

JUN 23 1959

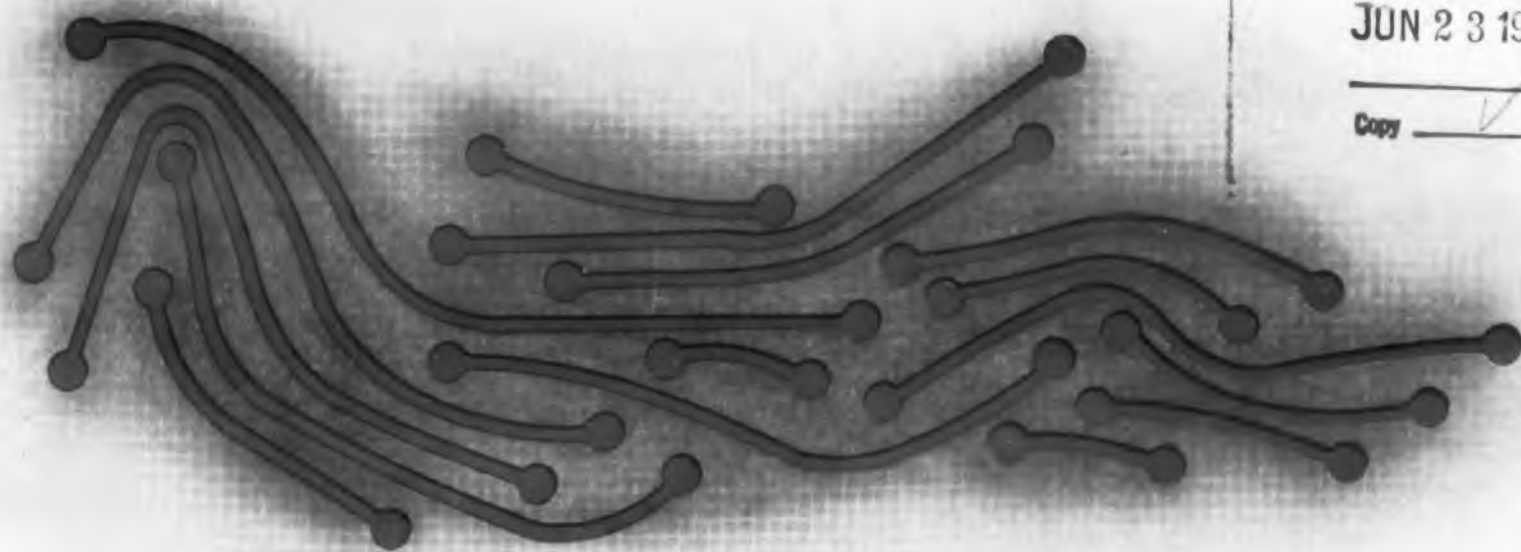
ELECTRONIC DESIGN

JUNE 24, 1959

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CIRCLE 1 ON READER-SERVICE CARD

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A specially designed ultra-violet lamp takes advantage of the natural fluorescence of many contaminants in electronic components. It makes it easy to spot hard-to-see residual solder flux and lint.

Transistor Hybrid Timing
Circuit 22

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Follows Penciled Curves . . 38

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. . . Sputniks 64

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Nonlinear and Parametric Phenomena in Radio Engineering 68

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CIRCLE 2 ON READER-SERVICE CARD ➤



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As part of an airborne fire control system, Waltham Precision Instrument Company's WG-2 Vertical Gyro provides vertical reference information. In achieving either initial or in-flight erection of the gyro, G-V Thermal Time Delay Relays control torque motor field currents that help find the vertical within 30 seconds!

