radar and sonar equipment, missile launching controls, electronic devices, computers and various types of scientific and industrial apparatus.

Borg offers a complete line of these high-precision, linear Micropots in 10-turn, 3-turn and single-turn models. The 900 Series created a new standard for multi-turn potentiometers. Borg 900 Series Micropots are more accurate, offer finer resolution, lower torque, longer life and greater versatility of application. Available in any quantity.

The following options of standard Borg 900 Micropots illustrate the extreme flexibility in this series. These standard models meet most special needs.

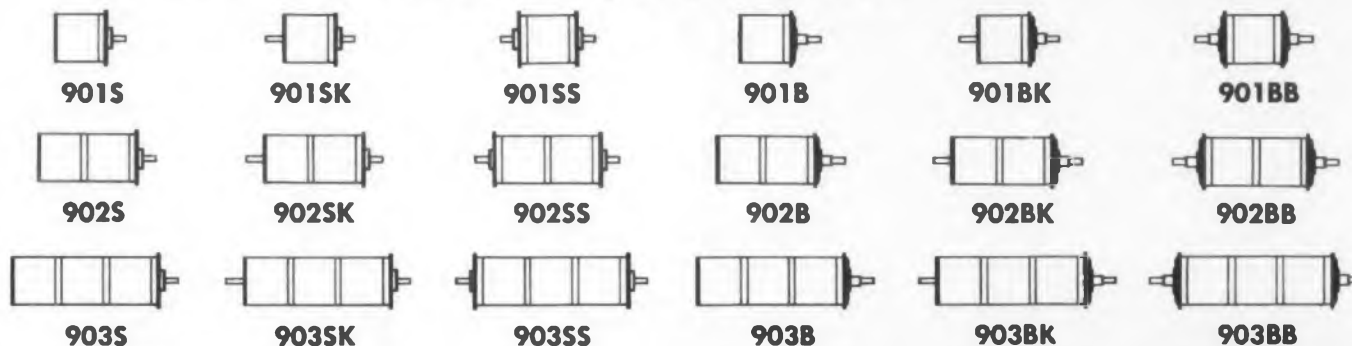
- Ten-turn Micropots in one, two or three gang models.
- Three-turn Micropots in one, two, three, four or five gang models.
- Single-turn Micropots in one, two or three-gang models.
- Single or double shaft on all models.
- Servo mount on either or both ends of all 3-turn and 10-turn models.
- Bushing mount on either or both ends of all 3-turn and 10-turn models.
- Any of three standard types of linearity.
- Available in all common resistance values.
- As many as nine additional taps available.

The flexibility of Borg 900 Series Micropot design enables *standard models to fit special design needs.*



LOOK AT THE FLEXIBILITY OF BORG 10-TURN MICROPOTS

Identical Models up to Five-Gang Available in Borg 3-Turn Series
Similar Models Available in Borg Single-Turn Series



WRITE FOR COMPLETE DATA ON ALL BORG COMPONENTS • CATALOG BED-A90

BORG EQUIPMENT DIVISION

THE GEORGE W. BORG CORPORATION

120 SOUTH MAIN STREET • JANESVILLE, WISCONSIN



Build by Borg

ELIMINATE FORCED-FAST-READING AND SETTING ERRORS WITH BORG MICRODIALS



DIRECT-READING MICRODIALS

Research proved that forced-fast-reading and setting of turn-counting dials is the primary cause of error in reading perception. Human engineering studies determined that inline digital presentation provides the highest accuracy of perception when forced-fast-reading and setting is required. These facts led to the development of Borg 1300 Series Direct-Reading Microdials.

To provide greatest sensitivity and accuracy, the control knob is mounted directly on the shaft to be controlled. This eliminates backlash. A finger-tip brake was developed to retain settings.

Borg 1300 Series Direct-Reading Microdials are available in 3-digit, 10-turn models counting from 0 to 999, 4-digit, 100-turn models counting from 0 to 9999 and 5-digit, 1000-turn models counting from 0 to 99999.

CONCENTRIC SCALE MICRODIALS

Borg Concentric Scale Microdials have an indexed accuracy of one part in 1000. They indicate the position of any multi-turn device of 10-turns or less. Direct-reading concentric scales indicate full turns and increments. Finger-tip brake retains any setting. Knob fastens directly to shaft . . . no backlash. Accurate . . . easy to read . . . easy to install.



BORG 1000 SERIES INSTRUMENT MOTORS SYNCHRONOUS AND INDUCTION WITH AND WITHOUT GEAR TRAIN

Borg-Motors bring to the electrical industry a line of fractional horsepower motors for recorders, instruments and timing devices. They have a long history of excellent performance in the Borg Time-O-Graph Watch Rate Recorder and other precision equipment. Borg-Motors are totally enclosed, using precision machined die cast alloys for end bells and gear train cases.

The die cast rotor, mounted on two ball bearings, assures longer life and continued accuracy. Standard gear train models have only the gear train shaft extension.

Capacitors are priced separately for each Borg-Motor.

WRITE FOR CATALOG OR ORDER INFORMATION ON ALL BORG COMPONENTS • CATALOG BED-A90



Built by Borg

BORG EQUIPMENT DIVISION

THE GEORGE W. BORG CORPORATION

120 SOUTH MAIN STREET • JANESVILLE, WISCONSIN

Potentiometers

Values up to 100,000 ohm



Model HP 101-AD ten-turn potentiometer is available in resistance values up to 100,000 ohm and with linearity up to 0.5 per cent. These potentiometers are low-noise types and will dissipate 3 w at 40 C derated to 0 at 100 C. The case measures 1 in. diam and 1-19/64 in. long. The potentiometers perform over a temperature range of -85 to 185 F and under extremes of shock, vibration and acceleration. These potentiometers are also available in 5-turn, 3-turn and single-turn types with servo mounting as well as various shaft configurations.

Hubbard Potentiometers, Inc., Dept. ED, 1242 E. Transit St., Pomona, Calif.

CIRCLE 134 ON READER-SERVICE CARD



Shields

For large power type tubes

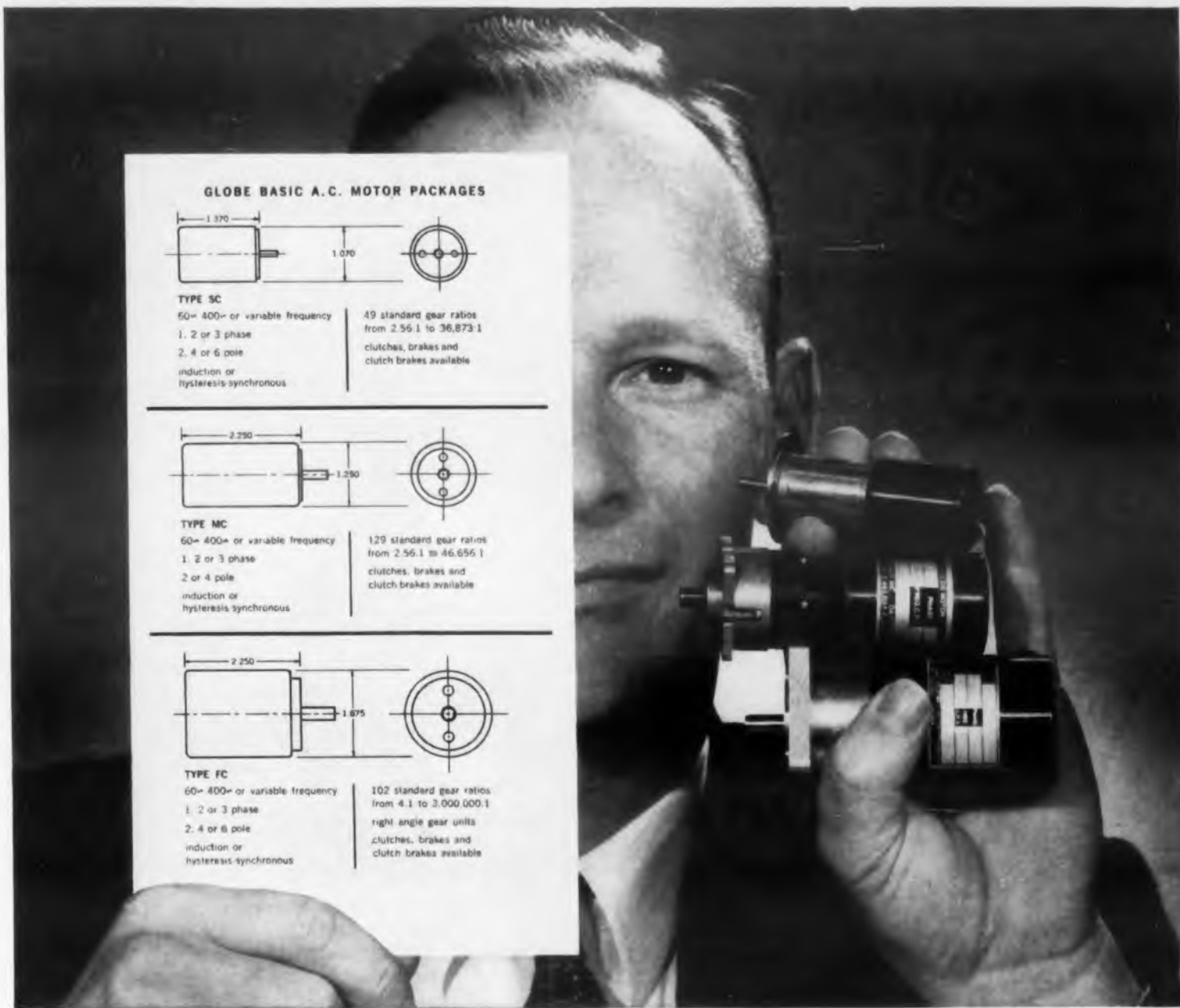
These large power tube heat-dissipating shields are used with matching IERC bases which provide a simple and efficient on or off twist-lock assembly. Friction fit between outside wall of shield skirt to inside surface of base makes good heat transfer through base and into chassis or heat sink.

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

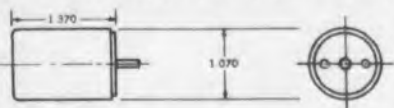
CIRCLE 135 ON READER-SERVICE CARD

CIRCLE 165 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958



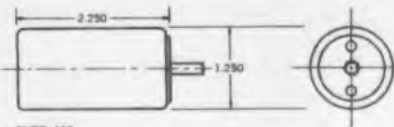
GLOBE BASIC A.C. MOTOR PACKAGES



TYPE SC

50- 400- or variable frequency
1. 2 or 3 phase
2. 4 or 6 pole
induction or hysteresis-synchronous

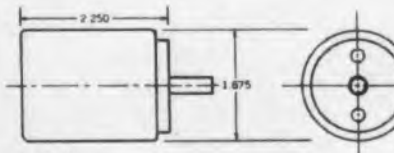
49 standard gear ratios from 2.56:1 to 36,873:1
clutches, brakes and clutch brakes available



TYPE MC

60- 400- or variable frequency
1. 2 or 3 phase
2. 4 or 6 pole
induction or hysteresis-synchronous

129 standard gear ratios from 2.56:1 to 46,656:1
clutches, brakes and clutch brakes available



TYPE FC

60- 400- or variable frequency
1. 2 or 3 phase
2. 4 or 6 pole
induction or hysteresis-synchronous

102 standard gear ratios from 4:1 to 3,000,000:1
right angle gear units
clutches, brakes and clutch brakes available

GLOBE A.C. MOTORS / GEAR REDUCERS / PACKAGES

In precision miniature motors, gear reducers, and small-package devices using clutches, brakes, and other components, Globe Industries has the hardware to meet your requirement. From a single source you can get fast 2 to 4 week prototype delivery of standard units. Modular design, interchangeable precision parts, and an efficient special order department are specific, unique reasons why you get what you need before your design grows cold.

Three basic A.C. motors are shown above. With their integral gear reducers they reliably span the torque range to more than 2000 in. oz. Custom modifications are a specialty.

Globe motor packages were chosen for the Army's Jupiter C, and as you read this, at least one such package is circling the earth. Ask the largest precision miniature motor manufacturer first. Request the Globe A.C. Motor Catalog now. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio. BALDWIN 2-3741.

CIRCLE 136 ON READER-SERVICE CARD



new!...printed circuit Continental Connector

Actual Size
9²⁷/₃₂" long

LONGEST
PRECISION MOLDED
CONNECTOR KNOWN

ONE PIECE
GLASS REINFORCED
ALKYD MOLDING

EXTRA
LONG
CREEPAGE
PATH

EXCLUSIVE
DESIGN
"BELLOWS"
CONTACTS*

SPRING TEMPER
PHOSPHOR BRONZE
GOLD PLATED
CONTACTS

ANODIZED
ALUMINUM
SHIELD FOR
HEAT DISSIPATION

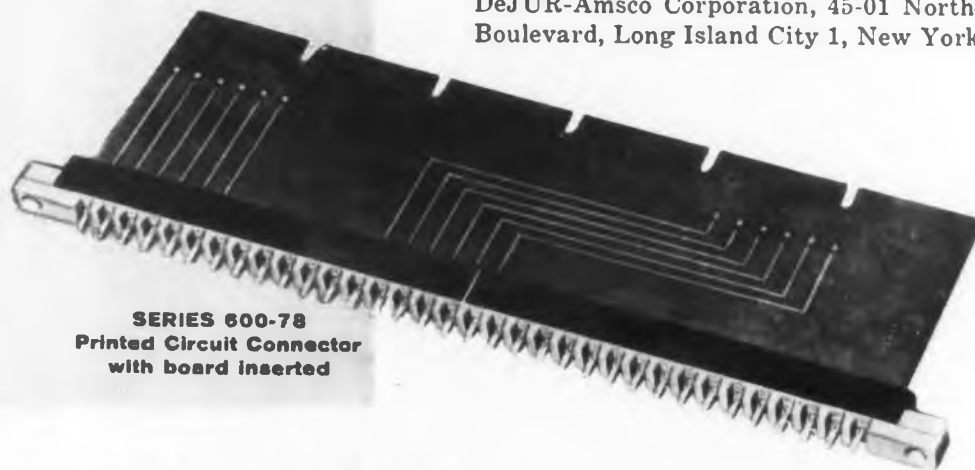
*Pat. Pending

designed for use in one of
the country's largest military
data processing systems

Again, Continental Connector proves its reliability and engineering know-how with this remarkable new printed circuit connector. Overall length is actually 9²⁷/₃₂"... the longest, single piece precision molded connector known!

Standard molding compound is high impact reinforced glass Alkyd (other molding materials available on request). 34 contacts have .250" spacing including heavy barriers for extra protection and long creepage path. Patented "Bellows Action" contacts are conservatively rated to accept printed circuit board thickness of .054 to .072", while maintaining low contact resistance and positive spring action grip over entire printed circuit contact area. Maximum board length is 8³/₄". Self-alignment of "Bellows" Contacts* allows for any residual warpage of printed circuit board. An anodized aluminum shield for dissipating heat is available as an optional accessory when required (see illustration).

Our engineering staff is available for developing other unique design printed circuit connectors that may solve your special connector problems. For complete technical specifications, write to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, New York.



SERIES 600-78
Printed Circuit Connector
with board inserted

you're
always
sure
with

DeJUR

electronic
components



CIRCLE 137 ON READER-SERVICE CARD

NEW PRODUCTS

Analog-Digital Converter
Speed of 6000 conversions per sec



This transistorized analog-to-digital converter operates at the rate of 100,000 bits per second (a 13 bit word would require 130 μ sec), has an accuracy of ± 0.05 per cent of full scale ($\pm 1/2$ digit), and a minimum full scale of 5 v. Acceptance of bipolar inputs from -5 to $+5$ v dc with automatic indication of polarity is optional. Output is in 1-2-2-4 binary decimal code; however, any other conventional code can be supplied. Both serial and parallel outputs are available. Parallel data output is 500 μ a at 4 v. Higher power output can be supplied.

Fischer & Porter Co., Dept. ED, 641 Jacksonville Rd., Hatboro, Pa.

CIRCLE 138 ON READER-SERVICE CARD

Oscilloscope

Screen area of 1-1/4 x 3 in.



Panelscope model P-1 consists of a cathode ray tube having a useable screen area of 1-1/4 x 3 in., a high-voltage power supply, a cathode ray tube escutcheon with positioning, beam and focus controls and a variable edge lighted graph screen with an ambient light filter. The indicator panelscope model P-100 consists in addition a selenium rectifier type low-voltage power supply for positioning and second anode adjustment only. Thus the spot may be positioned. The sensitivity of both models is 56 v peak to peak per inch vertical and 80 v peak to peak per inch horizontal.

Waterman Products Co., Inc., Dept. ED, 2445 Emerald St., Philadelphia 25, Pa.

CIRCLE 139 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958

Accelerometers

Employs torque generator restraint for accuracy



Torque generator linear accelerometers measure only 2 in. diam. Accuracy is assured in these units through use of torque generator restraint in place of the usual torsion bar. The unbalance weight is housed in a hermetically sealed cylinder, which, in turn, is fully floated in exact equilibrium in a high density viscous fluid. This flotation process serves to remove all load from the jewelled bearings, while at the same time providing viscous damping and shock absorption. Torque generators can be supplied for either ac or dc operation.

Reeves Instrument Corp., Commercial Products Dept., Dept. ED, 207 E. 91st St., New York 28, N.Y.

CIRCLE 140 ON READER-SERVICE CARD

Pot Cores

Has ± 1 per cent tolerances

These ferrite pot cores have permeability tolerances of ± 1 per cent. Cores are available in diameters ranging from 5/8 to 1-3/4 in. for frequencies from 1 kc to 4 mc. Typical permeability values and tolerances are: 150 ± 3 per cent, 80 ± 2 per cent, 45 ± 1 per cent.

Ferroxcube Corporation of America, Dept. ED, Saugerties, N.Y.

CIRCLE 141 ON READER-SERVICE CARD

Switch

Stay-on, stay-off feature



This waterproof switch has a stay-on, stay-off feature similar to a toggle switch without the conventional toggle switch mechanism. Electrical rating is 15 amp resistive at 115 v ac with an expected life of at least 25,000 cycles.

Control Products, Inc., Dept. ED, 306 Sussex St., Harrison, N.J.

CIRCLE 142 ON READER-SERVICE CARD

Industrial Laminates

from the company that really knows the electrical and electronics industry—General Electric



Announcing General Electric Textolite 11574

New self-extinguishing epoxy paper

Ideal for printed circuits, unique paper-base laminate quenches fire in one second in UL flame test . . . exceeds NEMA XXX-P requirements . . . machines freely at room temperature

Do you have a high-reliability application that's too tough for conventional paper-base laminates? Self-extinguishing Textolite 11574 may solve the problem. Check these extraordinary properties:

Electrical: one million megohms insulation resistance in humidity. **Mechanical:** about twice the flexural and impact strengths of NEMA XXX-P standards. **Physical:** best cold-punchability of any high-pressure laminate General Electric has ever tested; clean, precise pierced and blanked parts.

Consult Sweet's Product Design File, Catalog 2b/Gen for technical data on the full line of reliable Textolite laminates. Fabricated parts come to you from independent local fabricators (listed in the Yellow Pages under "Plastics"), geared to give you speedy delivery. For expert help with special problems, write to Technical Service, Laminated Products Dept., Section ED-86, General Electric Co., Coshocton, Ohio.

CIRCLE 143 ON READER-SERVICE CARD

Textolite[®]
INDUSTRIAL LAMINATES
GENERAL  ELECTRIC

HEATING BLANKETS

and Other Woven Heating Elements

by **Safeway**

for MYRIAD USES

Inherent in the rapid, unremitting advance of present-day technology is a growing need for accurately controlled delivery of heat in many industrial and military applications. **SAFEWAY** heating blankets or woven-wire heating elements can be designed specifically to fill countless of these needs. Indicative of their broad potential are the diversified purposes they are already serving with complete success.

In the field of missiles and rockets, fuels, propellants and launchers are kept at operational temperatures with controlled heat.

Airframe manufacturing utilizes heating blankets for both honeycomb and metal-to-metal bonding.

Component aircraft parts . . . gyros, cameras, computers, servos, batteries, antennas, to name just a few . . . must be heated when exposed to the freezing environment at the altitudes at which jets fly. Also needed at low operating temperatures are de-icing units for propellers, wings, vertical fins and horizontal stabilizers.

Apparent, too, is the marked growth in the usage of heating blankets to satisfy winterization needs and demands of certain types of refrigeration units for satisfactory defrosting methods.

If it has to be heated (and the "it" can be just about anything), you can rely on **SAFEWAY** engineers to study your problems and — without any obligation — submit an appropriate recommendation.

FOR YOUR COPY OF A
FACT-FILLED FOLDER,
PLEASE WRITE TO:

Safeway

**HEAT
ELEMENTS
INC.**

680 Newfield Street • Middletown, Connecticut

CIRCLE 144 ON READER-SERVICE CARD



ROCKETS AND
MISSILES



AIRFRAME
MANUFACTURING



COMPONENT
AIRCRAFT PARTS

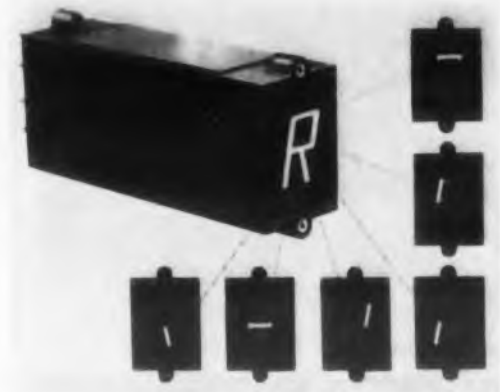


WINTERIZATION

NEW PRODUCTS

In-Line Display

Any number, letter or symbol



This in-line display unit displays any letter A through Z, any number 0 through 9, and + or - symbols. Characters are of uniform size and intensity, and good readability is insured from any angle of viewing. The size of the character displayed is approximately 7/8 in. high and 5/8 in. wide. Size of the viewing screen is 1-15/16 in. high and 1-9/16 in. wide.

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

CIRCLE 145 ON READER-SERVICE CARD

Power Supply

Features short-circuit protection



These transistorized power supplies feature electronic short-circuit protection, 100 per cent wire-wound MIL-type resistor complement, at least 25 per cent derating of all components, and internal blower cooling.

NJE Corp., Dept. ED, 345 Carnegie Ave.,
Kenilworth, N.J.

CIRCLE 146 ON READER-SERVICE CARD

Capacitors

Tantalum and electrolytic aluminum types

The polarized type dry electrolytic foil tantalum capacitor has capacity ratings from 0.3 to 200 mf and working voltages from 6 to 150 v at 50 C and 4 to 100 v at 85 C. The monopolarized types have capacity ratings from 0.15 to 100 mf at the same voltage ratings. The wet electrolytic sintered anode tantalum polarized capacitor has

ELECTRONIC DESIGN • June 11, 1958

capacity ratings from 3.5 to 325 mf at 6 to 75 v operating from -55 to 100 C. The solid electrolyte sintered anode tantalum polarized capacitor has capacity ratings from 2 to 240 mf and the working voltage from 4 to 35 v. The line of dry electrolytic aluminum capacitors have capacities from 1 to 200 mf at 3 to 250 v operating over a temperature range of -40 to 70 C.

International Telephone & Telegraph Corp., Components Div., Dept. ED, P.O. Box 412, Clifton, N.J.

CIRCLE 147 ON READER-SERVICE CARD

Converter

Changes 28 v dc to 400 cps



Model D-400 converts a dc voltage of 24 to 30 v to 400 cps with an output of 10 w. Other models provide for various dc input voltage between 100 v and 19 v.

The Standard Electric Time Co., Dept. ED, 97 Logan St., Springfield, Mass.

CIRCLE 148 ON READER-SERVICE CARD

Circuit Breaker

Compensates for ambient temperature

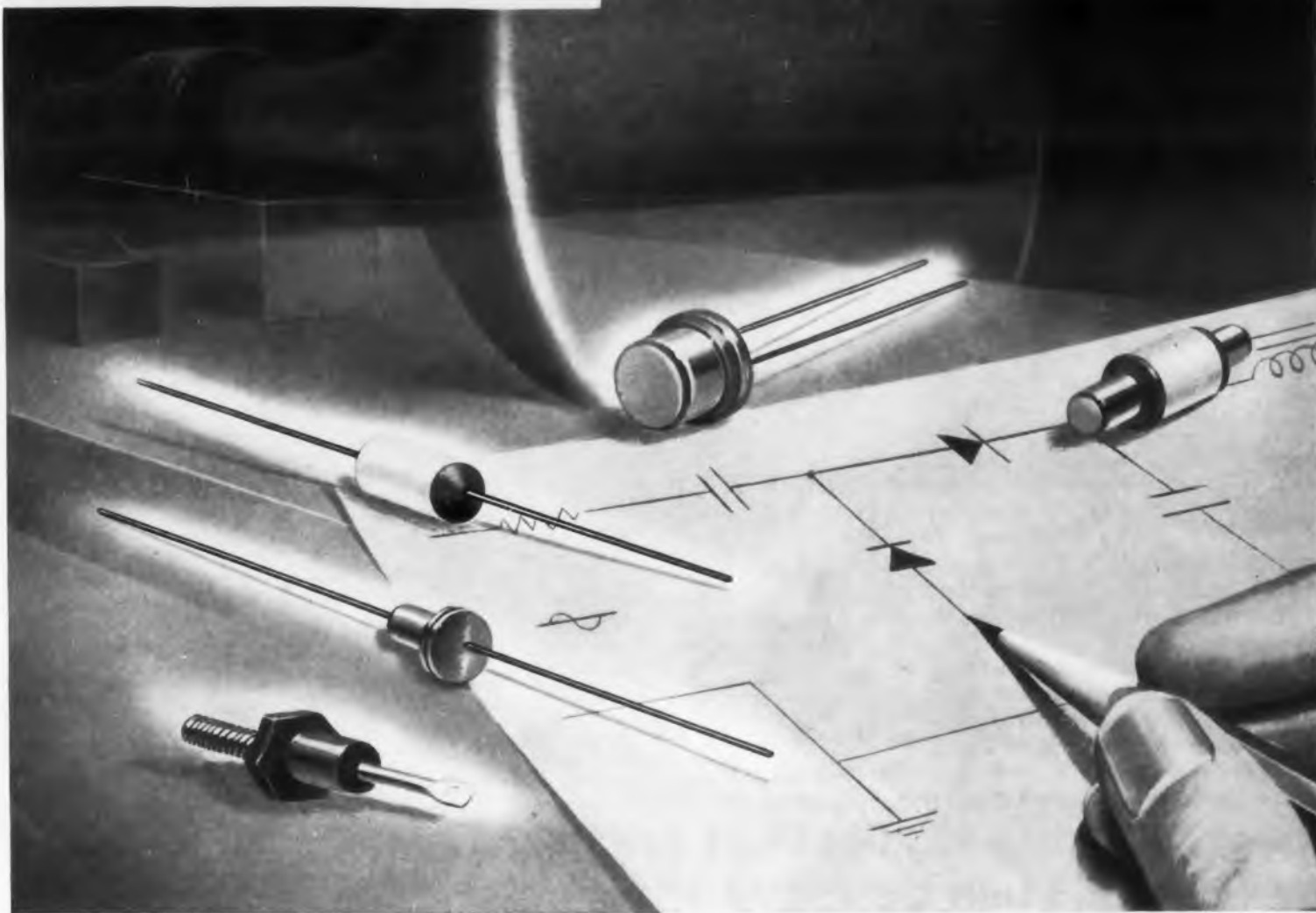


Klixon D6752-5 circuit breaker will carry rated current at 250 F, and 115 per cent of rating at 77 F and -60 F. Other features include: maximum weight of 0.2 lb; standard life of approximately 10,000 cps; high rupture capacity at 2500 a, 400 cps, 115/200 v ac and 6000 a, 28 v dc; and designed to trip at not more than 138 per cent at 250 and 77 F, and 160 per cent at -60 F.

Metals and Controls Corp., Spencer Thermostat Div., Dept. ED, Attleboro, Mass.

CIRCLE 149 ON READER-SERVICE CARD

NEWS ABOUT SILICON DEVICES



Reverse current: 10^{-7} amp. Rectification ratio: 10,000,000:1

Now... new efficiency for TV power supplies with dependable diodes of Du Pont Hyperpure Silicon

More efficient power supplies... savings in space and weight... important reasons why TV manufacturers are replacing conventional rectifying systems with silicon diodes. Today, several types of silicon diodes and rectifiers are readily available for TV circuits. TV manufacturers have tested silicon rectifiers and report no noticeable change in output voltage under continuous load conditions over long periods of time. Sil-

con components can operate in ambients from -65° to 150° C. They maintain excellent electrical stability and resist aging.

Silicon components have high shock and vibration limits. They are up to 99% efficient in units operated at 60 cps, and require little maintenance. Silicon cells permit a rectification ratio as high as 10 million to 1—almost negligible reverse conductance. Silicon bridges are

available with ratings from 1 to 1,000 amperes and more than 600 volts rms.

Note to device manufacturers: You can produce silicon transistors, rectifiers and diodes of the highest quality with Du Pont Hyperpure Silicon. It's now available in three grades for maximum efficiency and ease of use... with a purity range of 3 to 11 atoms of boron per billion. Technical information on crystal growing is available from Du Pont... pioneer producer of semiconductor-grade silicon.



NEW BOOKLET ON DU PONT HYPERPURE SILICON

You'll find our new, illustrated booklet about Hyperpure Silicon helpful and interesting—it describes the manufacture, properties and uses of Du Pont Hyperpure Silicon. Just drop us a card for your copy. E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Silicon Development Group, Wilmington 98, Delaware. (This offer limited to United States and Canada.)

CIRCLE 150 ON READER-SERVICE CARD

PIGMENTS DEPARTMENT



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

HETHERINGTON

SWITCHES • INDICATOR LIGHTS • SPECIAL ASSEMBLIES

ENGINEERING NEWS

Space-Saver Toggle Gives Big Switch Performance



When it comes to making a *real* saving in space, this new SP-DT Hetherington Toggle Switch is the answer. It is only $1\frac{1}{32}$ " in diameter by $1\frac{1}{32}$ " long. It weighs less than $\frac{1}{4}$ oz. Yet it breaks 5 amp. resistive loads at 28 volts dc ($2\frac{1}{2}$ amps @ 115 v ac) for 50,000 operations.

Best of all, Hetherington's tease-proof cam-roller snap-action gives the T3103 the "feel" of a real heavy-duty switch. Details are in Data Sheet S-3a.

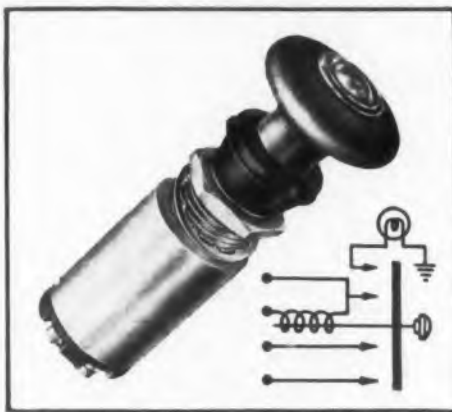
CIRCLE 200 ON READER-SERVICE CARD

Relay, Switch, and Pilot Light Functions in One Unit Only $1\frac{5}{16}$ " x $3\frac{3}{8}$ "

This "control engineer's delight" does the work of *two* conventional switches plus a holding relay and an indicator light. All of this is accomplished in only a fraction of the space, weight, and wiring needed for separate components.

Once the button is pressed, a built-in 28-volt solenoid holds the switch on contact until either the coil circuit is externally interrupted or the button is pulled out. A built-in indicator light shows when the coil circuit is energized.

Modifications of this basic Hetherington Holding Coil Switch design include a variety of circuit arrangements. Pull-on and push-on pushbutton types as well as a toggle type are available. Their many aviation and industrial uses center



around jobs where the switch is manually "closed" to start an operation; then electrically "opened" at the end of the sequence. In an emergency, the switch may be manually opened in the middle of the sequence if desired.

CIRCLE 201 ON READER-SERVICE CARD

HETHERINGTON INC. DELMAR DRIVE, FOLCROFT, PA. • 139 Illinois St., El Segundo, Calif.

Over 455 PRECISION push-button Switch Types

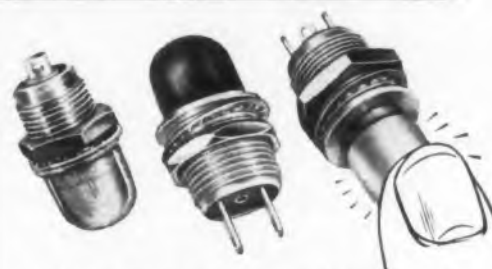
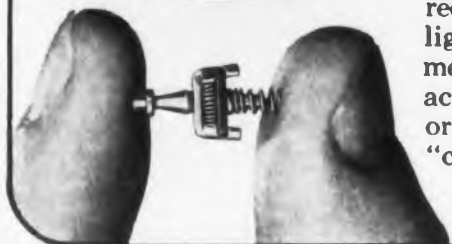
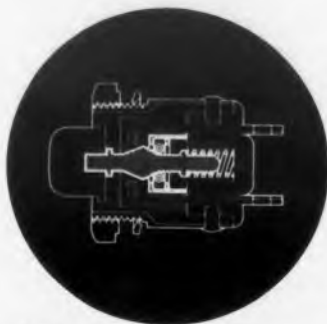
CIRCLE 151 ON READER-SERVICE CARD

The Switch Design That Says "NO FOOLIN"

No Tease . . . No Deceptive Clicks

Higher ratings in smaller, lighter-weight switches are made possible by this little beryllium device . . . the heart of every Hetherington snap-action switch.

A polished tapered rod operates through two compression springs in the shorting bar and against the return spring. Its lightning-fast, double-break snap action reduces arcing and contact welding to negligible proportions—even with high momentary overloads. Contact pressure is actually greatest at the point of "make" or "break" thus preventing deceptive "clicks" or contact teasing.



W-I-D-E Angle Visibility from Indicator Lights only $1\frac{1}{4}$ " Long

Almost 50 percent of the surface of these tiny units is useful illuminated area. Thanks to a specially-beveled lens cap, light is "piped" evenly throughout the entire lens. Full 180-degree visibility is assured on either standard or edge-lit panels.

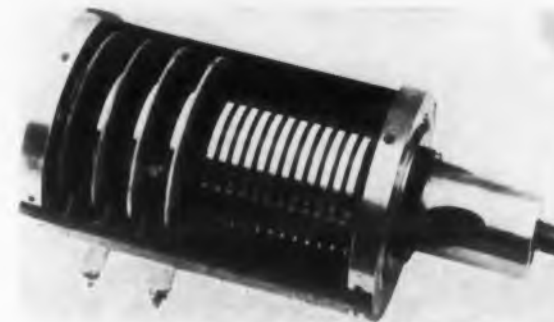
These miniature Hetherington Series L6000 lights come in both 2-terminal ungrounded, or 1-terminal case-ground styles. Single piece terminals and contacts cannot be torn loose by heavy wires. Request Bulletin L-2b.

CIRCLE 202 ON READER-SERVICE CARD

NEW PRODUCTS

Centrifuge Slip Ring

For voltages of 10 kv dc



This centrifuge slip ring has three high voltage circuits capable of 10 kv dc continuous and has been tested at 20,000 v hi-pot. Instrumentation circuits are unaffected by adjacent high voltage circuits. Minimum noise is accomplished by the use of precious metals. Dual brushes, riding on each ring, are tuned to different resonant frequencies, providing uninterrupted circuits despite severe shock and vibration. The assembly is rated at 350 F continuous operation. All 15 slip rings and shielded wires are high pressure molded into one integral assembly. The units provide 10 to 15 million revolutions of noise-free operation at 6000 rpm.

Slip Ring Company of America, Dept. ED, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 152 ON READER-SERVICE CARD

Test Shield

Substitutes for screen-room



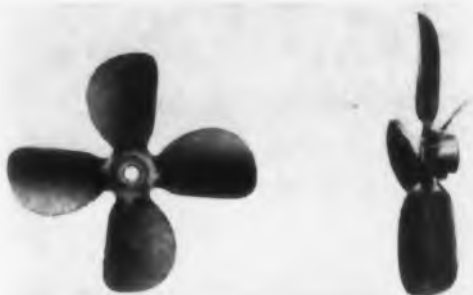
Type G-1 is engineered to replace a full-size, calibrated radio compass screen room. Weighing only 35 lb, the test shield can be powered by any standard signal generator. It produces a source of calibrated field strength together with dummy sense antennas of 25, 50, 100 and 150 μ f.

Transdyne Corp., Dept. ED, 58-15 57 Drive, Maspeth 78, N.Y.

CIRCLE 153 ON READER-SERVICE CARD

Fans

No vibration resonance below 1000 cps



Hi-Mode Series D four and five bladed all-aluminum fans, available in six diameters from 4 to 8 in., have been tested without blade resonance under applied frequencies of 1000 cps. These fans not only will not resonate at any external vibration excitation below this frequency, but will permit continuous operation at higher speeds and consequently higher air outputs.

Torrington Manufacturing Co., Air Impeller Div., Dept. ED, Torrington, Conn.

CIRCLE 154 ON READER-SERVICE CARD

Silicon Rectifiers

Feature 750 ma to 55 C



Type K silicon rectifiers feature 750 ma to 55 C. Voltage ratings are 100, 200, 300 and 400 piv.

Tarzian, Inc., Sarkes Rectifier Div., Dept. ED, 415 N. College Ave., Bloomington, Ind.

CIRCLE 155 ON READER-SERVICE CARD



Rheostat

Features fine adjustment

Mikrohm rheostats of the 310 series are available in resistance ranges of 0.25 to 3.0 ohm with maximum current ratings of 0.25 to 1.0 a. The minimum insertion resistance is approximately 10 per cent of the maximum resistance of the rheostat.

Superior Electric Co., Dept. ED, Bristol, Conn.

CIRCLE 156 ON READER-SERVICE CARD

Westinghouse Roberts Test Technique Frees Reject-Strangled Production...

*Perfectly paired Hipermag cores
boost magnetic amplifier output*



Mr. Cliff Horstman checks performance readings for Hipermag cores using the Roberts Dynamic Tester. This production-line test eliminates costly and complicated testing at your plant. After the Roberts test, Hipermag cores are "pegged" here according to their performance characteristics. This practice assures perfect performance-matching every time.

A very high reject ratio was strangling magnetic amplifier production at the plant of a large eastern manufacturer. Analyzed by the company's own engineers, the problem was found to be a case of inadequate core matching. A core-matching specification based on sine current dynamic testing was attempted. However, since the application was a voltage regulator using voltage reset, the problem of matching maximum permeability to the required tolerances was practically insurmountable for production-line testing.

After Westinghouse engineers analyzed the problem, it was decided that matching cores at zero control point with the Roberts tester would help obtain the desired high yields.

Production-run cores matched by this procedure were flown to the manufacturer from the Westinghouse Greenville plant. These cores resulted in an immediate improvement in production-line performance.

The Roberts core-matching technique provides the closest approach to magnetic amplifier design for commercial testing of cores that exists today. This testing technique on standard Hipermag cores provides performance tailored to your magnetic amplifier application.

Let our engineers help you with your magnetic amplifier production problems. Call your Westinghouse representative . . . or write Specialty Transformer Department, Westinghouse Electric Corporation, P.O. Box 231, Greenville, Pa.

[®]Trade-Mark

J-70873

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

CIRCLE 157 ON READER-SERVICE CARD

DO REGULATED

You get **MORE** from **STABLVOLT*** POWER SUPPLIES

These new DC power supplies feature line transient suppression, fast response, and achieve the highest possible degree of reliability.

Designed for a broad range of applications, they are recommended wherever accurate, trouble-free performance is desired.

Dual magnetic regulation plus the most modern electrical and mechanical design techniques are combined in these competitively priced power supplies. Built and guaranteed for the most rugged duty by Stablvolt*—your assurance of quality in service and performance.

Write for bulletin **DMR-100**.

Model DMR 136-15

Regulated broad range unit with output voltage from 0.5 to 36 volts DC, 0-15 amps.

Model DMR 28-5

One of many versatile models engineered to meet your specific requirements. 18-36 volts DC, 0-5 amps.

* Reg trade mark



STABLVOLT DIVISION

of MAGNETIC RESEARCH CORPORATION

200-202 Center Street, El Segundo, California

EAsgate 2-2403

CIRCLE 158 ON READER-SERVICE CARD

NEW PRODUCTS

Annunciator

Operates without relays



This annunciator for monitoring complex automatic systems uses static-magnetic controls instead of the relays used in conventional annunciators. The annunciator's plug-in design makes it possible to change sequences without rewiring.

Panellit, Inc., Dept. ED, 7401 N. Hamlin, Skokie, Ill.

CIRCLE 159 ON READER-SERVICE CARD

Erase Head

55 db erasure



This low power erase head is especially suited for use with transistor circuitry. With 0.5 va current, 55 db erasure is obtained. The unit is designed to permit ganging to obtain 2-track and 4-track erasure.

Michigan Magnetics, Inc., Dept. ED, Vermontville, Mich.

CIRCLE 160 ON READER-SERVICE CARD

Plugs

Varied 7 and 9 pin types



Model M-1037 is available in 7 and 9 pin versions. Model M-1000-1 accommodates 300 ohm

ELECTRONIC DESIGN • June 11, 1958

lead or other special wires. Model M-1002-4 accommodates 18 SPT 1, 20 XT, and other special wires. Model M-1025 is molded in vinyl and will accept XT cord only.

Phalo Plastics Corp., Dept. ED, 25 Foster St., Worcester, Mass.

CIRCLE 161 ON READER-SERVICE CARD

Relay Analyzer

Tests relays under actual contact loading



Model 140 has been designed to check every phase of relay operation. A cycling circuit permits automatic cycling of the relay at a rate selected by the operator. Adapters to accommodate various relay types may be plugged into the front panel. These are designed so they may contain switches for special measurement, such as analyzing relays with 8 from "C" contacts.

Schmeling Electronics, Dept. ED, 20 First St., Keyport, N.J.

CIRCLE 162 ON READER-SERVICE CARD



Bandpass Filter

Gives sharp low-high cutoff

This toroidal bandpass filter is available with a flat response through a 3 kc passband and sharp low-high cutoff. Frequencies range from 17.2 to 20.2 kcs. Designated as model 360B, unit is hermetically sealed and measures 2-1/4 x 2-3/4 x 3-7/8 in. Input impedance unbalanced is 20,000 ohms, output 20,000. Maximum operating voltage 500. The 360B has an insertion loss at 18.5 kcs of 6 db with a minimum stop-band attenuation of 45 db.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Pa.

CIRCLE 163 ON READER-SERVICE CARD

new and unique!



**Eliminate
Breadboard Layout!
SPEED DESIGN OF TRANSISTOR CIRCUITS
With the SPRAGUE TRANSIMULATOR**

Bring transistor circuits to life in a matter of minutes with the Sprague LF-1 Transimulator. This new instrument lets you simulate any amplifier stage, a-c or direct-coupled, short of high power audio output; also multivibrator, switching, phasing, push-pull, Class A and B, and many others using cross-coupled Transimulators . . . whether the circuit is common or grounded emitter, base, or collector . . . whether the transistors are PNP, NPN, or Surface Barrier. You can simulate circuits stage-by-stage for cascade operation . . . or use a separate Transimulator for each stage to get simultaneous multi-stage operation.

Bring Circuit Diagrams To Life In Minutes

Everything you need for RC amplifier circuits is built right into the LF-1, including coupling capacitors . . . bias and load resistors . . . battery voltage supplies . . . Base Collector—Voltage Divider stabilization circuits . . . 5-way binding posts for transformer coupling and metering.

Whether you're designing audio circuits or switching circuits, you'll get a true picture of operating parameters minutes after you've drawn the circuit diagram . . . without wasting valuable time with breadboard and soldering gun.

Pays For Itself In A Matter Of Weeks

An ideal laboratory instrument, Transimulators are inexpensive enough to justify several on every bench. You can even use the LF-1 to test transistors *in the circuit* . . . the only real proof of design parameters. And a complete step-by-step instruction manual makes operation fast, simple, and easy.

FEATURES OF THE LF-1 TRANSIMULATOR

- TRANSISTORS—PNP and NPN Junction, and Surface Barrier.
- CIRCUITS—Common or Grounded Emitter, Base, Collector.
- RANGE—Audio, up to 100 kc.
- TRANSISTOR POWER—Through medium power audio output.
- BATTERY SUPPLY—Separate bias and load. 1.5, 3, 4.5, 6 volts d-c. Polarity Reversing Switch.
- COUPLING—2 μ f and 20 μ f Direct, and Ext. C. posts, on both Input and Output.
- BIAS RESISTANCE—Up to 555,000 ohms continuously variable.
- LOAD RESISTANCE—Up to 277,500 ohms continuously variable.
- EMITTER RESISTANCE—Up to 2,500 ohms variable. Series resistor and bypass capacitor can be added.
- BASE COLLECTOR STABILITY—Up to 250,000 ohms variable. Series resistor and bypass capacitor can be added.
- VOLTAGE DIVIDER STABILITY—Up to 50,000 ohms variable.
- 5-WAY BINDING POSTS—For meters, transformer coupling, external supply voltage, degeneration, bypass, coupling, signal input and output, almost any connection required.

only **\$7950**
NET

SPRAGUE®

SPRAGUE PRODUCTS COMPANY, NORTH ADAMS, MASSACHUSETTS

CIRCLE 164 ON READER-SERVICE CARD



NEEDED:

Engineers who don't know
"It Can't be Done that Way!"

General Electric's Jet Engine Dept. at Cincinnati now conceives and designs its own Jet Engine controls, accessories, and components, also designs its own test instruments and instrumentation systems. This has created many new positions to be filled, and we have immediate openings for graduate engineers with experience in any of the following fields:

| | |
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| INSTRUMENTATION SYSTEMS | ACTUATION DEVICES |
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| AERODYNAMICS | SERVO MECHANISMS |
| ELECTRONIC PACKAGING | FUEL CONTROLS |
| MAGNETIC AMPLIFIERS | LUBE SYSTEMS |
| AIRCRAFT SURFACE CONTROLS | |

These are career jobs and they pay well for engineers willing and able to work on brand new problems and come up with new answers. Actually, you'll be finding answers that will appear in Tomorrow's textbooks!

If you like the challenge of new problems . . . if you like to work where Engineers don't know "it can't be done that way" . . . fill out the coupon below and mail to

J. A. McGovern, Jet Engine Dept. ED-611
 General Electric Co., Cincinnati 15, Ohio

Gentlemen: I am interested in the possibility of an association with the Jet Engine Dept. of General Electric.

Name _____

Address _____

City _____ Zone _____ State _____ Phone _____

Degrees _____ College _____ Date _____

My field of interest is: _____

ED-611

GENERAL ELECTRIC
 JET ENGINE DEPARTMENT CINCINNATI 15, OHIO
 CIRCLE 560 ON READER-SERVICE CARD

NEW PRODUCTS

Solenoid Valve

Quick disconnect features



Model P/N 220155 plug-in valve is a four-way, three-position solenoid actuated unit rated at 100 psi service pressure and operated by 115 v, 60 cps ac. Designed for operating pressures of 100 psi, this valve will withstand surge pressures of at least 250 psi.

Whittaker Controls, Div. of Telecomputing Corp., Dept. ED, 915 N. Citrus Ave., Hollywood, Calif.

CIRCLE 166 ON READER-SERVICE CARD

Power Supply

0.3 per cent regulation



Model 721A power supply has an output of 0 to 30 v. Regulation, no load to full load, is 0.3 per cent or 30 mv, whichever is greater.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Rd., Palo Alto, Calif.

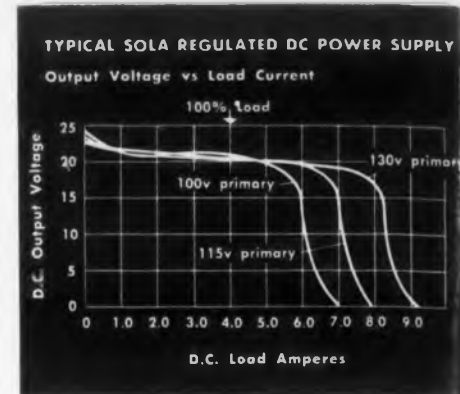
CIRCLE 167 ON READER-SERVICE CARD

Noise Figure Meter

Employs test facility for system errors



Model 501 automatic noise figure meter operates at 30 mc input with sensitivity sufficient to measure TWT noise figure without external amplification. Noise figure is read directly for a 15.2 db noise source. A test facility for system errors



RELIABLE

regulated DC power supply

Here's a regulated dc power supply that will protect its load and itself from a fault or short beyond the primary of its power transformer. If you're interested in a simple, reliable source of regulated dc power, you'll like the Sola Constant Voltage DC Power Supply.

This very desirable load protection characteristic results from the current-limiting action of the Sola Constant Voltage Transformer. It is combined with a semiconductor rectifier, and a high capacitance filter. The current-limiting action protects both the rectifier and capacitors from damage by preventing excessive charging current.

This unique combination of components results in a power supply that is unusual in many other ways as well. Regulation is within $\pm 1\%$ with up to 10% line voltage variation . . . ripple within 1% rms . . . efficiency is high. It's particularly well-suited for intermittent, variable, and pulse loads.

The Sola dc supply is reliable, simple, compact, and moderately-priced.



Available from stock, or as a custom designed unit.

Write for Bulletin 31F-DC-235

Sola Electric Co., 4633 W. 16th St., Chicago 90, Ill.

SOLA
 Constant Voltage Transformers
 Regulated DC Power Supplies
 Mercury Lamp Transformers
 Fluorescent Lamp Ballasts

CIRCLE 168 ON READER-SERVICE CARD

is employed for the first time in an automatic noise figure meter. Operating voltage for a gas noise source is provided at a BNC connector. Recorder output supplies noise figure information for either 100 mv or 1 ma recorder movements. Scope output permits optional monitoring of zero reference, noise figure and infinity reference as a three-step wave form.

Brocker Labs., Box 967, Dept. ED, Sunnyvale, Calif.

CIRCLE 169 ON READER-SERVICE CARD

Diode Function Generator

Features punched card memory



Model 100 diode function generator is used to generate either nonlinear functions of an independent input voltage, or of any parameter which may be converted to a voltage, or it may be used to generate nonlinear functions of time by using either an internal or an external time base. The fact that a complete library of nonlinear functions may be created for future use as necessary, makes the unit useful for data correction and data handling operations.

Electrol, Inc., Dept. ED, 9000 W. Pico Blvd., Los Angeles 35, Calif.

CIRCLE 170 ON READER-SERVICE CARD

Frequency Oscillator

Range from 100 cps to 100 kc



Model 110-A variable frequency oscillator has an adjustable output frequency range of 100 cps to 100 kc with an accuracy of 5 counts or 0.005 per cent. The unit may be automatically programmed by use of paper tape or patch programming, thereby permitting 11 or 18 point calibration.

Digital Instrument Labs., Dept. ED, 152 S. Atlantic Blvd., Los Angeles 32, Calif.

CIRCLE 171 ON READER-SERVICE CARD

THE
NEW SANBORN

“350”
SERIES

6- AND 8-CHANNEL

DIRECT WRITING SYSTEMS

Here are the completely new, instantaneous direct writing 6- and 8-channel Sanborn “350” oscillographic recording systems designed to give you the most useful possible combination of *performance accuracy—flexibility—reliability—and operating convenience.*

Consider first some characteristic *performance* figures and features: essentially flat response to 100 cps at 10-div. peak-to-peak amplitude, down 3db at 120 cps; limiter circuit *ahead* of Amplifier assures damping at all times; current feedback Power Amplifier design to prevent thermal drift; true damping by velocity feedback; galvanometer natural frequency 55 cps; hysteresis level less than 0.2 div.; linearity 0.20 div. over entire 50 divisions; permanent, inkless, direct writing in true rectangular coordinates on plastic coated Permapaper.

Now notice the *packaging*: an entire 6- or 8-channel “350” system—Preamplifiers and their own Power Supplies, Recorder assembly with built-in Power Amplifiers and Power Supplies, and other components—is housed in one mobile cabinet. Preamplifier modules are separated from Recorder-Power Amplifier unit, so that either can be used separately. Self-contained Recorder package uses transistorized, plug-in Power Amplifiers, Power Supplies with solid state rectifiers, low impedance, low voltage enclosed galvanometers; when used as a separate unit, sensitivity is 0.1 volt/chart division.

Add to these “350” performance and packaging features the value and convenience of extremely easy chart loading from the front; nine electrically controlled chart speeds, selected by pushbuttons, with contacts for remote control; built-in paper take-up, paper footage indicator and timer-marker stylus; four presently available interchangeable Preamplifiers (Carrier, DC Coupling, Servo Monitor-demodulator, True Differential DC), with several more to follow.

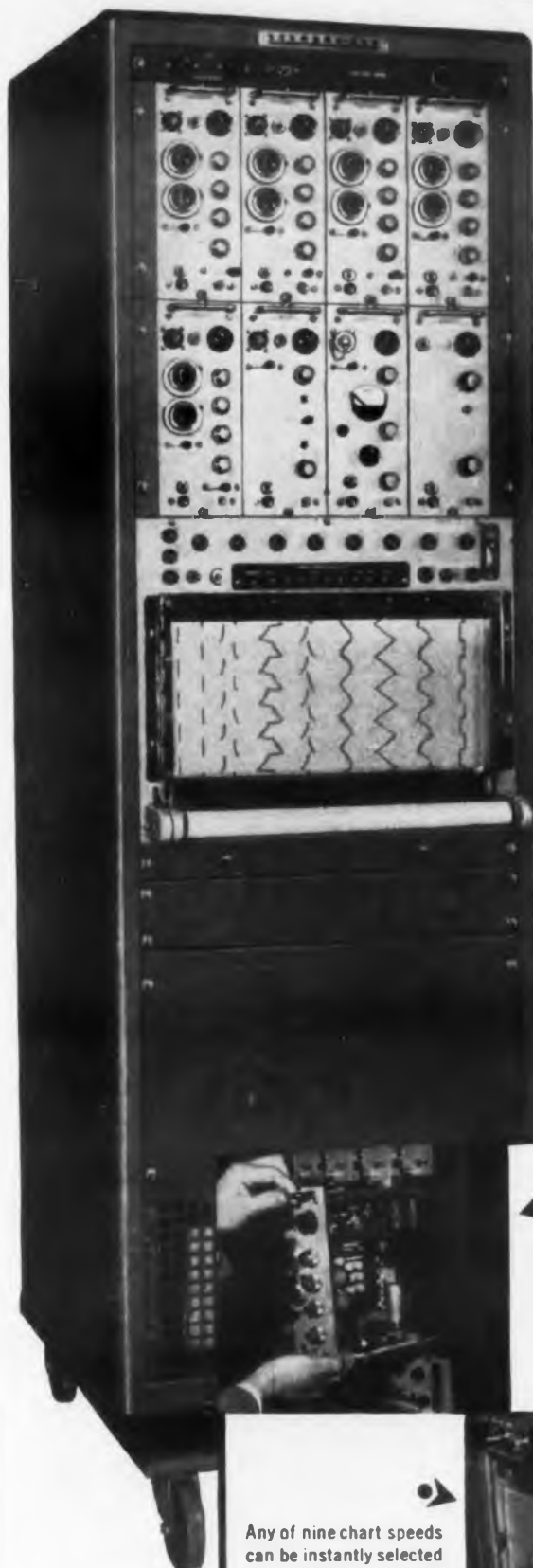
These are highlights of the new “350’s”—duplicated by no other equipment in existence today. *Ask your local Sanborn Engineering Representative for more information, or write Sanborn directly.*

(All data subject to change without notice)

INDUSTRIAL DIVISION

SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.



Any “350” Preamplifier installs easily in any channel. Electrical connections made by mating connectors on Preamp and Power Supply.

Quick, simple paper loading is done from front; hinged viewing window is removable. About 8” of record visible. All controls on front panel.

Any of nine chart speeds can be instantly selected by pushbutton. Remote control of all functions provided by connectors at rear.

Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged), four on either side of Power Supply section. Entire back plate removable for servicing.

CIRCLE 172 ON READER-SERVICE CARD



New, Improved WOBBULATOR

Model 7200



**Features
New Technique
In Electronic
Swept Frequency
Signal
Generators!**

One of the objectives in the design of the Canoga Wobbulator 7200 is to obtain high sensitivity without the "hum" problems normally experienced with other swept frequency generators. The swept frequency output voltage of the Wobbulator 7200 is modulated at approximately 50 Kc; the probes, with their internal diodes, detect this modulation which is then amplified in the vertical CRT band-pass amplifier. This new principle allows the use of swept generator techniques for evaluation of low gain or lossy circuits where point by point frequency measurements were previously necessary.

| | |
|---|--|
| Frequency Range: | 2.0 to 1000 mc |
| Swept Frequency Band: | 2.0 to 55 mc, continuously variable |
| Output: | More than 0.03 volts, 50 ohms |
| Sweep Circuit: | All electronic |
| Swept Output: | 1) Constant within ± 1 db over 40 mc 2) Constant within fractions of db over 30 mc |
| Attenuator Dial: | Calibrated in 1 db increments |
| Probe Detectors: | 1) Low impedance 50 ohms 2) High impedance |
| High Sensitivity Vertical Amplifier: | 50 microvolts input gives at least 2" deflection |
| Cathode Ray Tube: | 5UP1, with camera mounting bezel |
| Calibrated Panel Controls: | Center frequency Output Attenuator |
| Panel Controls: | Deviation Vertical Amplifier Gain Control Vertical Amplifier Gain Switch, high-low CRT intensity, focus CRT Vertical & Horizontal Centering On-off switch |
| Power: | 115V, 60 cps, 175 Watts |
| Output Impedance: | 50 ohms, BNC connector |

WRITE TODAY FOR COMPLETE DETAILED INFORMATION

Radar Systems
Antennas
Receivers
Test Equipment
Microwave Components

**CANOGA
CORPORATION**
5955 Sepulveda Boulevard
Van Nuys, California

CIRCLE 173 ON READER-SERVICE CARD

NEW PRODUCTS

Circuit Breaker

Has transparent cover



Named the Saf-T-Vue, the breaker has a removable transparent cover through which one may see at a glance whether the contacts are open or closed.

American Cyanamid Co., Dept. ED, 30 Rockefeller Plaza, New York 20, N.Y.

CIRCLE 174 ON READER-SERVICE CARD

Power Supply

0.5 to 30 v dc output



Model 30-500 transistorized power supply has a dc output from 0.5-30 v dc at 50 ma max. Ripple and noise is 2 mv rms at full load.

California Computer Products, Dept. ED, 3927 W. Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 175 ON READER-SERVICE CARD

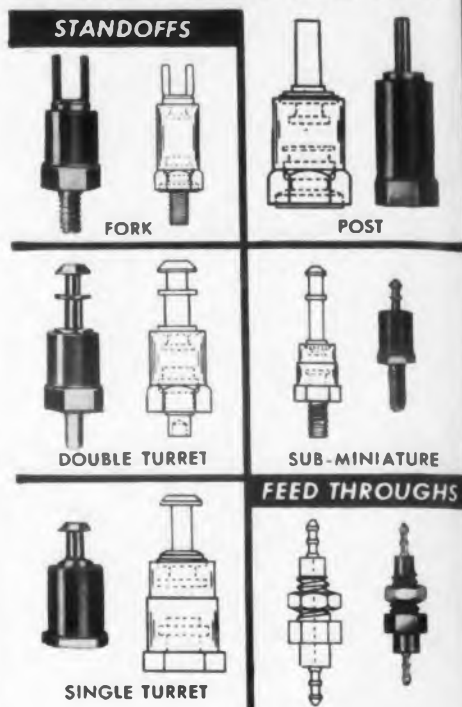
Recorder

Permits remote servo-control applications



SR-100 potentiometer-recorder, with plug-in servo amplifier and horizontal writing surface, records any phenomenon from which a dc volt-

GET THE EXACT TERMINAL YOU NEED AT NEW LOW PRICES!



FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

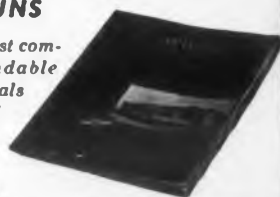
Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.

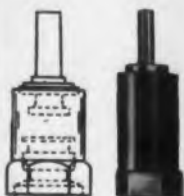


WHITSO, INC.

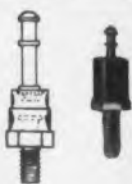
9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 176 ON READER-SERVICE CARD
CIRCLE 184 ON READER-SERVICE CARD

**THE EXACT,
WHAT YOU NEED
AT LOW PRICES!**

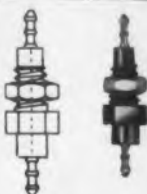


POST



SUB-MINIATURE

FEED THROUGHS



**THE LARGEST
STOCK and CUSTOM
AVAILABLE...**

Connectors are furnished as standard. We offer a full range of types, materials and plating combinations. They can be supplied to any specification. Our Whitso line is complete to meet the needs of every industrial, military or commercial requirement.

Types include fork, single and double, standard, miniature and body types—male, female or molded or metal base. Terminals are furnished standard or custom.

Connectors are molded from meliorating materials to provide special properties.

Standard as follows—metal grade (Mil-P-14, Type I) or impact grade (Mil-P-14, Type II) and phenolic, electrical grade (MFE).

Options: Twelve terminal arrangements, depending on electrical requirements, furnished as standard.

Materials and plating combinations, dimensions, can be supplied to meet specifications.

**EVERY IN ECONOMICAL
SOLUTIONS**

Not com-
parable
to others



WHITSO, INC

1000 North Dearborn Street, Schiller Park, Illinois
(Chicago Suburb)

FOR INFORMATION, FILL IN READER-SERVICE CARD
FOR INFORMATION, FILL IN READER-SERVICE CARD

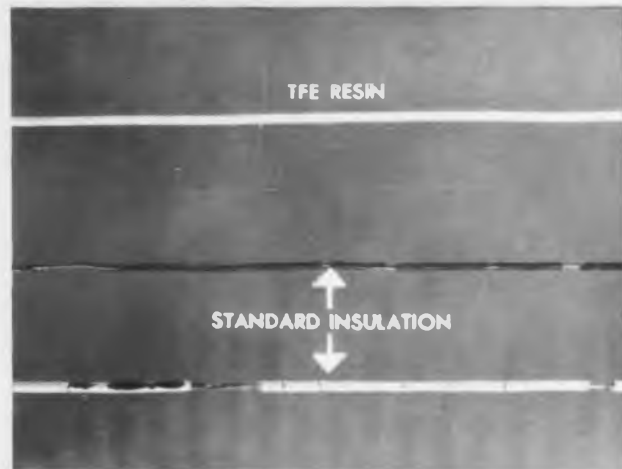
• June 11, 1955

Wire and Cable Insulated With DuPont TFE-Fluorocarbon Resins Offer Unmatched Reliability . . . With an Opportunity for Cost Savings . . . *Here are some of the ways you benefit—*



TEFLON®

No time limit on reliability . . . eliminates heat aging



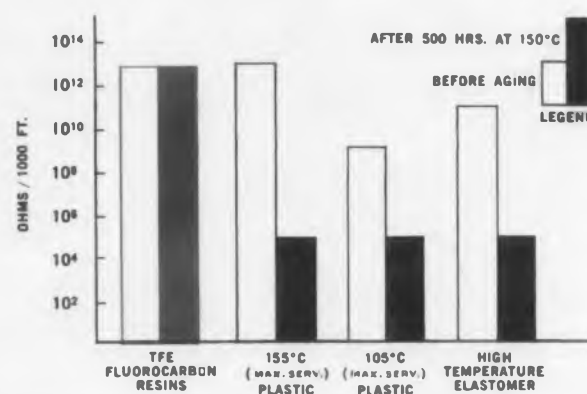
In laboratory tests of wire insulation, even after moderate accelerated aging, the TFE resins alone remained unchanged . . . other insulations cracked, charred, and even disintegrated.

Heat aging, which results in the cracking and embrittlement of most other high-grade insulations, is completely eliminated at temperatures up to 260° C. by the use of TFE resins.

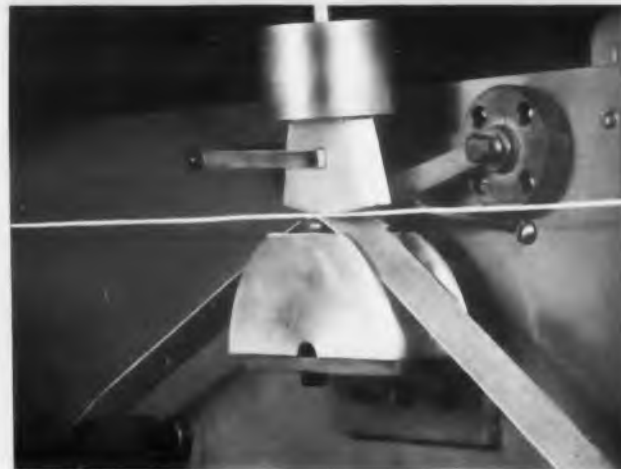
In lab tests of 7 different wire insulations, only TFE-fluorocarbon resins maintained an insulation resistance above 25,000 ohms per 1,000 feet after an aging period of 500 hours at 150° C. The TFE resins maintained their initial value of over 25 million megohms per 1,000 feet.

Consider what the elimination of heat aging means to you. For example, in home appliances, new designs are now being achieved. In plants, expensive down-time and maintenance can be reduced by the installation of TFE resin in hot spots, or where temporary electrical overloads may occur.

INSULATION RESISTANCE AFTER ACCELERATED HEAT AGING



Extends service life . . . reduces chafing and cracking



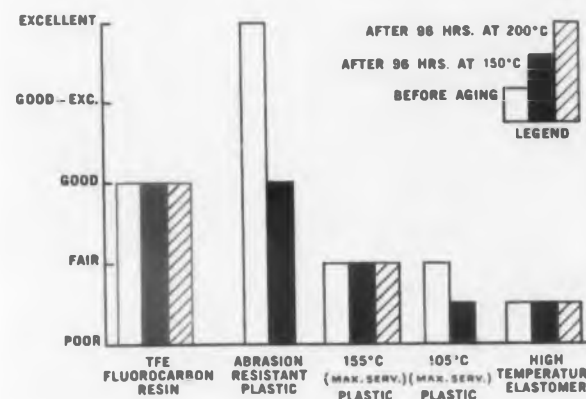
Standard abrasion tests prove that after even moderate aging, the abrasion resistance of insulation of TEFLON fluorocarbon resins is superior to that of all other high-grade wire insulations.

Even at tight bends, the extremely low surface friction of TFE resins prevents chafing of harnessed wires and twisted pairs. Fraying is no longer a problem where vibration, flexing or shock are present. Standard tape abrasion tests show that, after moderate aging, TFE resins are more durable than other wire insulations. This same low coefficient of friction makes it easy to slip spaghetti tubing over long conductors.

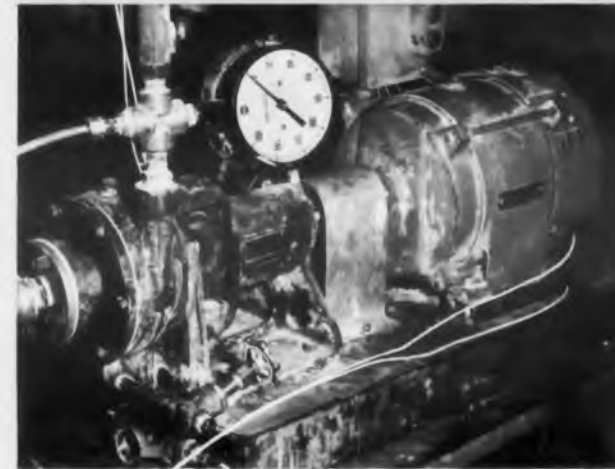
Tests also indicate that TFE resins have superior flex life. Even at extremely low temperatures, they will not crack when flexed.

Both of these properties of TFE resins mean longer service life and reduced maintenance time on equipment where vibration or flexing are encountered. Where ambient temperatures are high, TFE resins can eliminate chafing and cracking.

TAPE ABRASION RESISTANCE



Unaffected by lubricants, corrosive atmospheres or outdoor weathering



Insulation of TFE resin is unaffected by corrosive atmospheres, such as those found around this chemical equipment. Very low permeability reduces danger of shorts caused by splashing.

TFE resins are among the most chemically stable materials known. Wire and cable insulation remains 100% effective even when exposed to corrosive atmospheres—for example, in the control-panel wiring of chemical plants. This property is vital in electrical power installations, where the insulation may contact penetrating fluids, such as hot transformer oils.

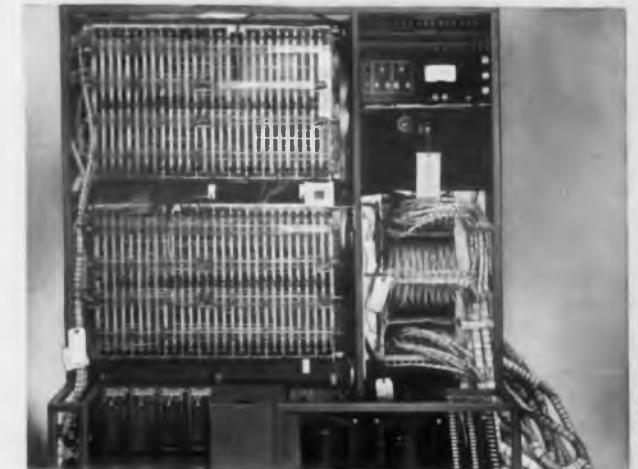
In addition, TFE resins are relatively impermeable to nearly all chemicals. They have less than 0.01% water absorption by ASTM test. Their waxy surface is actually water-repellent.

With TFE resins there are no weathering problems. Even freezing cold, ultraviolet rays, or salt spray are harmless to them. Exposure to Florida weather for over 10 years resulted in no measurable change in their properties.

RESISTANCE OF TFE RESINS TO COMMON CHEMICALS

| ONE WEEK EXPOSURE AT 212°F | DIELECTRIC STRENGTH | TENSILE STRENGTH ELONGATION |
|-----------------------------|---------------------|-----------------------------|
| "Hydrol" Hydraulic Fluid | Unchanged | Unchanged |
| Benzene | Unchanged | Unchanged |
| Carbon Tetrachloride | Unchanged | Unchanged |
| Ethanol | Unchanged | Unchanged |
| Red Fuming Nitric Acid | Unchanged | Unchanged |
| ONE WEEK EXPOSURE AT 73°F | | |
| A-8 Transformer Oil | Unchanged | Unchanged |
| 80 Octane Aviation Gasoline | Unchanged | Unchanged |
| JP-4 Turbo Fuel | Unchanged | Unchanged |
| Salt Water | Unchanged | Unchanged |
| Naptha | Unchanged | Unchanged |
| Isopropyl Alcohol | Unchanged | Unchanged |

Plus excellent, highly stable electrical properties



Where low attenuation and excellent dielectric properties are required such as in this data-processing equipment, TFE resins are unexcelled as wire and cable insulation.

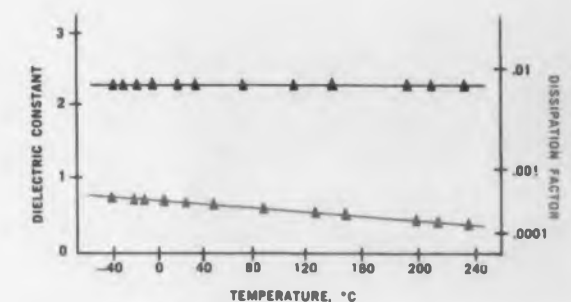
Photo Courtesy IBM Corporation

The dielectric strength of TFE resins is high and ranges from 400 to 4,000 volts per mil, depending on thickness. These values are unchanged by heat aging.

Both the dielectric constant and dissipation factor remain constant from below 60 cps to above 10,000 mc. The extremely low dissipation factor insures low signal attenuation, minimum energy losses.


Volume and surface resistivities are exceptionally high and are not affected by time or high temperature. Volume resistivity is greater than 10¹⁸ ohm-cm, while surface resistivity is more than 10¹⁷ ohms even at 100% relative humidity. Exposure to a surface arc leaves no carbonized conducting path. Because insulation of TFE resin contains no plasticizer which might alter these excellent electrical properties, consistently reliable performance is assured.

DIELECTRIC CONSTANT AND DISSIPATION FACTOR VS. TEMPERATURE



This insert is perforated
Tear out for handy reference

SEE PAGE 4 FOR THE STORY ON COST SAVINGS TO YOU



STORY
IN WIRE INSULATION!

It's easy to tell which is the insulation of TFE resin as other insulations melt, smoke and char during this simple test.

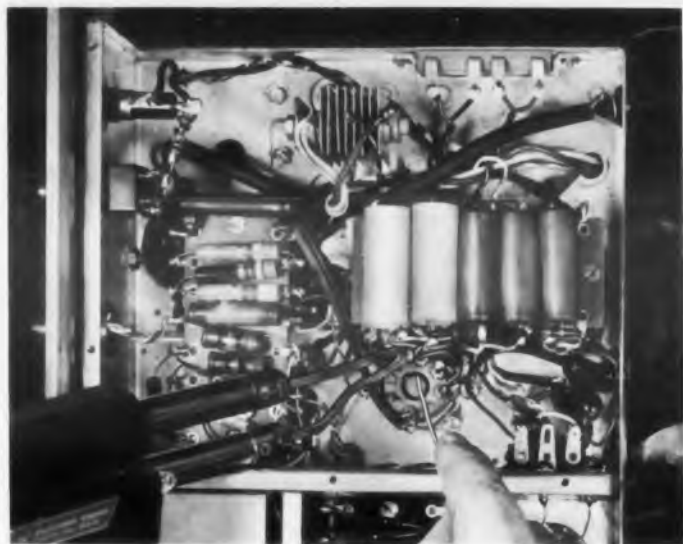
No other organic insulating material can match the properties of DuPont TFE-fluorocarbon resins. They have virtually ideal electrical properties. Their temperature ratings are unsurpassed by any other flexible insulation. TFE resins are steadily becoming more attractive to electrical and electronics engineers for economic reasons.

The two inside pages of this folder show you some of the ways you can benefit from the stable characteristics and reliability of TFE-fluorocarbon resins. On the back page you will learn how TFE resins speed fabrication and aid miniaturization . . . at cost savings to you!



BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Here's how Du Pont TFE resins provide easier assembly and space savings *... with cost reductions for you*

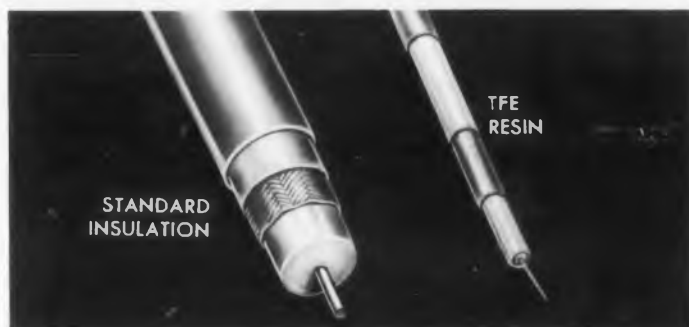


Wire insulated with TFE resin is unaffected by potting temperatures or soldering iron heat. Soldering time is shortened, inspection costs reduced, reliability improved.

IN ASSEMBLY, particularly of tightly spaced equipment where there is danger of injuring insulation, TFE resins are unsurpassed. They are unaffected by soldering iron temperatures, thus reducing danger of shorts. The insulation will not shrink back when soldering a connection. It can even be submerged indefinitely without damage during dip-soldering operations. This means economies for you, because assembly time is lowered, and wiring rejects are greatly reduced. Also, the cost of rejecting an entire potted assembly because of heat damage to the insulation is completely eliminated. One manufacturer of electronic components cut his inspection force to one-fourth its original size by changing to wire insulated with TFE resin.

DIFFICULT DESIGN PROBLEMS can be solved by TFE resins in areas where more power must be transmitted through the same space, such as underground wiring in municipalities, or increased power for existing structures. Since it is a superior moisture and electrical barrier, TFE resin permits design of wire and cable using less total insulation. Abnormal power surges are no problem because of mechanical strength and nonflammability of TFE resin at high temperatures.

MINIATURIZATION of electrical and electronic components is made possible by the heat resistance and high dielectric strength of TFE resins. For example, they solve the problem of getting more ampere turns into a winding. Finer wire can be used, so that miniaturized coils are possible. Smaller conductors transmit the same amount of power with less insulation.



Use of TFE resins in place of standard insulation in coaxial cable permits space saving of 4 to 1 and weight saving of 2 to 1. Smaller conductors transmit equivalent power with less insulation.

SEND FOR INFORMATION

Discover how well wire and cable insulated with Du Pont TFE resins help solve your design problems. For further information, contact a processor of fluorocarbon resins (listed in the Yellow Pages under "Plastics") or write to:

**E. I. DUPONT DENEMOURS & CO. (INC.)
POLYCHEMICALS DEPARTMENT, ROOM 146
DUPONT BUILDING, WILMINGTON, DELAWARE**

In Canada: DuPont Company of Canada (1956) Limited,
P. O. Box 660, Montreal, Quebec

TEFLON[®]

TFE-FLUOROCARBON RESINS

TEFLON is the registered trademark of the Du Pont Company for its fluorocarbon resins, including the TFE resins discussed herein and the new melt processable FEP resins.



BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

age or current is derived. Instrument design of the pen-glide permits auxiliary go-no-go limits and inking references, permitting remote servo-control application.

San Jose Scientific Co., Dept. ED, 605 Sunol St., San Jose, Calif.

CIRCLE 177 ON READER-SERVICE CARD

Trimmer System

Reduces hazards, speeds jet engine trimming



LEAR FUEL TRIMMER CONTROL BOX (TOP AND SERVO)

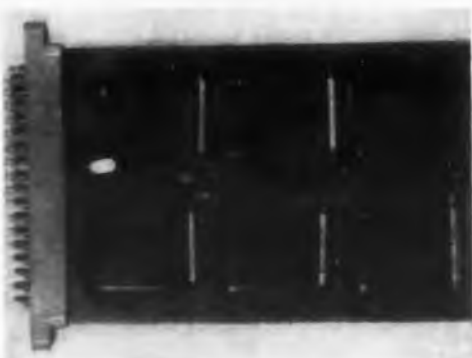
This trimmer system performs idle adjustment, jet engine trimming and the water-injection flow adjusted to provide maximum augmentation. Making these adjustments normally required three men. Now one man can perform the entire operation from the cockpit, at a safe distance from the operating engine.

Lear, Inc., Dept. ED, 110 Ionia N.W., Grand Rapids, Mich.

CIRCLE 178 ON READER-SERVICE CARD

Shift Register

Speeds up to 200 kc



This 5 bit transistor driven magnetic shift register can be directly cascaded to form shift registers of any length. Mounting centers between 5 bit boards are only 5/8 in. Output voltages are trapezoidal in shape with a minimum 5 microsecond flat top. Other units are available in which the width of the output pulse is controllable by the width of the shift pulse, and operate at speeds up to 200 kc.

Magnetics Research Co., Inc., Dept. ED, 255 Grove St., White Plains, N.Y.

CIRCLE 179 ON READER-SERVICE CARD

CIRCLE 184 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 11, 1958



Another Tinnerman Original...

Self-retaining "U" and "J" SPEED NUTS[®] cut assembly costs up to 50% or more!

If you are worried about rising assembly costs, let one-piece "U" and "J" SPEED NUTS keep costs down... and improve your product.

They can't fall off, once they've been pressed into screw-receiving position. No welding, staking or other secondary fastening devices needed. You eliminate lock washers—spring steel SPEED NUTS are self-locking, make vibration-proof attachments.

SPEED NUTS are ideal for blind assembly or hard-to-reach locations. Apply them *before* you paint panels without danger of paint-clogging. Or *after* porcelainizing, without damage to finishes. The "U" type is similar to the "J" type, shown above, but is used where full bearing surface on the lower leg is required.

A free Fastening Analysis can tell where SPEED NUT brand fasteners belong on your

products. Call your Tinnerman representative—he's listed in most major telephone directories. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN

Speed Nuts[®]



FASTEST THING IN FASTENINGS[®]

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Accessories Ltd., Trofrest, Wales. FRANCE: Simmonds S.A. 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

CIRCLE 180 ON READER-SERVICE CARD

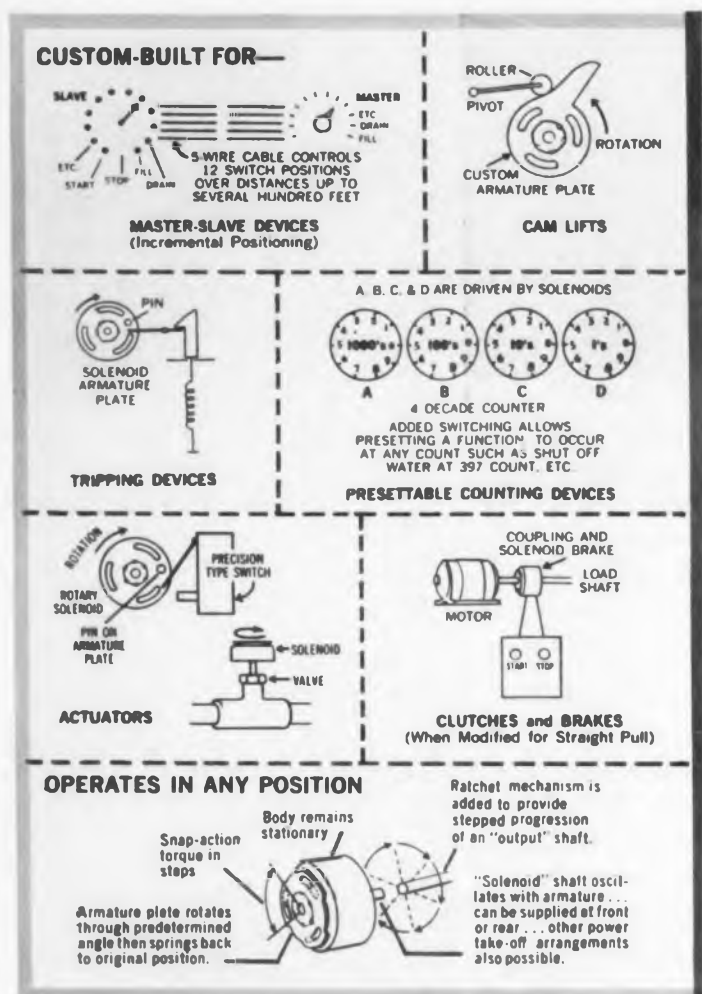
have you checked this
**Remote Actuator for jobs
 under Shock and Vibration?**

MODEL 5E
 SHOWN
 ACTUAL SIZE



OAK ROTARY SOLENOIDS

(Mfd. under license from G. H. LELAND, INC.)



Oak rotary solenoids meet such specs as MIL-S-4040A, and are unusually small for the work they can do. Custom-built, they operate on DC and provide stepping torques from 6.4 to 64 inch-ounces on intermittent duty. Standard models step at 25°, 35°, 45°, 67.5° or 95° in either a left or right-hand direction. Why not investigate these remarkable devices for your next job?

OAK MFG. CO.

1260 Clybourn Ave., Dept. D,
 Chicago 10, Ill. • Phone: MOhawk 4-2222

CIRCLE 181 ON READER-SERVICE CARD

SWITCHES
 ROTARY SOLENOIDS
 CHOPPERS • VIBRATORS
 SPECIAL ASSEMBLIES

NEW PRODUCTS

Sound Components

For pretesting aircraft and missile parts



An acoustic chamber has been designed to help determine causes of malfunction of electronic equipment in flight. It is energized by a number of 100 w loudspeaker covering the range from 40 cps to 10 kc and able to bombard the components with sound equal to that received by the equipment in high speed flight. The plane wave tube shown is capable of producing 166 db sound pressure levels. The tube is 2 in. in diam, 10 ft long, and is powered by two 100 w loudspeakers. A 5000 w amplifier will be used to drive the loudspeakers, which are especially designed for this purpose and are of 100 w capacity.

Altec Lansing Corp., Dept. ED, Anaheim, Calif.

CIRCLE 182 ON READER-SERVICE CARD

Capacitors

Ratings up to 125 C



Available with ratings to 125 C, these type CY glass capacitors have voltage ratings of 300 v and 500 v dc. Volume of the capacitors range from 0.005 cu in. for the CY10 to 0.080 cu in. for the CY30. Temperature coefficient is within the limits of $+140 \pm 25$ ppm/per deg C. The difference in temperature coefficient between any units at any given temperature is less than 15 ppm.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 183 ON READER-SERVICE CARD

most complete

- Design Forum
- Product Features
- Ideas for Design
- Engineering Review
- Standards and Specs
- Russian Translations
- Background for Design



More and more electronic engineers report: "I read *Electronic Design* first. It's complete, timely, easier to read, and I can depend upon getting *all* the new product information."

Electronic Design's 8 full time editors, plus staff of assistants, contributors, and correspondents scan the electronic horizons to bring you the complete design picture.

With reading time at a premium, ED's every-other-week frequency assures the prompt delivery of topical material; keeps up with this rapidly moving industry.

ELECTRONIC DESIGN

a HAYDEN publication
 830 Third Ave., New York 22, N. Y.
 PLaza 1-5530

NOW . . . FOR HIGH TEMPERATURE CAPACITORS



NEW MICO ISOMICA® AND SAMICA® DIELECTRICS

ADVANTAGES

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- Eliminate Pin Holes and Voids
- Uniform Thickness and Properties
- Mica Component Stable Up to 1000 F

Now you can design more efficient rolled and stacked capacitors at lower cost. Capacitor Grade SAMICA sheet can be rolled and handled like paper, yet will withstand operation up to 1000 F.

ISOMICA continuous sheet is available in virtually any size at a fraction of the cost of imported mica films.

Both are production-proved and readily available.

WRITE FOR COMPLETE DATA OR SAMPLES to the nearest Minnesota Mining & Manufacturing Company sales office or to Mica Insulator Division, Minnesota Mining & Manufacturing Company, 1714 Broadway, Schenectady 1, N. Y.



MICA INSULATOR

DIVISION OF MINNESOTA MINING & MFG. CO.
SCHENECTADY 1, NEW YORK

MICANITE® AND ISOMICA® PRODUCTS LAMICOID® LAMINATES &
FABRICATED PARTS SILICONE & TEFLON COATED CLOTHS & TAPES

CIRCLE 185 ON READER-SERVICE CARD

Capacitors

Features new impregnants and dielectrics



The XMP Series capacitor develops 100 per cent rated voltage from -60 to 85 C. The GMP capacitor finds wide application in high temperature ac and dc circuits, as low current power supply filters and as audio coupling and bypass condensers.

Potter Co., Dept. ED, 1950 Sheridan Rd., North Chicago, Ill.

CIRCLE 189 ON READER-SERVICE CARD

Rate Gyroscope

Provides constant damping

This rate gyroscope provides constant damping over a wide range of temperatures, without the use of heaters. Identified as RGB rate gyroscope, the unit measures angular velocity and converts it to an ac voltage output. Nominal damping ratio variation is ± 0.1 over the range -30 to 100 C.

Sanders Associates, Inc., Dept. ED, Nashua, N.H.

CIRCLE 190 ON READER-SERVICE CARD



Control Reactors

From 15 to 450 w

Control reactors for magnetic amplifiers are available covering 15 to 450 w. Four series cover sensitivity range from 1.5 to 3 a-turns. 117 v and 240 v are both standard. The military series meets all MIL-T-27-81 specifications, undergoing 2000 g shock tests.

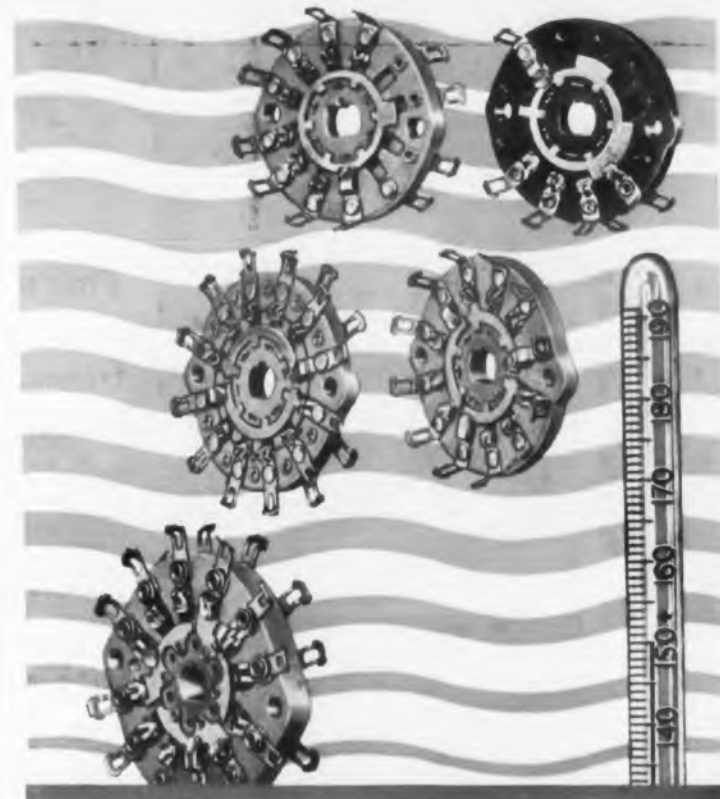
Chicago Magnetic Control, Div. of Chicago Electronic Engineering Co., Dept. ED, 1616 N. Damen Ave., Chicago 47, Ill.

CIRCLE 191 ON READER-SERVICE CARD

NEW 150°C

high-temperature, low-power


SWITCH SECTIONS



TESTED IN ACTUAL OPERATION FOR OVER
800 HOURS AT A CONTINUOUS
AMBIENT TEMPERATURE OF 150°C

Here's a new development in low-power, rotary switch wafers that gives *high* reliability at 150°C. They show a safety factor of 5 to 1 over the life requirements of MIL-S-3786. This unusual performance is due to a special alloy we have developed for the contact clips. Under all test conditions applied to date, these clips have demonstrated a remarkable ability to maintain spring tension at elevated temperatures. As a result, electrical contact remains uniformly excellent for the life of the switch. Currently, most Oak sections in ceramic or Mycalex insulation can be supplied with this high-temperature clip, offering you a selection of sizes and circuitry to handle most applications.

Contact the Oak Representative in Your Area for
Details or Send Us a Description of Your Application

OAK MFG. CO. 

1260 Clybourn Ave., Dept. D, Chicago 10, Illinois
Phone: MOhawk 4-2222

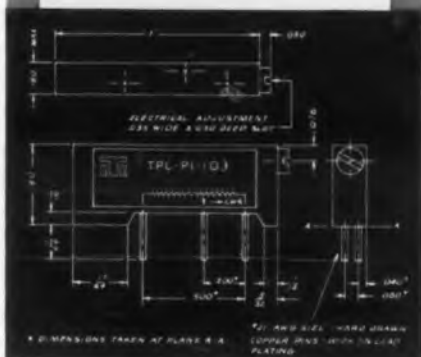
CIRCLE 192 ON READER-SERVICE CARD

PRINTED CIRCUIT TRIMMERS

BY



Type TPC Printed Circuit Trimmer Shown Actual Size



This new subminiature trimmer is designed for printed circuit assembly.

SLIM and TRIM,
they fit neatly with diodes and transistors.