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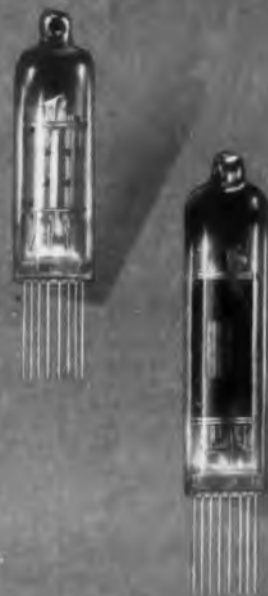
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CIRCLE 3 ON READER-SERVICE CARD

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Design Advances in DISPLAY

Mean New Era In Air-Traffic Control

HARD ON the heels of the Federal Aviation Agency's proposal for semi-automatic control of air-traffic (*ED*, Feb. 4, p 3) have come design details of new display equipment.

The designs show that display engineers are more than holding up their end of the rapidly advancing air-traffic technology. The advance in display breaks down into three stages.

First stage is improvement of existing equipment. The Raytheon scan-converter cathode ray tube described below fits this category.

The second stage is in R & D now for the most part. Some of it however, like the Stromberg-Carlson system described below, is advanced to the hardware stage. The FAA's integrated Data Processing Central, under development by General Precision Labs., characterizes this stage. Though it will make use of existing equipment, it will incorporate newly designed devices. The complete system will be installed in a few years to provide semi-automatic control of high-volume, fast-flying traffic.

Stage three will be completed after the Central is tested at Atlantic City and installed for proving at New York International Airport, Idlewild, Queens. Improvements will be added as the Centrals are installed throughout the country.

The three phases of display development can be described this way: (1) Present PPI systems using varying degrees of image persistence or scan conversion display; (2) Tomorrow's system using direct-view or projection equipment; (3) The eventual system, completely automatic and possibly using electroluminescence, dark tubes, transparent phosphors or developments not in sight at this time.

Scan-Conversion Display

Several companies, now make double-gun scan-conversion tubes for display applications: RCA makes the Graphecon; Intercontinental Electronic

(INTEC) will shortly make the "Frenchicon," which the company now markets here under an arrangement with the French firm CFS that developed the tube; Rauland makes a tube similar to the "Frenchicon," and Raytheon is now producing a new scan-conversion tube designed to do the same job.

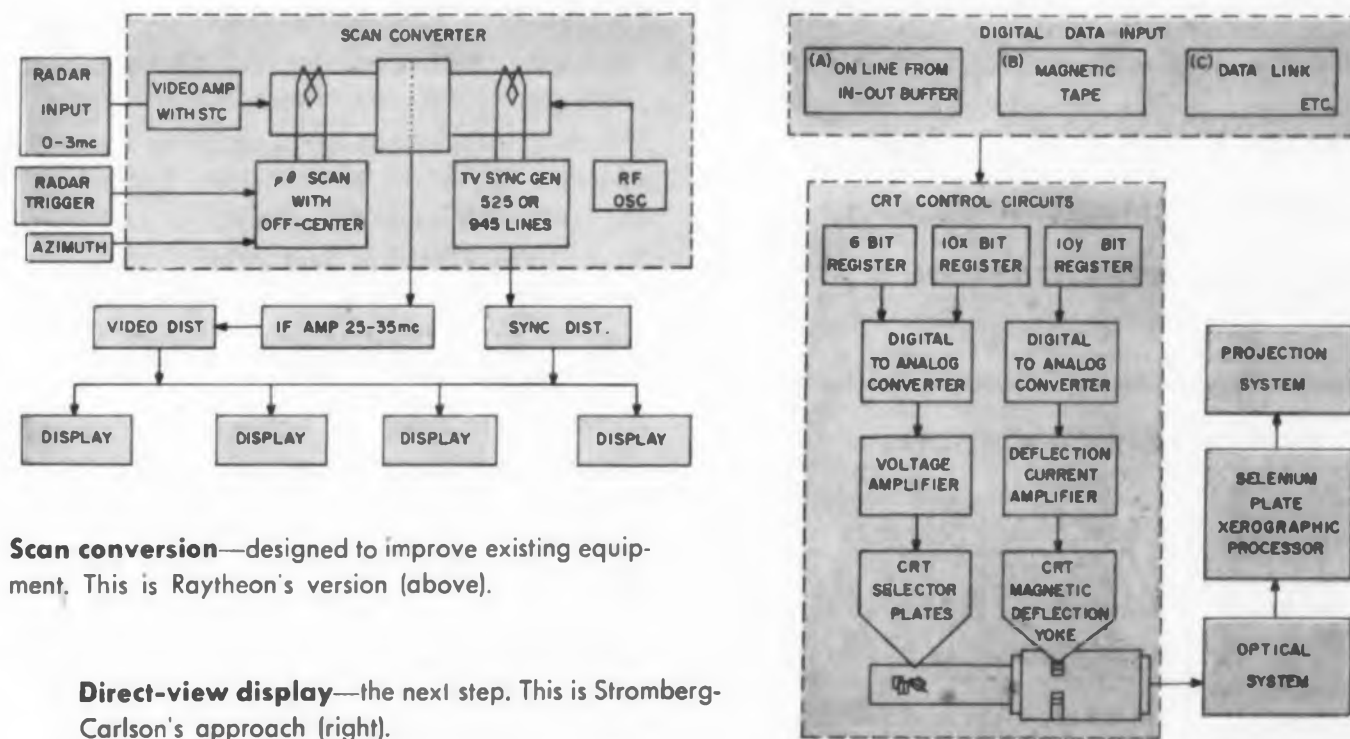
The Raytheon tube, called the "Quickitron" by the FAA, is substantially different from the