Constructed of high-temperature-resistant plastic, with a 37 turn lead-screw adjustment for fine trimming, the TPC trimmer is a masterpiece of miniaturization. Virtually hermetic sealed, this newest addition to the TIC line is moisture proof. Power rating is 1 watt at 70°C. derated to 0 at 225°C. Pretinned leads accommodate hot-tin dipping techniques. Lead separations are in multiples of 0.1" in accordance with standard printed circuit separations.

FEATURES:

- Reliability and performance in operations up to 225°C.
- Resistance Ranges from 100 to 30,000 ohms.

Environmental testing has proven these rugged, compact trimmers meet or exceed the military specifications required for airborne and missile applications.

Bulletins with full details available upon request.

TECHNOLOGY INSTRUMENT CORPORATION

555 Main St., Acton, Mass. • P.O. Box 3941, No. Hollywood, Calif.
Colonial 3-7711 • POplar 5-8620

CIRCLE 193 ON READER-SERVICE CARD

NEW PRODUCTS



Test Chamber

Range of -100
to +600 F

Model EP-125 high-low temperature test chambers for use in combination with vibration test equipment, has a 5 cu ft test space and a temperature range from -100 to +600 F.

Wyle Associates, Dept. ED, 128 Maryland St., El Segundo, Calif.

CIRCLE 194 ON READER-SERVICE CARD

Switch

Operates safely in class I hazardous atmosphere



This switching device permits exposed contact switches to be operated in class I hazardous atmospheres. Maximum electrical spark energy available at the remote exposed switch contacts is far less than the minimum required to ignite the surrounding hazardous atmospheres. Switching control distances up to 1000 ft are possible. The Intrinsitrol controller measures 7 x 12 x 6-1/2 in.

Brookdale Engineering and Services Co., Dept. ED, 6 Beacon St., Boston 8, Mass.

CIRCLE 195 ON READER-SERVICE CARD

Digital Position Indicator

Utilizes Datex encoders



This series of digital position indicating equipment, is designed to provide a continuous indica-



750

SILVER FLAKE

FOR ELECTRONIC APPLICATIONS

Allows unlimited formulation of conductive metallic paints.

MD 750 Silver Flake pigment, manufactured from pure silver, has proved itself an invaluable ally to manufacturers of electronic components.

This highly conductive pigment is especially adaptable in printed circuits because it allows a wide variance in binder, solvents and fluxes as well as base plate materials.

MD 750 Silver Flake is used in the cementing of end wire on resistors and in the fabrication of silver electrodes as connectors for adhesive type resistors. It may be fired on quartz, mica, steatite, porcelain and ceramics as a base for soldering. It also can be formulated into paints for thermoplastic or thermosetting plastics.

Special types of flake, finer or coarser than the standard MD 750 Silver Flake, are processed for specific requirements.

In general, the applications of MD Silver Flake pigment are limited only by the imagination and ingenuity of the electronics engineer.



METALS DISINTEGRATING COMPANY, Inc.

GENERAL OFFICES: Dept. 5,
Elizabeth B, N. J.

CIRCLE 196 ON READER-SERVICE CARD

tion of a shaft position on either a digital display for visual indication or on various recording media, or both. Models are available to indicate empirical numbers up to readings of 10^6 . The systems utilize standard Datex encoders and translating modules, which are designed to read out at speeds up to 120 rpm and to indicate continuously as the position changes.

G. M. Giannini & Co., Dept. ED, 1307 So. Myrtle Ave., Monrovia, Calif.

CIRCLE 197 ON READER-SERVICE CARD

Frequency Calibrator

Range from 50 to 11,000 mc



Model 121 frequency calibrator supplies a series of simultaneous, continuous wave marker signals spaced every 50 or 100 mc over a frequency range from 50 to 11,000 mc with accuracy of ± 0.005 per cent at any frequency. Unaffected by temperature or input power variations, model 121 is designed to be used with receivers and circuits having a 50 ohm input impedance and a dc return. Its power input is 115 v ac ± 10 per cent, single phase, 50 to 440 cps, 33 w. The unit measures 7 x 9 x 7 in. with weight of 10 lb.

Control Electronics Co., Dept. ED, Huntington Station, N.Y.

CIRCLE 198 ON READER-SERVICE CARD

Counter

Speeds up to 25 impulses per sec



Type TceZ4PE counter has speeds up to 25 impulses per sec. The figure drums can be set to any preselected number between zero and 9999. The counter measures 3-1/4 x 1-3/4 x 3-7/8 in.

Landis & Gyr, Inc., Dept. ED, 45 W. 45th St., New York 36, N.Y.

CIRCLE 199 ON READER-SERVICE CARD

THE NATIONAL SCENE

TEN-TO-ONE THE Copper Clad Laminate YOU WANT IS HERE!

From these ten basic PHENOLITE® Grades, you can select the base material, resin, properties and price to fit your present printed circuit need.

If your problem is finding a suitable cold-punch material, try samples of XXXP-470-1. It's designed for use in automated production equipment. If you are looking for higher heat resistance, check Grades G-10 and G-11.

Out of National's research laboratories come new advances every day. See your National Representative about new products and applications. He can keep you posted on the full line of PHENOLITE Laminated Plastic, Vulcanized Fibre and National Nylon for electronic applications across-the-board. In the meantime, write for our new "PHENOLITE Copper Clad Data" folder. Address Dept. E-6.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada:
NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario



TYPICAL TEST VALUES ON COPPER CLAD PHENOLITE

| GRADE | PROPERTIES OF BASE MATERIAL | | | | | COPPER CLAD PROPERTIES | | | RELATIVE COST Based on XXXP on Arbitrary Scale of 1 | |
|------------------------|-----------------------------|------------------------|------------------------|----------------------|-------------------------------------|----------------------------|----|---|--|--|
| | Dielectric Constant | Dissipation Factor | Moisture Absorption | Flexural Strength | Maximum Operating Temperature | Copper Bond Strength | | Hot Solder Resistance | | Surface Resistance |
| | 10 ⁶ Cycles | 10 ⁶ Cycles | 1/16", % 24 Hrs | Psi | Degrees F | Pounds to Pull 1" Strip | | Secs to Reheat 1" Square > Greater Than | | Megohms, Etched Retma Comb Pattern, 96 Hrs/35°C/90% RH |
| P-214-B-1 | 5.3 | .040 | 2.20 | 18,000 | 250 | 8 | 11 | > 10 @ 475°F | 100,000 | .81 |
| XXP-209-G-1 | 4.6 | .037 | 1.30 | 17,000 | 250 | 8 | 11 | > 10 @ 475°F | 200,000 | .92 |
| XXP-239-1 PHENOCLAD | 4.2 | .035 | 0.67 | 15,500 | 250 | 8 | 11 | > 10 @ 475°F | 200,000 | .92 |
| XXXP-219-C-1 | 4.5 | .030 | 0.70 | 15,500 | 250 | 8 | 11 | > 10 @ 475°F | 500,000-1,000,000 | 1.00 |
| XXXP-455-1 | 4.0 | .026 | 0.55 | 23,500 | 250 | 8 | 11 | > 10 @ 475°F | 1,000,000-1,500,000 | 1.00 |
| XXXP-470-1 | 3.7 | .027 | 0.48 | 14,000 | 250 | 8 | 11 | > 10 @ 475°F | 300,000-500,000 | 1.00 |
| N-1-852-1 | 3.3 | .030 | 0.20 | 16,000 | 165 | 8 | 11 | > 10 @ 450°F | 2,000,000 | 2.69 |
| G-5-813-1 | 6.8 | .018 | 1.00 | 55,000 | 300 | 8 | 11 | — | — | 2.98 |
| G-10-865-1 | 5.2 | .012 | 0.13 | 60,000 | 250 | 10 | 15 | > 30 @ 500°F | 1,500,000-2,000,000 | 3.49 |
| G-11-861-1 | 4.9 | .015 | 0.17 | 60,000 | 300 | 10 | 15 | > 30 @ 500°F | 2,000,000 | 3.55 |

CIRCLE 203 ON READER-SERVICE CARD



WHAT'S THE CATCH?

The catch or latching arrangement on all these Sigma relays is a permanent magnet. While this fact is not fraught with serious or far-reaching consequences, magnetic latching does have advantages worth considering. Since there are no triggers, catches or springs to wear out, magnetic latching relays do not fear early commitment to an eleemosynary institution. They do not continuously nibble a little stand-by power, adding their own little body warmth to the already stuffy environment; nor do power interruptions make them change position. What the armatures of these Sigma relays do is stay where the last coil signal sent them, moving to the other fixed position only when a resetting signal comes along.

An up-to-date inventory shows that there are now five Sigma magnetic latching relays available, with the following distinguishing traits. **SERIES 6** will switch 2 or 5 ampere loads on inputs from 22 to 450 mw., with contacts up to 4PDT; useful in memory circuits, fast enough for follow-up systems, reliable latching contactor. **SERIES 61** is a modification of the "6", with DPDT contacts capable of switching 20 ampere loads on 225 or 450 mw. signals; small, considering its ratings. **SERIES 32** is the newest and smallest of the group; DPDT, measures 0.800" x 0.400" x 0.900" high, max., has pins spaced equally on 0.200" centers; price is low. **SERIES 72** is the most sensitive (0.3-2.0 mw.), and is designed for bounce-free, high speed switching. Sensitivity is adjustable, contacts replaceable. **SERIES 73** is a small hermetically sealed SPDT type for use in miniature devices and guided missiles. Dimensions $\frac{3}{4}$ " dia. x $1\frac{1}{16}$ " high. Contacts rated 1.5 ampere, sensitivity 6 mw. and 12 mw.

If any of these magnetic latching relays (Sigma Form "Z") offer the characteristics you're looking for, write for more data. If they don't, write anyway and tell us what you expect. Maybe one of us could be talked into making a small modification, so that a Sigma relay will work.

SIGMA

SIGMA INSTRUMENTS, INC.,
91 Pearl Street, So. Braintree 85, Mass.
CIRCLE 204 ON READER-SERVICE CARD

NEW PRODUCTS

Current Limiter

Has high interrupting capacity



Called the Form 101, this circuit protective device has high interrupting capacity and becomes current limiting at about four times its normal current rating. It anticipates and prevents the rise of fault currents to high destructive maximums. It can be connected directly into circuits where the available current on short circuit is very high, even up to 100,000 a. Depending on its rating, this current limiter will continuously carry from one to 10,000 a of normal current. It limits on overload but blows instantly on short circuit before damage can be done.

Chase-Shawmut Co., Dept. ED, Merrimac St., Newburyport, Mass.

CIRCLE 205 ON READER-SERVICE CARD

Accelerometer

Ranges from ± 5 to ± 50 g



Utilizing gas damping, model A501 accelerometer operates at temperature extremes of -65 to 200 F. The unit offers ranges from ± 5 to ± 50 g.

Statham Instruments, Inc., Dept. ED, 12401 Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 206 ON READER-SERVICE CARD

"FACTORY FRESH" FEATURE of new diode package



General Transistor is now packaging their Germanium Gold-Bonded Diodes in individually sealed plastic envelopes. There are ten envelopes in each box and five boxes per master container.

The purpose of this new package is to offer OEM manufacturers "factory fresh" diodes, individually packed, for small quantity purchases.

General Transistor Authorized Distributors will carry this package... you'll receive fast deliveries of top performing diodes... every time.

Write today for complete specifications and engineering data on Gold-Bonded diodes, Bulletin GD-10.



GENERAL TRANSISTOR DISTRIBUTING CORP.

SUBSIDIARY OF GENERAL TRANSISTOR CORP.
91-27 138TH PLACE
JAMAICA 35, N. Y.

CIRCLE 207 ON READER-SERVICE CARD

Angular Acceleration Generator

Generates angular and near-linear acceleration motion



This angular acceleration generator is capable of generating closely controlled angular and near-linear acceleration motion. The instrument imparts sinusoidal angular motion to a test table by means of a cylindrical rotor motor, with a single phase, two-pole winding placed at right angles to a dc field.

Satham Development Corp., Dept. ED, 12411 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 186 ON READER-SERVICE CARD

Audio Plug

Protection against mechanical noise

XLR plug offers protection against mechanical noise, accomplished through resilient inserts with rubber cushioning ribs and latching mechanism. These audio plugs are available in a full range of shell styles with either three 15 a contacts or four 10 a contacts.

Cannon Electric Co., Dept. Ed, 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 187 ON READER-SERVICE CARD

Tube Socket

Provides blind positioning of tubes

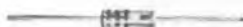


These 7- and 9-pin miniature tube sockets are designed to provide blind positioning of tubes. This is accomplished by a polarization key.

Elco Corp., Dept. ED, M St. below Erie Ave., Philadelphia 24, Pa.

CIRCLE 254 ON READER-SERVICE CARD

QUALITY PRODUCT
FROM GENERAL TRANSISTOR.



ACTUAL SIZE



C O R P O R A T I O N

In Canada: Desser E-E Ltd., 441 St. Francis Xavier, Montreal 1, Quebec
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR
GENERAL TRANSISTOR DISTRIBUTING CORP., 95-27 SUTPHIN BLVD., JAMAICA 35, NEW YORK FOR EXPORT: GENERAL
TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE JAMAICA 35, NEW YORK

Booth 728 and 730 at Automation Show

CIRCLE 188 ON READER-SERVICE CARD

new
complete line of

GERMANIUM
GOLD BONDED DIODES

GENERAL TRANSISTOR IS NOW MAKING
GERMANIUM SUBMINIATURE GOLD
BONDED DIODES

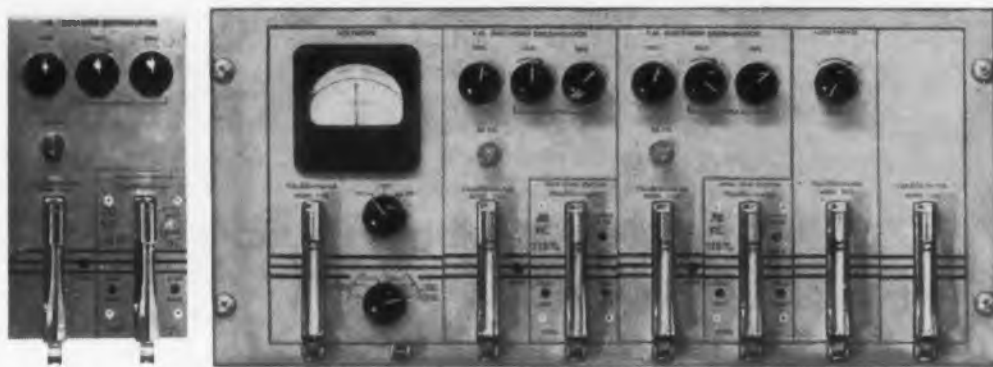
You may be assured that this new product line has the same high quality and reliability that has made General Transistor the Fastest Growing Name in Transistors. Experienced design engineers, quality materials, proven production techniques, and strictly enforced quality controls are your guarantees.

These diodes have been designed for computer, industrial and military applications where high reliability is of prime importance. They are hermetically sealed in a glass case with tinned leads. Their rugged construction makes them resistant to humidity, shock and vibration, and impervious to extreme environmental conditions.

Write today for Bulletin GD-10 showing complete specifications, diagrams and other engineering data.

91-27 138th Place
Jamaica 35, N. Y.

immediate delivery... phase-lock discriminators by Hallamore



Ready, as a "building-block" for your system application...Hallamore Model 0162, phase-lock discriminator, a compact plug-in type unit, has been thoroughly proven in telemetering systems of major missile programs. Designed around a concept entirely new to telemetry, it eliminates signal suppression by noise...non-linearity as a result of filtering...thresholding, common at low signal-to-noise levels. For quick action, wire Hallamore Electronics Company, Dept. 24P, 8352 Brookhurst Avenue, Anaheim, California / TWX: AH-9079.



**HALLAMORE
ELECTRONICS
COMPANY**

a division of The Siegler Corporation



Forerunner in System Development!

CIRCLE 208 ON READER-SERVICE CARD

NEW PRODUCTS

Frequency Standard

Stability of one-part in one billion



Model LA90 5 mc frequency standard offers stability to better than one-part in one billion. Long term operation results in temperature shifts of less than 0.01 C. The environmental temperature range is 0 to 50 C.

Lavoie Labs., Inc., Dept. ED, Matawan-Freehold Rd., Morganville, N.J.

CIRCLE 209 ON READER-SERVICE CARD

Electrical Disconnect

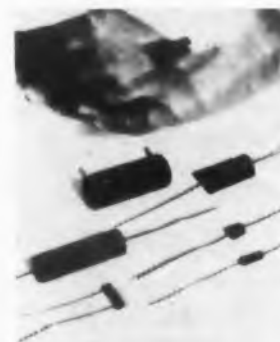
For use with 55-circuit Bendix pygmy connector



Used in missile operations for umbilical disconnects of other severing functions where guillotine choppers are not feasible, model 2011A explosive electrical disconnect is designed around the 55-circuit Bendix pygmy connector. It converts this unit into a reusable explosive-actuated device without altering in any way the electrical characteristics of the original connector.

Beckman & Whitley, Inc., Dept. ED, 1085 San Carlos Ave., San Carlos, Calif.

CIRCLE 213 ON READER-SERVICE CARD



Wirewound Resistors

Maintain ± 0.01 per cent tolerances

Available in any value from 1 ohm to 20 meg, these wirewound resistors possess a high degree of stability. The resistors are made up of multiple

NO MICROWAVE
SPECIFICATION
IS TOO CRITICAL FOR
J-V-M*

***CUSTOM BUILDERS
AND DESIGNERS OF:**

CAVITIES

**MIXERS • DETECTOR MOUNTS
DUPLEXERS • MULTIPLIERS
ROTARY JOINTS • BENDS
TWISTS • OTHER COMPLEX
COMPONENTS & ASSEMBLIES**

Application-engineered microwave parts and complex assemblies are our specialized field. We'll manufacture components to your prints...or we will design and integrate them into your application.

You can depend on J-V-M for close coordination, guaranteed electrical performance and "know how" that is attested by innumerable assemblies ranging from dc. to 40,000 mc. now in industrial and military use.

FOR EXAMPLE:



1. Variable vane directional coupler... sliding vane type... high directivity—low VSWR.



2. Pre-selector-mixer... S band... 50 ohm input impedance... high Q double-tuned ganged cavities... detector output... frequency stable from -55° to $+85^{\circ}$ C.

Get full information on J-V-M standard or custom-engineered microwave parts and components... also complex mechanical assemblies. Request catalog today.

CUSTOM-ENGINEERED
MICROWAVE
PARTS

J-V-M

**J-V-M MICROWAVE
COMPANY**

4635 LAWDALE AVENUE, LYONS, ILLINOIS
Phone: Lyons 3-7990—TWX: Lyons, Ill. 279

CIRCLE 214 ON READER-SERVICE CARD

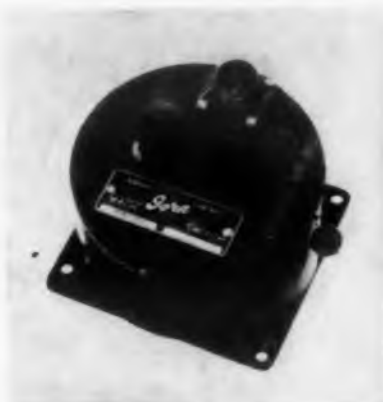
reversed windings substantially non-inductive up to 50 kc. The resistors are completely sealed in Plaskon alkyd No. 417 resin which has a coefficient of linear expansion matching that of the resistance wire. Required tolerance specification as low as ± 0.01 per cent can be held, even at low resistance values. Temperature coefficient is less than 20 ppm per deg C over the operating temperature range of -65 to $+125$ C.

Ultronix, Inc., Dept. ED, 116 S. Bayshore Blvd., San Mateo, Calif.

CIRCLE 215 ON READER-SERVICE CARD

Ratio Pressure Switch

Response to mach 0.75 and 3.00 at altitudes to 70,000 ft



This ratio pressure switch is suitable for indication of for controlling equipment in response to mach numbers between mach 0.75 and 3.00 at altitudes to 70,000 ft, depending on the actuation and reactivation band specified. This switch will make and break an electrical load of 28 v dc at 4 a, resistive; 2 1/2 a, inductive. This switch weighs only 1.4 lbs.

Gorn Electric Co., Inc., Aircraft Controls Co. Div., Dept. ED, 845 Main St., Stamford, Conn.

CIRCLE 216 ON READER-SERVICE CARD

Panel Enclosures

Available in 13 standard sizes



Type 1 panel enclosures are available in 13 standard sizes ranging from 16 x 12 x 6-5/8 in. to 42 x 24 x 8-5/8 in. Enclosures are made of 14 gage sheet steel.

Hoffman Engineering Corp., Dept. ED, 1426 Tyler St., Anoka, Minn.

CIRCLE 217 ON READER-SERVICE CARD

SELL HARDER AT...



WESCON 1958—in Los Angeles America's 2nd Largest Electronic Market

Well over half of the nation's aircraft and missile contracts are held by Southern California firms. Supporting them are hundreds of manufacturers of electronic equipment and components up and down the coast.

WESCON attracts more than 30,000 interested electronic engineers, scientists, and businessmen—and you can alert these men to your booth and products *before the show* in *Electronic Design's* pre-show issue.

Electronic Design has more circulation among manufacturers on the West Coast than any other electronic publication. WESCON has become one of America's greatest electronic industry events. Sell harder at WESCON beginning August 6th by reserving space now in *Electronic Design*. Final closing date is July 7th.



a HAYDEN publication

830 Third Avenue, New York 22, N.Y., Telephone PLaza 1-5530

Now you can order from stock...

the new
**BRYANT MAGNETIC
STORAGE
DRUM**

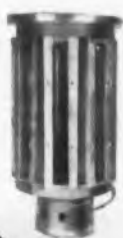
Unequaled for precision, versatility, and low cost



The new 512A Bryant general purpose magnetic storage drum meets the exacting demands of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. These 5" dia. x 12" long drums are stocked for immediate shipment at a price that is far below the cost of customer-designed drums.

Features: Guaranteed accuracy of drum run-out, .00010" T.I.R. or less; Integral motor drive; Capacities to 625,000 bits; Speeds up to 12,000 R.P.M.; 500 kilocycle drum operation possible; Accommodates up to 240 magnetic read/record heads; For re-circulating registers as well as general storage.

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R.P.M. can be attained, with frequencies from 20 C.P.S. to 5 M.C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512A booklet, or for special information.



High Speed
Computer
Drum

Mobile
Military
Computer
Drum



Synchronous
Computer
Drum



Airborne
Computer
Drum



BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-M, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supplies

Wide current ranges



These units offer a fast response time of less than 50 μ sec recovery to load transients. Regulation on the Model CCS-1/1000 is ± 1 per cent to load variations 5 ma to 1 a; ± 2 per cent to load variations 1 ma to 5 ma; ± 1 per cent to line variations. The Model CCS-1/5 offers a regulation of ± 1 per cent to line and load variations. Ripple is less than 1 per cent on both units.

Ultradyn, Inc., Dept. ED, P.O. Box 3308, Albuquerque, N.M.

CIRCLE 220 ON READER-SERVICE CARD

Modulation Meter

For a-m generators and transmitters



This a-m modulation meter model MM-120 uses two interchangeable plug-in tuning units to measure modulation depths, envelope distortion, amplitude noise and hum modulation at frequencies from 15 kc to 1000 mc.

Empire Devices Products Corp., Dept. ED, Amsterdam, N.Y.

CIRCLE 221 ON READER-SERVICE CARD

DC Amplifier

Dual Channel



Dc amplifier model M-220 for use with electrodynamic recorder model GA-1023, provides a



Duck, Smedley!
That pot
isn't magnetized!

Space ship designer Smedley forgot there is no gravity in outer space and a permanent magnet in the bottom of the pot could have assured its sticking to the galley range.

A vendor is useful if he anticipates customer's needs and problems. This is our end and aim.

By the way, if you want a small magnet for your own coffee pot, send 25 cents (for handling). Our business is magnetic material, and the magnet will hold the coffee pot down, but Smedley, what's going to keep the coffee in the pot in gravity-less space?

**SPECIALISTS IN
MAGNETIC MATERIALS**

Permanent Magnets Magnetic Tapes
Laminations and Wound Cores

Thomas & Skinner, Inc.

1157 East 23rd Street
INDIANAPOLIS 7, INDIANA
CIRCLE 222 ON READER-SERVICE CARD

ON THE SHELF!



Ford Instrument's Oldham Couplings

Features

- No loose parts; when shafts are separated completely, there are no parts to fall.
- Low cost.
- Available in models for 3/16", 1/4" and 5/16" shaft diameters — and 3/16"-1/4" and 1/4"-5/16" shaft combinations.
- Maximum backlash of 10 minutes of arc.

Applications include

- Servomechanisms : Missile Control Systems
- Computers : Aircraft Control Equipment
- Indicating Devices : — and similar uses

FREE— Circle reader-service card number for fully illustrated data bulletin giving specifications and performance information.



FORD INSTRUMENT COMPANY DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue
Long Island City 1, N. Y.

Component Sales Division

Please send me prices on the following unit(s):

(Circle Model number desired)

| Model No. | Shafts Accommodated | |
|-----------|---------------------|------|
| C-316 | 3/16 | 3/16 |
| C-416 | 1/4 | 1/4 |
| C-516 | 5/16 | 5/16 |
| C-316-416 | 3/16 | 1/4 |
| C-416-516 | 1/4 | 5/16 |

No. of units desired _____

Name _____

Position _____

Company _____

Street _____

City _____ Zone _____ State _____

ED

CIRCLE 223 ON READER-SERVICE CARD

portable two-channel direct inking or electric recording system for measurement over the frequency range from dc to 200 cps. Sensitivity range for each of the two-channels is separately adjustable in 12 steps from 5 mv/mm to 20 v/mm chart deflection. The combination of amplifier and recorder results in flat writing response from dc to 200 cps. The amplifier delivers 80 ma rms into 1000 ohm at max power output.

Massa Labs., Inc., Dept. ED, 5 Fottler Rd., Hingham, Mass.

CIRCLE 224 ON READER-SERVICE CARD

Indicating Meters

Ranges from 1 ma to 100 a



Indicating meters are available in ranges of dc sensitivities from 1 ma to 100 a, and in voltmeters up to 300 v.

Hoyt Electrical Instrument Works, Inc., Dept. ED, 42 Carleton St., Cambridge 42, Mass.

CIRCLE 225 ON READER-SERVICE CARD

Relay

Thermal time delay type



Actuated by heater and hermetically sealed, thermal time delay relay model T-99 operates on ac or dc, or pulsating currents of 2 sec to 3 min delay periods. When subjected to ambient temperature changes from -60 to +85 C, the relay delay interval varies slightly from room temperature delay periods.

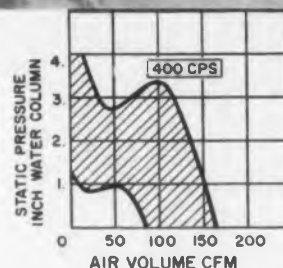
R.C.O. Electronics, Dept. ED, 145 Valley St., Belleville, N.J.

CIRCLE 226 ON READER-SERVICE CARD

For 400 CPS Cooling Applications



AXIMAX-3



For airborne and missile cooling applications, the AXIMAX-3 when turning at 20,000 rpm will deliver 165 cfm at free delivery. This performance is possible although the fan is only 2.8" in diameter, 2.3" in length and weighs a mere 14 ounces.

Variation in driving motors include constant speed and Altivar designs. The latter automatically vary their speeds inversely with altitude and thereby approach constant cooling with a minimum of power drain and noise.

Mounting is simplified by the provision of "servo" clamping rims at either end of the barrel. Airflow can be reversed by turning the fan end-for-end. Electrical connection is made to a compact terminal block. Power requirement is 400 cps, 1 or 3 phase.

Write today for complete technical details to . . .



ROTRON mfg. co., inc.

WOODSTOCK, NEW YORK

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 227 ON READER-SERVICE CARD



Now! a standardized line CONTROL REACTORS rated to fit the job...

Control! You name it. CMC has a unit for it. Designed to do one job . . . better, more efficiently, at less cost!

The curves show the principle . . . but for complete details—see the one manual that tells the whole story!

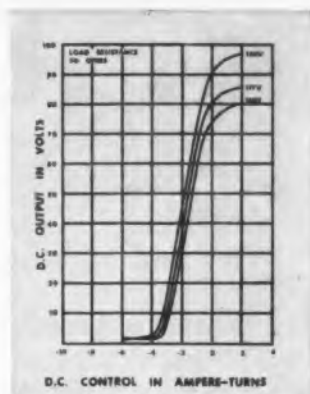
Write for it today!



"a look inside tomorrow's engineering." Concise, easy-to-read performance data. Choose the exact unit to fit your need.

CHICAGO
MAGNETIC
CONTROL

1616 N. DAMEN AVE., CHICAGO
CIRCLE 228 ON READER-SERVICE CARD



performance
characteristic
using
silicone diodes

NEW PRODUCTS

Power Supply
Delivers up to 125 a



Model MA28-125 dc power supply can feed entire systems drawing up to 125 a at 18 to 36 v dc. Specifications include 208, 230 or 460 v, 3-phase, 60 cps input; ± 0.1 per cent typical regulation accuracy; 1 per cent maximum ripple; and less than 0.1 sec response time.

Sorensen & Co., Inc., Dept. ED, Richards Ave., S. Norwalk, Conn.

CIRCLE 230 ON READER-SERVICE CARD

Shaft Encoders

1024 positions in one revolution



Series 700 shaft encoders features compact units with up to 1024 positions in one revolution of the input shaft. The C-711 series is available with discs coded in Gray code or a cyclic binary coded decimal. Accuracy is better than ± 1 bit and the transition points of each bit are held to within ± 0.05 deg. The C-711 is designed to have a minimum life of 10^6 revolutions of the input shaft. Torque is less than 0.4 in.-oz and inertia is less than 150 gm-cm².

G. M. Giannini & Co., Inc., Datex Div., Dept. ED, 918 E. Green St., Pasadena 1, Calif.

CIRCLE 231 ON READER-SERVICE CARD

DESIGN ENGINEER AVAILABLE

...His name is
American Rectifier-

ALTHOUGH he is not human he can absorb your design, development and manufacturing costs, if need be.

American Rectifier Power Supplies are employed by numerous firms . . . They can go to work for you to save you time and money.

CUSTOM
ENGINEERING
and
STANDARD
RECTIFIER
POWER
SUPPLIES
AVAILABLE
TO MEET
YOUR
SPECIFIC
REQUIREMENTS
up to 500 KW



COMPARE THESE FEATURES—

- Either silicon, selenium or germanium stacks as desired.
- Heavy duty, dependable rectifier.
- Magnetically or electrically regulated.
- Virtually no maintenance.

Write for Details!
AMERICAN RECTIFIER
CORPORATION

95 Lafayette Street—New York 13, N. Y.
Phone: WOrth 6-3350

CIRCLE 231 ON READER-SERVICE CARD

Voltmeter

Frequency range from 1 to 400 kc



Model 2174 frequency selective voltmeter has a frequency range from 1 to 400 kc. A direct reading meter is calibrated for db or rms voltages, from -90 dbm to $+32$ dbm with accuracy of ± 0.5 db over the tunable range of 1 to 400 kc. The input circuit is provided with a selector switch for 600 ohm terminating or high impedance bridging balanced or unbalanced lines. Spurious response below 60 db, and low intermodulation are also featured.

Rycom Instruments, Div. of Railway Communications, Inc., Dept. ED, 9351 E. 59th St., Raytown, Mo.

CIRCLE 210 ON READER-SERVICE CARD

LC Filter

Frequency range of 0.4 to 60.0 mc

This LC filter covers the range from 0.4 to 60.0 mc with center frequency stability of ± 1.0 kc per mc from -55 to $+105$ C; shape factor: BW_{60}/BW_6 to 2.1.

Daven Co., Dept. ED, Livingston, N.J.

CIRCLE 211 ON READER-SERVICE CARD

AC Voltage Divider

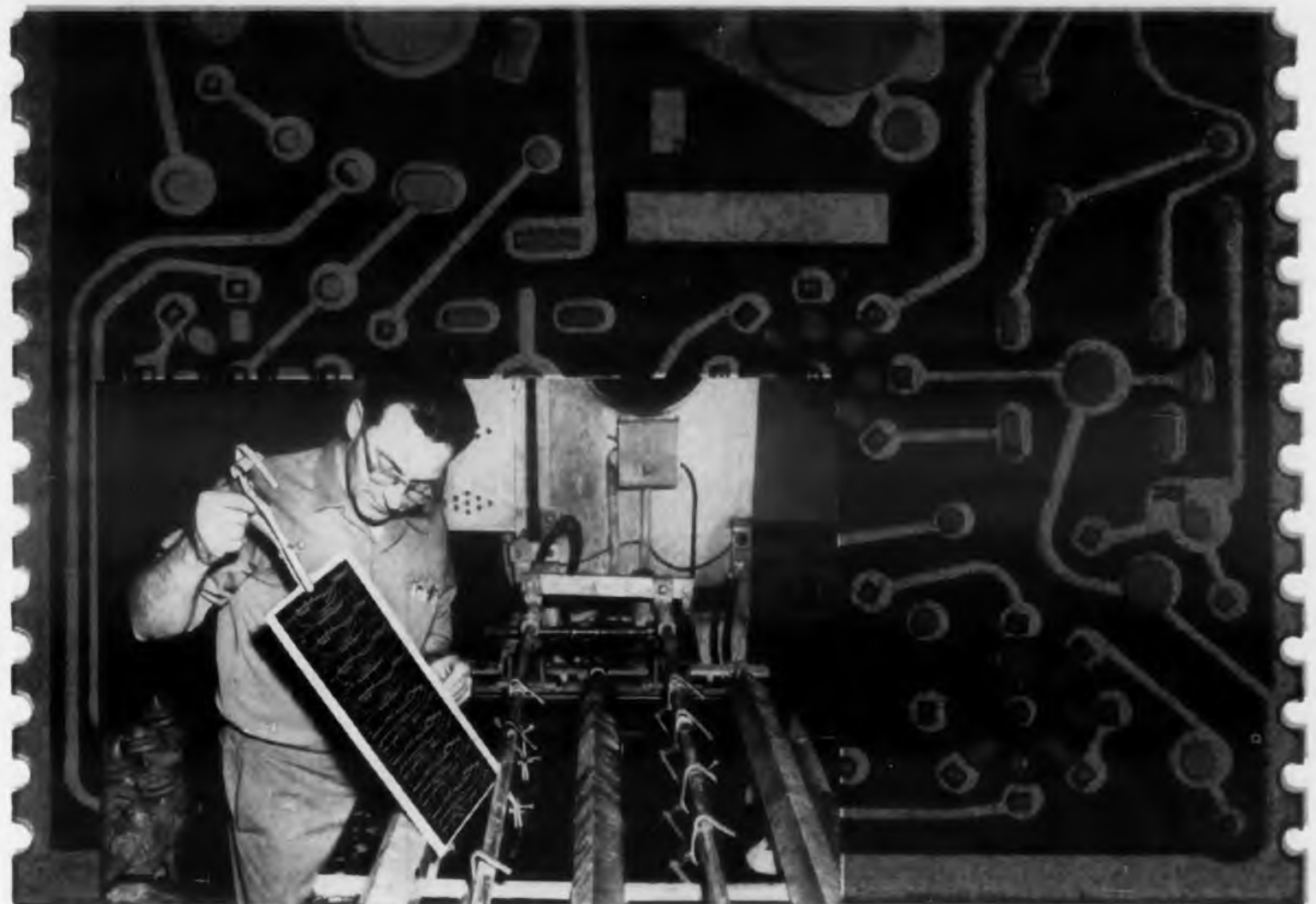
0.002 per cent linearity



This ac voltage divider called Dekatran employs a special tapped toroidal transformer, and coaxial switches. Four coaxial dials give a simple straight line reading to five significant figures. Overall linearity is better than 0.002 per cent.

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

CIRCLE 255 ON READER-SERVICE CARD



HOW TO PLATE PRINTED CIRCUITS

FASTER, BETTER, AT LOWER COST

...with B&A Fluoborates

First step—use B&A copper fluoborate for high-speed copper plating of thick, high quality circuits.

Second step—use B&A lead-tin fluoborate for maximum solderability (60:40 tin-lead deposit).

Advantages: Both of these high purity fluoborate plating solutions come in concentrated solution form. They give you easy bath make-up and easy control. Since anode and cathode efficiencies approximate 100%, you get easy maintenance, too. They require no mixing or dissolving, and offer excellent bath stability, good anode corrosion.

BAKER & ADAMSON® Fine Chemicals



GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Result: You produce *better* printed circuits, *faster* and *at lower cost*—*more easily*, too!

Mail coupon now for comprehensive technical bulletins giving complete information on these improved plating techniques for printed circuits.



BAKER & ADAMSON® Fine Chemicals
GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Please send technical bulletins on the use of B&A Fluoborates in the production of printed circuits.

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Title _____

Company _____

Address _____

City _____ Zone _____ State _____

ED-68

CIRCLE 212 ON READER-SERVICE CARD

HAZELTINE *relies on Photocircuits*

"Tuf-Plate" plated-thru holes

HEART OF ADVANCED AIRBORNE RADAR

Strategic military decisions stem from reliable knowledge of an entire situation. To gather reliable information, our nation depends on airborne radar.

Hazeltine's universal radar indicator... the advanced AN/APA-125... displays signal data of many types: Submarine detection, AEW, IFF, AMTI, LAB, beacon and others. With this electronic plotting board, an operator can plot any tactical problem and accurately interpret the solution for evaluation and action.

For the compact, lightweight AN/APA-125, Hazeltine specifies space-saving, double-sided printed circuit boards with "TUF-PLATE" plated-thru holes by PHOTOCIRCUITS. Here is reliability never before possible in two-sided thru circuitry.

"TUF-PLATE" reliability is guarded by rigid process engineering controls, developed by PHOTOCIRCUITS and unmatched in the printed wiring industry. Proper design, precision production and advanced quality control techniques assure consistently dependable performance... often at lower cost.

Get the detailed "TUF-PLATE" story today from PHOTOCIRCUITS... the largest and most experienced manufacturer in printed circuitry. Write our Engineering Department PS-3.



PC **Photocircuits**
CORPORATION

GLEN COVE, NEW YORK

PHONES | CABLE
GLEN COVE 4-8000 FLUSHING 7-8100 | PHOCIRCO
CIRCLE 232 ON READER-SERVICE CARD

NEW PRODUCTS

Digital System

Easy maintenance



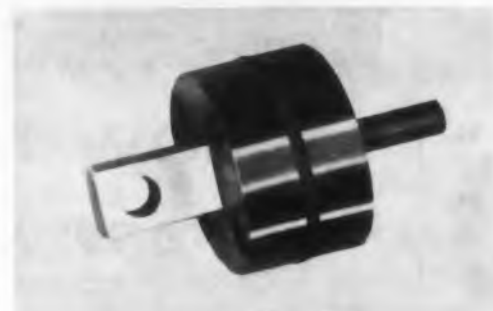
This digital system includes a 4 and 5 digit voltmeter, a master scanner, auxiliary scanners, an ac converter, control unit, remote readout as well as an ohmmeter ratiometer. The cubic digital system units feature easy access to replaceable parts and adjustments.

Cubic Corp., San Diego Electronics Firm, Dept. ED, 2841 Canon St., San Diego, Calif.

CIRCLE 233 ON READER-SERVICE CARD

Silicon Rectifier

For high current applications



This diffused silicon junction rectifier has ratings up to 400 a. Power supply applications of 5000 a capacity can be handled by stacked combinations. Chief features are low forward resistance and wide temperature range of operation to 150 C.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

CIRCLE 234 ON READER-SERVICE CARD

Vibration Pickups

High temperature stability



The TD-series of vibration pickups combines the temperature stability of magnetic damping

How to get the RESOLVERS you want



Size 15 resolver
with compensating windings

The answer: *Specify Bendix* • Wide selection assures you of exact performance you want • Frame sizes 8, 10, 11, and 15 at production prices and, in many cases, on immediate delivery • Other sizes available on special order • Operating temperature ranges from -65°C to $+200^{\circ}\text{C}$ • 200 ohms to 6000 ohms impedance ranges • With or without compensating windings • Typical accuracy: 4-resolver cascaded chains with an accuracy of 1/6 of a degree *without the use of a booster amplifier* are now in production.

Further proof that . . .

YCBTBS*



*You Can't Beat The Bendix Supermarket.
For full facts on Bendix Resolvers, and other precision components, write—

Eclipse-Pioneer
Division
Teterboro, N. J.



District Offices: Burbank and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D. C. Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 235 ON READER-SERVICE CARD

with sensitivity previously available only in fluid damped units. The series produces sensitivities of over 300 mv/in./sec. Weighing 9 oz, five models are available with natural frequencies ranging from 1.8 to 5.6 cps and response to 2500 on undamped models and 1500 cps on damped units.

Southwestern Industrial Electronics Co., Dept. ED, 2831 Post Oak Rd., P.O. Box 13058, Houston 19, Tex.

CIRCLE 236 ON READER-SERVICE CARD

Coaxial Attenuators

1000 to 11,000 mc range



Coaxial attenuators are available for 1000 to 11,000 mc, at 3, 6, and 10 db attenuation. 20 db models are available for 2000 to 11,000 mc. All have an impedance of 50 ohm. Calibration accuracy is ± 0.2 db for 20 db models; ± 0.1 db for others.

Narda Microwave Corp., Dept. ED, 160 Hericks Rd., Mineola, L. I., N.Y.

CIRCLE 366 ON READER-SERVICE CARD

Switches

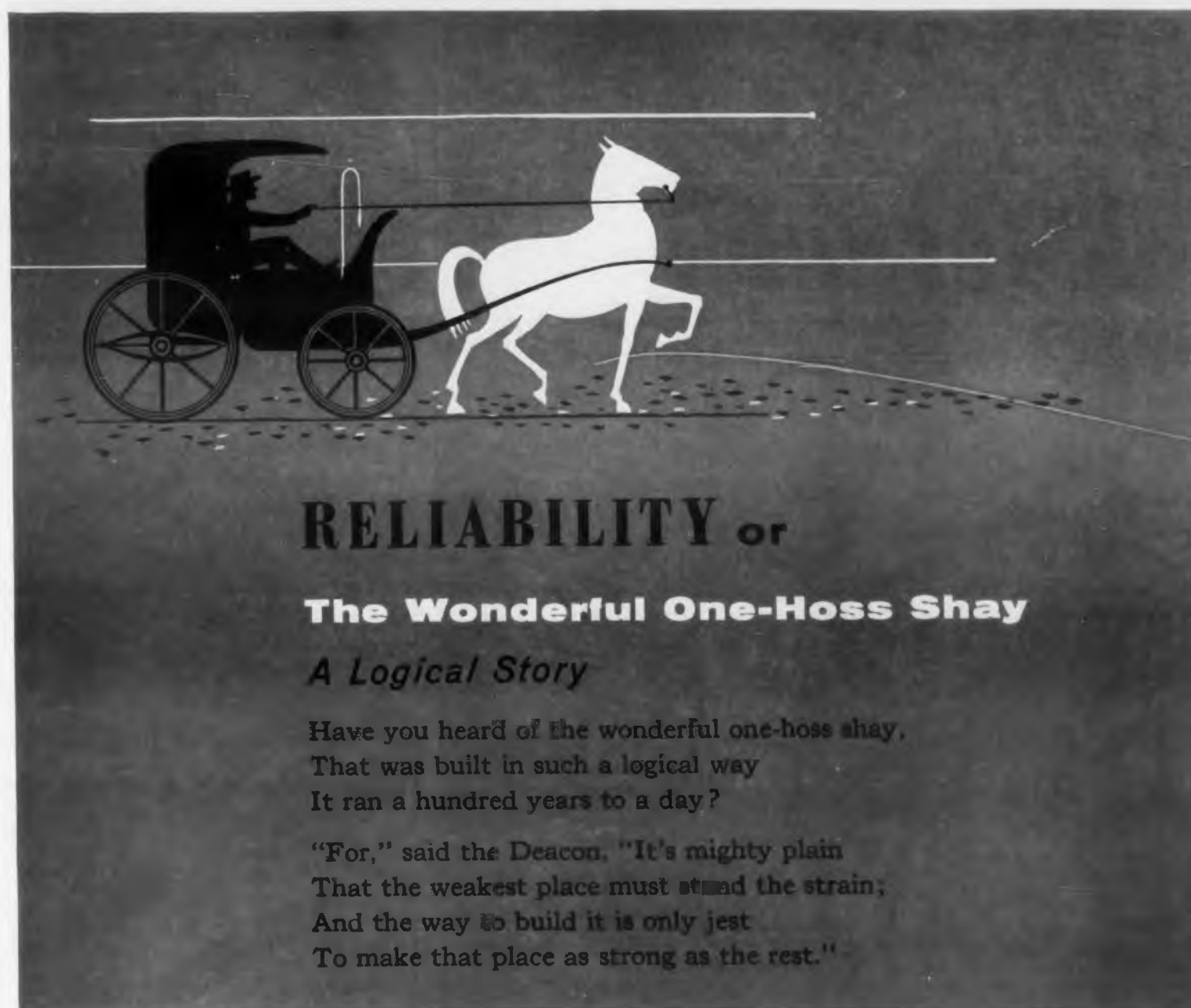
Three and five decade types



Model 7110 Digiswitch is a 3 or 5 decade switch having single and double pole as well as binary-coded switch configurations for each decade. Both three-decade and five-decade units are available with contact ratings of 200 v and 1 a.

Digitran Co., Dept. ED, 45 W. Union, Pasadena, Calif.

CIRCLE 367 ON READER-SERVICE CARD



RELIABILITY or

The Wonderful One-Hoss Shay

A Logical Story

Have you heard of the wonderful one-hoss shay,
That was built in such a logical way
It ran a hundred years to a day?

"For," said the Deacon, "It's mighty plain
That the weakest place must stand the strain;
And the way to build it is only jest
To make that place as strong as the rest."

The Deacon followed the two cardinal principles for reliability.