others. A storage screen is used as the read-write target, RF-video separation is used to keep the writing and reading functions from interfering with each other, and a sensitivity-time-control circuit is included in the video amplifier stage to cut over-writing at the target's center.

A typical air-traffic-control system using the tube would work this way:

Ordinary scanning radar picks up a target. A

Two Generations of Air-Traffic Display



Scan conversion—designed to improve existing equipment. This is Raytheon's version (above).

Direct-view display—the next step. This is Stromberg-Carlson's approach (right).

Scan converter in Raytheon's system takes radar input, feeds it to one side of a storage screen at radio frequencies, reads it at video frequency from the other side of the screen and transmits the TV signal to multiple display tubes. The system is adaptable for alphanumeric display and is available in 525 and 945 lines, both at a 30-frame-per-sec rate of scan.

Direct-view tube in Stromberg-Carlson's system provides an alphanumeric image for a lens system that feeds images to a xerographic processor. This unit consists of sensitized plates that are rotated after exposure, so their information can be combined optically with radar images and projected to the display screen. Capacity: 45 frames per min.

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The new circulator, designated CLL1, combines an extremely low insertion loss of 0.3 db with 25 db isolation and VSWR of less than 1.1 centered at any frequency from 900 to 1,600 mc. With a permanent magnet, as illustrated, performance is typically 0.4 db and 20 db with a maximum VSWR of 1.25 over any 50 mc band. However, with a tuned magnetic field, the same performance is obtainable over a 100 mc band.

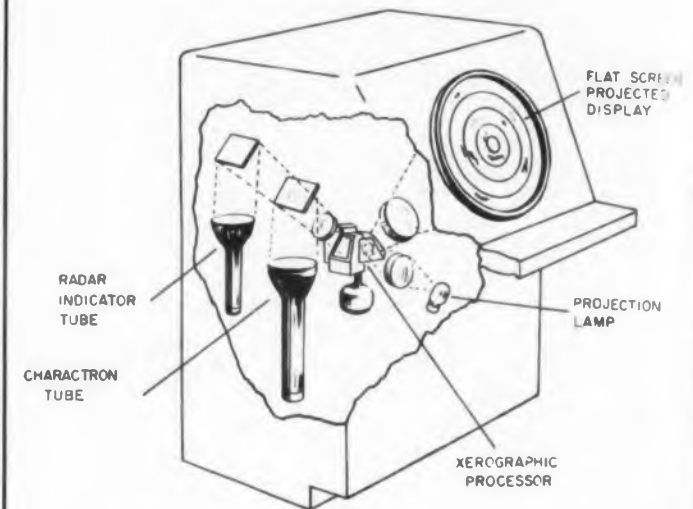
To learn more about this significant development or other important Raytheon advances in microwave ferrite devices, please write stating your particular area of interest to the address below.