1. Know the stresses your component will be subject to (in other words know the environment).
2. Build faithfully to the specifications that cope with this environment.

At CPPC we feel one of our great assets is careful manufacture by a skilled and conscientious crew.

Reprints of the complete, original poem—
*The Deacon's Masterpiece or The Wonderful One-Hoss
Shay* by Oliver Wendell Holmes sent upon request.



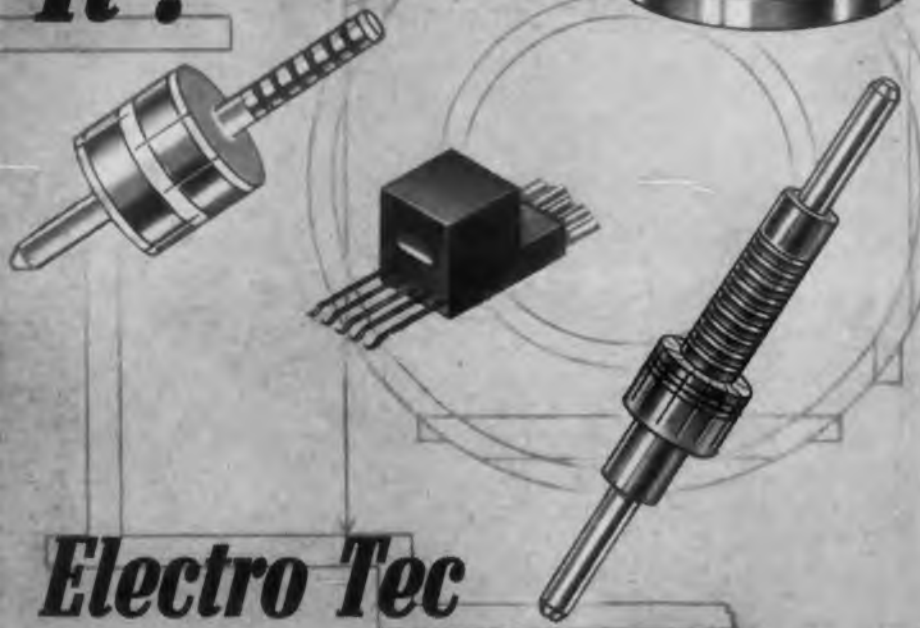
LOOK TO CPPC FOR SYNCHRO

PROGRESS

CLIFTON PRECISION PRODUCTS COMPANY, INC.
Clifton Heights Pennsylvania

CIRCLE 368 ON READER-SERVICE CARD

Why Redesign It?



Electro Tec solves the toughies

If longevity is a problem with your miniature slip ring and brush assemblies, chances are Electro Tec has the answer for critical circuits operating in the -46°F. to $+260^{\circ}\text{F.}$ ambient range.

Electro Tec brush assemblies exceed performance specifications because—every brush wire is individually hand polished to better than a 3 microinch ($\frac{3}{1000}$) finish in the contact area to reduce significantly both friction and ring wear!

Because of Electro Tec's precision manufacturing techniques, you can be sure that each and every brush assembly will be uniformly top quality and will be held to absolute tolerances. Exact control of tolerances provides unparalleled uniformity, including contact pressures and space alignment. Because of the interchangeability of these parts you can standardize your inventory at lower cost!

There is an Electro Tec sales engineer near you. He will be glad to visit you and help with your design problems.

Write for illustrated literature.

ELECTRO TEC CORP. *Products of Precision
Craftsmanship*

P. O. Box 37B, SOUTH HACKENSACK, N. J.

CIRCLE 369 ON READER-SERVICE CARD



Pat. No. 2,696,470

NEW PRODUCTS

Demodulator

Lowers receiver threshold by 6 db



Model 8-100 receiver phase-lock demodulator lowers the improvement threshold by at least 6 db. This lowering of the receiver threshold provides system gain which may be traded for increased range, reduced transmitter power, decreased antenna gain, or increased safety factor.

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

CIRCLE 370 ON READER-SERVICE CARD

Printed Circuit Connector

Features floating mounting bobbins



This printed circuit connector features floating mounting bobbins which insure good alignment between printed circuit board and connector. Connectors are available in 10, 15, 22 and 28 single row contacts and in 30 and 44 double row contacts.

Viking Industries, Inc., Dept. ED, 21434 Roscoe Blvd., Canoga Park, Calif.

CIRCLE 371 ON READER-SERVICE CARD



Delay Lines

8 to 30 μsec

A series of distributed constant delay lines has been made in delays ranging from 8 through

NEW



TYPE 115

MINIATURE TELEPHONE-TYPE DC RELAY CUTS SPACE REQUIREMENTS BY 1/2!

Available up to 4PDT, this compact telephone-type DC relay measures only $1\frac{1}{8}$ " long x $\frac{3}{8}$ " wide x $1\frac{3}{8}$ " high over stack. Up to 500 CPS Vibration. Current rating: up to 3 amps. Furnished with silver, palladium, or gold alloy contacts and beryllium copper contact springs. Stack insulation: Type G5 Glass Melamine. Coil resistances available up to 10,000 ohms. Insulated up to $+125^{\circ}\text{C.}$ Available in open or hermetically sealed models. Type "K" enclosure available with either plug-in or solder terminals. Dimensions of hermetically sealed unit: $1\frac{1}{2}$ " long x $1\frac{1}{8}$ " wide x $1\frac{3}{8}$ " high. For detailed specifications on this compact unit write for your free copy of AEMCO's newest relay catalog.

Need relays?
ask



AEMCO offers a complete line of relays in a wide choice of spring and coil combinations, operating potentials, and contact ratings. If one of hundreds of standard AEMCO relay types does not exactly meet your requirements, we will be happy to design and manufacture a unit to meet or exceed your requirements.

AEMCO also manufactures a complete line of Sequence and Automatic Re-Set Timers, Time Switches and Sign Flashers.

WRITE TODAY

Your inquiries are invited. Ask for your free copy of Relay Catalog describing all standard relays in the AEMCO line.



INCORPORATED

22 State St. • Mankato, Minn.

CIRCLE 372 ON READER-SERVICE CARD

STROMBERG-CARLSON
Type "A" Relays
 with
Plug-in mountings



For fast, easy removal and replacement you can get Stromberg-Carlson Type "A" Relays with *plug-in mountings*.

The Stromberg-Carlson Plug (illustrated above) automatically locks the relay in place and guarantees a low-resistance connection between plug and socket. Its 36 terminals provide enough connections for practically all relay applications. Coils and contacts are wired to terminals as your needs dictate. Contacts can be furnished in silver, palladium, gold alloy or palladium-silver alloy.

Spring combinations possible with this assembly are 17 Form A or Form B; 10 Form C or Form D.

Also available in an "A" Relay is a plug used with commercial radio type sockets. It can mount relays with 8, 9, 12 or 20 connections.

For technical details and ordering information, send for Bulletin T-5000R, available on request. Write to:



STROMBERG-CARLSON

DIVISION OF GENERAL DYNAMICS CORPORATION
 TELECOMMUNICATION INDUSTRIAL SALES
 116 Carlson Road, Rochester 3, N. Y.

Electronic and communication products
 for home, industry and defense

CIRCLE 373 ON READER-SERVICE CARD

30 μ sec. The FD288-C shown has an overall delay of 8 μ sec with a rise time of 0.8 μ sec. Attenuation is 3 db total, less than 0.5 db per μ sec. Impedance is 3300 ohm. Additional taps are furnished at 3, 5, and 6 μ sec. Total delay and tap delay accuracy can be held to 1 per cent.

Control Electronics Co., Inc., Dept. ED, Huntington Station, N.Y.

CIRCLE 374 ON READER-SERVICE CARD

Vacuum Relay
 10 kv voltage rating



The spdt RBI relay is a miniature unit designed for high voltage and high current operation. Measuring 2-1/2 in. long and 1-3/4 in. in diam, it has a voltage rating of 10 kv and continuous current rating of 15 a rms.

Jennings Radio Mfg. Corp., Dept. ED, P.O. Box 1278, San Jose, Calif.

CIRCLE 375 ON READER-SERVICE CARD



Geiger-Mueller Tube

Detects beta radiation of 0.1 mev

Type GM4LB Geiger-Mueller tube is capable of detecting minute amounts of beta radiation at energy levels of 0.1 mev and above. Background response is low as 0.4 counts per minute. Operation is at 1200 to 1400 v, with a plateau length of 150 to 200 v and an average slope of 0.05 per cent per v. Approximate overall dimensions are 2-1/2 in. long x 1-1/2 in. diam.

British Industries Corp., Dept. ED, 80 Shore Rd., Port Washington, N.Y.

CIRCLE 376 ON READER-SERVICE CARD

From General Electric . . .

PLAIN TALK ON TANTALYTIC* CAPACITOR AVAILABILITY

It's time for plain talk on the facts of tantalum electrolytic capacitor availability. There is no "availability" problem as far as General Electric is concerned.

Here's why:

- No metal shortage—Stocks of capacitor-grade tantalum have doubled within the past year.
- No production capability shortage—General Electric's production facilities have tripled in the past year.
- No delivery bottlenecks—General Electric's improved manufacturing processes and techniques have virtually eliminated production rescheduling.
- Few military directive priorities—Since the supply of Tantalitic capacitors has met demand, the military requirements can be met without directive priorities.

This is why we say—now and in the future, General Electric will continue to provide Tantalitic capacitors in the types and ratings you want—when you want them.

For specific information on Tantalitic capacitor ratings, prices, deliveries, contact your nearest General Electric Apparatus Sales Office or write to General Electric Co., Section 449-4, Schenectady 5, N. Y.

*Registered trade-mark of General Electric Co.

**Trade-mark of General Electric Co.

SOLID TANTALYTIC CAPACITORS—for transistorized circuit applications—rated up to 60 volts, polar units only—sizes down to 0.125 inches by 0.250 inches.

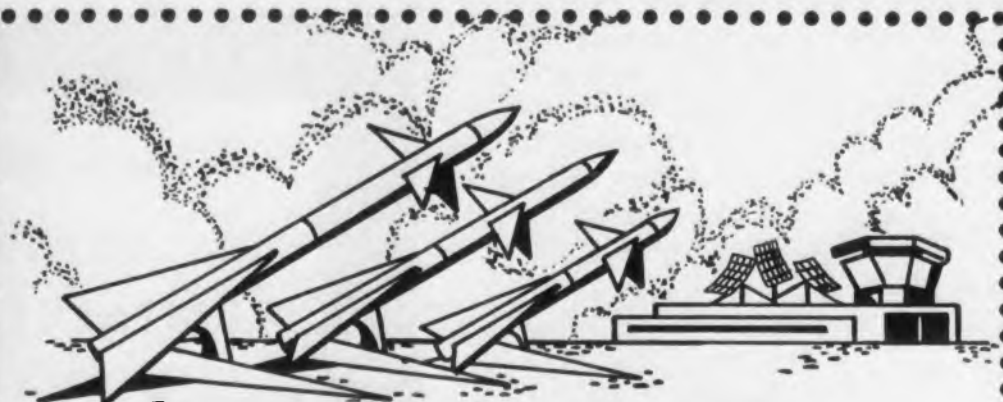
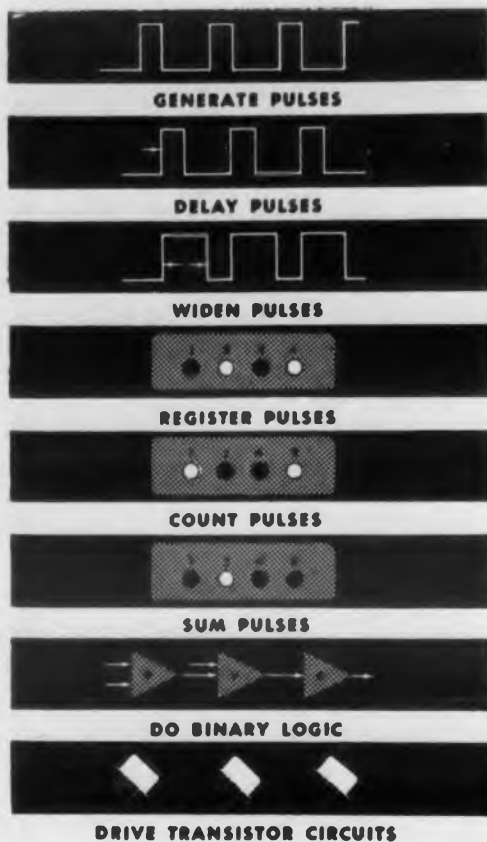
125C TANTALYTIC CAPACITORS—for aircraft electronic systems—ratings 10-180 mfd, 30 to 100 volts. Sizes 1/2 to 1 1/2 inches in height. Also tubular, double-cased units.

KSR TANTALYTIC CAPACITORS**—for missiles, radar, airborne electronic equipment applications—ratings up to 3500 mfd—three case sizes 1.375, 2, 2.5 inches in height.

85C TANTALYTIC CAPACITORS—for applications requiring high quality but where temperatures are less severe.

GENERAL ELECTRIC

CIRCLE 377 ON READER-SERVICE CARD



From the launching pad to machine controls—

NAVCOR completely transistorized pulse programming equipment is being utilized to do many military and industrial jobs, and do them well! The original concept of functional units pioneered by NAVCOR, and already proven in thousands of hours of use-test, feature quickly interchangeable modular blocks creatively engineered for multi-purpose operations. Write for data and specifications that will show how NAVCOR transistorized pulse programming equipment can be effectively used in your current computer project.

Navcor

NAVIGATION COMPUTER CORPORATION

1621 SNYDER AVE., PHILADELPHIA 45, PENNA. / HOward 5-7700

CIRCLE 378 ON READER-SERVICE CARD



HIGH PRESSURE
PLASTIC LAMINATES
FOR UNIFORM,
FAST, ACCURATE
POST-FORMING



● Half the weight of aluminum, chemically inert, electrically safe, mechanically strong . . . Farlite Postforming Laminates deserve your design consideration! Available in paper or fabric base, 1/32" to 1/4" thickness. FREE CATALOG!



PLASTICS DIVISION
FARLEY & LOETSCHER MFG. CO.
DUBUQUE, IOWA

CIRCLE 468 ON READER-SERVICE CARD

**ACE for
EXTRUDED
PLASTIC
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fast . . .
at low cost

RODS • TUBES • SHAPES

in all colors . . . in your choice of

PLEXIGLAS • LUCITE • ETHYLCELLULOSE
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AND FABRICATORS

ACE PLASTIC COMPANY

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CIRCLE 469 ON READER-SERVICE CARD

NEW PRODUCTS

Mechanisms and Components

Predesigned for many applications



This line of predesigned mechanisms and mechanical components for the servo and instrument includes clamp-on gears, anti-backlash gears, pin couplings, and slip clutches. These, in conjunction with a predesigned ball bearing gear plate assembly and 0.125 in. diam shafts of various standard lengths, provide a versatile precision gear box with as many as six shaft extensions on either side.

Precision Mechanisms Corp., Dept. ED, 577 Newbridge Ave., East Meadow, N.Y.

CIRCLE 379 ON READER-SERVICE CARD

Discriminator

For use in radio telemetry ground station



Subcarrier discriminator model GFD-2 and associated bandpass and lowpass filters is available for use in radio telemetry ground stations and data reduction centers. Model GFD-2 converts frequency modulated subcarriers into intelligence signals at output levels suitable for recording with penmotors or galvanometers.

Data-Control Systems, Inc., Dept. ED, 39 Rose St., Danbury, Conn.

CIRCLE 380 ON READER-SERVICE CARD

Core

Structure with complex surfaces

This core development known as the Stalagmite process, makes possible structures with complex surfaces heretofore impracticable when using honeycomb elements. Distribution of the core ma-

ELECTRONIC DESIGN • June 11, 1958

the multi-channel
heart of any
automation
system...

BEATTIE-COLEMAN'S
LPR-6
PROGRAMER

Twelve functions controlled by punched Mylar tape
Six channels operated by punched Mylar tape



Up to 30 minutes of repeated program

This LPR-6 Programer is the inexpensive laboratory version of the famous Beattie Coleman MPR-13 missile Programer. Immediate delivery. Let us show you how the LPR-6 can help solve your programming problems.

Over-all timing accuracy of .05%

BEATTIE-COLEMAN inc.

1300 N. Olive St., Anaheim, California

CIRCLE 381 ON READER-SERVICE CARD

material can be varied to handle unequal loading on the surfaces and predecorated surfaces can be joined without marring or other damage. Passageways can be constructed in the core material for heat exchange systems, gas type conduits, and other similar uses.

Arvin Industries, Inc., Dept. ED, Columbus, Ind.

CIRCLE 455 ON READER-SERVICE CARD

Interval Timer

Features low contact bounce



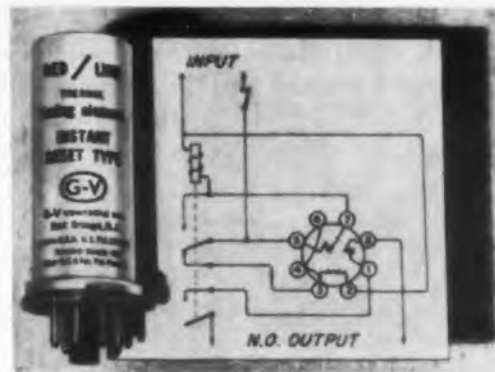
This fixed position interval timer limits contact bounce to within a range of 50 to 300 μ sec. Timing cycles may be as short as one second or as long as several hours. With up to five independent channels available in the standard unit, events may be sequenced simultaneously or in a series, or in a combination of both.

U.S. Industries, Inc., Western Design & Manufacturing Corp. Div., Dept. ED, 5947 Sheila St., Los Angeles 2, Calif. 2

CIRCLE 456 ON READER-SERVICE CARD

Time Delay

Thermal unit combines with magnetic relay



This time delay is instantly reset by the type DM thermal timing element when combined with a small magnetic relay in the circuit illustrated. Type DM thermal timing elements are available for any delay period from 5 sec to 6 min and for operating voltages from 6.3 to 230 v. Load rating is 5 a to 125 v ac; 3 a to 250 v ac; 1 a resistive to 32 v dc.

G-V Controls, Inc., Dept. ED, 28 Hollywood Plaza, East Orange, N.J.

CIRCLE 457 ON READER-SERVICE CARD

Vitramon[®]
CAPACITORS
PROVED

Up To 12 Times
More Reliable Than
Mil Specifications

all "VITRAMON" Capacitors ordered under High Reliability Specification S-1002 have a proven A. Q. L. life reliability 12 times higher than Mil Specifications. In qualification tests, for which Mil Specifications allow a failure rate of 4 out of 54 — "VITRAMON" CAPACITORS CANNOT EXCEED 4 OUT OF 354. While Mil Specs do not require requalification, S-1002 calls for complete retesting at least once every six weeks.

Group A Tests are made and results submitted on a sampling of pieces shipped to the customer under Specification S-1002; recently run Group B and C test results are also furnished with every shipment under that specification.

The high reliability of "VITRAMON" Capacitors is achieved by building inherent characteristics into the piece through the fusing of quality porcelain enamel and fine silver to produce a dense, homogeneous, truly monolithic unit that requires no case or hermetic seal. Quality control, including a LIFE TEST ON EVERY LOT, and rigid testing during and after manufacture assure near-perfect dependability.

"VITRAMON'S" High Reliability Specification S-1002, describing materials used, manufacturing process, as well as all tests and failure rates, is now available on request.

Vitramon[®]
INCORPORATED

BOX 544 • BRIDGEPORT 1, CONNECTICUT

CIRCLE 458 ON READER-SERVICE CARD

NEW RADIAL SERIES

NEW PARALLEL SERIES

NEW CO AXIAL SERIES

Standard Axial Series and
Axial-Radial Series

8 GOOD REASONS

for

Using the improved
HYSOL 6230 System

to Protect
Printed Circuits

1. SURVIVES SEVERE THERMALSHOCK
2. RESISTS HIGH HUMIDITY
3. BONDS COMPONENTS TO BOARD
4. BETTER FLEXIBILITY
5. SPRAY, BRUSH OR DIP
6. 100% SOLIDS
7. NO SPECIAL CLEANING
8. DEVELOPED FOR MILITARY APPLICATIONS

WRITE, WIRE OR PHONE

HOUGHTON LABORATORIES INC.

OLEAN, NEW YORK

In California
Culver City



In Canada
HYSOL (CANADA) LTD
TORONTO 17

CIRCLE 459 ON READER-SERVICE CARD

NEW PRODUCTS



Relay
Anti-chatter feature

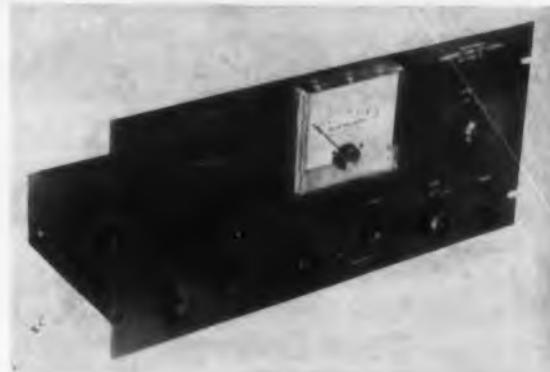
Model P215 polarized relay has sensitivity as low as 20 μ w. It features spdt with anti-chatter feature. Value of resistances are up to 1400 ohm for single windings or parallel windings of 825 ohm each.

Kurman Electric Co., Dept. ED, 191 Newel St., Brooklyn, N.Y.

CIRCLE 460 ON READER-SERVICE CARD

Flutter Meter

For accurate measurements of flutter and wow



This flutter meter is designed to indicate wow and flutter content of all types of tape recorders and playback equipment including 33-1/3, 45 and 78 rpm discs and 16 and 35 mm sound film mechanisms.

Amplifier Corp. of America, Dept. ED, 398 Broadway, New York 13, N.Y.

CIRCLE 461 ON READER-SERVICE CARD

Ball Bearings

Feature miniature size

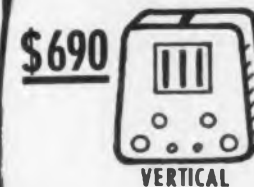


Midget T series bearing requires less than 15 per cent of the volume required by counterpart

NOW!
IMMEDIATE
DELIVERY

DIGITAL VOLT- OHMMETER

ALL
ELECTRONIC



0.5% DC
0.5% OHMS
1.0% AC

**FRANKLIN
ELECTRONICS,
INC.**

BRIDGEPORT
MONTGOMERY CO., PA.
Broadway 2-4800



CIRCLE 462 ON READER-SERVICE CARD

POTENTIOMETERS

DIGITOMETERS

ELECTRO-MEC

PRECISION • ACCURATE LINEARITY • ULTRA LOW TORQUE • RUGGEDNESS • HIGH RELIABILITY

POTENTIOMETER
TYPE 9



TYPE 11



TYPE 14



TYPE 18



TYPE 30



DIGITOMETER
TYPE D-15



ELECTRO-MEC
LABORATORY, INC.

7-51 33 Street, Long Island City 1, N. Y.

CIRCLE 463 ON READER-SERVICE CARD

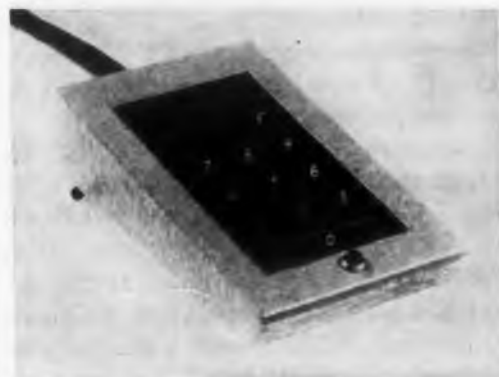
bore sizes in conventional ball bearings. The ratio of load capacity to unit volume of bearing is much higher than in conventional inch series instrument bearings. Four sizes have bores of 3/8, 1/2, 5/8, and 3/4 in. The cross-section of the bearing from bore to OD measures 1/8 in. Widths on the four sizes are held to 5/32 in. Close manufacturing tolerances are maintained. Standard material is 440C stainless steel for rings and balls, with one-piece retainer of machined phenolic.

MBP Inc., Split Ballbearing Div., Dept. ED, Lebanon, N.H.

CIRCLE 464 ON READER-SERVICE CARD

Keyboard

Contains 10 decimal keys



Decimal keyboard model 410 provides rapid manual digital input to a variety of devices. Each of its key-operated, spdp throw switches (125 v ac, 5 amp and 30 v dc, 2 amp) has three taper pin terminated leads for flexibility in terminal strip installation.

ElectroData Div. of Burroughs Corp., Dept. ED, 460 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 465 ON READER-SERVICE CARD

Power Supply

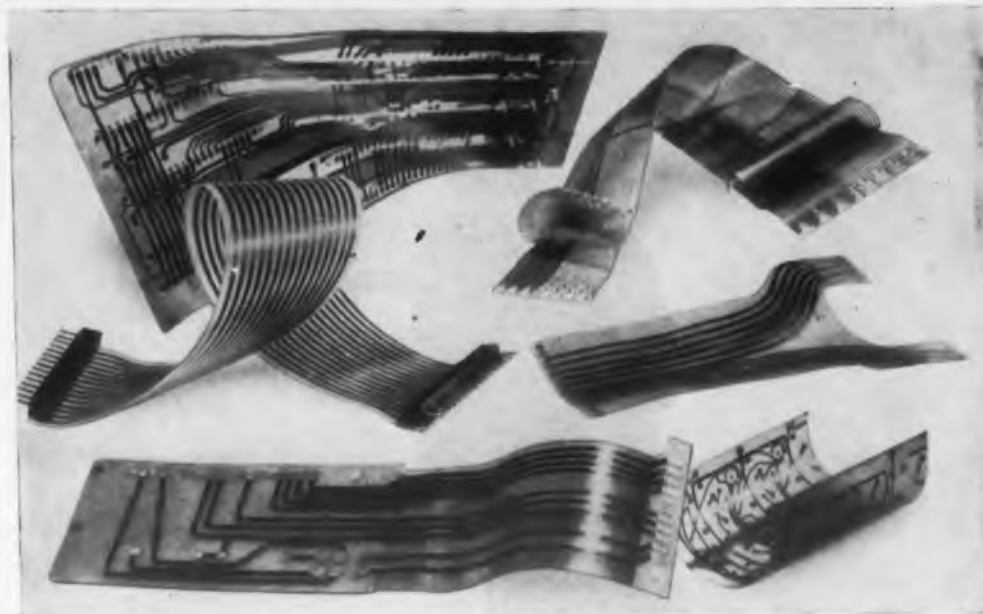
10 to 32 v, 0 to 15 a



Model SC-32-15 transistorized power supply delivers 0.32 v, 0-15 a. Regulation for line or load is less than 0.01 per cent or 0.001 v, whichever is greater. Ripple is less than 500 μ v rms. Recovery time is less than 50 μ sec. Operating ambient temperature is 50 C max. Output impedance is less than 0.001 ohms.

Kepeco Labs., Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

CIRCLE 466 ON READER-SERVICE CARD



SANDERS FLEXPRINT® WIRING

New, flat, flexible wiring sharply reduces weight, bulk and cost of electronic and electrical assemblies.

Sanders Flexprint Wiring brings to commercial and military applications a combination of field-tested advantages unmatched by conventional wiring and ordinary printed circuits.

- Completely flexible . . . exactly reproducible.
- Available in all lengths and current-carrying capacities.
- Weighs less than half as much as conventional wiring . . . occupies less than one-third the space . . . conforms to any housing shape or layout.
- Designed and produced in straight cables or complex harnesses . . . in single or multiple layers or bonded to rigid materials as a replacement for printed board.
- Permanently bonded in insulating plastics to meet environmental and reliability requirements.
- Withstands effects of vibration and flexing . . . allows interconnected assemblies to move independently.
- Speeds up assembly . . . permits automatic production . . . eliminates error.
- Easily cut, stripped and connected.
- Available in vinyls, polyethylenes, polyesters, silicones, Kel-F, Teflon, or other insulations.

Write today for complete data about capabilities, prices and deliveries.

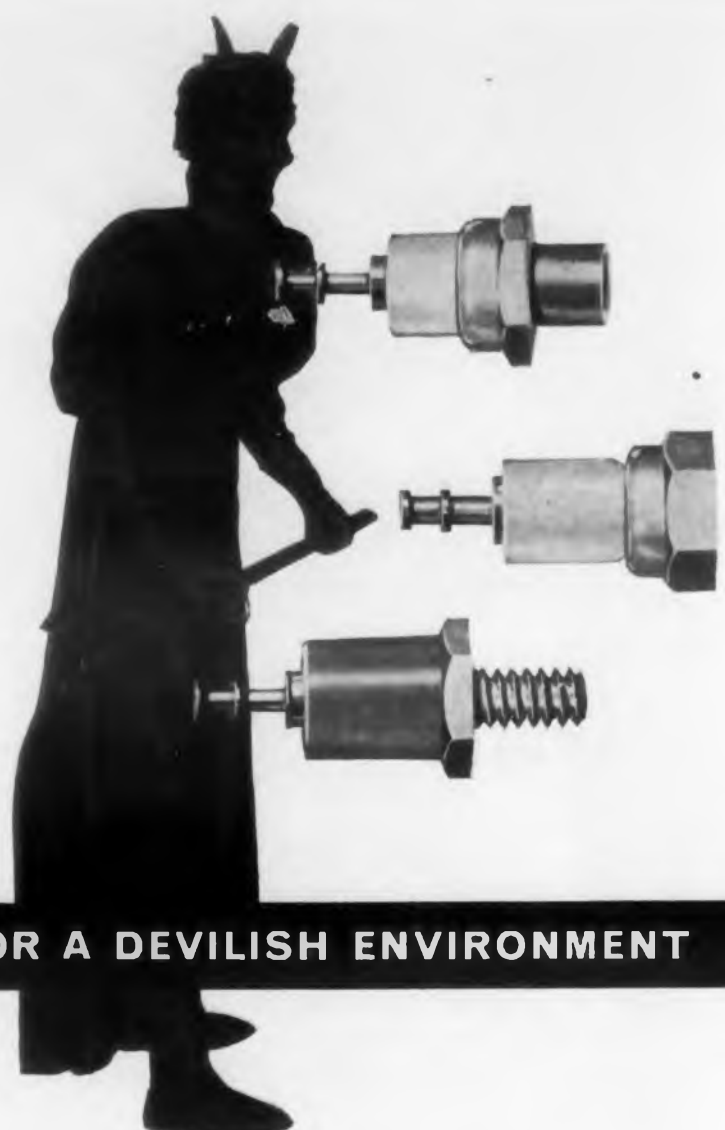


TRADEMARK - SANDERS ASSOCIATES, INC.

SANDERS ASSOCIATES, INC.

NASHUA, NEW HAMPSHIRE • Dayton, Ohio • Inglewood, Calif. • Washington, D.C.

CIRCLE 467 ON READER-SERVICE CARD



FOR A DEVILISH ENVIRONMENT

Available now...THREE completely new lines of USECO Insulated Terminals. They cover a wide range of operating conditions, including the most severe environments.

The result of exhaustive materials research and terminal design evaluation, these new USECO Insulated Terminals are closely controlled in production to assure reliable performance in your equipment.

USECO HI-ALUMINA—For the ultimate in resistance to shock, vibration and extreme temperature, from 800° F. to 1800° F. ratings. Bonus advantages include resistance to nuclear radiation and zero water absorption. Available in subminiature and standard size with both turret and bifurcated terminal configurations.

USECO TEFLON—For low constant electrical loss and excellent dielectric characteristics, coupled with mechanical resiliency at a service temperature range up to 500° F. Design advantages include the high pull strength of 37 pounds. Available in standard sizes and in a wide range of configurations.

USECO UNI-MOLD—For outstanding electrical and mechanical characteristics under high humidity and up to 300° F. These new terminals incorporate a mineral-filled alkyd material in a one-piece molded construction, and provide exceptional dimensional stability. Available in a wide variety of stud, female and swage types with both turret and bifurcated terminals.

There is a USECO Insulated Terminal, and other USECO Electronic Hardware that best meet your specific requirement. Write for detailed information, no obligation. Litton Industries, Components Division, Dept. 2, 5873 Rodeo Road, Los Angeles 16, California, or Litton Industries, Dept. 1, 215 South Fulton Avenue, Mount Vernon, New York.



LITTON INDUSTRIES, INC.
Components Division

LITTON PRECISION COMPONENTS: Potentiometers • Ferrite Isolators • Rotary Joints
USECO ELECTRONIC HARDWARE: Hardware & Terminals • Terminal Boards • Printed Circuits
CIRCLE 237 ON READER-SERVICE CARD

NEW PRODUCTS

CAPACITOR CAPS.—These mylar capacitor caps, when used as an insulator placed over each end of the capacitor winding, will not shrink or twist after it has been formed.

Milam Electric Mfg. Co., Dept. ED, 1100 Elmwood Ave., Providence, R. I.

CIRCLE 238 ON READER-SERVICE CARD

PRESSURE TRANSDUCER.—PSG-1 series, including absolute, gage and differential pressure types, is supplied in standard ranges from 25 to 300 psi, for performance in temperatures ranging from -100 to +300 F.

Gulton Industries, Inc, Dept. ED, 212 Durham Ave., Metuchen, N. J.

CIRCLE 239 ON READER-SERVICE CARD

PLUGS.—These teflon-insulated plugs may be used in conjunction with type SKT-10 jacks which mount directly on metal panels as close as 1/4 in. between centers, for tight assemblies.

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

CIRCLE 240 ON READER-SERVICE CARD

PYROMETER.—Model DR35 surface pyrometer has a 4-3/4 in. indicator with two scale ranges: the low range from 0-500 F read in 5 deg divisions, and a high range from 0-1500 F.

The Pyrometer Instrument Co, Dept. ED, Bergenfield, N.J.

CIRCLE 241 ON READER-SERVICE CARD

TIMER.—This reset timer features a cycle progress pointer and is available in time ranges from 10 sec to 10 hr in 115 or 230 v models.

Eagle Signal Corp., Dept. ED, 202-20th St., Moline, Ill.

CIRCLE 242 ON READER-SERVICE CARD

ANCHOR NUTS.—Configurations are a two-lug anchor nut type LHA3006, a one-lug anchor nut type LHA3207 and gang channel assembly type G15 which were designed for service at temperatures up to 550 F.

Elastic Stop Nut Corp. of America, Dept. ED, 2330 Vauxhall Rd., Union, N.J.

CIRCLE 243 ON READER-SERVICE CARD

VOLTAGE VARIABLE CAPACITORS.—With maximum operating range of 100 v, the new types are rate 7, 10, 12, and 15 μ f.

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

CIRCLE 244 ON READER-SERVICE CARD

FASTENER.—This seal-sealing fastener has a thin shim of Teflon set in a specially designed "O" ring groove which absorbs a maximum amount of friction between the metal and the "O" ring during installation, preventing cold-flow and abrasion.

Uniseal Co. of Calif., Dept. ED, 8021 S. Western Ave., Los Angeles, Calif.

CIRCLE 245 ON READER-SERVICE CARD

**DESIGNED
ENGINEERED
PRODUCED
TO RIVAL
NATURE'S
PERFECTION...**



That's the story of Boehme Fine Pitch Precision Gears. Hobbed to meet requirements that include up to 1/8" x 5" O.D. — 180 — 16 D.P. AGMA Precision #3.



Spiral Gears



Spur Gear Clusters



Quadruple Thread Worms

... and when it comes to Boehme Precision Manufacturing Facilities

you'll find a whole new concept of design and engineering skills backed by experienced craftsmanship in the production of electrical, electro-mechanical and electronic products for automation and instrumentation.

Learn how Boehme can help you meet today's competitive demands. Send for descriptive literature, now — There is no obligation.

H. O. Boehme, Inc.
Designers and Manufacturers
Communication Equipment
Precision Electro-Mechanical
Apparatus Since 1917

915 Broadway New York 10, N.Y.

CIRCLE 246 ON READER-SERVICE CARD

Using Thermistors

Edited by

FENWAL ELECTRONICS



New Experimenter's Thermistor Kit

Now it's easier than ever to choose the thermistor best for your application!

New Fenwal Thermistor Kit No. G200 can be purchased for experimental work and use in circuit design. It contains a selection of 12 thermistors — 2 glass probes, 8 beads, 2 discs, 3 rods and 2 washers. Price is only \$19.95 f.o.b. Framingham, Massachusetts.



Complete technical data provided with each thermistor right on its individual package. Information includes: ratio of resistance at 0°C and 50°C; dissipation constant; time constant; typical E-I curve; typical Resistance-Temperature curve; actual resistance at 5 specific temperatures; plus current, voltage and temperature parameters.

To order Fenwal Thermistor Kit No. G200, write — FENWAL ELECTRONICS, Inc., 36 Mellen St., Framingham, Mass.



Design — Engineering — Production
of Precision Thermistors
CIRCLE 247 ON READER-SERVICE CARD

PREAMPLIFIER.—Model 201 extends instrument sensitivity by a factor of 10 or 100. The line-powered unit achieves good hum reduction by utilizing a well-filtered dc filament supply together with a VR tube-regulated and filtered plate supply.

EO Electronics, Dept. ED, Mountain Lakes, N.J.
CIRCLE 248 ON READER-SERVICE CARD

PRESSURE SWITCH.—Designed for high temperature, close operating tolerance for liquid or gaseous applications.

Carleton Aviation Co., Inc., Aeronautical Div., Dept. ED, 411 North St., East Aurora, N.Y.
CIRCLE 249 ON READER-SERVICE CARD

DATA WRITER TESTER.—Automatically operates keyboard solenoids in a predetermined sequence, permitting malfunctions and momentary hangups to be isolated and identified by comparing the printed test record with a master record.

Hanson-Gorrill-Brian, Inc., Dept. ED, 85 Hazel St., Glen Cove, N.Y.

CIRCLE 250 ON READER-SERVICE CARD

POWER OSCILLATOR.—Model 150 has an internal oscillator that generates a fixed frequency of 400 cps ± 0.25 per cent or a variable frequency from 350 to 450 cps.

Industrial Test Equipment Co., Dept. ED, 55 East 11th St., New York 3, N.Y.

CIRCLE 258 ON READER-SERVICE CARD

MEGPOT.—This is a combination megohm-meter and high potential test set, with variable voltage ranges to 10,000 v.

General Hermetic Sealing Corp., Dept. ED, Valley Stream, N.Y.

CIRCLE 259 ON READER-SERVICE CARD

SERVO.—Measuring 3 x 1-1/4 in., this servo meets the needs for an isolation servo between synchro components, or a synchro controlled servo drive for resolvers, potentiometer, or shaft to digital converters.

Librascope, Inc., Sub. of General Precision Equipment Corp., Dept. ED, 808 Western Ave., Glendale 1, Calif.

CIRCLE 260 ON READER-SERVICE CARD

BALUN COIL KIT.—Suitable for connecting either 75 ohm unbalanced to 300 ohm balanced, or 75 ohm unbalanced to 75 ohm balanced.

Barker & Williamson, Inc., Dept. ED, Canal St. & Beaver Dam Rd., Bristol, Conn.

CIRCLE 261 ON READER-SERVICE CARD

PRESSURE PICKUP.—Operating from -300 to +300 F with a nominal output of 40 mv, type 4-323 pressure pickup measure up to 5000 psi.

Consolidated Electrodynamics Corp., Dept. ED, 300 North Sierra Villa, Pasadena, Calif.

CIRCLE 262 ON READER-SERVICE CARD

POWER SUPPLY.—Designed to test 400 cycle servo systems and motors. The unit has three continuously variable outputs: two at 0 deg and one at ± 90 deg.

Pacific Technical Co., Dept. ED, 2047 Sawtelle Blvd., Los Angeles 25, Calif.

CIRCLE 263 ON READER-SERVICE CARD



Catalog 105 AVAILABLE
UPON YOUR REQUEST

Strict adherence to top quality standards offers EMCOR® enclosure users the benefit of custom design and construction at mass production costs. Pictured above are just two of the quality controlled operations . . . Heliarc welding which offers extreme strength and clean welds . . . and controlled inspection of EMCOR's beautiful and durable baked enamel finish.

Extensive production research has brought about the design, development and application of precision tooling, special welding assembly jigs and fixtures assuring close dimensional tolerances specified by EMCOR's engineering staff. From the engineering drawings to the baked enamel finish, EMCOR's production skill assures positive customer satisfaction through rigid quality controlled standards.

Discover how EMCOR engineering and production "know-how" can work for you. Write for the name of the EMCOR Sales Engineer nearest you.

*Registered Trademark of Elgin Metalformers Corporation.

ORIGINATORS OF THE MODULAR ENCLOSURE SYSTEM



630 CONGDON, DEPT. 1221 • ELGIN, ILLINOIS
CIRCLE 264 ON READER-SERVICE CARD

'DIAMOND H'

SERIES W



General Purpose Relays

MEASURE ONLY: 1½" x 1½" x 1⅞"

BUT CARRY: to 25 A. resistive at 115-230 V., A. C.; 1 h.p., 125 V., 2 h.p., 250 V., A. C.; D. C. and other higher ratings on request.

CONTACTS: DPDT, Double Break-Double Make (Form Z). Special arrangements and sequence on request.

MOUNTINGS: Socket, panel and sidewall arrangements standard; others to meet special needs.

"Diamond H" engineers are prepared to work out variations of these rugged, dependable relays to meet your specific requirements in such applications as automation controls, appliances and air conditioning equipment, or what you will. Just ask.

THE
HART MANUFACTURING
COMPANY

210 Bartholomew Ave., Hartford, Conn.
Phone Jackson 5-3491
CIRCLE 265 ON READER-SERVICE CARD

NEW MATERIALS

Cleaning Solvent

For gyroscopes, precision instruments

Gyroclean solvent No. 113, a purified trichlorotrifluoroethane, is a cleaner for use with gyroscopes and other precision instruments. The solvent has low toxicity, evaporates quickly, is non-flammable, has low residue, and is compatible with gyroscope sealing and potting resins.

Bacon Industries, Inc., Dept. ED, 192 Pleasant St., Watertown 72, Mass.

CIRCLE 266 ON READER-SERVICE CARD

Glass Screens

For storage and image orthicon tubes



Automatically produced glass screens with 562,500 precisely etched holes per sq in. are available. Having good dielectric properties, the screens are particularly suitable for electronic storage tubes and for targets in image orthicon tubes. Transmission of these screens can be as low as 40 per cent or as high as 70 per cent, depending on width of the holes. These range from 0.00085 to 0.00112 in. For certain sealing operations the screens are available with metalized perimeters.

The screens are made of Fotoform, a strong, chemically etchable photosensitive glass. Thickness of the circular screens after etching is 0.003 to 0.005 in. Largest size now available is 1.75 in. diam, with a screen diameter of 1.5 in.

Corning Glass Works, Dept. ED, Corning, N.Y.

CIRCLE 267 ON READER-SERVICE CARD

Hook-up Wire

For high temperature use

Made with silver-plated, stranded copper conductors type 500 is insulated with Teflon tape by a process which increases flexibility at low temperatures. The wire is made in awg sizes 20, 18, 16, 14, 12, and 10, and is available in all colors, solid, and striped combinations.

Western Insulated Wire Co., Dept. ED, 2425 E. 30th St., Los Angeles 58, Calif.

CIRCLE 268 ON READER-SERVICE CARD

HIGH SPEED TESTING.



• CAPACITORS

• RESISTORS

• INDUCTANCES

Manual-Feed — Manual-Sort

AUTO-BRIDGE

The newest addition to Industrial Instruments' Auto-Bridge line of automatic and semi-automatic test equipment is the Model AB-3X2 manual-feed, manual-sort bridge. Fully automatic hopper or tape-fed equipments have a definite place in component testing, but they are not the most efficient system whereby a large variety of small and medium-size lots of components can be tested.

The Model AB-3X2 is manually loaded and unloaded. One of the two colored lights indicates whether the component under test is "in" or "out" of preset tolerance. Plug-ins are used to set the "high" and the "low" limits and the standard jig supplied with the equipment accepts most wire lead components. There are no meters to read... the only interpretation required by the operator is to determine which of the two colored lights is lit. A true limit bridge principle is used. There is no drift in the operating point and daily calibrations are not necessary.

TABLE OF SPECIFICATIONS

| | RANGE | ACCURACY |
|------------|---|----------|
| Capacity | 100 uuf to 15 uf lower at reduced accuracy | ±0.3% |
| Resistance | 10 ohms to 5 megohms, higher at reduced accuracy | ±0.3% |
| Impedance | 10 ohms to 5 megohms, higher at reduced accuracy | ±0.3% |

For complete details on this economical Auto-Bridge as well as our full line of associated equipment, write...



Industrial Instruments Inc.

89 Commerce Road, Cedar Grove, Essex County, N.J.

CIRCLE 269 ON READER-SERVICE CARD

HUNTER ENGINE HEATERS



for military
applications at
sub-zero temperatures



- designed and produced in accordance with military requirements.
- for starting internal combustion engines at sub-zero temperatures, cold starts to -65°F .
- standard winterization gear for military vehicle engines, generator sets, compressors, hydraulic test stands, battery starting carts, other ground support and special purpose equipment applications.
- burn any type gasoline or JP-4 fuel.
- BTU/Hour range: from 30,000 to 90,000 input, utilizing both uncontaminated air and exhaust.
- compact, light-weight, high capacity units for delivery of high temperature, high-volume air as required for specific applications.

Other Hunter military equipment: space and personnel heaters; instant lighting torches, refrigeration units.

GET
THESE
BROCHURES
TODAY!

for complete
specifications
and details

MH-166 "Hunter
Engine Heaters"



MH-162 "Hunter Space
and Personnel Heaters"



MH-167 "Hunter
Instant Lighting
Torches"



HUNTER MANUFACTURING CO.
30539 AURORA RD.
OLON, OHIO
HEATING AND REFRIGERATION SYSTEMS
CIRCLE 270 ON READER-SERVICE CARD

Plating Process

Plates copper on ceramic

A process of plating high conductivity copper on ceramic directly out of solution is proving both economical and more efficient electrically because of the close chemical bond achieved. Called the Kemetal process, it is used in the manufacture of disc capacitors and feed-thrus. The copper plates uniformly on irregular or complex surfaces.

Radio Industries, Inc., Dept. ED, 5225 N. Ravenswood Ave., Chicago 40, Ill.

CIRCLE 271 ON READER-SERVICE CARD

Ceramic Components

Thickness down to 0.005 in.



These ceramic parts are made of vitrified, vacuum-tight AlSiMag Alumina. Thicknesses as low as 0.005 in. are practical. Besides the usual applications, the semi-transparent ceramics have also been found highly satisfactory for use as micro-wave windows, transistor platforms, insulators for hearing aids, and in digital counter tubes.

American Lava Corp., Dept. ED, Cherokee Blvd. & Manufacturers Rd., Chattanooga 5, Tenn.

CIRCLE 272 ON READER-SERVICE CARD

Ductile Bismuth

For instrument components

The development of pure bismuth and special bismuth alloys in ductile form now make its use in instruments practical. The natural sensitivity of bismuth to changes in temperature and magnetic field make the material useful in thermocouples and devices for measuring Gauss and Hall effects. The pure metal is available in strip, grid and film form for Gauss and Hall measurements, and in two alloys formed into wires for use as the negative and positive legs of thermocouples. Wires, grids, films, and strips are available in a variety of standard sizes.

Fitzpatrick Electric Supply Co., Dept. ED, 444 Irwin St., Muskegon, Mich.

CIRCLE 273 ON READER-SERVICE CARD



SUPER-TEMP makes teflon insulated wires and cables perform to all kinds of tricky specifications...with wide margins of reliability. But the performance our customers like best is the SUPER-FAST DELIVERY. Need it fast... see us first... SUPER-TEMP'S management team will take personal interest in your problems.

HIGH QUALITY TEFLON* INSULATED

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American Super-Temperature Wires, Inc.

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General Sales Office: 195 Nassau St. • Princeton, N. J. • Walnut 4-4450

Agents in principal electronic manufacturing areas

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STATE _____

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IMPORTANT NOTICE TO PHYSICISTS AND ELECTRONIC ENGINEERS:

INFRA-RED OPTICS RADAR SYSTEMS ANALYSIS ELECTRONIC SUPPORT EQUIPMENT DESIGNERS MISSILE GUIDANCE SYSTEMS CONTROL SYSTEMS ANALYSIS

SEVERAL UNUSUAL CAREER OPPORTUNITIES:

We have a high priority need for qualified men experienced in any of these fields. Requires Bachelor's Degree in electrical engineering or physics plus 3-6 years' experience. Or an advanced degree plus 2-5 years' experience in design and analysis of communication, detection or control systems.

CONTINUED EXPANSION IN ELECTRONICS & AVIONICS:

Emerson Electric has completed a record-setting year and the pace is not slackening at all! Already a leading manufacturer of missiles and electronic equipment, Emerson has a firmly outlined program for the future. We anticipate increased volume and diversity in 1958, and doubling these figures over the next few years. Therefore, a new, broader organizational structure has created these excellent career openings with complex challenges.

CURRENT PROJECTS AT EMERSON ELECTRIC:

B-58 fire control system, mortar locators, radar components and assemblies, servomechanisms, missiles and rockets, ground support equipment, microwave antennas, F-101 Voodoo structures, plus a host of other electronic devices for the supersonic era. We emphasize research, design and development, with a healthy balance in production.

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- Advanced education program
- Moving expenses fully paid
- Plus other top-level benefits

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for new illustrated brochure "Talent
Grows at Emerson Electric," a
pictorial tour of our engineering
facilities. Simply address A. L. Depke,
Technical Employment Manager.



YOUR FUTURE IS OUR BUSINESS!

Electronics and Avionics Division

EMERSON ELECTRIC

8100 W. Florissant Ave. • St. Louis 21, Mo.

CIRCLE 275 ON READER-SERVICE CARD

NEW MATERIALS



**Epoxy
System**
For dip
encapsulation

This resin system, type 6-02, is applied at room temperature by dipping. Resin cure can be attained in 5 hours with virtually no coating drain at oven temperatures and yet the bath life extends for more than a day at room temperature. The resin is particularly well suited for automatic conveyor dipping.

Michell-Rand Manufacturing Corp., Dept. ED, 51 Murray St., New York 7, N.Y.

CIRCLE 276 ON READER-SERVICE CARD

Colloidal Graphite

A list of electronic applications

Colloidal graphite consists basically of a high-purity graphite processed down to colloidal size and dispersed in a wide variety of fluid carriers. The characteristics of the material can be best described by a listing of some of its applications. The largest single application is for vacuum tubes, where it can be applied directly to parts which need not have undergone such preliminary treatments as acid etching, sand blasting, or oxidation. Specific examples are as follows:

Tube shielding: tubes which acquire surface charges merely by handling (the FP-54 Piotron, for example) are coated with an appropriate dispersion of colloidal graphite to within an inch of the control-grid connection. This shielding is then connected to a source of potential equal to that of the grid;

Phototubes: since graphite, being non-metallic, does not react with selenium to form selenides, it is ideal for light-sensitive cells. In this instance, it is useful as electrode material in selenium-tellurium phototubes. Colloidal graphite has a marked physical affinity for cesium and, therefore, finds application in phototubes and half-wave rectifiers where surplus cesium can be adsorbed by the graphite coating;

Cathode ray tubes: special dispersions of colloidal graphite in deionized water are available to be applied to the inside surfaces of TV and oscilloscope tubes. These graphite films serve as ray-focusing anode materials to prevent stray electrons from being reflected back into the electron beam and distorting the image;

Instrument applications: instrument windows

23 DIFFERENT RATIO SET-UPS...



WITH HI-PRECISION GEAR REDUCTION KIT

A Link Gear Reducer with 16 interchangeable precision-class gear and pinion clusters make up Link's new Gear Reduction Kit. This kit, which provides 23 different ratio set-ups, is ideal for experimental and development work where designs are fluid and changes anticipated.

Now there is no further need to order several gear reducers for each development job or to assemble makeshift gear trains. After designs have been frozen, simply order production quantities of factory-assembled Link Model 012 gear reducers.

There are Link Servo Motor Mounting Adapters available for coupling most of the commonly used servo motors to the Model 026 Gear Reducer.

Specify Link Model 026 Gear Reduction Kit, priced at only \$375 F.O.B. Binghamton.

For complete catalog,
write Department ED

Let Link help you with the design and assembly of all your servo mechanism projects.

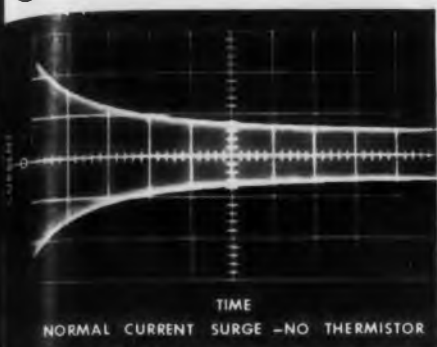


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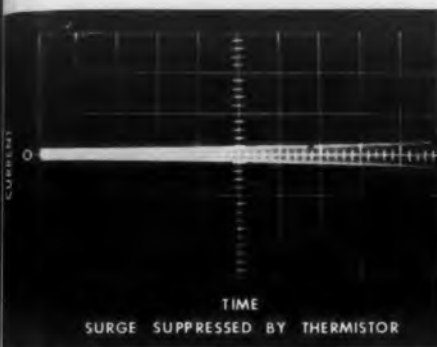
LINK AVIATION, INC.
BINGHAMTON, NEW YORK

CIRCLE 277 ON READER-SERVICE CARD

THERMISTORS



SUPPRESS INITIAL SURGE CURRENTS...



PROTECT FILAMENTS

Application of voltage to tubes in receivers, transmitters, computers, and other electronic equipment subjects their filaments to initial current surges (top oscillogram).

These surges cause premature failure or unsatisfactory service life. Bottom oscillogram shows how a G-E thermistor can suppress the surge and protect the tube filaments.

The thermistor has a large *negative* temperature coefficient of resistance. The high resistance holds surge current to a low value during initial application of voltage. As the cold filament gradually heats up—raising its resistance to normal level—the thermistor's resistance lowers to a negligible value, permitting full current to flow after a brief period.

G-E thermistors can also be used to prevent surges from operating relays, or disturbing sensitive apparatus. They can provide time delay, control warning circuits, sequence switching.

For more information, or thermistor test kits, write: *Magnetic Materials Section, General Electric Company, 1820 N. Neff Ave., Edmore, Michigan.*

THERMISTOR TEST KITS \$12.50 each



- Kit A: 12 DISKS (10-30 OHMS), 6 SIZES.
- Kit B: 12 DISKS (100-10,000 OHMS), 6 SIZES, 2 GRADES.
- Kit C: 12 WASHERS AND RODS (10-410 OHMS), 6 SIZES, 2 GRADES.
- Kit D: 12 DISKS (1000 OHMS), 5 SIZES, 2 GRADES.

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GENERAL ELECTRIC

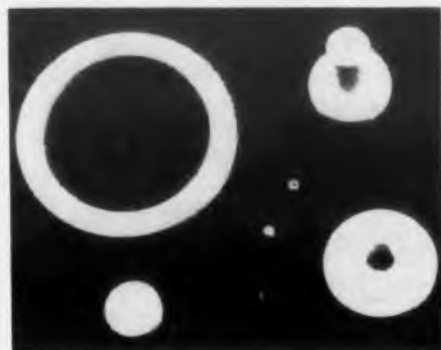
CIRCLE 438 ON READER-SERVICE CARD

in low-torque meters are made conductive and protected from the accumulation of static charges by thin, buffed films formed from diluted colloidal graphite;

Bolometers: when heat radiation falls on a thin sheet of cellophane painted on each side with a colloidal graphite dispersion, the electrical conductivity measured through the sheet changes sufficiently so that the cellophane can be used as the sensitive element in a bolometer.

Acheson Colloids Co., Dept. ED, Port Huron, Mich.

CIRCLE 439 ON READER-SERVICE CARD



Epoxy Resin
Reinforced Teflon

A reinforced Teflon, called Fluorosint, exhibits a two to fourfold improvement in dimensional tolerances over unmodified Teflon. In addition to close tolerances in molding, the material has a thermal coefficient of expansion approximately one fifth that of Teflon. Fluorosint may be quenched in water from 700 F with negligible change in dimensions. The addition of the high temperature inorganic reinforcing agent has a negligible effect on dielectric strength, volume or surface resistivity, or density. Pilot quantities of Fluorosint, in the form of molded parts and in standard stock shapes such as bars, tape and tubular bars, are available.

Polymer Corporation of Pennsylvania, Dept. ED, 2140 Fairmont Ave., Reading, Pa.

CIRCLE 440 ON READER-SERVICE CARD

Ceramic Coated Wire

Continuous operation at 1000 F

This insulated wire, called Ceramicite, is ceramic coated and rated for continuous operation to 1000 F. The wire is flexible, and can be wrapped repeatedly around a mandrel three times its own diameter without damage. It has excellent electrical characteristics and abrasion resistance, as compared to normal insulating materials. Ceramicite is presently applied to solid conductors only, the conductors being nickel-clad copper or solid nickel. For hook-up wire which must be made with flexible stranding, the strands are individually insulated.

Sequoia Wire and Cable Co., Dept. ED, Redwood City, Calif.

CIRCLE 441 ON READER-SERVICE CARD

WAVE GUIDE COMPONENTS

by Kennedy



All Kennedy wave guide components for microwave applications are precision engineered to attain the highest level of performance, with highest transmitted power, lowest standing wave ratio. They are fully tested for trouble-free operation.

- **COMPLETE FEED SYSTEMS** designed and installed. For any antenna, anywhere.
- **HORNS**—both single and dual polarization. Exceptional low VSWR.
- **TRANSITIONS**—better bandwidth and lower VSWR.
- **DUPLEXERS**—rejection ratios better than 100 db
- **STRAIGHT SECTIONS**—Length 3" to 20'
- **BENDS**—E-plane or H-plane
- **COMPLETE HARDWARE** and accessories

For the most efficient use of your antenna, let Kennedy engineers design your feed system. Complete, detailed specification data is yours for the asking. Write today for your free copy of the handy file size Kennedy Antenna Equipment folder.

ANTENNA EQUIPMENT

• **D. S. KENNEDY & CO.**

Route 3A, Cohasset, Mass. EVergreen 3-1200

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NOW, a special division for this high precision work:

- ★ Separate management and operating team specializing in reliable production of precision printed circuits
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- ★ A number of important projects for missiles, radar and airborne ordnance continuously in production

METHODE also offers film insulated wiring harness and connectors for printed circuit applications. Write for bulletin.

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METHODE
Manufacturing Corporation
7447 W. Wilson Ave • Chicago 31

CIRCLE 443 ON READER-SERVICE CARD

NEW MATERIALS

Spiral Cable Lacing

Tool permits easy application



Spirally-cut wiring tube is easily applied using a simple tool, called the Cable-Former. As the tool is moved along the length of the wires, it unwinds the tightly formed spiral tube and wraps it over the wires with uniform pressure. This makes a secure free-running cable which is flexible yet firmly held.

Panduit Co., Dept. ED, 14461 S. Waverly Ave., Midlothian, Ill.

CIRCLE 444 ON READER-SERVICE CARD



Encapsulating Shells

Odd shapes custom molded

Custom molded odd-sized epoxy encapsulating shells are available. They are manufactured with a high degree of accuracy and eliminate the need for expensive temporary molds, release agents, and patching. The shells have excellent chemical and solvent resistance.

Epoxy Products, Inc., Dept. ED, 137 Colt St., Irvington 11, N.J.

CIRCLE 445 ON READER-SERVICE CARD

Photo-Recording Paper

Provides instantaneous visible image

Designated as Linagraph direct print paper, this photo-recording material provides an instantaneous visible record of instrumentation test data, such as that of moving-mirror galvanometer oscillographs. At low recording and writing speeds, a legible record is visible immediately. At higher recording speeds, the trace becomes visible within ten seconds after post-exposure to fluorescent light. When multiple work prints of the original records are desired, intermediates may be made on Autopositive materials

FOR TIMELY DESIGN INFORMATION



In *Electronic Design*, engineers find not only more new products, but all the new products normally encountered in the design of electronic original equipment. 26-time publishing frequency brings this information quickly to the engineer's attention, timed to a fast-moving industry. *Electronic Design* is more up-to-the-minute, more complete, more helpful, and easier to read than any other electronic publication. No wonder more and more engineers read *Electronic Design* first!

ELECTRONIC DESIGN

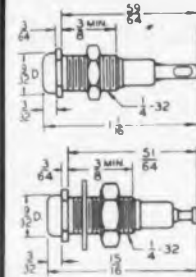
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830 THIRD AVENUE, NEW YORK 22, N. Y.
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NEW! MEETS MIL SPECS!



JOHNSON METAL-CLAD NYLON TIP JACKS

- Shock-proof nylon and metal construction
- Resistant to extremes of heat, cold, moisture
- Available in 13 bright, permanent colors



New . . . from E. F. Johnson . . . these metal-clad nylon tip jacks will not chip or crack with even the hardest usage. Available in three basic grades: Standard, Industrial, and Military . . . all completely insulated with a rugged nylon

body . . . protected by a nickel-plated, machined brass jacket. Quickly fastens to any mounting surface . . . capacity to $\frac{1}{8}$ " panel: 3.8 mmf. Continuous current rating: 10 amps. Internal silver-plated contact is recessed in head for safety . . . accommodates tip plugs of a nominal .081" diameter. Single $\frac{1}{4}$ "-32 nut furnished. Mounts in $\frac{17}{64}$ " dia. hole. Variations in the three grades listed below.

STANDARD—105-201-1 Series—Low cost, metal-clad nylon tip jack with formed silver-plated phosphor bronze contact. Voltage breakdown: 7,000 Volts DC.

INDUSTRIAL—105-201-100 Series—Furnished with nickel-plated phosphor bronze lock washer. Machined beryllium copper contact, silver-plated—hot tin-dipped terminal end. Voltage breakdown: 8,000 Volts DC.

MILITARY—105-201-200 Series—Fully complies with MS-16108 of MIL-STD-242A. Heavy nickel-plated brass jacket meets Federal specifications QQ-N-290. High insulation resistance of nylon body complies with MIL-P-17091. Machined beryllium copper contact, silver-plated—hot tin-dipped terminal end. Supplied with tin-plated phosphor bronze lock washer. Voltage breakdown: 8,000 Volts DC.

Other nylon connectors . . .

- NYLON TIP JACK AND SLEEVE
- NYLON TIP JACK (Low Cost)
- NYLON TIP JACK (Standard)
- NYLON BANANA PLUG
- NYLON BANANA JACK
- NYLON BINDING POST
- NYLON TIP PLUG

write today

Johnson manufactures a complete line of connectors. For complete information write for your copy of our newest component catalog.



E. F. Johnson Company

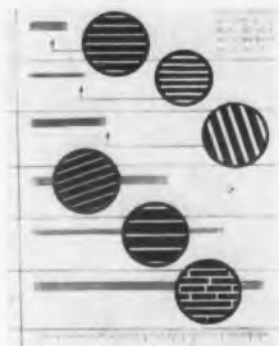
2012 Second Ave. S. W. • Waseca, Minnesota

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Eastman Kodak Co., Dept. ED, Rochester 4, New York.

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Ceramic Rod

Custom-metalized for delay line cores

Precision-metalizing (with high-fired conductive silver and other metals) of very small diameters and very short lengths of Steatite rod and tubing has been developed for delay line cores and other applications. Several examples are illustrated, all of which are made with silver soldering bands. Custom-metalizing is also done on flat and certain eccentric shapes.

Ceramet Corp., Dept. ED, 451 West 216th St., New York 34, N.Y.

CIRCLE 449 ON READER-SERVICE CARD



Epoxy Compounds

Foam-in-place types

Foam-in-place potting compounds are available in two forms. Sealfoam 601 is a two-component liquid which when mixed in proper proportions and heated will expand and cure to a rigid, closed-cell structure with good electrical characteristics and mechanical strength. This compound protects components from moisture, fungus, vibration and shock loading. Sealfoam 603 is a single-component, free-flowing powdered material which requires the relatively low foaming temperature of 175 F. The cured material has a compressive strength of 110 psi, maintains good electrical resistivity even at 350 F and is also an excellent thermal insulator.

Minneapolis-Honeywell Regulator Co., Dept. ED, 2753 4th Ave., S., Minneapolis 8, Minn.

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TOBE
CREATIVE
ENGINEERING

THE NRG-200 SERIES OF LOW-INDUCTANCE THERMONUCLEAR ENERGY-STORAGE CAPACITORS

| Type No. | Watt Seconds | Rating | | Self Inductance (Microhenries) |
|----------|--------------|--------|---------|--------------------------------|
| | | Mfd. | DC Peak | |
| NRG-201 | 1000 | 5.0 | 20 KV | .04 |
| NRG-202 | 1500 | 7.5 | 20 KV | .045 |
| NRG-203 | 2000 | 10.0 | 20 KV | .055 |
| NRG-204 | 3000 | 15.0 | 20 KV | .06 |

Tobe now announces the availability of a series of reliable, low-cost energy-storage capacitors for thermonuclear equipment and similar applications. The NRG-200 series capacitors have a minimum life expectancy of 1000 operations, and may be operated at ambient temperatures up to 40°C. Maximum permissible reversal voltage is 90%. They can be discharged into a very low-impedance load with complete safety.

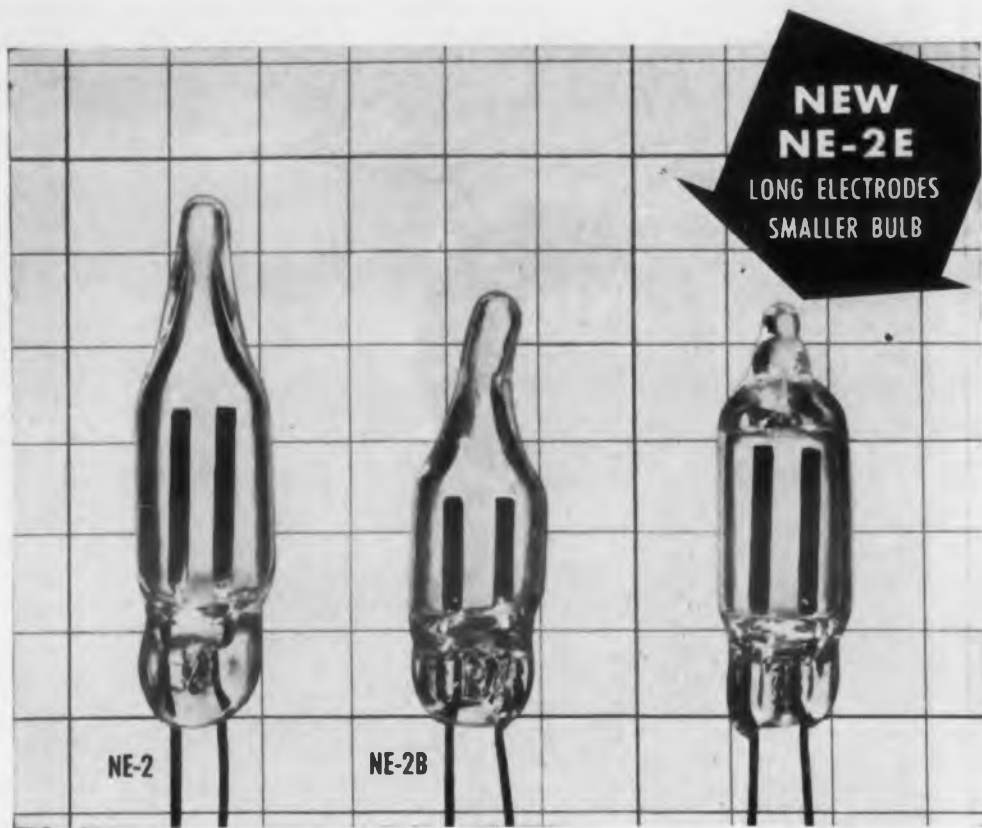


For further technical information or engineering aid, write Tobe Deutschmann Corporation, Norwood, Mass.

Specify



TOBE DEUTSCHMANN • CAPACITOR PIONEERS SINCE 1929
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Three diameter enlargement

Introducing General Electric's NE-2E Glow Lamp

NEW "SNUB-NOSE" DESIGN PERMITS LONG ELECTRODES IN SMALLER BULBS FOR BETTER PERFORMANCE

The new General Electric NE-2E is as small in length as the NE-2B—yet has electrodes fully as long as those in the larger NE-2. The exclusive molded tip permits use where space is restricted—performs better and provides better indicator viewing—especially end-on.

Only glow lamps offer small size, low wattage, long life, wide voltage tolerances, rugged construction. And they don't fail suddenly—so there's almost no chance of false indications.

Any G-E Glow Lamp can be used in many ways. A single lamp may serve as a relaxation oscillator, a leakage indicator, a switch, a voltage regulator, or a voltage indicator. Send for the folder, "G-E Glow Lamps As Circuit Control Components". Write: General Electric Co., Miniature Lamp Dept. ED-58, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

NEW LITERATURE

Inertia Calculation 280

Literature is available which provides a tabulated table to supply data pertaining to mass moment of inertia for precision potentiometers. An experimental method is described to serve as a guide in the compilation of mass moment of inertia of other related components within a system. Designated as Technical Bulletin #20, this literature is complete with formula, schematic, and graph. Technology Instrument Corp. of Calif., 7229 Atoll Ave., North Hollywood, Calif.

Switching Reactors 281

A 16-page catalog on a complete line of standard switching reactors for one-step, low-cost static control is now available. The switching reactor catalog contains tables of electrical characteristics and several typical application circuits, as well as complete descriptions of the units, their applications, and physical dimensions. Control, Div. of Magnetics, Inc., Butler, Pa.

Tube Shields 282

A six page folder with complete details on tube shielding and tube guard products for miniature and subminiature electron tubes is available. The folder gives sizes, specifications, and applications of the two products. The Stave Co., Inc., 41-51 N. Saxon Ave., Bay Shore, N.Y.

Insulated Wire and Cable 283

A complete up-to-date catalog on insulated wire and cable is now available. Applications, specifications and temperature ratings are given. Plastoid Corp., Hamburg, N.J.

Strain Gage Measurements 284

A resistance bridge indicator and its applications are explained in a four-page technical brochure. The instrument can be calibrated to indicate in microinches of strain, psi, pounds, ft pounds, etc., de

NEW SYNCHRONOUS TIMERS by Cutler-Hammer

- 1-minute timer adjustable in 1 second intervals—0 to 60 seconds.
- 3-minute timer adjustable in 3 second intervals—0 to 180 seconds.
- 5-minute timer adjustable in 5 second intervals—0 to 300 seconds.
- No guesswork . . . exact time interval set by positioning bronze pointer.
- Sweep-second pointer provides visual count-down during timing operation.
- Automatic reset returns pointer to start position after each cycle.
- Models interchangeable without disturbing mounting base or wiring.
- Rugged timing mechanism guarantees accurate, trouble-free performance.



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CUTLER-HAMMER
MOTOR CONTROL


For complete information, write today for descriptive bulletin 10336.

CIRCLE 285 ON READER-SERVICE CARD

ending upon the type of strain gage transducer being used. Principles of operation, a schematic diagram, and other specifications are included. Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.

Chopper 286

A general chopper catalog gives complete technical specifications for 60 different models including external size and mounting diagrams, plus data on contact ratings, frequency, thermal and residual noise, high and low temperature operation and life. James Vibrapowr Co., 150 N. Rockwell St., Chicago, Ill.

Transformers 287

A fully-illustrated, 49-page catalog is now available for immediate distribution. The products which are described in this catalog, No. 581, are a complete line of audio transformer, discriminators, filters, high Q reactors, magnetic amplifiers, power components, pulse transformers, and ultrasonic components. The catalog offers complete data on military

and commercial application of these products. Freed Transformer Co., Inc., 1727 Weirfield St., Brooklyn, N.Y.

Accelerometer Calibration 288

Methods and accuracies of crystal accelerometer calibration are featured in a 25-page manual. Frequency response, linearity with temperature, mounting methods, and many other topics are covered. The "Accelerometer Manual" is illustrated with graphs and photographs. Endeveco Corp., 161 E. California St., Pasadena, Calif.

Grid Construction 289

"Framelok Grid" describes design and performance advantages of this electron tube construction technique. The 12-page brochure lists structural features of the grid design and points up their effect on other tube elements. Featuring an introduction on the evolution of "Framelok," the booklet contains an actual grid sample. Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N.Y.



Douglas Aircraft Co. uses
Phaotron RUGGEDIZED Panel Meters

PHAOSTRON RUGGEDIZED PANEL METERS

SEALED CASE
INBUILT SHOCK MOUNTS
RUGGEDIZED MOVEMENT



Critical manufacturers choose Phaotron meters because of their superior consistent accuracy and proven performance. Sealed, the movement has shock mounted jewels, ground and polished pivots. Dials are easy to read. Metal case provides anti-magnetic shielding. Phaotron meters meet and conform to dimensional and performance requirements of MIL-10304A specifications. Write for additional information.

Available:
2 1/2" - 3 1/2" - 4 1/2" Round
1 1/2" Square

PHAOSTRON Instrument & Electronic Co.

151 Pasadena Avenue, South Pasadena, California

CIRCLE 290 ON READER-SERVICE CARD

PHAOSTRON

muscles for missile servos



KEARFOTT SERVO MOTORS MEET ALL REQUIREMENTS
OF RELIABLE, HIGH-PERFORMANCE MISSILE SERVO SYSTEMS.

SHOCK AND VIBRATION: Ruggedized to withstand 30 g's and 2000 cps

TEMPERATURE: Designed for operation at 400° F. or higher.

CORROSION RESISTANT: Materials used assure freedom from corrosion.

IMPEDANCE LEVEL: Matched to function with transistorized amplifiers.

| TYPE | SIZE | STALL TORQUE OZ.-IN. | NO LOAD SPEED RPM | VOLTAGE Ø1/Ø2 | TRANSISTORIZED AMPLIFIER |
|----------------|------|-------------------------|----------------------|------------------|-----------------------------|
| 400 cps | | | | | |
| R-123-5 | 8 | .33 | 6500 | 26/40V | A3105 |
| R-124-5 | 10 | .20 | 6500 | 26/40V | A3105 |
| R-118-5 | 11 | .60 | 6200 | 115/40V | A3108 |
| R-110-5 | 15 | 1.45 | 5000 | 115/40V | A3108 |
| R-111-5 | 18 | 2.4 | 4800 | 115/40V | A3104 |
| R-112-5 | 18 | 2.8 | 9800 | 115/40V | A3104 |
| 60 cps | | | | | |
| R-160-5 | 18 | 3.5 | 3400 | 115/40V | A3300 |

Send for detailed data on all Kearfott components



KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

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West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

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ENGINEERS ...

tie your future to the
unlimited potential of
system electronics
at The Garrett
Corporation



As communication and control problems multiply, one of the most rapidly growing of all missile and aircraft fields is that of system electronics. Stick-force reversal problems are solved by the air data system above.

ing group, liaison with customer during initial equipment installation in aircraft, engineering instruction writing for inspection and production departments, and additional engineering functions necessary for establishing efficient production of the equipment hardware.

- **TECHNICAL DEVELOPMENT ENGINEERS—ELECTRONICS** Graduate engineers required for preliminary design and analysis of electronic-mechanical systems involving closed-loop servos and low frequency amplifier circuitry. A mathematical background and experience with problem setups on digital and analogue computers are essential.
- **TECHNICAL DEVELOPMENT ENGINEERS—FLIGHT INSTRUMENTS & TRANSDUCERS** Graduate engineers required for preliminary design and analysis of small, precision, electro-mechanical, pneumatic devices involving bellows, diaphragms, cams, proportional pickoff sensors, pneumatic amplifiers, servo loops, etc. A mathematical background and experience with problem setups on digital and analogue computers are very desirable.
- **OPERATIONAL ENGINEERS** Graduate engineers for follow-on development of the above mentioned product categories. This work includes such activities as: laboratory circuit development of breadboards and prototype hardware, specialized test equipment design and construction, liaison with design draft-
- **COMPONENTS ENGINEERS** Graduate engineers to act as consultants in matters of vendor contact on electronic and electro-mechanical components. These positions require experience in component testing as on potentiometers, capacitors, etc., and a knowledge of relative qualities and state-of-the-art of such components as manufactured by various vendors. Familiarity with military aircraft specifications desirable.
- **DRAFTING DESIGN ENGINEERS** Designers required for board work in originating packaging designs of electronic, electro-mechanical, and precision miniature pneumatic mechanisms.

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CIRCLE 559 ON READER-SERVICE CARD

NEW LITERATURE

Electronic Parts

Components and equipment for the electronic industries are presented in a catalog of 108 pages. Complete lines are covered with details and prices. Blowers, motors, synchros, capacitors, resistors, and controls are some of the items the catalog contains. *Persons requesting a copy should write on company letterhead and give their title. Requests should be sent to Electro Sales Co., Inc., 50-58 Eastern Ave., Boston 13, Mass.*

Silicon Diodes

293

A 24-page brochure describing microwave silicon diodes has been issued. The catalog includes up-to-date technical data and receiver design information for low noise mixer and video diodes for applications in the 300 mc to 70,000 mc frequency range. A recently developed diode for test equipment applications is also described. Performance curves, nomographs, outline drawings, and photographic illustrations are given. Micro-wave Assoc., Inc., Burlington, Mass.

Fasteners

Detailed specifications, engineering drawings, applications, and installation information are provided in a 40-page catalog. Data as well as complete details on special fasteners is given. Siram Fasteners Corp., North Broadway, Albany 1, N.Y.

Meter Mountings

Bulletin 601 features a low-cost bonded rubber meter mounting for protecting sensitive instruments against shock and vibration. The 4-page text outlines the design features and performance of the mountings, and installation photographs show typical applications. Complete meter mounting specifications include an application cross-reference table listing meters from various manufacturers. Lord Mfg. Co., Erie, Pa.

Armature Winder

A high speed small armature winder with a self-resetting automatic counter introduced in a catalog page. Details are

Ceramaseal
HERMETIC
TERMINALS

- 100% leak-tested
- High alumina ceramic
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- High resistance to thermal shock
- Pressures to 10,000 psi

SPECIAL TERMINALS, SAPPHIRE-TO-METAL SEALS AND MAGNETRON WELLS AVAILABLE

High alumina ceramic and metal parts are brazed together to form a high-strength, long-life, molecular seal.

Stock sizes for up to 100 KV-DC operating voltages available for short delivery.

For complete information, brochure, spec sheets and price lists, write or phone: Ceramaseal, Inc., New Lebanon Center, N. Y. West Lebanon 3-5851.

CERAMASEAL, Inc.

CIRCLE 297 ON READER-SERVICE CARD

29... on the capabilities and special features of the unit. A photograph is provided for illustration. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Sealing Alloys 298

Rodar, Niron 46, and Niron 52—three alloys developed especially for sealing metal to glass—are described in a 4-page folder. For each alloy there is a brief description, a list of average mechanical properties and physical constants, and a graph showing thermal expansion. Wilcox B. Driver Co., 1875 McCarter Hwy., Newark 4, N.J.

Plastic Knobs 299

A picture catalog shows standard thermosetting plastic knobs. It contains complete diagrams, dimensions, and specifications for a representative selection ranging from 1/4 to 3 in. in diameter. Included are pointers as well as knurled and plain knobs. Waterbury Companies, Inc., 528 Washington St., Waterbury 20, Conn.

Disc Capacitors 300

Bulletin C-81 is a 6-page folder about ceramic disc capacitors. It covers types for general use, temperature compensating, and deflection yoke applications. Also listed with specifications are high voltage types in standard and printed circuit styles. The folder is illustrated with dimensional drawings and temperature characteristics curves. The Gude-man Co. of California, Inc., Dilectron Div., 2669 S. Myrtle Ave., Monrovia, Calif.

Plastics 301

Fabricators and suppliers of a complete line of plastic sheets, rods, and tubes have now issued a 52-page plastics catalog and price list. Among the wide range of products covered in the catalog are Plexiglas, vinyl, acetate, phenolics, polyethylene, polystyrene, Nylon, Kel-F, and Lucite in all commercial forms. Prices, sizes, and other specifications are listed. Also included in the catalog is a complete table of properties of plastic materials. Almac Plastics, Inc., 600 Broadway, New York 12, N.Y.

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PREVENT THERMAL RUNAWAY

Prevent excessive heat from causing "thermal runaway" in power diodes by maintaining collector junction temperatures at, or below, levels recommended by manufacturers, through the use of new Birtcher Diode Radiators. Cooling by conduction, convection and radiation, Birtcher Diode Radiators are inexpensive and easy to install in new or existing equipment. To fit all popularly used power diodes.



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CIRCLE 302 ON READER-SERVICE CARD



NEW LOX TEMPERATURE PROBE



Temperature range from
-200° C (or lower) to
+250° C (or higher)

This new liquid oxygen probe operates within the extraordinary working range designated by the drawing at right. Applications at even lower and higher temperatures are anticipated. We expect the probe to be useful down to the liquid helium range. Model 134 provides 100 ohm variation in the range from -270 to -300° F, which corresponds to pure platinum wire having a resistance of 1380 ohms at 0° C. The high impedance level together with a capability for large power dissipation permits large voltage variations to be developed for telemetering purposes.

Contact us for Bulletin No. 5581. Also, we will be glad to propose on variations in calibration, calibration interchangeability, mounting and electrical connection provisions.

REC MODEL 134 SPECIFICATIONS—

- Sensing Element. Pure platinum wire with strain-free mounting and protected by ceramic coating.
- Resistance. 1380 ohms at 0° C is standard; lower and somewhat higher also possible.
- Calibration Stability. After 50 cycles from boiling water to LN₂, R₀ drifts less than 0.1 ohms which is equivalent to 0.02° C.
- Interchangeability. Standard adjustment is within 10 ohms (1.7° C) at 0° C to 2 ohms (0.3° C) at LN₂. On special order, for greater interchangeability (or reproducibility) is possible.
- Time Constant. 0.1 seconds in water at 3 ft. per second.
- Self Heating Effect. 2 watts per ° C in water at 3 ft. per second.
- Vibration. 1/2" DA to 30 g's and 30 g's to 2000 cps.
- Pressure Test. 6,000 psi. std; up to 16,000 psi is possible.
- Thermal Shock. May be plunged from boiling water into LN₂ and back to boiling water repeatedly.

ENGINEERS — Is your data file on temperature probes up to date?

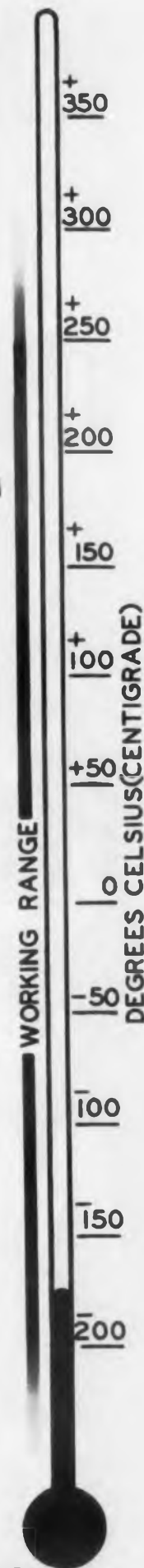
We will welcome your inquiry for information on the REC 134 (Bulletin No. 5581) or any of the many other temperature probes we manufacture; also for research and development or consultation.



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wire corporation

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YORK, PENNA.

CIRCLE 304 ON READER-SERVICE CARD

NEW LITERATURE

Summing Amplifier 305

A bulletin which lists several applications of a magnetic summing amplifier together with the basic circuit for each is available. Performance data, electrical, mechanical, and environmental specifications are also given. The amplifier is designed for missile guidance, analog controls, telemetering, null balance detectors, and similar uses. The unit is completely self-contained, plug-in magnetic amplifier and power supply weighing less than nine ounces. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich.

Radar Reflectors 306

According to an eight page bulletin "Radar Reflectors of Sandwich Design", tracking and scanning radar reflectors can be designed and fabricated of light-weight sandwich materials at a fraction of the cost of conventional tubular truss structures. The bulletin gives construction, installation, and operation of the reflector. Naranco Mfg. Co., 5159 Baltimore Dr., La Mesa, Calif.

Relays

A 20-page booklet catalogs a full line of relays. It contains complete engineering specifications, operational data, and detailed drawings for all major subminiature and microminiature types. Filterco, Inc., Port Washington, N.Y.

Epoxy Encapsulation

Bulletin G6 describes in four illustrated pages a low-temperature melting (281°) bismuth-tin alloy for making extremely accurate and inexpensive dip or slush cast molds for encapsulating electronic components with epoxy resins. Cerro Pasco Sales Corp., 300 Park Ave., New York 2, N.Y.

Analog Computer

A four-page brochure on an analog computer, the K5-U is available. The bulletin contains a general description of the computer specifications and a brief comparison of the K5-U techniques with other methods of analog formulation. Geo. A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

ANALYZE PRINTED CIRCUIT WIRING CAPACITANCE

Another of the Many Applications for the Model 74-C CAPACITANCE BRIDGE



The Model 74-C Capacitance Bridge is a self-contained, precision instrument designed for measuring either two or three terminal capacitance configurations. As a three terminal device it can measure the capacitance and conductance between any two conductors on a printed circuit board, disregarding capacitance to all other conductors. This feature, in conjunction with its high accuracy and resolution, provides an ideal means for analyzing printed wiring capacitance.

SPECIFICATIONS

CAPACITANCE RANGE: .0002 to 11,000 mmf ACCURACY: $\pm(0.25\%$ to 001 mmf)
CONDUCTANCE RANGE: .01 to 1000 micromhos TEST FREQUENCY: 100 kilocycles

Price \$935



Boonton ELECTRONICS Corp.

Morris Plains, N. J. • Phone: Jefferson 9-4210

CIRCLE 310 ON READER-SERVICE CARD

30 RF Filters 311
 A 4-page catalog sheet is available which lists all the standardized combinations of a standard line of 90 basic rf filters with possibilities of some 20,000 combinations. All are in stock. All-Tronics, Inc., Westbury, N.Y.

30 Transformer Catalog 312
 Blocking oscillator pulse transformers, coupling transformers, and pulse transformer sample kits are among the items in a recent catalog-folder. The folder contains operational data, test circuit diagrams, and other information. ESC Corp., Electronic Components Div., 534 Bergen Blvd., Palisades Park, N.J.

30 Capacitors 313
 This literature is a 17-page catalog, CRC-100, showing complete specifications and engineering data on precision film capacitors in Mylar, Polystyrene, Teflon, and metallized Mylar. It includes tubular, Mylar wrap, bathtub, adjustable, decade, and special configurations. Condenser Research Corp., Seymour, Ind.

Anechoic Chambers 314
 Literature on a series of anechoic chambers has been announced. An 8-page brochure contains a description of electro-magnetic energy absorbers for vhf, uhf, and microwave frequencies. Details of construction and illustrations of various types of chamber installations designed to meet specific requirements of frequency range, shielding, and working conditions, are shown. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Transducers 315
 A 16-page catalog, T-10, describes a company's two standard transducer designs; one open for bus bar use, and one enclosed for cable service. Both are available in nine sizes. Titled, "Control Standard Transducers," the catalog describes transducer capabilities and includes typical applications. It contains tables listing detailed electrical characteristics and outlining physical dimensions for each size in both models. Control, Div. of Magnetics, Inc., Butler, Pa.



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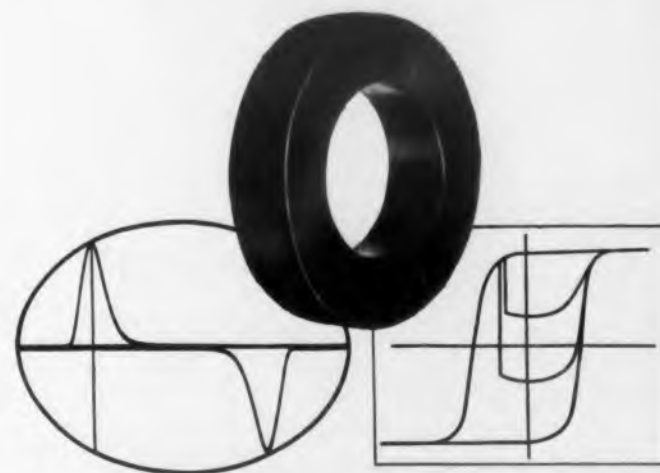
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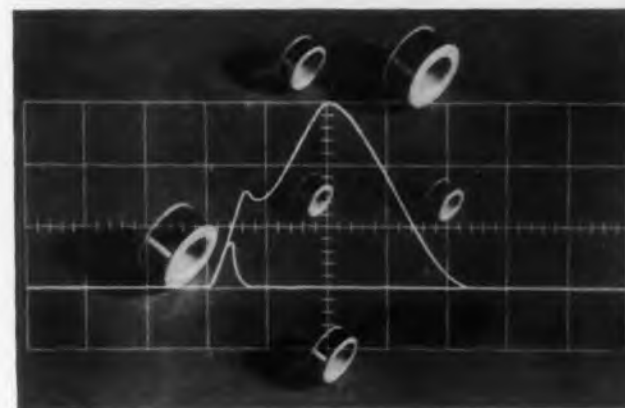
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Bobbin Cores



Not only G-L but our customers, too, claim consistent uniformity with every G-L Tape Wound Core and Bobbin Core. This consistent uniformity is the result of: an accuracy of control never before achieved in each and every step of the manufacturing process; the use of the highest quality raw materials and new and exclusive manufacturing technologies.