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EXCELLENCE IN ELECTRONICS

NEWS



How the alphanumeric and radar data are combined in Stromberg-Carlson's S-C 2000 display system.

signal is sent to the double-gun converter tube, where radar raster-type information is converted to TV video. While one gun writes plots on a storage screen, another simultaneously reads the screen's other side. The readings are transferred over coaxial lines or microwave links to a high-resolution display screen. Plots appear on the display screen as a series of connected or almost connected blips tracing, with each sweep, the target's flight path.

Direct-View Display

FAA goals for this type of equipment are:

- The system should be non-volatile—if a power failure occurs not one bit of data should be lost.
- Display should be bright enough for viewing in a well-lit room—60-100-ft lamberts ambient lighting.
- Resolution should be high—1000 lines per diameter.
- One-eighth-inch-high alphanumeric characters should be readable from two feet.

Many companies are developing bright display systems to meet the FAA goals and to improve the performance of scan-conversion systems, which are sometimes complex and have inherent resolution limits.

Most prominent design feature of one of these projects, the Stromberg-Carlson S-C 2000, is a xerographic processor that stores information gathered from the face of one or more small-screen tubes for projection onto a viewing screen. The S-C system uses a Charactron "shaped-beam" tube to project alphanumeric symbols through etched templates mounted in the tube. The alphanumeric symbols are superimposed opti-

TYPICAL SPECIFICATIONS

	CLL1	CLL2
Frequency range	1260 ± 25 mc	1400 ± 25 mc
Isolation		
Minimum	20 db	20 db
Maximum	25 db	25 db
Insertion loss		
Minimum	0.3 db	0.3 db
Maximum	0.4 db	0.4 db
Power Average	5 watts	5 watts
VSWR		
Minimum	1.08	1.08
Maximum	1.25	1.25
Weight (max.)	9.0 lbs.	9.0 lbs.
Max. dimension	7½ in.	7½ in.

CIRCLE 4 ON READER-SERVICE CARD

cally through a mirror-projection system on the images picked up from a radar-type tube.

The combined data sensitize a xerographic plate. The plates are successively sensitized, rotated and displayed. Advantages of this type of operation are flicker-free display, fail-safe operation, and the variety of information that can be displayed with the radar data. Both tabular and situation display are possible with this equipment.

Beyond the Near Future

The FAA visualizes a completely automatic display system for traffic control that will use equipment now in only the earliest research stages. Some of these systems might resemble Westinghouse's electroluminescent display panel, which uses ferroelectric control; display is flicker free, and both tabular and situation display are possible.

Dark trace tubes are also being investigated. On these, data would be shown in dark trace on a light background.

Another possibility is display using transparent phosphors. Tubeface phosphor would be transparent to permit the inside surface of the tube to absorb ambient light. The tube's interior would be made as black as possible, providing contrast so great that the display would be visible under nearly all conditions. ■ ■

Housefly Goes On "Outer Space" Binge

The "spacemen" recently selected to take the first sojourn in outer space may do well to equip themselves with a flyswatter. And don't look forward to a picnic in outer space to get away from insects. Perhaps this conclusion is hasty—but here are the facts.

Two technicians were making some environmental tests at the Bulova Watch Company, in Woodside, N. Y. They were harassed by a persistent fly who managed to get past the security guards.

The technicians caught the pest, placed him in a vacuum chamber, and raised the altitude. As the pump began to draw vacuum, the fly became restive but retained his faculties.

At 26,000 feet, his wings began to droop but he continued walking briskly. Even at 50,000 feet he was ambulant, but at this altitude, his gait resembled that of a man who, having tried a quart of bourbon, found he liked it, and decided to order some.

When released after being brought down to earth, the creature flew off, apparently undisturbed by his "outer space" adventure.



THE SHRINKING MAN'S FILTER

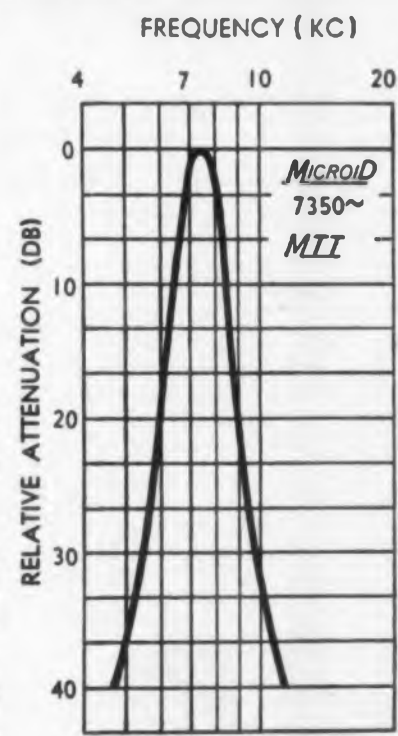
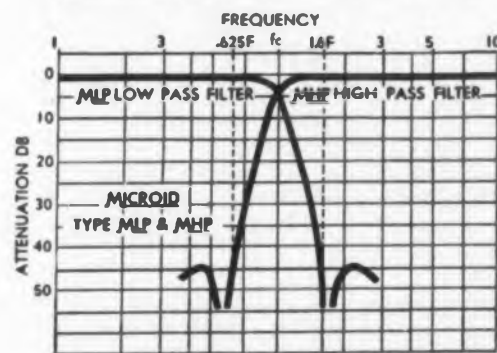
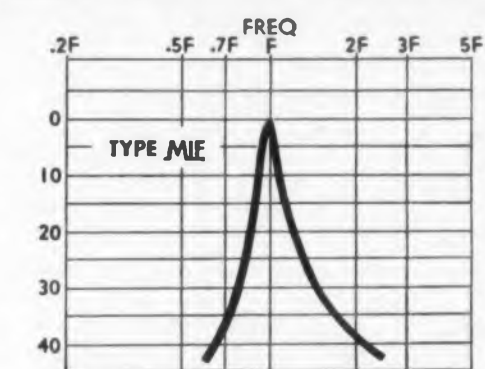
Although worlds apart in purpose, practitioners of the art of head shrinking and Burnell & Co. miniaturization engineers are both expert in reducing to size. For example, Burnell's new microminiature **MICROID** filters are particularly valuable in transistorized circuitry and only a step away from micro-module use. Range of the new Type **MTI** band pass filter is 7.35 kc to 100 kc, band width 15% at 3 db and +60% -40% at 40 db. Size is 1/2" x 19/32" x 15/16", weight .3 oz. Types **MLP** and **MHP** cover 5 kc to 100 kc with a standard impedance of 10K ohms. These are microminiature counterparts of the popular Burnell TCL and TCH low pass and band pass filters. The band pass filter results when cascading a TCL with TCH filter. Size is 3/4" x 1/2" x 1".

Type **MIF** microminiature interstage filters are designed for a wide variety of applications. Input impedance is 10K ohms, output to grid with a voltage gain of approximately 2:1. The 3 db band width is nominally 8%. Ranging from 7.5 kc to 100 kc, these interstage filters are provided in the same case as Type **MLP**.

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CIRCLE 6 ON READER-SERVICE CARD

NEWS

Design News From Abroad

**Pokrovskiy's Funnel:
A 60-Mi.-high Cosmic
Tower Proposed in USSR**

One way to reach the upper atmosphere to conduct space studies is to build an "aerostatic" tower, according to a Russian scientist.