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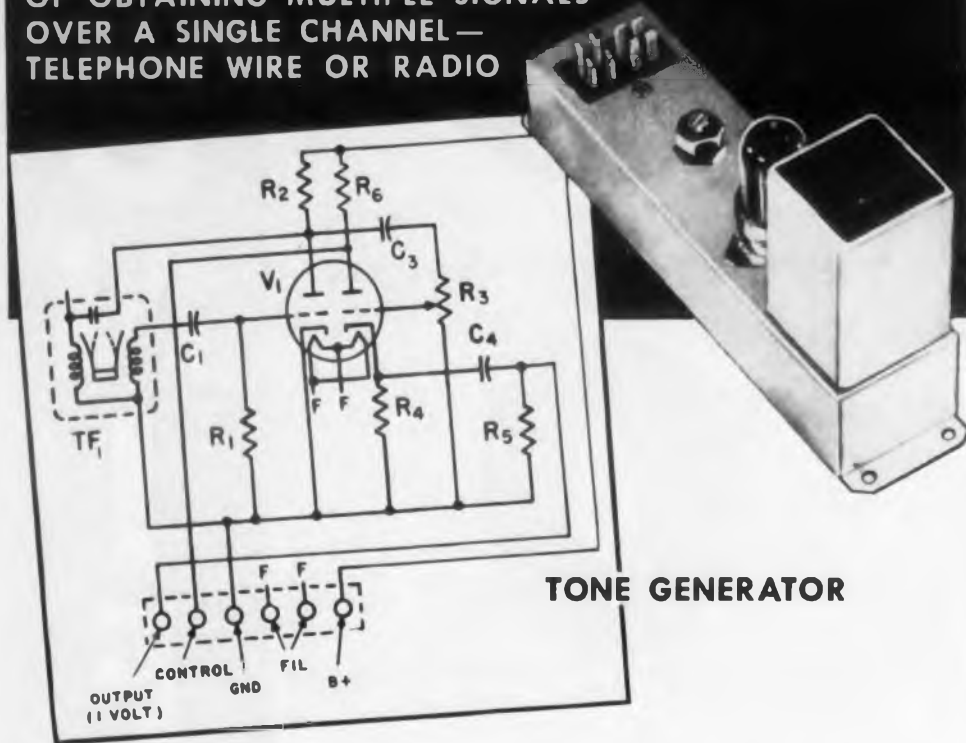
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CIRCLE 317 ON READER-SERVICE CARD

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BIDDLE TONE SIGNALLING EQUIPMENT ... Packaged Circuits

A LOW COST, FLEXIBLE MEANS
OF OBTAINING MULTIPLE SIGNALS
OVER A SINGLE CHANNEL—
TELEPHONE WIRE OR RADIO



TONE GENERATOR

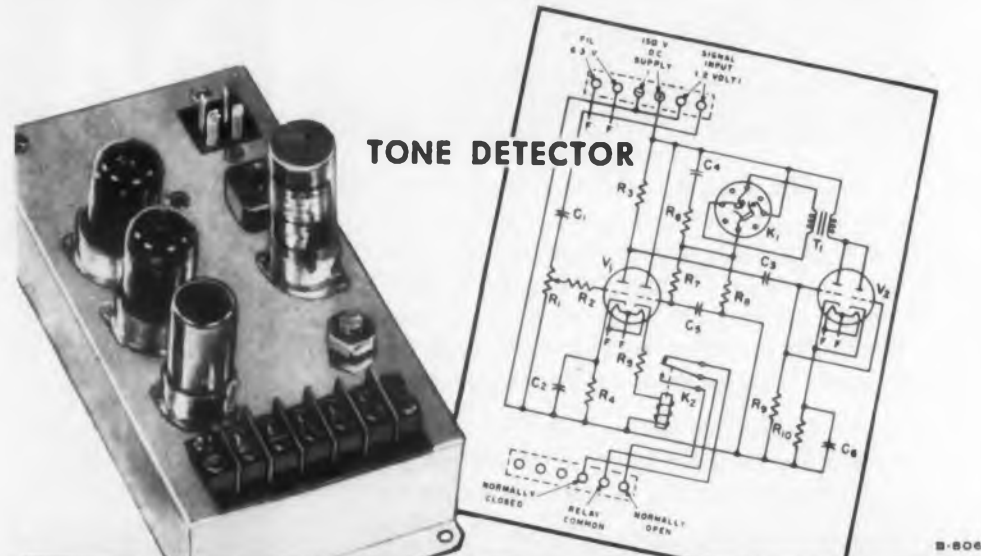
These complete tone generator and tone detector circuits, employing Frahm® Resonant Reed Oscillator Controls and Relays, are available as veritable "building blocks" for your communications system.

Applications for these packaged circuits include: selective calling, remote operation, supervisory control, data transmission, telemetering, and monitoring.

The Tone Generators are complete packaged oscillator circuits capable of supplying any one signal frequency within the ranges of 20 to 250 cps or 250 and 1100 cps, with accuracy of $\pm 0.15\%$.

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We particularly encourage your inquiries and correspondence on special applications and problems. Complete details on these packaged circuits as well as specifications, characteristics, etc., of our Frahm Relays and Oscillator Controls are available for the asking. Request Bulletins 33 and 34-ED.



TONE DETECTOR

JAMES G. BIDDLE CO.

Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

CIRCLE 318 ON READER-SERVICE CARD

NEW LITERATURE

Crystal Filter 319

Characteristics of a company's high frequency crystal filter, both in the steady state and under transient conditions, are summarized in this 6-page illustrated memorandum. The pulse response and optimum point for sampling filter output with a pulse input are described. Hycon Eastern, Inc., 75 Cambridge Pkwy., Cambridge, Mass.

Inductive Devices 320

Catalog 102 lists 390 transformers, chokes, filters, and other inductive devices. The 28-page booklet illustrates each unit and offers descriptions and specifications. Hermetic Seal Transformer Co., 555 N. 5th St., Garland, Tex.

Counters 321

A diversity of counters is described in a 20-page extract of Catalog 57. Dimensions, specifications, ordering directions, and photographs are presented for

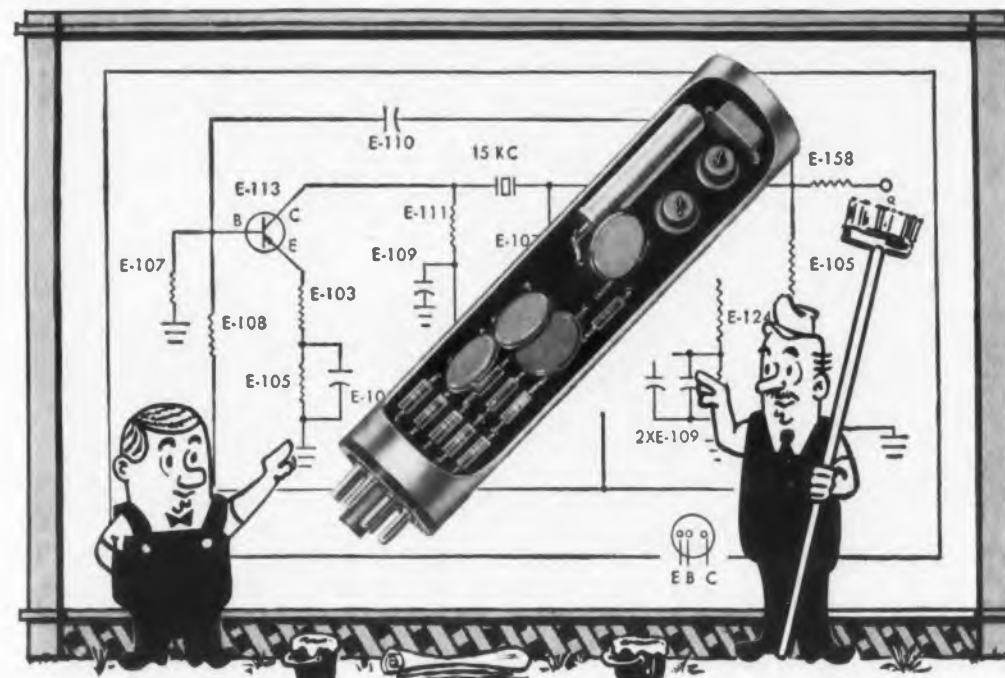
each model. Covered are electromagnetic, printing, predetermining, measuring, small stroke, and revolution counters. Presin Co., 12128 W. Pico Blvd., Los Angeles 64, Calif.

Fan Motors 322

This 12-page bulletin contains design, dimension, rating, performance, and application data on shaded pole motors for a number of applications. The two-color bulletin includes information on the "slim" motor that is thirty-three per cent lighter in weight than previous models. General Electric Co., Schenectady, N.Y.

Glass-to-Metal Seals 323

A brochure has been issued to introduce a line of glass-to-metal seals. Included are many precision-made compression and Kovar designs. The booklet also depicts and describes facilities for production, quality control, inspection, and environmental and qualification testing. Networks Electronic Corp., 14806 Oxnard St., Van Nuys, Calif.



"They're sure compact, K.C." "You bet, M.C., only 1¼ by 6½ inches!"

NEW REEVES-HOFFMAN TRANSISTOR OSCILLATORS

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BULLETIN RH-OS.



New Reeves-Hoffman oscillators are transistorized for compactness and crystal controlled for unerring accuracy. Each oscillator is produced and tested with exacting care by skilled craftsmen using the most modern equipment and facilities available. Reeves-Hoffman will manufacture these units in volume to your specifications.

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CARLISLE, PENNSYLVANIA

CIRCLE 324 ON READER-SERVICE CARD

Printed Circuitry 325

A 6-page brochure discusses printed circuits. It gives data on materials, specifications, design tolerances, and applications. It also discusses a patented process for plating holes and equipment which can produce prototype circuits in minutes. The brochure is illustrated with photographs. Printed Electronics Corp., 7 North St., Natick, Mass.

Waveguide Windows 326

This brochure describes waveguide pressure windows and their uses. Performance curves, outline dimensions, and drawings, and complete electrical and mechanical data are given for each window type. Helpful installation instructions are also included. Microwave Associates, Inc., Burlington, Mass.

Infrared Analyzers 327

This 6-page brochure describes Model 15-A Infrared Analyzer for continuous laboratory and pilot plant analysis, and Model 21 Infrared Analyzer for continuous process stream analysis. Included in

this bulletin, IR-4005, are specifications, features, operating principles, applications, accessories, and applications engineering. Illustrations include both instruments and accessories, as well as instrument mounting dimensions. Beckman/Process Instruments Div., Fullerton, Calif.

Hermetic Terminals 328

Technical Data Sheet EC-1225 features a line of metallized ceramic hermetic terminals which withstand temperatures of 260 C. The sheet lists types and sizes along with specifications. Thermo Materials, Inc., 4040 Campbell Ave., Menlo Park, Calif.

Production Controls 329

Bulletin GET-2676, 14 pages, describes the functions of numerical positioning control, giving a detailed breakdown of the three major elements: data input; director; and servo drive. Accumulated data from particular applications on a variety of machines using this type of control are provided. General Electric Co., Schenectady 5, N.Y.

another
unique
GRC die cast
zinc alloy
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cast-assembled in one operation



GRC's unique, patented INTERCAST method die casts multiple-part zinc alloy units with moving elements in a single, automatic, time-saving, money-saving operation . . . even continuously interlocked assemblies. Units leave the machine complete, ready for immediate use. This INTERCAST technique is an ingenious refinement of GRC's exclusive method of small parts die casting—providing broad design latitude, close tolerances, economies in quantities of 100,000 and more. Let GRC solve your problems. No size too small! Maximum length 1 3/4", maximum weight: 1/2 oz.



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MARCONI

a must for
missile
measurements

FM Telemetry equipment is quickly and accurately checked with the unique instruments described below. All are immediately available against DX Priorities.



FM DEVIATION METER model 928/2

Freq. Range: 215 to 260 Mc, directly calibrated.
Modulation Freqs: 50 cps to 120 kc.
Deviation Ranges:
0 to 100, 200 and 400 kc, or to order.
Accuracy of Measurement: 3%.

Built in crystal standardization, aural and visual monitoring, counter type discriminator. Instrument is ruggedized and waterproof.

FM DEVIATION METER model 928,
similar to 928/2, covers 20 to 500 Mc.

FM SIGNAL GENERATOR model 1066/1

Freq. Range: 10 to 470 Mc in 5 bands.
FM, continuously variable:
0 to 100 kc. Higher to order.
Δ Frequency: 1 to 200 kc, calibrated.
Stability: .0025% per 10 min.

AMPLITUDE MODULATOR model 1102 For use
with any Sig Gen. Gives monitored AM, 0 to 80%
with zero FM. Handles any wave shape.



EDDYSTONE FM/AM RECEIVERS, models 770 R, 770 U

Model 770U covers 150 to 500 Mc, 770R covers
19 to 165 Mc. Both are sensitive, stable, directly
calibrated and have excellent logging scales.

AS SUPPLIED TO: US Signal Corps, Wright Patterson AFB, Navy Electronics Lab, AEC, Convair,
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MARCONI instruments
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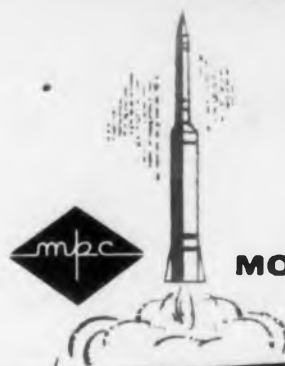
Fully tested from 2 to 2,000 CPS vibration. Acceleration of 15 to 30 G's. Frequency range 16 to 100 kc — typical tolerance $\pm .012\%$ from -40°C to $+70^{\circ}\text{C}$. Lower frequencies down to 400 cycles available in other Monitor types with less rigid requirements.

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Low Frequency
crystals to
meet high
vibration
requirements

Monitor's modern facilities and techniques insures the quality of all units.



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If you have a special crystal problem,
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CIRCLE 437 ON READER-SERVICE CARD

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readings with your
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INVERTER**

Add a new dimension
to your standard AC
vacuum tube voltmeter at
little additional cost! MICRODYNE

VOLTMETER INVERTER gives you accurate low
level DC voltage readings as a simple plug-in
accessory. Other functions, too... detailed
in our Bulletin No. 100, yours for the asking.



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Range 100 Microvolts to 100 Volts
AC Meter Scales Read Directly in DC
High Input Impedance... 10 Megohms
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CIRCLE 332 ON READER-SERVICE CARD

NEW LITERATURE

Templates 333

Catalog No. 60 carries photographs and a description of a line of 91 templates. The catalog index lists templates by number and category. The catalog is divided into seven sections: electrical; ellipses; mechanical engineering; general; architectural; processing; and miscellaneous specialized. A price list is also given. RapiDesign, Inc., P.O. Box 429, Burbank, Calif.

Ballizing Process 334

The ballizing process, forcing a ball through a part for hole sizing and/or finishing, is explained in detail in this 16-page combination technical bulletin and catalog. Typical applications are described, and tables are included giving performance, production, and cost saving data. A complete line of ballizing equipment is shown in actual use, ranging from a service and repair tool to a semi-automated operation. Industrial Tectonics, Inc., 3686 Jackson Rd., Ann Arbor, Mich.

Optical Comparators Movie 335

A 31-minute movie about the operation of optical inspection and measuring machines may be booked free. The 16-mm sound and color film shows how the machines are used in electronics and other fields. Arrange bookings directly with Jones & Lamson Machine Co., Advertising Dept., Springfield, Vt.

Ceramics

"Thermal Properties of Ceramics," Engineering Research Bulletin No. 40 is a report on the findings in some phases of the research in ceramic dielectrics which has been carried out by a research station over the past 12 years. The subject matter of the bulletin is divided into five sections: Melting and Safe Operating Temperatures of Ceramic Materials; Thermal Conductivity of Ceramics; Thermal Expansion of Ceramics; Thermal Endurance of Dense Ceramics; and Thermal Conditioning. Each section has its own bibliography. Included also in the publication are 17 illustrations and 8 tables. "Thermal Properties of Ceramics" is available from the Bureau of

Machlett ML-C19K Scriptron®

Character Writing Display Tube



Machlett Laboratories, Inc. announces the availability of the ML-C19K Scriptron, a 19" beam forming display tube for alphanumeric situation display. The Scriptron is designed for applications requiring maximum writing speed—up to 20,000 characters or symbols per second—(over five times faster than functionally similar mechanical devices currently available) and high speed readout.

The ML-C19K Scriptron converts coded information into situation display and is

especially useful in applications where simultaneous identification of radar targets together with an indication of normal plan position is required.

Current applications include—Aircraft Surveillance (target position and identification)

Computer readout

Situation display of air or surface targets.

Maximum Voltages

Anode

First Second Screen

Pertinent technical data follows:

| | Dia. | Defl. method | Storage | Phosphor | Maximum Voltages | | |
|-----------|------|--------------|---------|---------------------|------------------|--------|--------|
| | | | | (any) | Anode | First | Second |
| Scriptron | | | | | | Screen | Screen |
| C19K | 19" | magnetic | no | usually P11, P14 | 1,300 | 3,600 | 15,000 |

For full technical information on this or any other Machlett tube type, write:

Machlett Laboratories, Inc., 1063 Hope Street, Springdale, Connecticut

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CIRCLE 336 ON READER-SERVICE CARD

335 *Engineering Research, College of Engineering, Rutgers University, New Brunswick, N.J., and is priced at \$.75.*

Programmable Power 337

Bulletin 765 shows how to use programmed power supplies as the basis for automation. Simplified block diagrams illustrate such applications as high-speed transistor testing, motion-to-voltage conversion, and strain gauge instrumentation. The booklet lists dimensional data, performance characteristics, and other engineering information. Electronic Measurements Co., Inc., Eatontown, N.J.

Infrared Optics 338

TDS-4, an 8-page booklet, describes arsenic trisulfide glass for use in infrared instruments. The text covers the optical, chemical, physical, and thermal properties of the glass and describes available coatings. It also lists optical flats and single element and achromat lenses carried in stock. Drawings and photographs provide illustration. Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, N.Y.

Pushbutton Switches 339

This 8-page data sheet describes a modular-mount series of lighted pushbuttons—switches that can bring new simplicity and efficiency to control panels. Data Sheet 143 gives complete information, photos of typical applications, and dimension drawings of the new series. Pushbutton colors and types are detailed. Electrical characteristics and prices are also covered. Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Measuring Units 340

A 32-page catalog describes a line of more than 40 accelerometers; high temperature strain gages, and associated equipment. A series of engineering drawings, tables and graphs are employed to specify sensitivities, natural frequencies, acceleration, and temperature ranges for the accelerometers. Also given are gage factors, resistances, drift rates, temperature ranges, and card sizes of the strain gages. Columbia Research Labs., MacDade Blvd. and Bullens Lane, Woodlyn, Pa.

unprecedented ...

TRUE RMS VTVM

 with **1/4%** accuracy



Exclusive from Trio Labs—laboratory precision measurement of complex waves with VTVM versatility ...
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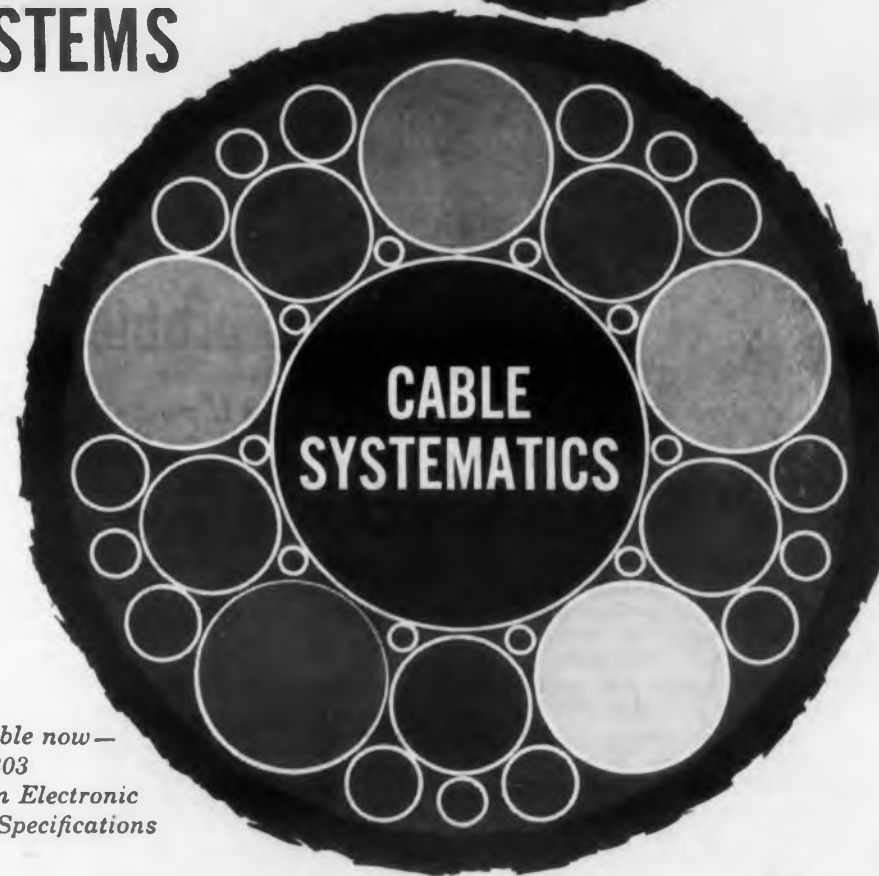
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Saving Tantalum Capacitors

TANTALUM capacitors, frequently used in transistorized circuits, often cost more than the transistors themselves, and often take more space. It's worthwhile to use a few extra components to reduce the size of these capacitors and protect them against failure.

In many circuits, a tantalum capacitor is used as an emitter bypass. A common way to temperature stabilize a grounded emitter stage against I_{co} variations is to use a resistance in the emitter circuit, about the same size as the resistance in the base circuit.

If the emitter resistor is grounded, as in Fig. 1, the voltage across it and its bypass capacitor is quite high. Capacity required, in the audio range, sometimes exceed 100 μ f, so the bypass capacitor must be quite large.

Sometimes the emitter resistor is returned to a bias voltage. Then the emitter to ground voltage can be quite small, so, in theory at least, the capacitor voltage rating can be small, too. The capacitor is polarized as shown in Fig. 2, while the emitter is held positive by biasing the base.

But if the transistor opens up, or is removed from its socket with voltage on, the full bias voltage is applied to the capacitor. Here, also, conservative design calls for a high voltage capacitor.

Furthermore, at high temperatures, the emitter stabilization circuit causes the emitter to become more negative. So, unless lots of bias is used on the base, a reverse voltage of a few volts may be applied to the capacitor, possibly causing failure.

The New Scheme

A diode is connected across the capacitor, in such a direction as to be normally nonconducting. With pnp transistors, the base bias is adjusted a few tenths of a volt negative with respect to ground. The cathode of the diode and the positive terminal of the capacitor are grounded as shown in Fig. 3.

If the transistor opens, or is removed from the circuit, the diode limits the positive voltage across the capacitor to a fraction of a volt. This is not harmful to most tantalum capacitors since they can stand a small reverse voltage. Some are actually formed with an auxiliary film, good for a few reverse volts.

Notice in Fig. 3, that when I_{co} causes the emitter to become more negative, the voltage is applied to the capacitor in the forward direction. This effect may determine the capacitor voltage rating.

Stabilizing for AC

If ac degeneration is required, and the emitter resistance should be smaller than that required for dc stabilization, it is common practice to tap the emitter bypass capacitor down on the emitter resistance as shown in Fig. 4. Unfortunately, this requires much more negative bias on the transistor base, if the capacitor voltage is always to be negative.

If the additional bias is undesirable, the circuit of Fig. 5 can be used. This requires no additional bias.

William Q. Hatton, Sr. Engineer, Raytheon Manufacturing Co., Wayland, Mass.

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| | DT100 | DT80 | **2N174A | 2N174 | 2N173 | 2N443 | 2N278 | 2N442 | 2N277 | 2N441 |
|---|-------|------|----------|-------|-------|-------|-------|-------|-------|---------|
| Maximum Collector Current | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| | | | | | | | | | | amps |
| Maximum Collector Voltage (Emitter Open) | 100 | 80 | 80 | 80 | 60 | 60 | 50 | 50 | 40 | 40 |
| | | | | | | | | | | volts |
| Saturation Resistance (13 amp.) | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 | .02 |
| | | | | | | | | | | ohms |
| Max. Square Wave Power Output at 400 ~ P-P* | 400 | 310 | 310 | 310 | 225 | 225 | 180 | 180 | 135 | 135 |
| | | | | | | | | | | watts |
| Max. Sine Wave Power Output at 400 ~ P-P* | 180 | 140 | 140 | 140 | 100 | 100 | 80 | 80 | 60 | 60 |
| | | | | | | | | | | watts |
| Power Dissipation (Stud Temperature 25°C) | 70 | 70 | 70 | 70 | 70 | 55 | 55 | 55 | 55 | 55 |
| | | | | | | | | | | watts |
| Thermal Gradient from Junction to Mounting Base | 1.0° | 1.0° | 1.0° | 1.0° | 1.0° | 1.2° | 1.2° | 1.2° | 1.2° | 1.2° |
| | | | | | | | | | | °C/watt |
| Nominal Base Current I _B (V _{EC} = -2 volts, I _C = -1.2 amp.) | -19 | -13 | -19 | -19 | -13 | -24 | -13 | -24 | -13 | -27 |
| | | | | | | | | | | ma |

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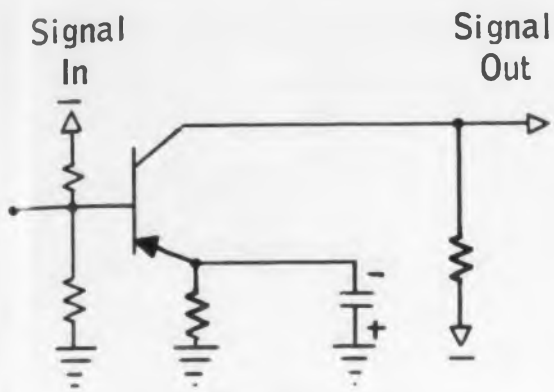


Fig. 1

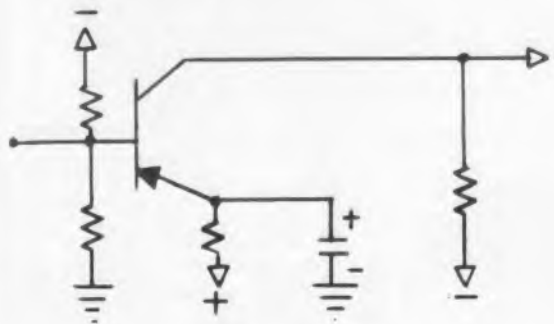


Fig. 2

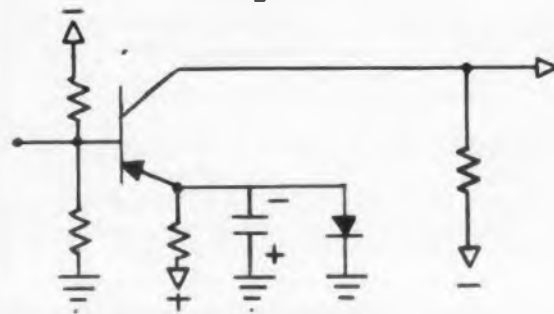


Fig. 3

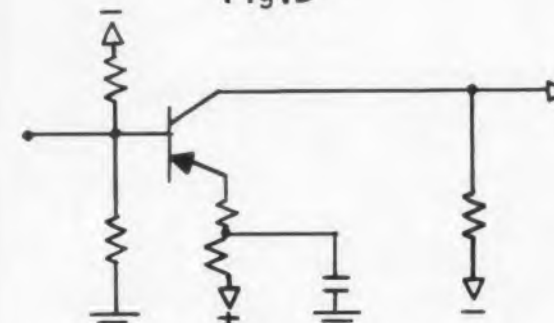


Fig. 4

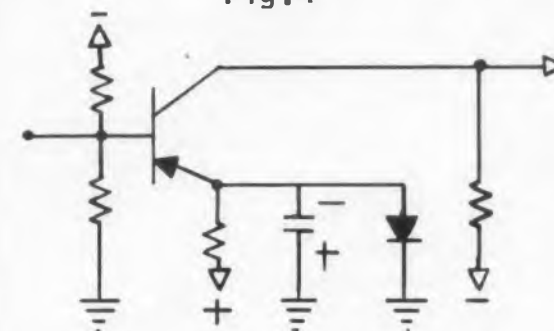


Fig. 5

Figs. 1, 2, and 4 require large tantalum capacitors. Figs. 3 and 5 take smaller ones and they're safer. (Polarities are shown for pnp transistors. For npn's, all polarities and diodes are reversed).



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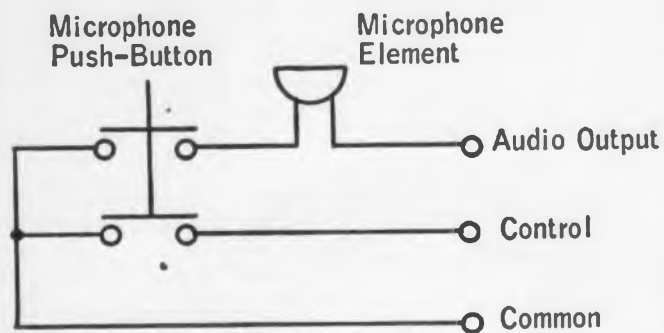


Fig. 1. Circuit of microphone with "push-to-talk" button.

Transistor Priority System

Fig. 1 shows the circuit of a microphone. The unit has a pushbutton to activate the microphone. The "push-to-talk" button completes a circuit to the microphone element and closes a control circuit to activate other equipment, such as transmitters or audio amplifiers.

Where more than one microphone is used, it is convenient to establish a priority system so that one microphone has precedence over others. The second microphone has precedence over the third and so on.

This has been done, in the past, with multi-contact relays, connected so each microphone has the proper priority.

The disadvantages are that the relays use a large number of contacts, they're heavy, and they waste power and space.

The transistor priority system overcomes these disadvantages to a high degree.

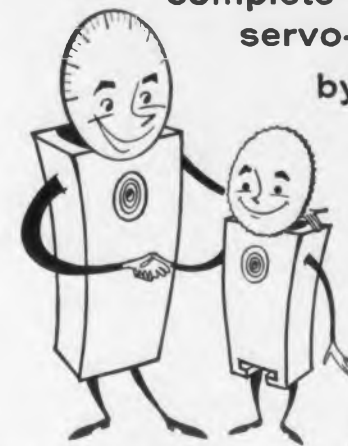
Referring to Fig. 2, assume 20 v is applied as shown. Voltage divider R_7 and R_{11} places a somewhat lower voltage, (say 18 v), on the three emitters which are connected in parallel. When no microphone control circuit is activated the base voltage of all three transistors will be about 20 v. This is a reverse bias so the transistors are completely deactivated. If a signal exists at any of the inputs it is not transferred through the system.

When the control of microphone number 3 establishes a circuit through to ground, the voltage divider R_1 and R_2 establishes a voltage at the base of Q_1 such that Q_1 becomes active. Consequently, any audio voltage present at the input to Q_1 is transferred to the output. Thus Q_1 is connected in a common collector or, as sometimes called, an emitter follower circuit.

R_7 is the load resistor. The signal coupled through C_1 drives the base, and resistor R_8 isolates the input audio from the divider system R_1 and R_2 .

The bases of Q_2 and Q_3 are still at very nearly 20 v and therefore are reverse biased and cannot contribute to the output.

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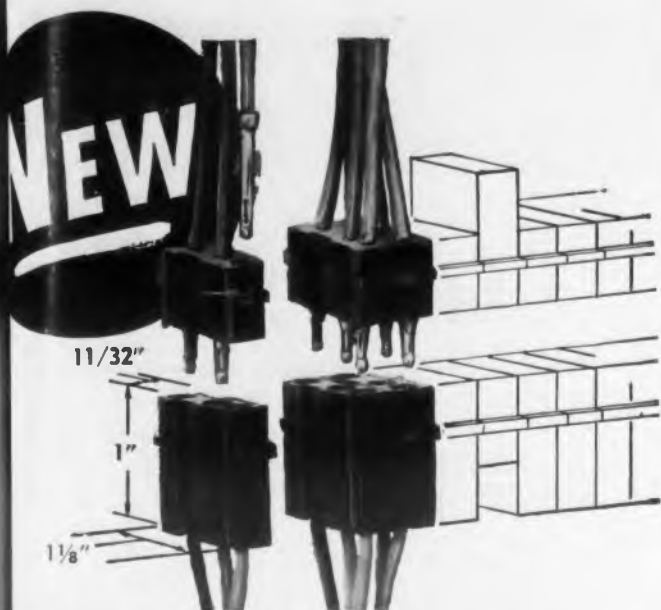
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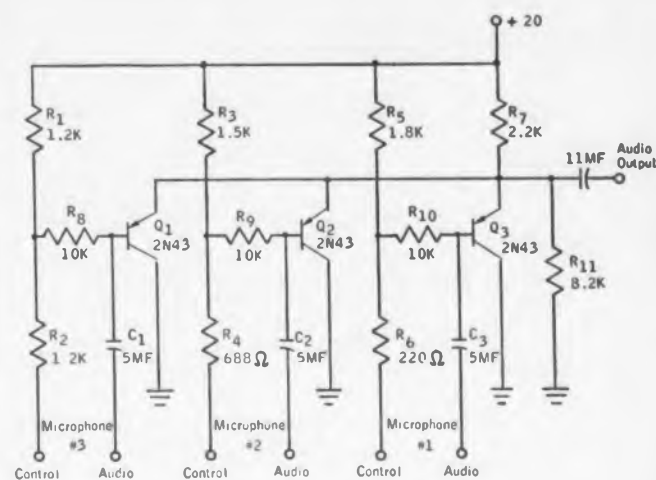


Fig. 2. Transistor priority system. Microphone #1 has priority over microphone #2 which has priority over microphone #3.

Now, if the push button of number 1 microphone is depressed, control circuit number 1 is completed to ground, and a voltage is established at the base of Q_3 by voltage divider R_5 and R_6 .

The divider R_5 - R_6 is so arranged that it produces a voltage at the base of Q_3 which is considerable less than that at the base of Q_1 . The emitters will come to the potential dictated by the base of Q_3 and, consequently, the base of Q_1 will be reverse biased regardless of whether control number 3 is or is not activated.

Furthermore, any audio present at the input from microphone number 1 will be transferred through the system to the output. Audio from microphone number 3 cannot get through the system, because transistor Q_1 is reverse biased.

The dividers associated with number 1, 2, and 3 controls are arranged so that the derived voltages go down in "staircase fashion," being highest at number 3 and lowest at number 1. This establishes a priority system such that number 1 has priority over numbers 2 and 3 while number 2 has priority over number 3.

In a practical model which has been built and tested, the isolation achieved between desired and undesired inputs is about 80 db. The voltage gain of the system is approximately "one," while its power gain is about 17 db.

This circuit is used in Bendix Radio's Passenger Address Amplifier, AMA-10A.

J. M. Tewksbury, Bendix Aviation Corp., Baltimore 4, Md.

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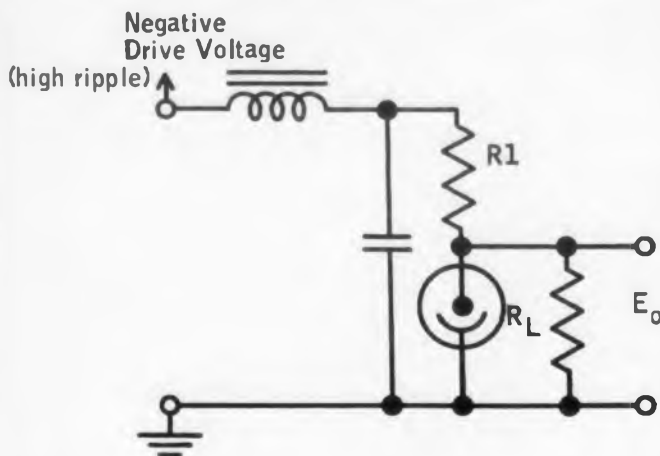


Fig. 1. Conventional VR tube won't work if load is too heavy.

Silicon Diode Helps Gas Diode Get To Work

Conventional gas diode regulator circuits, like the one in Fig. 1, often don't regulate when a heavy load is permanently tied at the output, E_o . As the drive voltage comes up, the load draws too much current, so too much voltage drops across the series resistor, R_1 , rather than across the gas tube. The gas tube can't fire because it never gets enough starting voltage.

The addition of a silicon diode and a resistor, as in Fig. 2, solves the problem neatly. Since the gas diode is initially off, any negative drive voltage is applied through the 200 K resistor to the

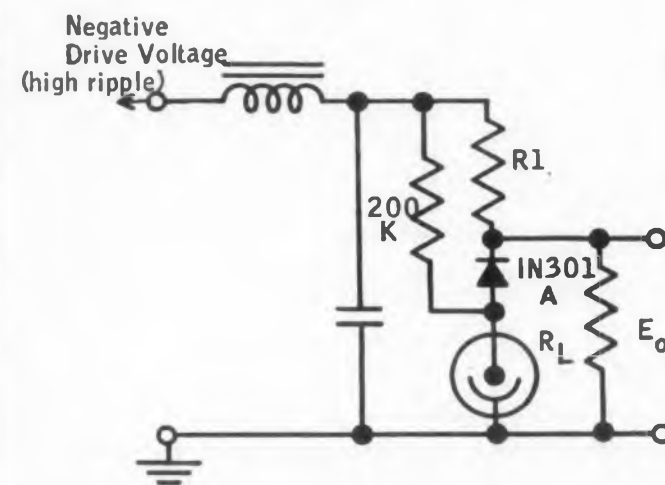


Fig. 2. This scheme assures enough starting voltage for the gas tube.

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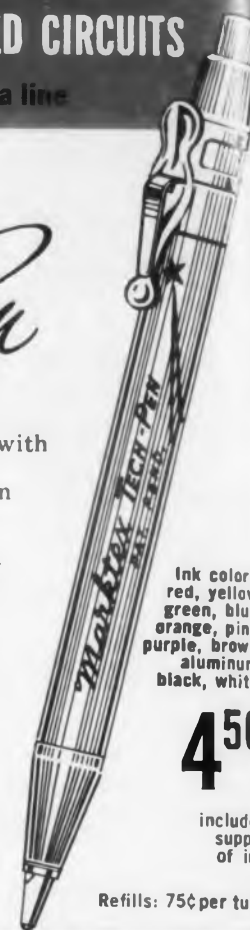
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gas tube anode, with no voltage drop across the resistor. The 1N301A blocks the lower voltage at the load from the gas tube until it ionizes. After ionization, the 1N301 conducts, and the gas diode can get to work and regulate the output voltage.

The scheme works just as well for positive voltage supplies if both diodes are reversed.

R. C. Van Dick, Test Engineer, Convair, Pomona, Calif.

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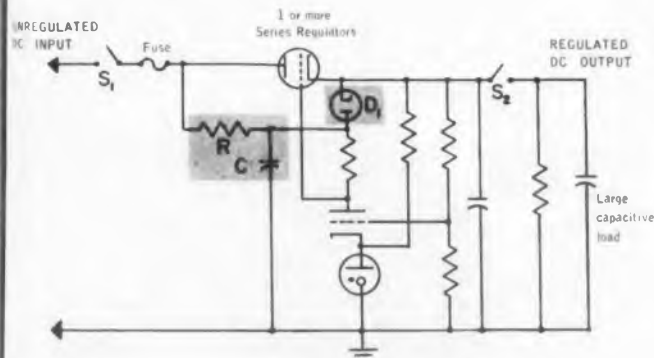
If switching on is done by switch S_1 , the RC combination prevents the grid voltage of the series regulators, and hence the output voltage, from rising rapidly. If switching is done by S_2 , the output of the regulator is momentarily "shorted" by the capacitive load. The output voltage must drop, causing diode D_1 to conduct, thereby partially discharging capacitor C .

After this initial transient, the grid voltage of the series regulator tube again cannot rise faster than the RC time constant permits, since diode D_1 is now reverse-biased.

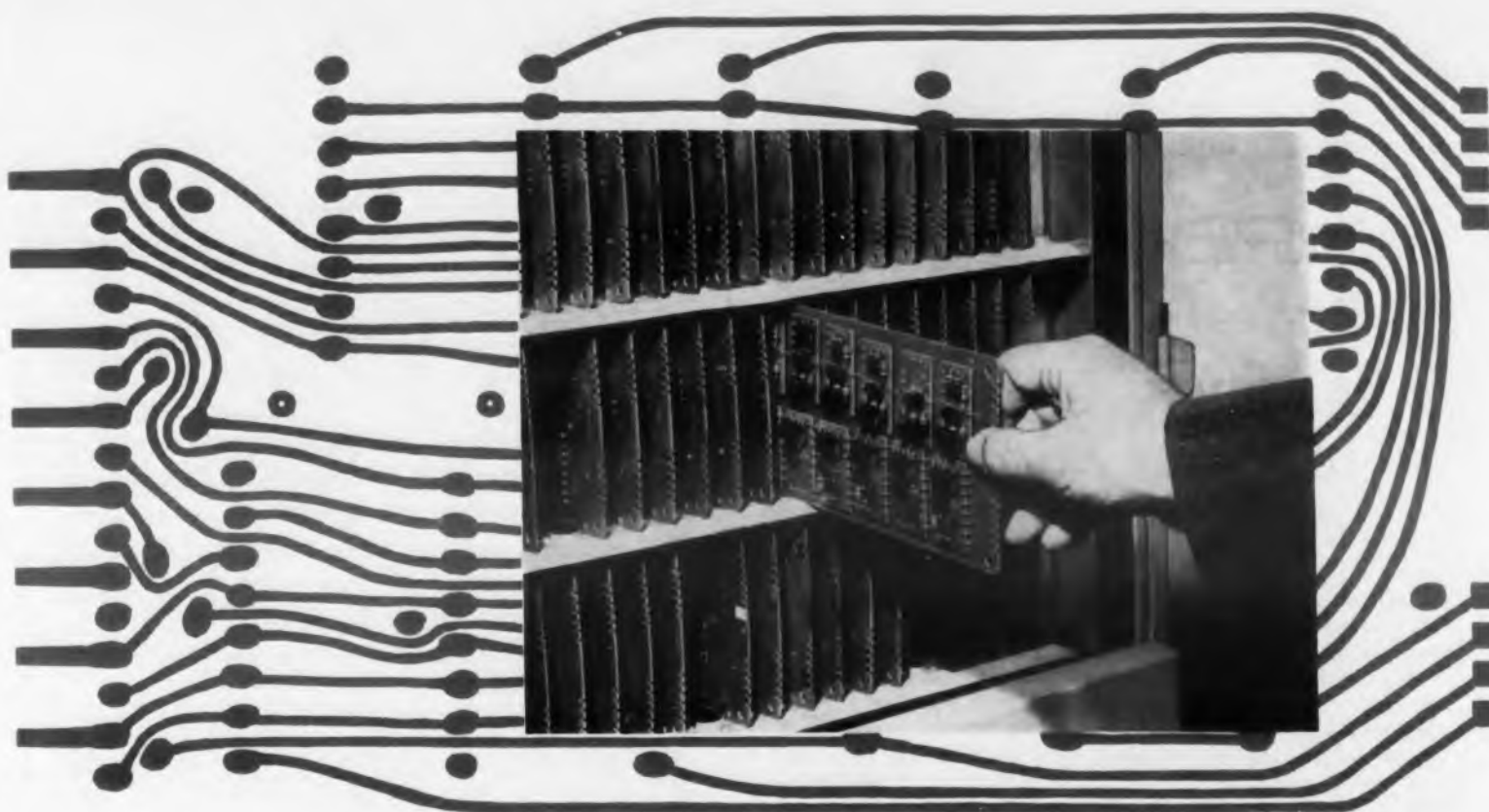
Resistor R is made sufficiently small so that diode D_1 is normally conducting. A small neon lamp (NE-2) can also be used instead of a regular vacuum or semiconductor diode.

These modifications permitted the use of regular fuses in a 285 v, 1 amp regulated supply which would blow out "slow-blow" fuses when subjected to sudden heavy capacitive loads of over 200 μ f.

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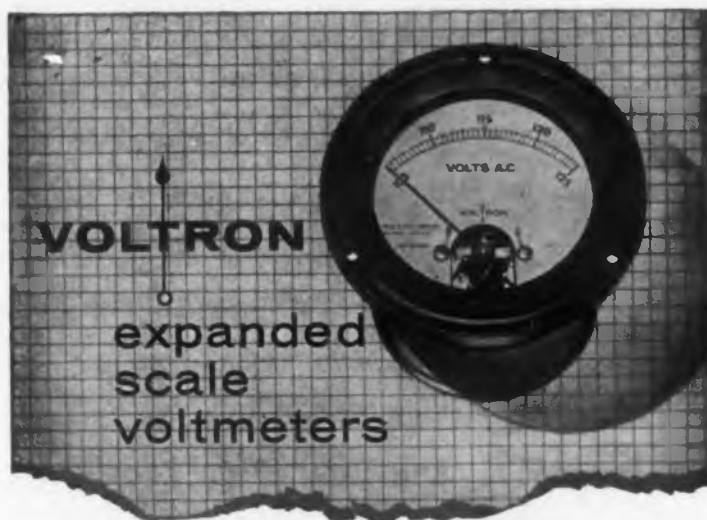
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IDEAS FOR DESIGN

Transistorized Electronic Filter

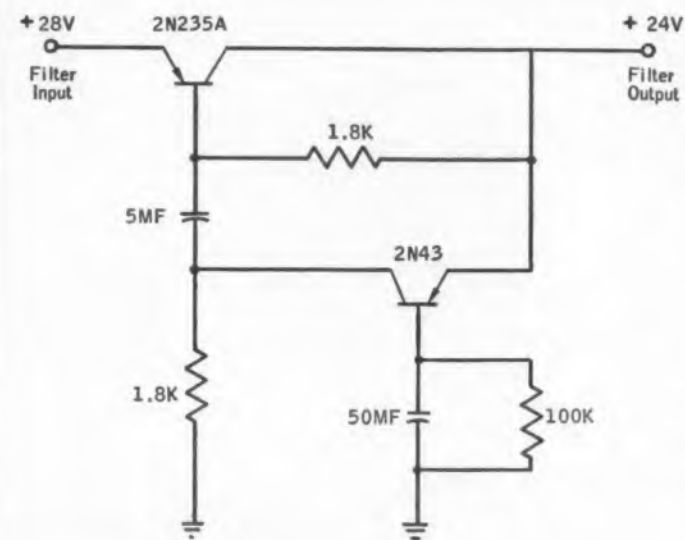
Most transistorized equipment requires a low voltage, high current power source. In many airborne applications, power comes from a 28-volt primary power system. Since this primary power source is connected to other equipment, the voltage is subject to fluctuations and noise.

When a transistorized circuit is connected to this primary voltage source, there is a tendency for the line noise to feed through the circuit and appear in the output as a spurious response. Usually, the practice has been to reduce spurious voltages with filters in series with the primary source of power. These filters are large, heavy, and costly, since they use high-current inductors and large capacitors.

The filter described here is entirely electronic, and uses only 2 transistors, 2 capacitors, and 3 resistors. It permits savings in size, weight and cost.

Referring to the figure, the current from the power source passes through the 2N235A transistor and is delivered at the output terminal. The output current, however, is subject to control of the 2N235A base, which, in turn, derives its voltage from the remainder of the circuit to produce the filtering action.