Professor Pokrovskiy proposes to use light plastic to make a funnel with a 60-mile-diam base. The funnel would be inflated with a gas lighter than air and would reach up 60 mi to where atmospheric pressure is only about a millionth as dense as on the ground.

The scientist believes an upper diameter of less than 35 feet would suffice and that a platform there could support a weight of about 200 tons.

**Ionosscatter Transmitter
in NATO Use**



Turkish terminal of new NATO radio link is 1600 mi from Paris end of net. The VHF system uses forward scatter principles to achieve high reliability. Designs were worked out at the Dutch Defense Technical Center, The Hague.

**Facsimile Refined for
Use in Japan**



Facsimile negative of Japanese newspaper is received in Sapporo, Hokkaido, 600 miles from home office. Japanese engineers had to refine the British-built (Muirhead & Co.) units so they could handle the fine lines of Japanese printed characters. Double-channeling is used to provide two sheets at a time at the receiving end.

**Jupiter's Emission Secrets
Elude Russian Scientists**

Russian scientists say they have identified 13.5-meter waves coming from Jupiter, but they admit that the signal's source is still a mystery.

Only two other solar-system bodies emit signals: the sun and the moon. Thermal radiation is the source of signals in both cases. But this does not apply to Jupiter, which gets little heat from the sun.

Temperature of Jupiter's cloud layer is -110 C. Therefore thermal radiation is very weak.

The theory that storm phenomena cause the emissions is countered by the observation that Jupiter's emissions always seem to come from the same spot, believed to be below the cloud layer.

Russians Report Progress on Reading and Printing Machines

Unconfirmed reports from the Soviet Union describe a pair of machines designed to solve the problem of literature searching. The Russians report development of a machine that can read a million pages an hour and that can be questioned by dialing. Literature stored in the machine, however, must be coded.

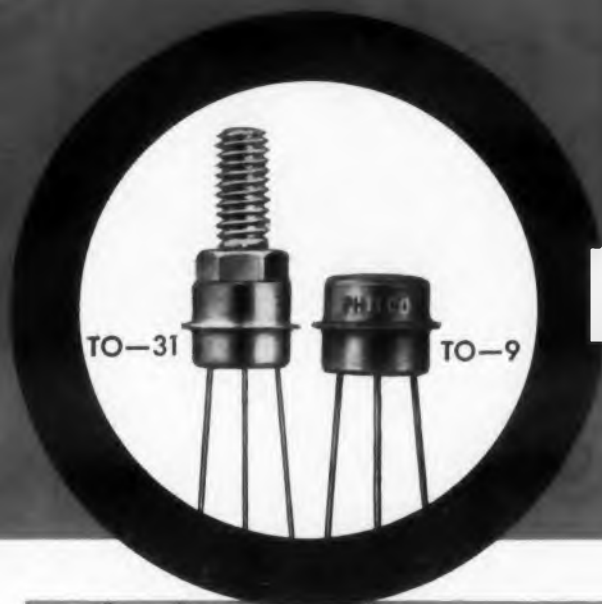
Perhaps part of the same development is a memory device that the Russians say can handle 4 million pages of conventional text an hour. The device, designed at the Electro-Modeling Lab of the USSR Academy of Sciences, is intended for use with language-translation machines.

And Moscow Radio reports that the Vilna Electrography Research Institute has developed a machine that records printed images on magnetic tape, through a photoelectric device, and then prints the image on ordinary paper—all in seconds.

Russians Also Developing Self-powered Telephone

From the Soviet's Physics Institute of the Academy of Sciences comes word of a Russian telephone said to be superior to all others in clarity and range.

A ceramic dielectric plate heated to 200 C and allowed to cool in a strong electric field is reported to store opposite electrical charges for years. Energy "frozen" this way can be applied to a variety of instruments, according to the Russians. The telephone's mouthpiece is simply a charged ceramic disc covered by a membrane. One such telephone has been in institute service for over a year. Its range is more than 1000 mi.