Assume that the output voltage starts to rise. The instant this occurs, the emitter of the 2N43 senses the minute change in voltage. Its base potential cannot change instantly because of the 50 mf capacitor. Therefore, the 2N43 acts as a common base amplifier. The small rise in emitter voltage, greatly amplified, is impressed across the 1.8 K load resistor in the collector circuit. This amplified voltage is coupled through the 5



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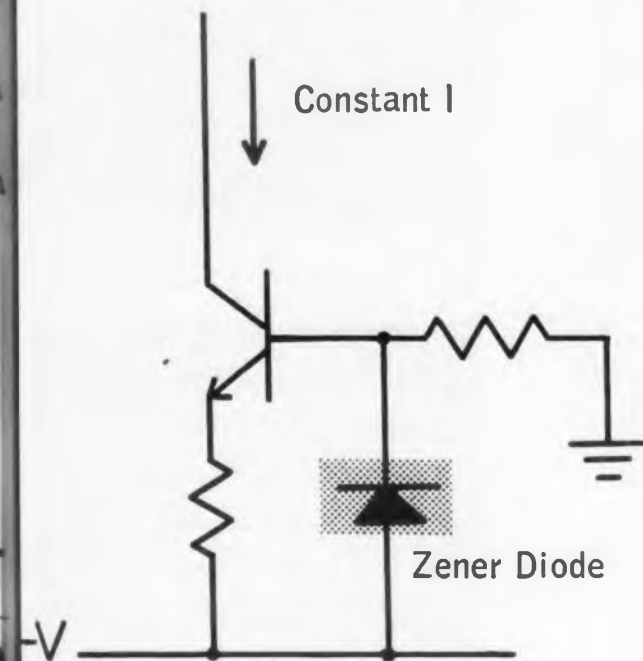
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mf capacitor to the base of the 2N235A. Its phase and amplitude are such as to oppose the change in output voltage, thereby practically eliminating the original voltage rise.

Since a decrease in output voltage would also be amplified by the 2N43 transistor and impressed on the base of the 2N235A, it can be seen that the filter eliminates any ac components which tend to appear across the load.

J. M. Tewksbury, Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.



This simple circuit provides stable emitter currents for transistor pairs.

Stabilizing Emitter Current

When using transistor pairs in the grounded emitter configuration it becomes difficult to sufficiently stabilize the emitter currents without resorting to higher emitter resistance values and supply voltages. The following describes a simple constant current source which has proven well worth an extra transistor in many circuit applications. These applications involved a common emitter feed current for various free running monostable and bistable multivibrators, and in different amplifiers.

The circuit involves a constant voltage applied to the base. This is converted to a constant emitter current by the external emitter resistor. It is not difficult to hold the collector current constant to within plus or minus 2 per cent with changes in transistor parameters and temperature encountered in normal military electronic equipment. (Any convenient zener breakdown diode is used).

J. R. Siconolfi, Engineer, Farnsworth Electronics, Ft. Wayne, Ind.

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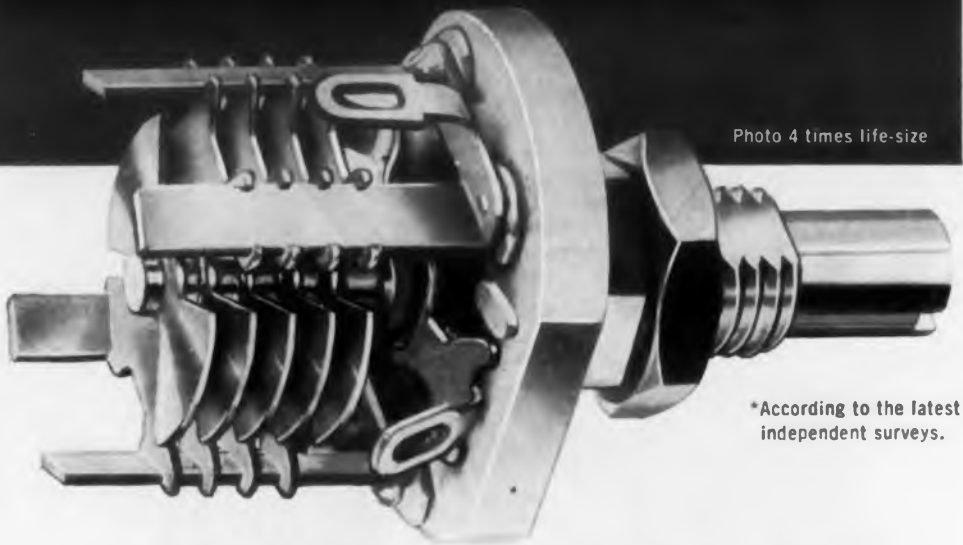


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REPORT BRIEFS

Magnetic Amplifiers for Feedback Control

This consists of Chapter IV, Experimental investigation of the self saturating ac output circuit, including: (1) circuit components; (2) dynamic behavior of the B-H loop; (3) steady-state transfer characteristics compared to "exact" analysis; and (4) to approximate linear analysis; Chapter V, Transfer function of the n-winding magnetic amplifier, includes: (1) derivation of the transfer function of the self-saturating (ac output) magnetic amplifier; and (2) self-saturating (ac output) magnetic-amplifier with n control windings. *Dynamic Operation of Magnetic Amplifiers for Feedback Control Systems. Scientific report No. 2 for period June 1-August 31, 1956 under Contract AF 19(604)-1813, Henry C. Bourne, Jr., Takashi T. Kadota and David Nitzan, California University, Div. Electrical Engineering, Electronics Research Laboratory, Berkeley, Calif. August, 1956, 48 pp, microfilm \$3.30. Order PB 125984 from Library of Congress, Washington 25, D.C.*

Feedback System Testing

An analog method of servo system performance testing applicable to experimental analysis and system development and to go-no-go production and maintenance testing has been devised. The analog method described, as distinguished from transient and sinusoidal methods, uses time-domain signals (a step-function signal generator input is found suitable) to obtain frequency-domain parameters in a method effectively making an open-loop test of a closed-loop servo system. The $1-\mu$ β signal generator is conveniently realized using an analog computer of the operational amplifier type. An alternative mechanization of the signal generator uses only passive elements. Non-linear as well as linear servo systems may be tested by the method. Single-integrator, angle tracking, and range-tracking servo systems, have been analyzed. The range-tracking transfer function was employed in an analog computer experiment. A study of these recordings revealed potentialities for control of adaptive servo systems. *Feedback System Testing, Charles F. White, U. S. Naval Research Lab. Nov., 1957, 31 pp, \$1.00. Order PB 131345 from OTS, Dept. of Commerce, Washington 25, D.C.*

Magnetic Modulators For Radar

The basic theory of the cascaded magnetic-modulator circuit is extended to include the effects of copper and core losses, and a magnetic pulse-shaping technique is described. Experiment-



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al results obtained from a model low-power modulator are presented. Finally, core-loss data for representative square-loop magnetic materials, under conditions of sinusoidal and pulse excitation, are presented and the calorimeter measurements technique is described. *Magnetic Modulators for Radar Applications*, E. J. Smith, J. Antin, and K. T. Lian, Polytechnic Institute of Brooklyn, N.Y. Apr., 1955, 106 pp, \$2.00. Order PB 127543 from Polytechnic Institute of Brooklyn, 55 Johnson St., Brooklyn, N.Y.

Radar Receiver Shock Excitation

Electrical shock excitation of the input circuits of the intermediate-frequency amplifier of a radar system is discussed. The deleterious effects of shock from the trailing edge of a high-amplitude pulse is shown to be related to the frequency at which the amplifier input circuit is resonant. The pulse fall time is shown to be an important factor in the choice of an intermediate frequency. Although the report is written with reference to a marine navigational radar having high definition at short range, it may be of value in the design of other radar systems where shock effects following a high-amplitude pulse cannot be tolerated. *Shock Excitation in Radar Receiver Circuits*, W. M. Cameron, National Research Council of Canada, Radio and Electrical Engineering Div., Ottawa 2, Canada. May, 1956, 17 pp, \$.25. Order PB 126012 from National Research Council of Canada, Ottawa 2, Canada.

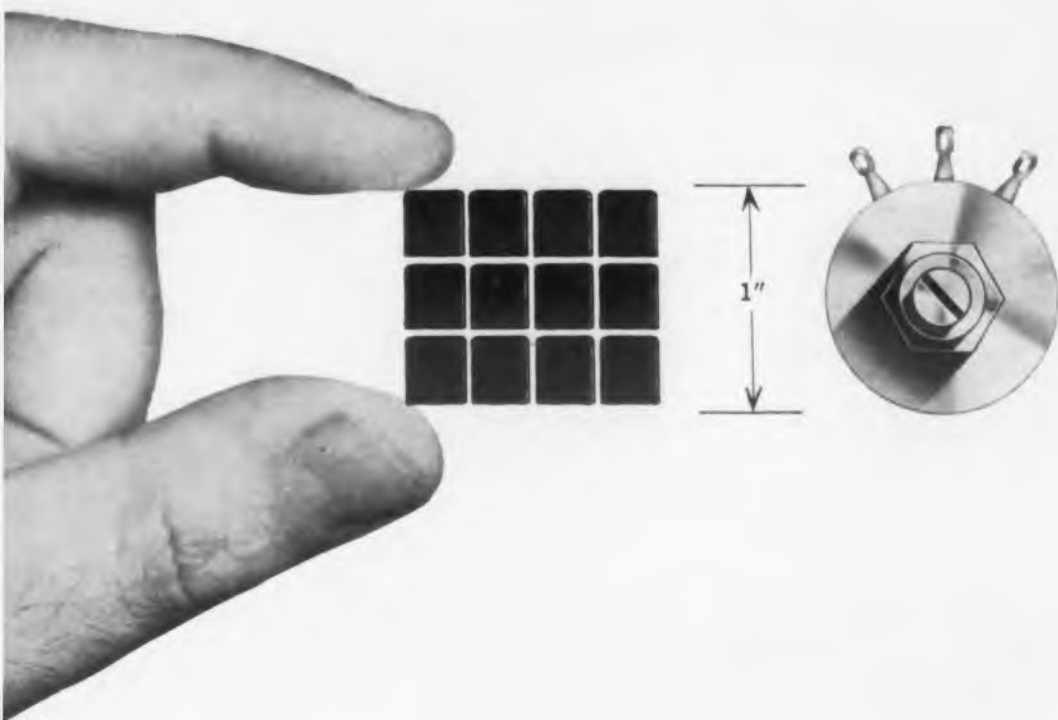
Digital Pulse-Width Modulation

The results of a search for more efficient means of telemetering quantitative data are presented here. This work was undertaken to explore the possibilities of a technique for transmitting continuous data that would enable efficiencies analogous to the saving of recording space achieved with "unitary" and "incremental" notations for continuous data. It has resulted in the formulation of a digital pulse-width technique of modulating telemetering carriers which is applicable to transmissions of alphabetical text messages as well as all kinds of quantitative data. The theory underlying these investigations, the experiments performed to determine the effects of transmission characteristics, and an analysis of possible applications to various kinds of meteorological data are presented in that order. *Digital Pulse-Width Modulation*, John C. Bellamy, S. Clifford Henjum, Robert F. Bosshart, and Eugene A. Reich, Cook Electric Co., Cook Research Labs., Chicago, Ill. Sept., 1956, 50 pp, microfilm \$3.60, photocopy \$9.30. Order PB 124694 from Library of Congress, Washington 25, D.C.



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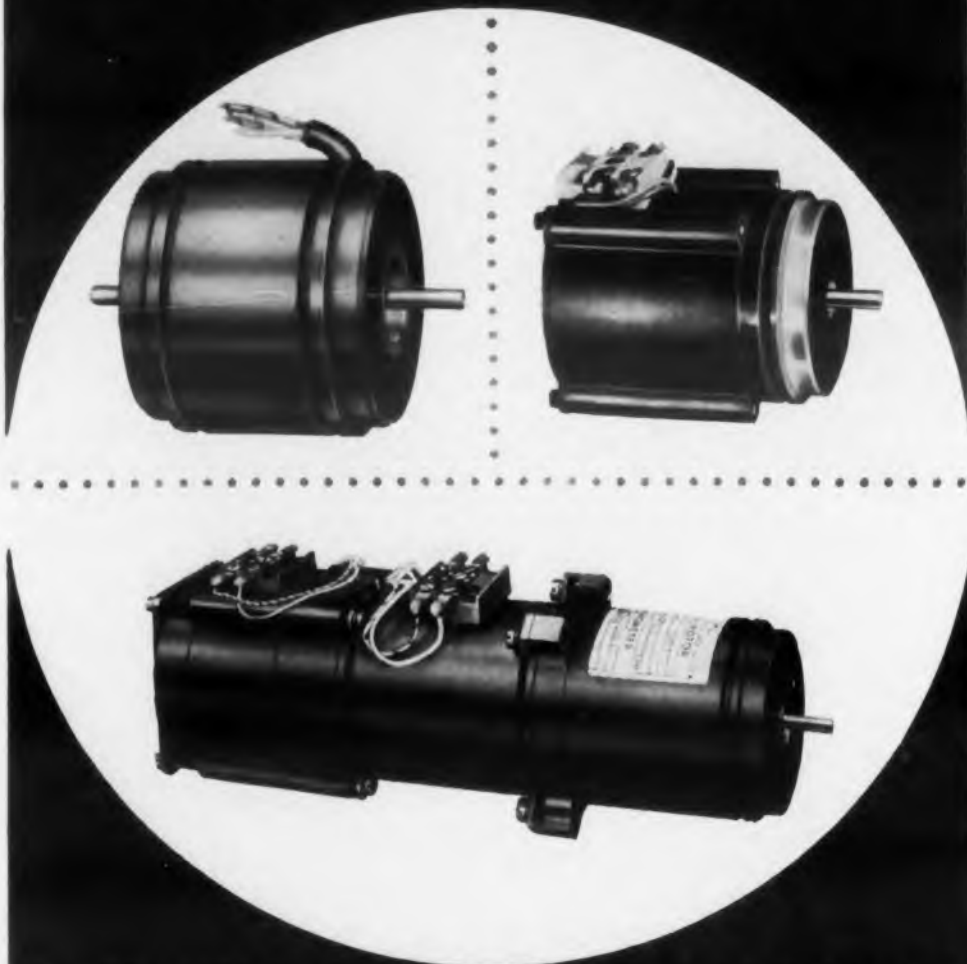
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REPORT BRIEFS

AC Servo Amplifier

A servo amplifier has been designed for the purpose of driving a dc servo-motor. Not only does this amplifier retain the advantages of ac amplification, but it also decreases the time delay resulting from demodulation and filtering. The reduction of the generated ripple voltage is accomplished by the employment of a square-wave carrier signal with a synchronous chopper used for detection. This procedure permits the reduction of the filter time constant with its associated time delay. *Study of an AC Servo Amplifier Employing a Chopper Demodulator, Thesis: University of Maryland. Richard H. Peery, Johns Hopkins University, Applied Physics Lab., Silver Spring, Md. June 1955, 84 pp, photos, diagrams, graphs, tables, microfilm \$4.80, photocopy \$13.80. Order PB 129632 from Library of Congress, Washington 25, D.C.*

Microwave Broadband Amplification

The research work carried out under the auspices of this contract was concentrated on three major areas: (1) thermodynamics of the pure electron gas, (2) analysis of uhf-modulated electron beams; and (3) general problems connected with the production of sub-millimeter waves. *General Problems of Broadband Amplification in The Microwave Frequency Range, H.M. von Foerster, Engineering Experiment Station, Electrical Engineering Research Lab., Electron Tube Research Section, Urbana, Ill. March, 1955, 9 pp, microfilm \$1.80, photocopy \$1.80. Order PB 125574 from Library of Congress, Washington 25, D.C.*

High Sensitivity Multiplier Phototube

The multiplier phototube described here has cathode sensitivity over 100 $\mu\text{a}/1$ primarily in the blue similar to S-11, stable output over four hours of continuous operation, rugged antivibration construction, moderate gain, low dark current high collection efficiency, and uniformity over large areas of the cathode. The tube is particularly well suited for detection of a weak signal against a high background. Many of the individual features and the combination of characteristics are new in a production-type multiplier phototube. Summarizes research from July 1, 1955-Jan 31, 1957. *Development of a High Sensitivity Multiplier Phototube, D.A. Bly, Radio Corporation of America, Tube Div., Lancaster, Pa. Oct., 1957, 33 pp, \$1.00. Order PB 131561 from OTS, U.S. Department of Commerce, Washington 25, D.C.*

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Nonmetallic Ferromagnetic Materials

The work presented in this report describes the effort expended in the various areas of ferrite development covered by the subject contract. These areas include the development of ferrite materials for high power applications, low signal applications, and dynamic magnetostrictive applications for operation in the temperature range -65 to -250 C; and a high frequency, narrow band (30 mc) modulated delay line. *Nonmetallic Ferromagnetic Materials and Devices*, John M. Blank, Robert W. Johnston, Harold W. Katz, Gerald G. Palmer, and Nathan Schwartz, General Electric Co., Defense Electronics Div., Syracuse, N.Y. Oct., 1957, 143 pp, \$3.75. Order PB 131559 from OTS, U.S. Department of Commerce, Washington 25, D.C.

Russian-English Aeronautical Glossary

Contains approximately 30,000 terms with emphasis placed on compound terms which frequently present difficulties for translators and evaluators in rendering idiomatically accurate translations. *Russian-English Glossary, Aeronautical and Miscellaneous Technical Terms*, U. S. Air Force Technical Documents Liaison Office, Wright-Patterson Air Force Base, Dayton, Ohio. Nov. 1956, 702 pp, \$7.00. Order PB 131634 from Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C.

Upper-Atmosphere Research

In 1946 the Naval Research Laboratory initiated a program of basic research in the physics of the upper atmosphere by means of high-altitude sounding rockets. Since that time the Laboratory has instrumented and flown 104 rockets carrying upper-air research experiments. This effort has resulted in the publication of approximately 300 scientific papers in the open literature and in a number of notable initial measurements of high-altitude physical parameters. On the practical side, there have been a number of applications which have developed as a result of this upper-air rocket-research program. Since the program is on a continuing basis, it can be expected that further scientific results will be forthcoming, not only from future rocket flights but from data from past firings which have been analyzed in the light of current data. *Upper-Atmosphere Research Report No. XXXII: History of the Upper-Air Rocket-Research Program at the Naval Research Lab., 1946-1957*, J. W. Townsend, Jr., H. Friedman, and R. Tousey. U. S. Naval Research Lab. Feb. 1958, 52 pp, photos, graphs, \$1.50. Order PB 131521 from Office of Technical Service, U. S. Department of Commerce, Washington 25, D.C.



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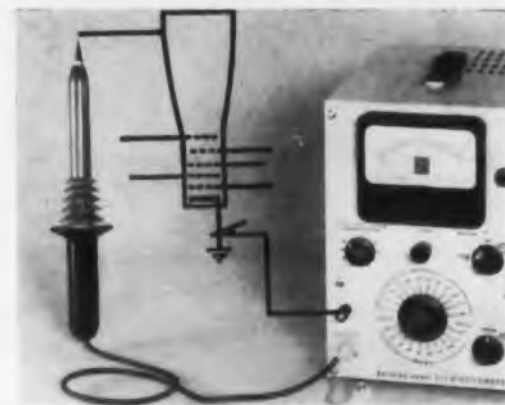
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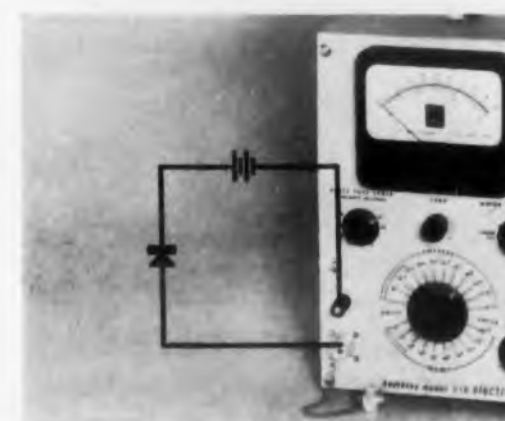
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PATENTS

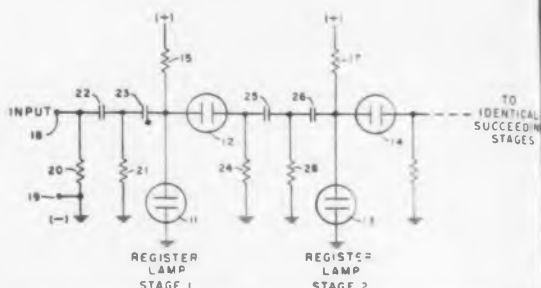
Pulse Counting Circuit

Patent No. 2,822,471. Howard L. Foote.
(Assigned to General Dynamics Corp.)

The invention comprises a scale-of-two pulse dividing circuit using two-element gaseous discharge devices in cascade. The simple circuit should provide exceptional stability. Each of the gaseous discharge devices, 11 through 14, shown in the diagram, may be a neon lamp such as a NE-96 which has a minimum specified firing voltage of about 135 v and sustains conductive discharge at about 70 v.

The pulse counter as a scale-of-two pulse divider operates in the following manner: Initially all neon lamps are extinguished. A positive pulse applied to the INPUT added to the supply voltage fires lamp 11. Lamp 12 will also conduct. A positive pulse will be delivered through condenser 26 firing lamps 13 and 14. At the end of the input pulse lamps 11 and 13 will be conducting at about 70 v. Lamps 12 and 14 will become extin-

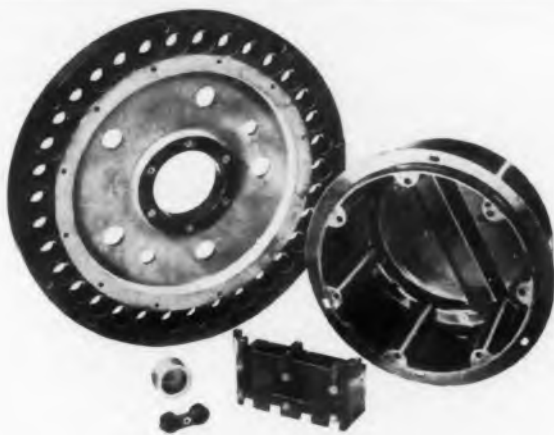
guished since resistor 15, lamp 12 and discharge resistor 24 are selected such that lamp 12 is non-conducting. It will fire only for the interval that the voltage across lamp 11 raised by an input pulse initially fires lamp 11. A second positive going pulse to be counted applied to the INPUT will not effect lamp 11 which is conducting but will charge condenser 23. At the end of the second pulse, condenser 23 discharges through resistors 21 and 15 and the additional drop across resistor 15 lowers the voltage across lamp 11 below 70 v and lamp 11 is extinguished. Thereafter, a third positive going pulse causes lamps 11



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and 12 to conduct and condenser 26 to charge. At the end of the third pulse, condenser 26 discharges and lamp 13 is extinguished. Thus, the continued action of the circuit permits one pulse out for each two pulses in.

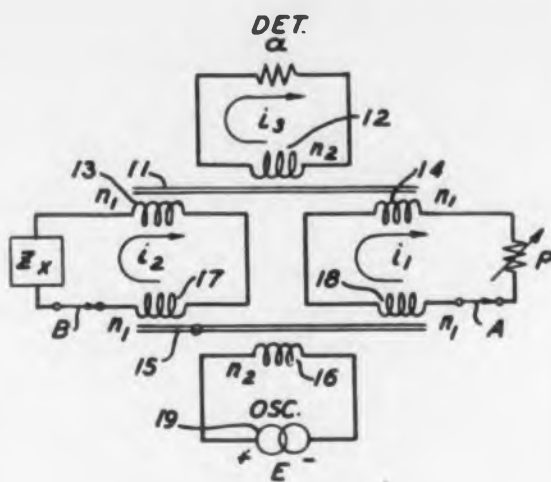
Impedance Measuring

Patent No. 2,820,195. S. T. Meyers. (Assigned to Bell Telephone Labs., Inc.)

The apparatus permits the magnitudes and phase angles of both positive and negative impedances to be measured accurately without using active elements in the critical apparatus.

The magnitude of the impedance Z_x is measured by adjusting the standard decade resistor R until the detector current for $i_2 = 0$ (switch B open) equals the detector current for $i_1 = 0$ (switch A open).

Phase angle is determined by measuring the difference in detector current as the polarity of secondary winding 18 is reversed from the position shown in the diagram. Switches A and B are kept in the closed position and resistor R is set



to the magnitude of impedance Z_x . The difference between the two detector readings is, in effect, a return loss measurement of the unknown impedance Z_x against a known resistance of equal magnitude which is a measure of the phase angle of the unknown impedance. To find the sense of the phase angle, a condenser is alternately connected across unknown impedance Z_x and standard resistor R . The direction of the change of transmission is noted. An increase in transmission indicates a positive reactance.



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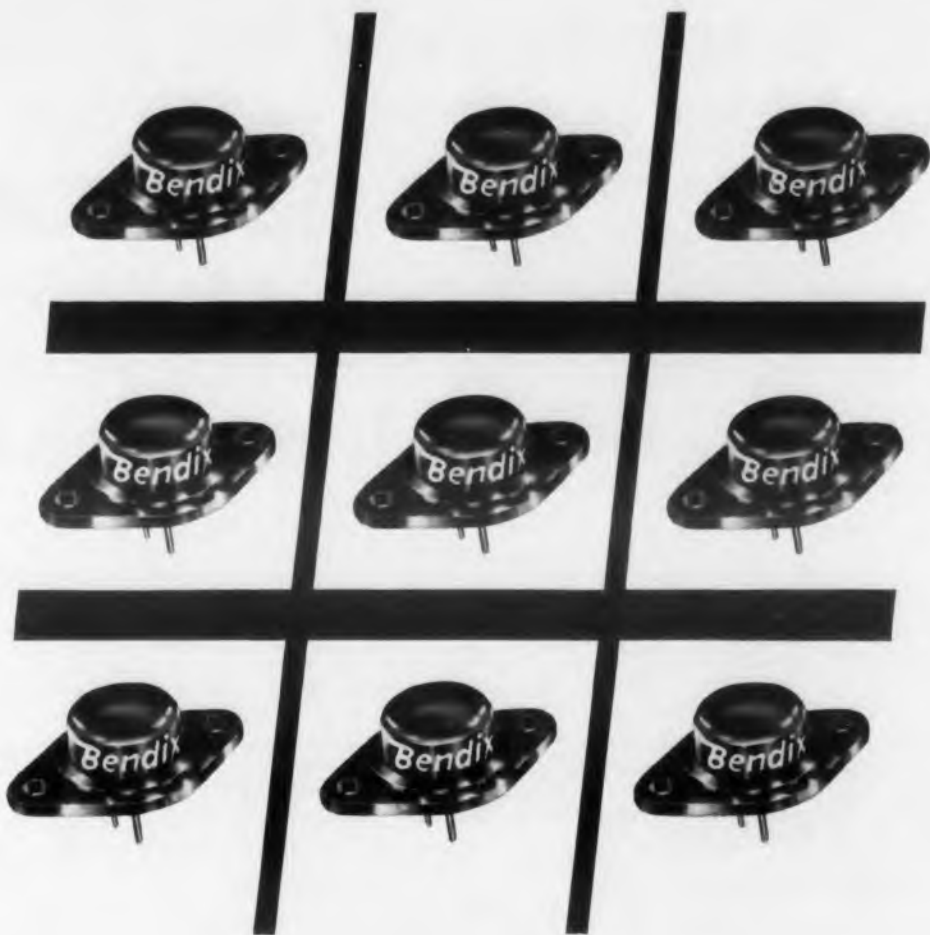


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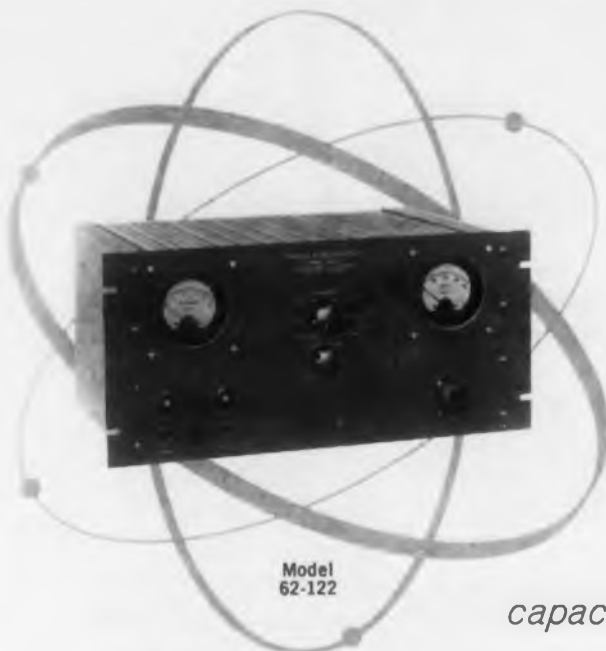
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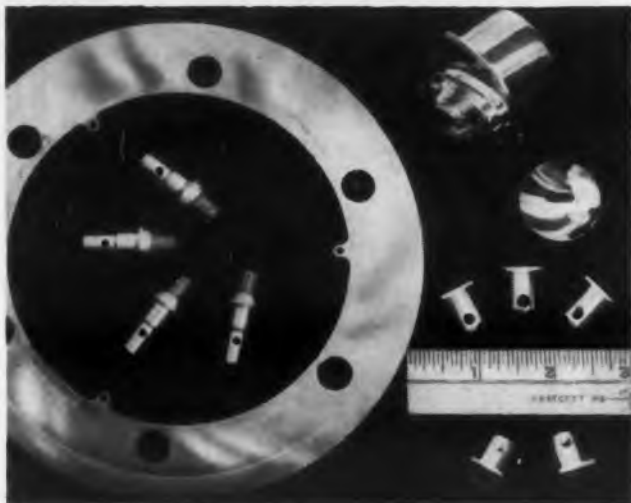
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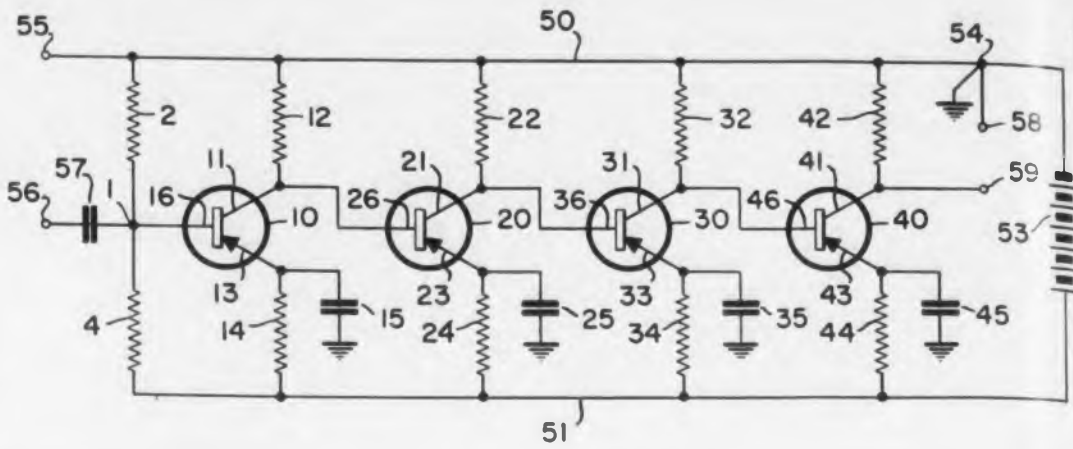
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PATENTS



Amplifying Apparatus

Patent No. 2,822,434. Robert J. Ehret.
(Assigned to Minneapolis-Honeywell
Regulator Co.)

This multistage transistor a-c amplifier having less than unity d-c gain is temperature stable and relatively independent of individual transistor characteristics. As illustrated, the transistor stages are direct coupled and connected in parallel resistive networks across the power supply 53. The collector electrode of each transistor is directly coupled to the base electrode of the succeeding stage so that these electrodes are at the same voltage. The emit-

ter electrode of each transistor is connected to power supply through resistor 14, which is larger than the resistor connecting the collector electrode to the opposite side of the power supply. The operating points of the transistors are chosen so that the amplifier is independent of power supply variations. The d-c gain may be made so low that differences between transistors which affect their operating characteristics are not amplified. The emitters operate at constant current and the collectors at constant voltage.

Under these conditions, with the am-

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er stages direct coupled, and change the zero-emitter collector current of the transistor stage will be cancelled in the collector circuit resistor of that stage a similar change in the zero-emitter-collector current of the next stage. This prevents the cascading of the effects of such changes.

Although the amplifier is not a dc amplifier, it is very practical in a-c operation. An a-c signal applied to the input will vary the emitter-base voltage of the first amplifier. This changes the base current of that stage causing a large change in the collector current flowing through resistor 12. The emitter-base voltage of the next stage changes effecting a still larger increase in that transistor's collector current. The process of amplification is repeated in the succeeding stages.

Transistor Push-Pull Amplifier

Patent No. 2,816,179. *Ralph Gittleman and Jacob Tellerman.* (Assigned to *Bosch Radio Corp.*)

The amplifier consists of a single-ended input signal source and a pair of similar type transistors with the input

signal source connected across the bases of the transistors. One of the transistors is connected as a grounded base transistor. The emitters are connected through a short circuit; the collectors are connected to the output circuit. Bias for the collector is provided between the output circuit and the base of the grounded base transistor. A relatively high impedance is provided between the emitters and ground external to the transistors. The collector current of one transistor is caused to flow through both emitters. The collector currents of each transistor are made equal without the necessity of matching the transistors.

Selenium Rectifier

Patent No. 2,815,475. *Paul W. Lighty.* (Assigned to *International Telephone and Telegraph Corp.*)

A selenium rectifier is improved by poly-mono-chlorotrifluoroethylene. The normal rectifier has a layer of selenium on a base plate, and a counter-electrode on the selenium layer. The intermediate layer goes between the selenium and the counter-electrode.

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CHARACTERISTICS

Maximum Power : 5000 watts
Pumping Rate : 3/8 g.p.m.
Measuring Time : 1 minute
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Spec. MIL-R-25018 (USAF) Class B; Type 11. Grade 3

Drawing. MIL-STD MS24115 (USAF)

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PATENTS

Current Control Regulator

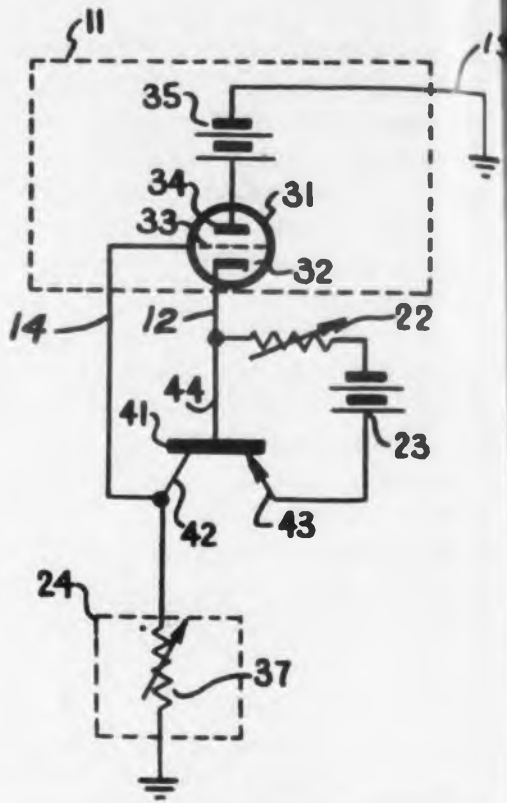
Patent No. 2,824,276 Harvey Stump. (Assigned to Hughes Aircraft Co.)

A transistor, connected as a variable impedance in series with the current source and the load, maintains the current supplied to the load constant in this patent. The dynamic impedance is of the order of 16,000 meg while the transistor presents a small resistance to steady-state d-c flow.

Referring to the diagram, the current generator 11 consists of a triode 31, in this instance a 6J5 vacuum tube, connected to the load 37 through the n-type transistor 41. Biasing battery 23 is inserted between the emitter electrode 43 and the base electrode 44. Variable resistor 22 adjusts the quiescent condition of transistor 41. The voltage difference between cathode 32 and grid 31 is determined by the voltage across the collector 42 and the base 44.

If, for example, the value of resistor 37 decreases, the plate current through triode 31 tends to increase. This increase causes the current flowing through trans-

istor 41 to increase. As a result, the voltage across collector 42 and base 44 will increase. The grid to cathode bias triode 31 will also increase, causing the current flowing through triode 31 to decrease.



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crease to the value existing before the load 37 was changed.

The negative feedback will maintain the load current constant when the value of the load 37 increases. Finally, should the plate voltage of triode 31 change, this would be the same effect as a change in the load current compensated in magnitude and phase by negative feedback.

A typical design of the current regulator uses a Raytheon CK721 transistor with a 6J5 tube operated at 300 v. The transistor bias supply is a 1.5 v battery in series with an adjustable resistor 1000 to 10,000 ohms.

Phase Shifting Circuit

Patent No. 2,805,386. R. W. Pfaff. (Assigned to The Reliance Electric & Engineering Co.)

The phase of the output potential may be varied over a wide range with the circuit shown. The circuit is readily adjusted to give the desired phase of the output voltage. A vector diagram of the potential across the various elements of and at various points in the circuit is also illustrated. The particular potentials

are indicated by reference to the part number of the circuit, i.e., EX21 is the potential of the reactive component of the inductor 21 and ER21 is the potential of the resistive component of the inductor. Locus of the variation in potential of the inductive component of the inductive element 21 is a circle 34 and a similar locus 36 gives the variation of the potential EM28 across the inductor 28 which is inductively coupled to inductor 21. The phase of the potential vector EM28 is always parallel with the vector EX21.

The condenser 19 and resistor 18 may be dispensed with in the broader aspect of the circuit, however, the resistor 18 provides the base potential E18 shown. Also the resonant circuit, which includes inductor 21 and condenser 22, may consist of one adjustable element. A wider range of phase variation, however, is secured by making both of these elements adjustable. As long as the ratio of inductances to resistance remains constant, the output potential remains constant. It does not matter how the resistance is distributed in the circuit. The phase change capabilities of the circuit is well in excess of 180 deg.



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Sweep Rate: Cont. variable, 10-40 cps; locks to line freq.
RF Output: 1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 220 mc; 0.5 V rms to 470 mc. AGC'd constant over

widest sweep and entire range to ± 0.5 db.
Attenuators: Switched 20, 20, 10, 6 & 3 db plus cont. variable 6 db.
Sweep Output: Reg. sawtooth in sync with oscillator. Amplitude 7.0 V approx.
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DIRECT reading digital converter fits all vertical DCU system counters — no wiring changes, no plug-in connections or mechanical modifications required.

DIGIVERTER clamps on front panel of counter over vertical windows; has self-contained power supply with line cord for 115-volt, 50-2400 cycle outlet; uses less than one watt per DCU. Its photoelectric system transmits directly whatever the counter reads without interference; no relays, vacuum tubes, thyratrons, or transistors are used. Utmost simplicity results in greatest reliability.

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BOOKS

Process Instruments and Controls Handbook

Douglas M. Considine, McGraw-Hill Book Co., 330 West 42nd St., New York 36, N.Y., \$19.50.

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Among the subjects covered are measurements systems, indicators and recorders, automatic controllers, timers and program controllers, electric and pneumatic telemetering, final control elements, fundamental principles of process control, and mathematical techniques for solving automatic control problems.

Calculus for Electronics

A. E. Richmond, McGraw-Hill Book Co. Inc., 330 West 42nd St., New York, N.Y. 407 pp, \$8.25.

This basic book describes the practical applications of calculus to electric-circuit

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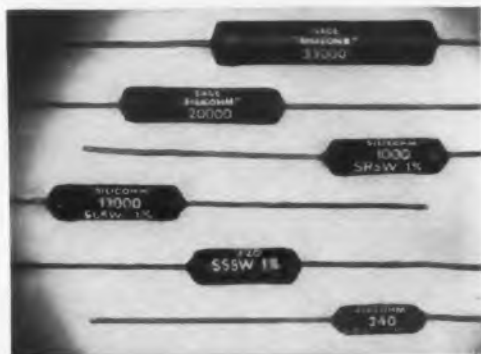
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Proceedings of The Fourth Annual Computer Applications Symposium

Armour Research Foundation of Illinois Institute of Technology, Technology Center, 10 West 35th St., Chicago 16, Ill. 26 pp, \$3.00.

The sessions of the Fourth Annual Computer Applications Symposium stressed new areas of application, use of new computers and accessories, and recent developments in automatic programming. The dual structure of the conference emphasized business and management applications and engineering and research applications. The two

luncheon talks and the final panel discussion are more speculative in nature than the main body of papers, being in large part oriented toward possible future developments in the tools and the art of computing.

Russian-English Glossary of Acoustics and Ultrasonics

Consultants Bureau, Inc., 227 W. 17th St., New York, N.Y. 170 pp, \$10.00.

This glossary contains the most up-to-date Russian-English vocabulary in the fields of acoustics, electro-acoustics, and ultrasonics. There are over 10,000 terms taken from numerous articles. These articles appeared in several thousand pages of the most recent issues of Soviet physics and engineering journals, especially *Journal of Acoustics*, *Journal of Technical Physics*, and *Radio-Engineering*. Also included are many terms found in Russian texts and English texts which have been translated. A special effort has been made to emphasize the rapidly growing field of ultrasonics. This preliminary glossary will eventually be considerably enlarged and improved.

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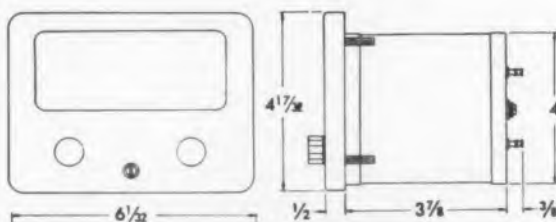
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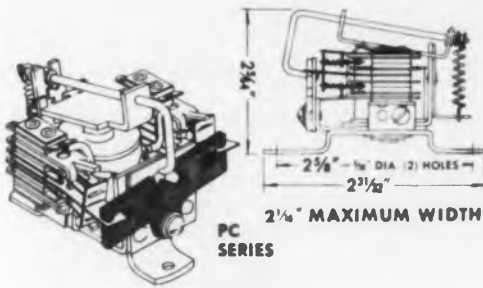
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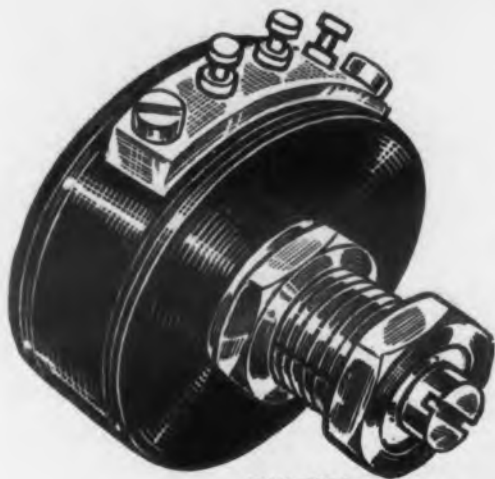


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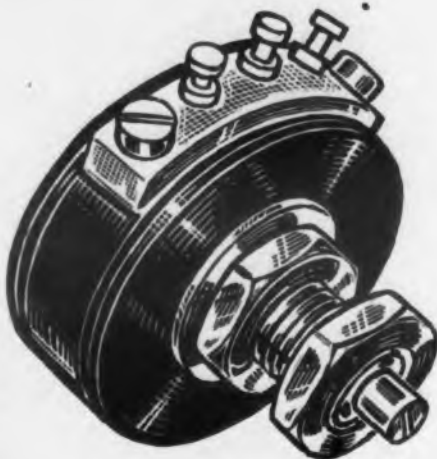
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What The Russians Are Writing

J. George Adashko

PROPAGATION

Geometrical Characteristics of Scattering of Radio Waves by Turbulent Tropospheric Irregularities by D. M. Vysokovskiy. EC 9/57, pp 12-19, 2 figs.

Exact and approximate formulas are derived for dimensions of scattering volume and scattering angle. An expression is derived for scattered power in the form of an integral over the scattering volume. The extremum of this integral leads to the determination of dimensions of the effective scattering volume for broad directivity patterns. The choice of antenna dimensions for communication by diffuse propagation are considered. Fundamental geometrical characteristics of scattering volume for narrow directivity patterns are also given. Refers to "Theory of Radio Scattering in the

Troposphere" by Booker and Gordon (*Proceedings IRE*, Volume 38, April, 1950), "Radio Scattering in the Troposphere" by Gordon (*Proceedings IRE*, January 1955), "The Use of Angular Distance in Estimating Transmission Loss and Fading Range for Propagation Through a Turbulent Atmosphere over Irregular Terrain" by Norton, Rice, and Vogler (*Proceedings IRE*, October 1955) and "The Rate of Fading in Propagation Through a Turbulent Atmosphere" by Norton, Rice, Janes and Barsis (*Proceedings IRE*, October 1955).

Choice of Routes for Sections of Radio Relay Lines by A. I. Kalinin. EC 9/57, pp 20-29, 7 figs.

The choice of routes for maximum line stability is considered. Formulas are given for the minimum heights of an-

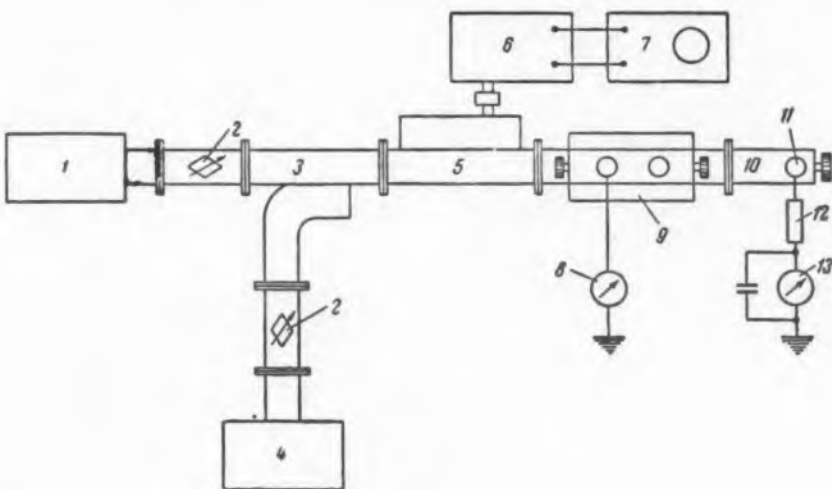


Fig. 1. Experimental setup for investigating the deterioration of detectors: 1—microwave pulse generator; 2—attenuator; 3—directional coupler; 4—auxiliary cw generator; 5—directional coupler for identifying microwave pulses; 6—video pulse amplifier; 7—oscillograph; 8—indicator for slotted line; 9—slotted line; 10—detector head; 11—detector; 12—resistance (approx. 100 ohms); 13—milliammeter.

tenna towers and for the maximum lengths of line sections. The effect of the terrain of the locality and the statistical distribution of the vertical gradient of the dielectric constant of air are taken into account.

COMPONENTS

Effect of Temporary Deterioration on the Detecting Properties of Crystal Diodes Operating at High Frequencies by S. Ye. Temkin and K. M. Korolevets. REE 8/57, pp 1062-1070, 11 figs.

Report of results of the investigation of fully reversible changes in the detecting properties of crystal silicon detectors operating at microwave frequencies. This type of temporary deterioration of the properties is called "coarsening" of the detector. It is due to the change in the capacity of the barrier layer. The observed recovery times are attributed to multiple capture of electrons in one part of the contact region. Reference is made to work by Hornbeck and Haynes. *Physical Review*, 1955, Vol. 96, pp 311-321. Fig. 1 shows the experimental setup.

Influence of the Speed of Recombination at the Non-Rectifying Electrode on the Frequency Properties of the p-n Junction for the Case of Small Alternating Voltages by N. A. Penin. REE 8/57, pp 1053-1061, 6 figs.

An expression is derived for the voltage-current characteristic, and also for the total conduction of the p-n junction with alternating current for small voltages, with allowance for the speed of recombination on the non-rectifying electrode.

To improve the frequency characteristics of a semiconducting diode, the thickness of the p and n regions should be reduced to a minimum. However, at small distances between the junction and the non-rectifying electrode the influence of the rate of recombination at the electrode on the properties of the p-n junction becomes substantial. The author calculates the voltage-current characteristic of the p-n junction and the total conductivity of the diode with alternating current for low voltages. The original Shockley theory applies to an infinite distance between the junction and the electrode, and naturally must be modified in this case.

TELEPHONY

Additional Induction Between Circuits

Due to Presence of Insulators in the Line by N. P. Volnova. EC 9/57, pp 65-73, 7 figs.

The distribution of insulators along transposed and untransposed lines, and its effect on the values of the wave impedance of the line are given an extensive mathematical treatment.

RECEPTION

Suppression of Non-working Sideband Frequency in Multi-phase Systems of Single-Band Radio Communication by I. V. Lobanov. EC 9/57, pp 3-11, 6 figs.

Formulas are derived for the degree of suppression of the non-working sideband frequency in three- and four-phase systems as a function of the amplitude and phase errors in the voltage supplying the system. The calculated results are presented in the form of curves from which it is possible to estimate the possibility of a practical realization of systems in various particular cases.

CIRCUITS

Investigation of the Characteristic Features of the Operation of Transistors in Nonlinear Circuits by V. V. Migulin. REE 9/57, pp 1091-1096.

A brief article, in which the fundamental considerations that require a special approach to many semiconductor circuits are discussed. A concise formulation is given of the methods in use now, together with a brief survey of several other articles published in the same issue of the journal on the investigation of transistor circuits and the features of the transistors themselves. Certain trends in future developments in this field are noted.

This is a report of a survey made at the Moscow State University on various transistor circuits in which the nonlinear properties of the transistor are investigated. The summary given in this article touches upon the specific nature of transistorized systems, possible methods of investigation of such circuits, and the contents of recently published articles in the USSR on these subjects.

Analysis of a High Frequency Self-Oscillator Employing Junction Transistors by L. N. Kaptsov and V. V. Yablonskiy. REE 9/57, pp 1136-1145, 7 figs, 2 tables.

The authors determine the limits to which the simplified equivalent circuit of a transistor can be used to analyze a high

(Continued on following page)

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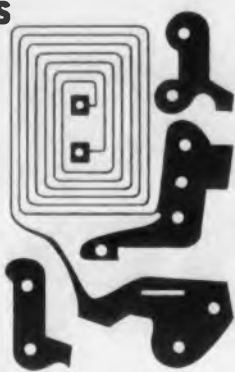
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RUSSIAN TRANSLATIONS

frequency junction transistor oscillator with a tuned collector circuit. Refers to work by Pritchard "High Frequency Power Gain of Junction Transistors" *Proceedings IRE*, 1955, Page 1075, "Frequency Variations of Junction Transistor Parameters" *Proceedings IRE*, 1954, Page 1786, Weinreich "Transit Time Transistor" *Journal of Applied Physics*, 1956, Page 1025, Zawels *Journal of Applied Physics*, 1954, Page 976, Giacometto "Terminology and Equations for Linear Active Four-Terminal Networks Including Transistors," *RCA Review*, 1953, Vol. 14, No. 3, Page 28, and Early "Effects of Space Charge Layer

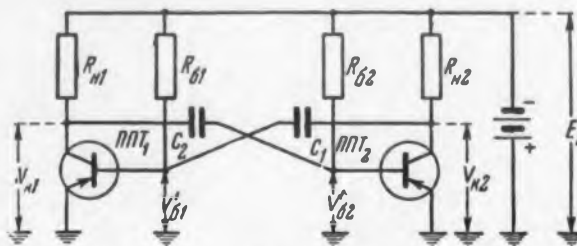


Fig. 2. Circuit used to investigate slow and fast processes in junction transistor multivibrators.

Widening in Junction Transistors" *Proceedings IRE*, 1952, Page 1401.

Investigation of Multivibrators with Junction Transistors by K. S. Rzhevkin, K. Ya. Senatorov, and S. P. Maslov. *REE* 9/57, pp 1110-1118, 7 figs.

An investigation of slow and fast processes in a free-running junction-transistor multivibrator. The dependence of the amplitude and duration of the generated pulses on the circuit parameters, on the transistors, and on the supply voltage is established. Refers to work by A. P. Thomas (*Electronics*, 1955, Vol. 28, Page 168), J. E. Flood (*Wireless Engineer*, 1955, Vol. 32, Page 122), D. F. James (*Electronics*, 1953, Vol. 26, Page 112) and E. W. Sard (*Convention Record of the IRE*, Part II, 1954, Page 110). Fig. 2 shows the circuit, and Fig. 3 the waveforms.

Transient Characteristics of Junction Transistors by Yu. M. Az'yan, K. S. Rzhevkin, and K. Ya. Senatorov. *REE* 9/57, pp 1097-1109, 8 figs.

Report of a theoretical and experimental investigation of the non-stationary processes at the base of a transistor during the transmission of an electric signal. The transient characteristics of common-emitter and common-base connections are theoretically derived from physical considerations. It is shown experimentally that the theory of small-signal amplification can be applied to a transistor even when the small-signal conditions are not satisfied. Refers to work by Schaffner and Suran (*Journal of Applied Physics*, 1953, Vol. 24, Page 1355), Steele (*Proceedings IRE*, 1952, Vol. 40, Page 1424), and Pritchard (*Proceedings IRE*, 1955, Vol. 43, Page 1075).

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Processes in a Junction-Transistor Blocking Generator by K. Ya. Senatorov and V. P. Guzhov. REE 9/57, pp 1119-1126, 11 figs.

The authors analyze the processes that take place in a blocking oscillator using high frequency p-n-i-p type transistors in the cut-off mode to form the leading edge of the pulse. Transistor and circuit parameters are studied in forming the leading edge and the transient from the stage where the capacitor is overcharged to the leading front. Refers to work by Sulzer (*Electronics*, August 1953, Vol. 26, Page 173), J. E. Flood (*Wireless Engineer*, May 1955, Vol. 32, Page 112), and Linvill and Mattson (*Proceedings IRE*, 1955, Vol 43, Page 1632).

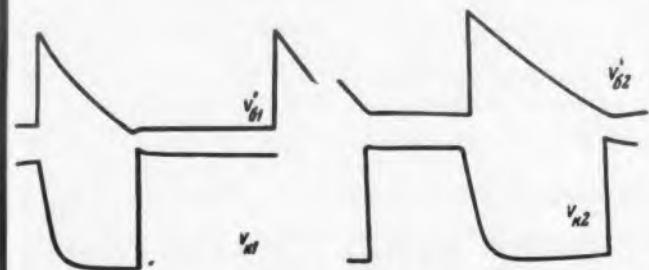


Fig. 3. Waveforms in the multivibrator of Fig. 2.

Certain Features of Self-Oscillators Employing Transistors by L. N. Kaptsov. REE 9/57, pp 1127-1137, 12 figs.

A qualitative examination of the waveforms of currents and voltages in various points of a transistorized oscillator with nearly harmonic oscillations. The methods used to calculate the amplitudes and the settling time of the oscillations in vacuum tube oscillators are applicable to semiconductor oscillators only in a narrow range near the excitation threshold. Refers to "Frequency Stability of Point Contact Transistor Oscillators" by C. C. Cheng (*Proceedings IRE*, 1956, Vol. 44, Page 219) and "Isocline Diagrams for Transistor Circuits" by R. Oakes (*Electronic Engineering*, July 1955, Page 27, Page 312).

Correction of Transistor Amplifiers by K. S. Rzhevkin and Ye. S. Andrianov. REE 9/57, pp 1157-1169, 8 figs.

An analysis of the single-stage transistor amplifier, in which formulas are derived for the engineering computations of correcting elements which can extend the amplifier bandwidth above critical frequencies. Refers to work by Sawels, Early, and Pritchard.

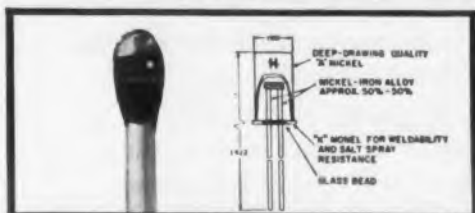
Application of Quasi-Linear Method to the Analysis of a Transistor High Frequency Generator by L. N. Kaptsov, M. A. Abdyukhanov, and A. A. Kashir. REE 9/57, pp 1170-1173, 5 figs, 1 table.

The high frequency RC transistor oscillator was treated by L. N. Kaptsov in the November 1956 issue of *Radiotekhnika i Elektronika* (Page 1413). (*ED* 7/15/57). The inertia (time-delay)

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DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS



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Nickel guards against shock in new high power ceramic tetrode



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SAN BRUNO, CALIFORNIA: A high degree of immunity to damage by mechanical or thermal shock is claimed for a new, air-cooled, 1-kw ceramic tetrode produced by Eitel-McCullough, Inc. The tube (4CX1000A) is a low-voltage, high-current, class AB₁, RF, or AF linear amplifier designed for heavy-duty single side band operation with zero grid drive.

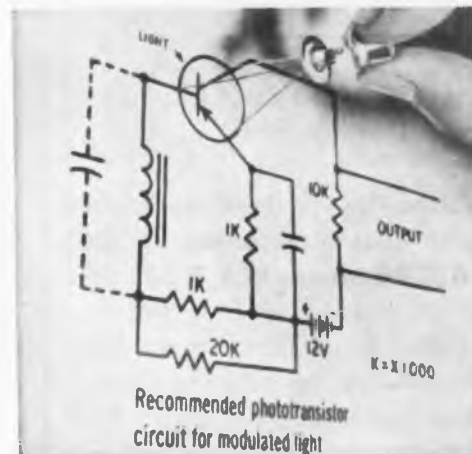
As the illustrations show, the designers have made liberal use of Nickel to give the tube maximum shock resistance. Most current-carrying supports are Inco Nickel "330". Non-current-carrying structurals are Nickel-clad steel. The inner cathode cylinder (oxide-coated) is Inco Electronic Nickel.

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| Drill | 60-80 | 0.001 -0.005 |
| Ream | 30-45 | 0.003 -0.012 |
| Tap | 30-40 | |
| Thread | 30-40 | |
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¹ For cemented-carbide tools, speeds may be increased 25-30%.



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RUSSIAN TRANSLATIONS

properties of transistors manifest themselves even at relatively low frequencies. Consequently the nonlinear characteristics of transistors, obtained at low frequencies without allowance for time-delay, cannot be directly used to calculate the amplitudes of high frequency generators employing such transistors. In fact, the input and output impedances and the current (or voltage) gain coefficients of transistors contain reactive components at high frequencies, and the breakdown of such parameters into real and imaginary parts for the purpose of providing an equivalent circuit is possible only for sinusoidal voltages and currents, since the real and imaginary parts are functions of frequency. Consequently, such a breakdown is permissible only in the linear or quasi-linear approximation, a procedure to which this article is devoted.

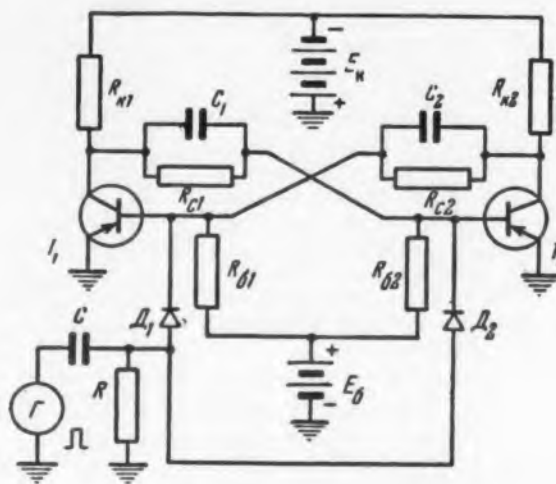


Fig. 4. A bistable trigger circuit using junction transistors.

Certain Nonlinear Properties of Junction Transistors, Connected with Base Modulation by Yu. M. Az'yan and A. A. Tikhonova. REE 9/57, pp 1174-1177.

The collector current of a junction transistor is calculated with allowance for the effect of variation of the thickness of the base layer under the influence of variable voltage on a resistive collector load. This is for a case when a small sinusoidal signal is applied to the emitter circuit. The solution of this nonlinear problem, using the small-parameter method in the first approximation, contains the second harmonic of the collector current.

Voltage Converter Employing High Power Transistors by G. N. Berestovskiy and K. Ya. Senatorov. REE 9/57, pp 1178-1188, 10 figs.

An analysis is given of the physical processes in a voltage converter employing power transistors. Equations and curves are given for the calculation of the converter circuit to meet specified output power and specified supply voltage. The



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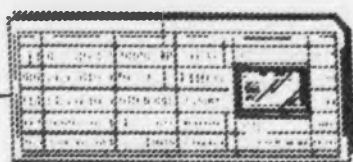
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characteristics of the Russian type PZV power transistors in the saturation region are given.

Analysis of Trigger Circuit Using Junction Transistors by T. N. Yastrebtseva. *REE* 9/57, pp 1146-1156, 10 figs.

Circuits of this type were studied by Linvill "Non-Saturating Pulse Circuits Using Two Junction Transistors." (*Proceedings IRE*, 1955, Page 826) and by Suran-Reibert "Two-Terminal Analysis and Synthesis of Junction Transistor Multivibrators," (*IRE Transactions*, 1956, Page 26.) Linvill analyzed a symmetrical binary counting circuit under the conditions when the transistors are not saturated. He gave an estimate of the value of the input signal required to trigger the circuit. Suran and Reibert considered a circuit that can have one or two stable equilibrium states, but is also capable of self-oscillation. They gave only an approximation of the maximum oscillating frequency and the maximum repetition frequency of the triggering pulses. This article considers a trigger circuit having two stable equilibrium conditions (Fig. 4), triggered by positive rectangular pulses, applied once to the base of each transistor through diodes. Certain simplifying assumptions are made in the calculations.

KEY

The sources of the Russian articles and their dates of issue follow the authors' names. Here is the key to the names of the journals in which the articles originally appeared.

| | |
|-----|--|
| AT | Automation and Telemechanics (<i>Avtomatika i Telemekhanika</i>) |
| CJ | Communications Journal (<i>Vestnik Svyazi</i>) |
| EC | Electrical Communications (<i>Elektrosvyaz</i>) |
| IET | Instruments and Experimental Techniques (<i>Pribori i Tekhnika Eksperimenta</i>) |
| R | Radio |
| RE | Radio Engineering (<i>Radiotekhnika</i>) |
| REE | Radio Engineering and Electronics (<i>Radio-tehnika i Elektronika</i>) |

TRANSLATIONS AVAILABLE

ELECTRONIC DESIGN is gratified to learn of the growing availability of full translations of important Russian electronics journals.

Consultants Bureau, Inc. of 227 W. 17th St., New York 11, N.Y. translates *Automation and Telemechanics* regularly.

Pergamon Press of 155 E. 53th St., New York 22, N.Y. is preparing translations of *Radio Engineering*, *Radio Engineering and Electronics*, and *Electrical Communications*.

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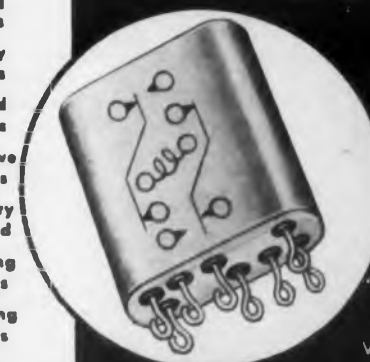
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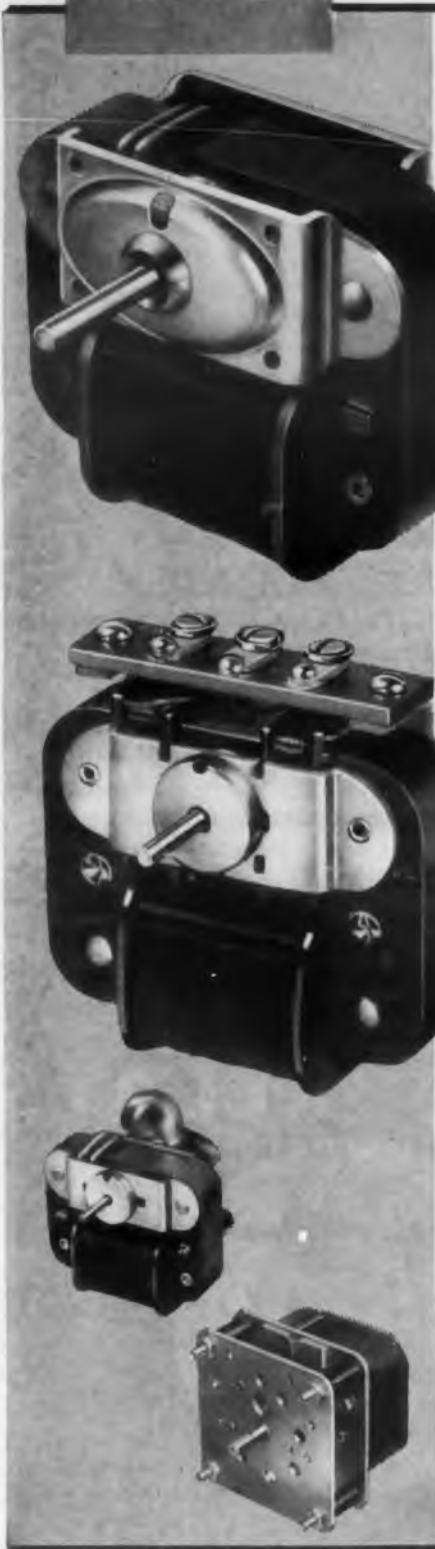
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CIRCLE 426 ON READER-SERVICE CARD

Resonant Absorbers for Microwaves

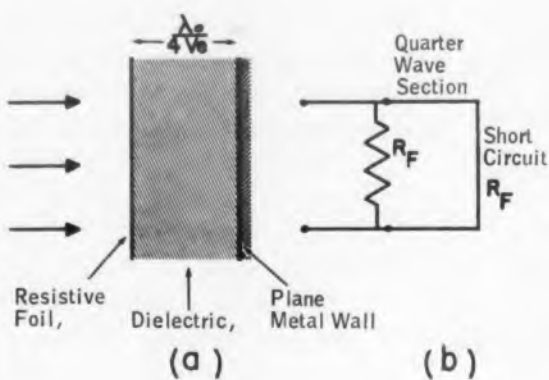


Fig. 1. Singly Resonant Absorber. λ_0 is the freespace wavelength.

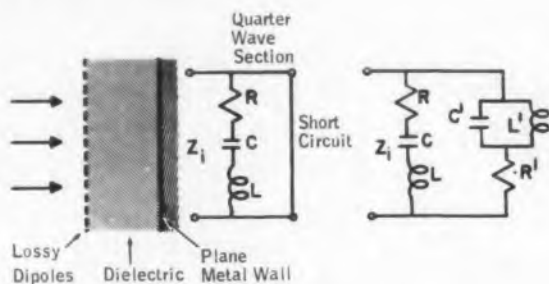


Fig. 2. Doubly Resonant Absorber.

THREE types of loads can be used to accomplish reflectionless loading of microwave structures.

- Homogeneous materials in which the (complex) dielectric constant is equal to the permeability;
- In homogeneous materials, such as wedges;
- Resonant absorbers which are multiply resonant.

The basic resonant absorber, as shown in Fig. 1, consists of a quarter wave dielectric section which terminates in a metal wall and is covered with a resistive foil at the input surface. This absorber is represented by a resonant circuit with high Q. The bandwidth is limited accordingly.

If the homogeneous resistance foil is replaced by a dipole "grid" as shown in Fig. 2 then the resulting equivalent circuit contains two resonant branches. This structure can be designed for appreci-

Zener Diodes

SILICON diodes to which a voltage in the reverse direction is applied, pass currents which are only a fraction of a μa until application of a voltage exceeding 4 v. There upon the "Zener current" is observed, i.e., the current increases rapidly with only very small increases in voltage. This effect suggests the possibility of using such a "Zener" diode as a reference voltage source. In this connection small variations of voltage with current and variations of voltage with temperature are of interest.

The variation of voltage with current can be described through the internal

resistance variation. Temperature dependence can be described through a temperature coefficient (mv/deg C). Typical curves for both effects are illustrated. It is noted that both effects are substantially independent of each other.

The temperature coefficient is zero in the neighborhood of 5 v. It is exceedingly difficult to produce Zener diodes which have a 5 v (or less) Zener voltage. It is however, possible to compensate for this effect by using, in conjunction with the Zener diode, silicon diodes which carry a current in the forward direction. These have a negative temperature coefficient

ably larger bandwidths than the singly resonant system.

In Fig. 3 a triply resonant system is shown. Two dipole layers are used in this structure. They are spaced an eighth of a wavelength apart (in the dielectric). With this arrangement a frequency range which exceeds 2:1 is possible.

The three systems are compared by

means of the graph shown in Fig. 4. These curves were calculated from the equivalent circuits. Experimental results using actual microwave structures are in agreement with the calculated curves.

Abstracted from an article by H. J. Schmitt, and W. Futtermenger, Zeitschrift fuer Angewandte Physik, Vol. 10, No. 1, Jan. 1958, pp 1-7.

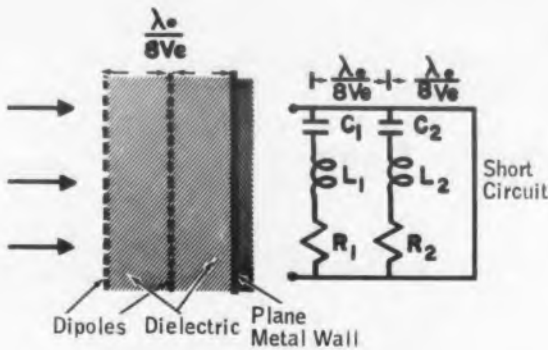


Fig. 3. Triply resonant absorber.

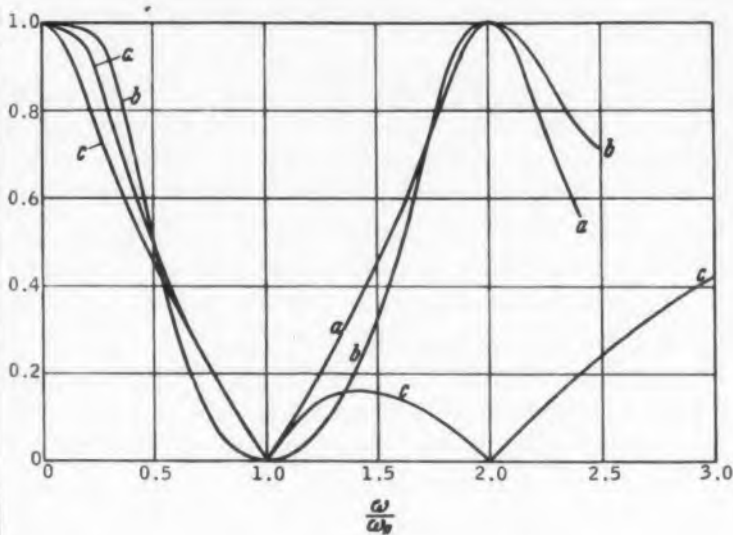


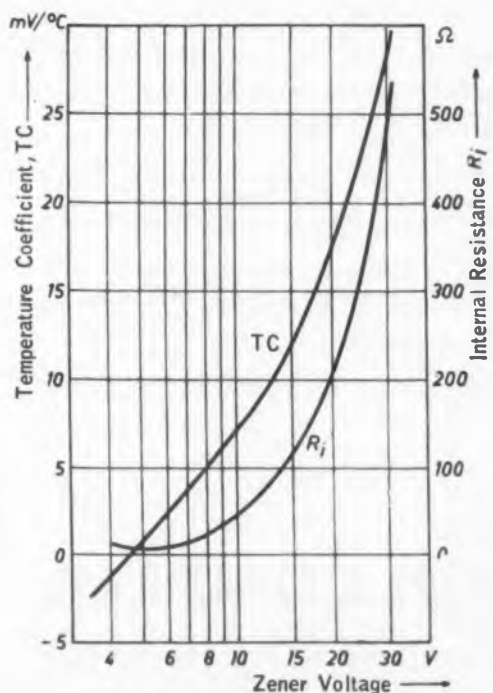
Fig. 4. Reflection factor, $|r|$, as a function of normalized frequency for various absorbers: (a) Single resonant case, Fig. 1; (b) Doubly Resonant case, Fig. 2; (c) Triply resonant case, Fig. 3.

(about -2.4 y/deg C) which offset the positive coefficient of the Zener diodes.

A number of specific applications are suggested in the original paper.

Abstracted from an article by G. Meyer-Broetz, Elektronische Rundschau, Vol. 11, No. 12, Dec. 1957 pp 376-377

Temperature coefficient and internal resistance variation as a function of Zener voltage for a 125 mw diode.



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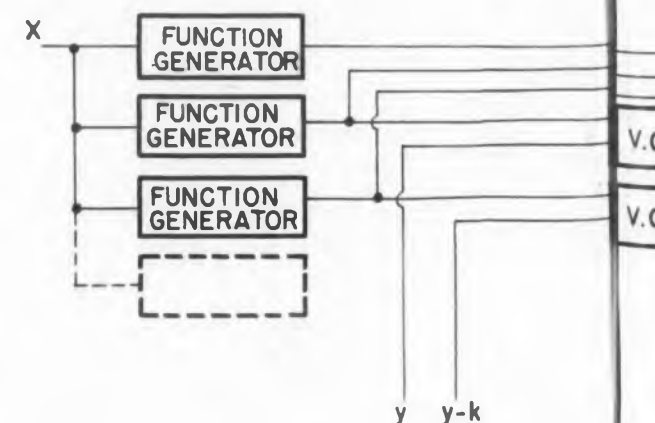
ABSTRACT

Function Generator For Two Independent Variables

THE NATIONAL Bureau of Standards has constructed a function generator that produces an output which is a function of two independent input variables. The instrument is fully electronic, operates at much higher frequencies than is possible with electro-mechanical systems, and can be built from commercially-available equipment.

Basically, the instrument employs a number of single-variable function generators and provides a method for interpolating linearly between them. A block diagram of the instrument is shown in Fig. 1. The x variable drives a number of function generators; the y variable drives a number of voltage-controlled attenuators.

Each function generator, except for the first whose output corresponds to the value of the function for $y = 0$, is fed through an electronic attenuator. Each successive attenuator is ad-



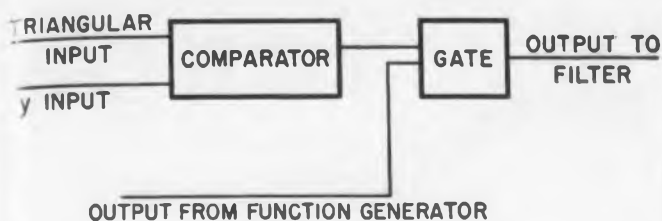


Fig. 2. Block diagram of one channel of voltage-controlled attenuator.

justed to begin conducting when the previous one is almost fully on. All of the generators are fed in parallel from the x input. The outputs of the attenuators are filtered and summed in the output amplifier. A portion of the output of each function generator is subtracted from the output through the use of an inverting amplifier. This is to compensate for the residual output of the voltage-controlled attenuators when they are supposed to be off. A filter is used here to make the frequency response of both amplifiers equal.

The voltage-controlled attenuators receive their inputs from the y variable. A triangular wave is generated and compared to the y input. Whenever the triangular wave plus the y input exceeds zero, the comparator turns on a gate to admit the output from one of the function generators. There is a voltage-controlled attenuator for each function generator except for the case where $y = 0$. Block diagram of one channel of the attenuator is shown in Fig. 2. Whenever the triangular wave plus the y is less than zero, the gate is turned off. The output of the gate, containing both x and y values, is filtered to remove the triangular wave. It is then summed with the outputs of the other gates to produce the desired $f(x,y)$. Non-linear interpolation may be accomplished by changing the shape of the triangular wave. Operating frequencies up to about 100 cps are acceptable for the Bureau's unit. Linearity of interpolation is about 1 per cent, which is sufficient for most applications.

Abstracted from *National Bureau of Standards Technical News Bulletin*, Apr. 1958, Vol 42, No. 4.

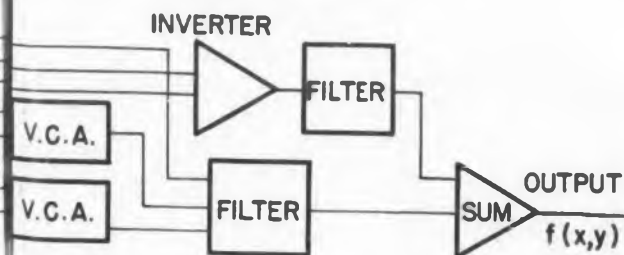
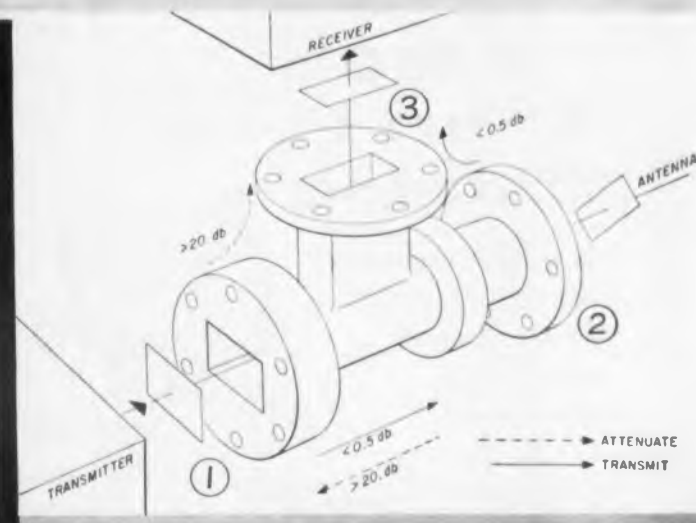


Fig. 1. Block diagram of function generator which produces an output that is a function of two independent input variables.

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STANDARDS AND SPECS

Sherman H. Hubelbank

EIA Issues Spec for Military Components

The Electronic Industries Association has increased its engineering effort to include specifications for component parts for military equipment. The first spec issued was SMC-1, entitled Fixed Ceramic Capacitors, Low Loss (High Reliability). This program [See "Designing For Reliability," ED, Feb. 19, p. 3, insert.] was undertaken by EIA after they recognized the need for up-to-date reliable component parts specs for use in military equipment the fact that ASES, due to its lack of authority and agreement between the Services, was about three years behind in this program. The program was considered necessary due to the difficulties being encountered by end-equipment manufacturers in obtaining the components they needed of sufficient quality to meet the end-equipment reliability requirements. Many of these end-equipment manufacturers were forced to expend considerable engineering and testing effort to write their own procurement documents, while at the same time the differences in the various manufacturers' procurement documents and the extra testing requirements contained therein caused hardships to the parts producers.

The EIA program for specs for military component parts is presently divided into three parts: (1) the preparation of specs for parts now available; (2) the preparation of specs for parts not immediately available, but which are within the accomplishment of the present state of the art; and (3) the preparation of "blue sky" specs for future needs.

To date, the action has been concerned with category (1) items, and preliminary work is now being directed to category (2) fields. At present, work under category (1) is concerned with eight specific areas: capacitors, connectors, resistors, relays, switches, transformers, wire, and cable.

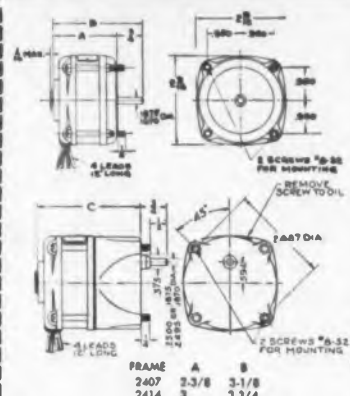
The primary objective in preparing specs for parts now available is to combine the procurement documents of various end-equipment manufacturers (most of which are based upon MIL specs with various requirements added) into common EIA component parts specs for use in military equipment. These specs are limited to components available from at least two makers. This is a practical program, an administrative job which should result in one spec and one number for each given part without excessive delay.

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Assembly Products Inc.

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EIA SMC-1, FIXED CERAMIC CAPACITORS, LOW LOSS (HIGH RELIABILITY), NOVEMBER, 1957
 Primarily designed for military end-equipment manufacturers, this spec covers high reliability, fixed ceramic capacitors, of up to and including 500-volt rating. The type capacitor is specifically suited for resonant circuit application or any other application where high figure of merit Q and stability of capacitance are essential. The objective reliability is defined as that which will result in an in-service failure rate of less than 0.01% per 1000 hours. A typical type designation for capacitors meeting this spec follows: CCR22-U2J470G. The basic format of this spec follows the format established by the military. Copies of this spec are available from the Electronic Industries Association, 11 West 42nd Street, New York 36, N.Y., for \$1.10 per copy.

Resistors

MIL-R-19A, RESISTORS, VARIABLE, WIREWOUND, (LOW OPERATING, TEMPERATURE), AMENDMENT 1, 16 DECEMBER 1957

Hardware is no longer to be assembled on the resistor unless specified. However, for direct Government orders, the hardware is to be assembled on the resistors. Footnotes 3 and 4 under table IV are clarified by indicating the type bushing and style resistor involved.

Use of Non-Standard Specs

ANA BULLETIN No. 147q, SPECIFICATIONS AND STANDARDS OF NON-GOVERNMENT ORGANIZATIONS, 1 DECEMBER 1957

Subject to the limitations imposed by ANA Bulletin No. 143 and in the absence of an applicable Government spec or standard, those non-Government specs and standards listed in this bulletin may be used without further approval by the Service. For example, a spec or standard listed may be used or specified by the contractor based on his engineering determination of its application. Satisfactory operation of equipment manufactured to these specs and standards is still the responsibility of the manufacturer.

AF Specs

The Air Force has announced the release of the following specs:

MIL-D-9310A, DATA FOR GUIDED MISSILE WEAPON SYSTEMS, 20 NOVEMBER 1957

MIL-G-9412B, GROUND SUPPORT EQUIPMENT FOR WEAPON SYSTEMS, SUPPORT SYSTEMS, SUBSYSTEMS, AND EQUIPMENT; ENGINEERING, 8 NOVEMBER 1957

MIL-R-25717B, RELIABILITY ASSURANCE PROGRAM FOR ELECTRONIC EQUIPMENT, 13 NOVEMBER 1957



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The miniaturized jack, #2378, is just $\frac{1}{8}$ " in diameter and $\frac{3}{16}$ " high. The plug, #2379, has a .054" pin diameter. Both are carefully processed from top grade brass and finished with .0002" bright alloy plate.

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STANDARDS AND SPECS

Capacitors

MIL-C-19624(SHIPS), CAPACITORS; FIXED, BY-PASS, METAL-ENCASED, HERMETICALLY SEALED, ALTERNATING AND DIRECT CURRENT (INTERFERENCE REDUCTION), AMENDMENT 1, 16 JANUARY 1958

The graph showing insertion losses (Fig. 2) has been deleted.

MIL-C-25A, CAPACITORS, FIXED, PAPER-DIELECTRIC DIRECT-CURRENT (HERMETICALLY SEALED IN METALLIC CASES), SUPPLEMENT 1G, 12 DECEMBER 1957

This supplement lists the fifteen military spec sheets which form a part of this spec.

MIL-C-12889A, CAPACITORS, BY-PASS, RADIO-INTERFERENCE REDUCTION, PAPER DIELECTRIC, AC AND DC (HERMETICALLY SEALED IN METALLIC CASES), GENERAL SPECIFICATION FOR, AMENDMENT 1, 10 JANUARY 1958

The "life test voltage" in Table II has been clarified. A requirement that the dissipation factor shall not exceed 1.5% has been added to the life test.

ASA Price List and Index

The American Standards Association has released the 1958 price list and index of all ASA standards. Included in this publication are publications of the International Organization for Standardization and the International Electrochemical Commission. Copies of this 68-page publication may be obtained without charge from the American Standards Association, 70 E. 45th St., New York 17, N.Y.

Canadian Standards

CSA C22.2 No. 02-1958, USE OF FLEXIBLE SUPPLY CORDS AND FIXTURE WIRES WITH ELECTRICAL APPLIANCES

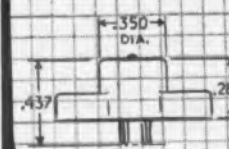
The minimum grades of flexible supply cords that may be used on cord-connected electric appliances of many kinds are specified by this standard. Also included is information as to when a grounding conductor is required for grounding the appliance when in use. Additional data on the various types of flexible supply cords are also given in order to assist in the selection of other acceptable types. Copies of this standard may be obtained from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada, for \$1.00 per copy.

NEW

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- For use with 3 and 4 pin JETEC 30 transistors.
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Mechanical Charts

SAMA RC11-1-1958, MECHANICAL CHART DRIVES, JANUARY 16, 1958

Spring-driven chart drives for recording instruments employing circular charts are covered by this standard. This standard establishes a minimum number of limiting dimensions so that chart drives complying with the standard can be used interchangeably in recording instruments made by different manufacturers. Also established are minimum performance requirements so that chart drives complying with the standard may give adequate service in average recording industrial instrument applications. Copies of this standard may be obtained without charge from the Scientific Apparatus Makers Association, 522 Fifth Ave., New York 36, N.Y.

Testing

MIL-STD-271(SHIPS), NONDESTRUCTIVE TESTING REQUIREMENTS FOR METALS, 2 JANUARY 1958

The entire section dealing with the use of liquid penetrants for detecting the discontinuities in ferrous and nonferrous materials has been revised.

Test Points

MIL-T-25453A(ASG), TEST POINTS AND TEST FACILITIES, AIRBORNE AND ASSOCIATED ELECTRONIC EQUIPMENT, 12 NOVEMBER 1957

Test points and facilities to be utilized in the testing of airborne and associated electronic equipment are covered in this spec. The purposes of these test points are to provide optimum operation, expedite alignment and maintenance, and to permit continuous monitoring by observation of significant voltages, currents, and waveforms. This spec defines a test point as a convenient safe access to a circuit in a system or equipment for the introduction, measurements, or display of a significant quantity or parameter in order to facilitate monitoring, calibration, repair, or maintenance. Thirty-one test points are listed as desirable for consideration where practicable and applicable to the equipment. Ten test points are listed for consideration where applicable for providing display of waveforms in the operation or adjustment of the equipment. Sufficient test points shall be made available to facilitate the location of the most probable circuit malfunctions which may reasonably be expected to occur within the equipment. These built-in test facilities shall be incorporated to the fullest extent to permit monitoring of performance on a "go, no-go" basis. This spec has been approved by the Department of the Air Force and the Navy Bureau of Aeronautics and supersedes the earlier Air Force spec.



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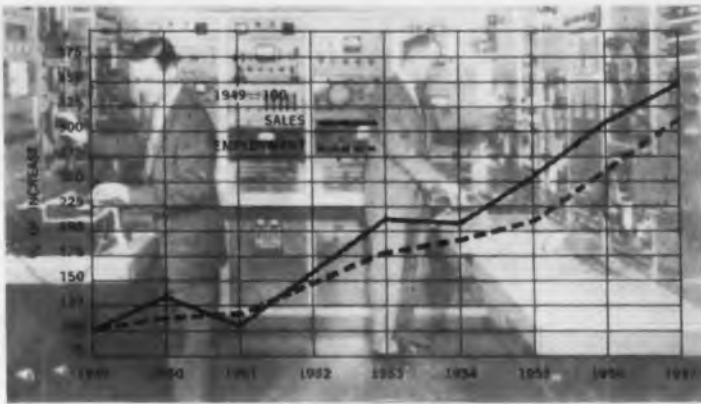
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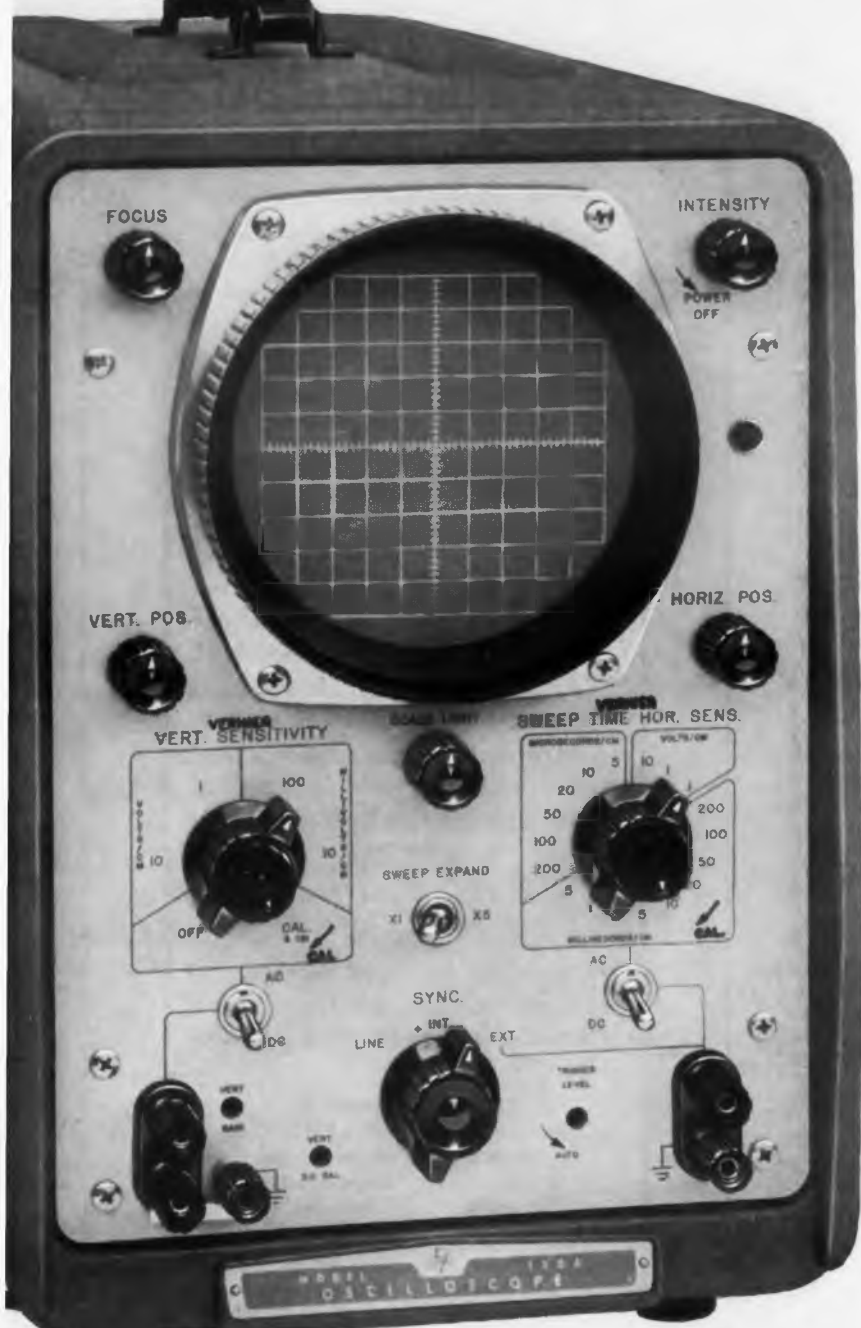
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| Type | MAXIMUM RATINGS | | | TYPICAL OPERATION ^a | | |
|---------|--|---------------------------|--------------------------------|--------------------------------|---------------|--|
| | Collector ^a Dissipation Watts | Peak Collector-Base Volts | Peak Collector Current Amperes | Class A Service | | Class B Service |
| | | | | Max.-Sig. Power Output Watts | Power Gain db | Max.-Sig. Power Output (2 transistors) Watts |
| 2N301 | 11 | -40 | -3 | 5 | 33 at 5 watts | 12 |
| 2N301-A | 11 | -60 | -3 | 5 | 33 at 5 watts | 12 |
| 2N176 | 10 | -40 | -3 | 2 | 35.5 | — |
| 2N351 | 10 | -40 | -3 | 4 | 33.5 | — |
| 2N376 | 10 | -40 | -3 | 4 | 35 | — |

^a At mounting-flange temperature of 80°C



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