Now...from PHILCO

A complete family of Medium Frequency Transistors

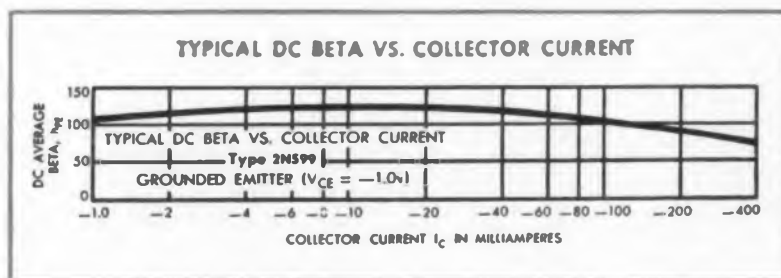
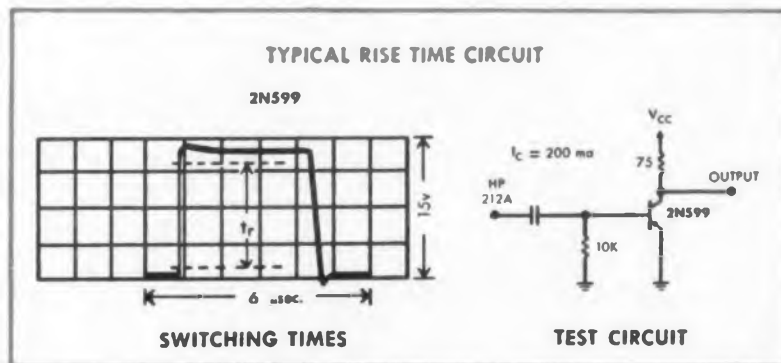
Type	Outline	Max. Readings			General Performance		"ON" Switch Performance	
		P_T mw	V_{CB} volts	I_C ma	Min. $f_{\alpha b}$ mc	Typical h_{FE} $V_{CE} = -1v, I_C = -100ma$	Max. V_{CE}	Max. V_{BI}
2N597	TO-9	250	45	400	3	70	0.2	0.34
2N1123	TO-31	750*	45	400	3	70	0.2	0.34
2N598	TO-9	250	30	400	5	85	0.2	0.34
2N600	TO-31	750*	30	400	5	85	0.2	0.34
2N599	TO-9	250	30	400	12	105	0.2	0.34
2N601	TO-31	750*	30	400	12	105	0.2	0.34

*Peak Dissipation at 25°C = 1 Watt

- High Dissipation: to 1 watt peak at 25°C
- High Current: Max. $I_C = -400$ ma
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100KC, MODEL 7150



1MC, MODEL 7160



10MC, MODEL 7170

EPUT® METERS

Long considered standard equipment for making rapid, precise frequency measurements, Berkeley EPUT meters are now available with over twenty standard modifications designed for an ever-broadening variety of applications. Most EPUT meters are equipped to make period measurements of low frequency signals.



5210 PORTABLE
100KC



10μSEC, UNITS MODEL 7250



1μSEC, UNITS MODEL 7260



0.1μSEC, UNITS MODEL 7270

TIME INTERVAL METERS

The full line offers meters of four degrees of precision ranging from a tenth of a millisecond to a tenth of a microsecond. Versatile 7000 Series instruments feature selectable sensitivity for noise discrimination, trigger level adjustable over a wide range, slope selection and very high input impedance.



5220 PORTABLE, 100μSEC UNITS



100KC, MODEL 7350



1MC, MODEL 7360



10MC, MODEL 7370

UNIVERSAL EPUT AND TIMERS

Combining the functions of an EPUT meter and time interval meter in a compact economical package, these instruments are widely preferred as general purpose laboratory equipment for precise frequency and time measurement. Universal instruments feature as many as ten distinct operating functions.



5230 PORTABLE



100KC, MODEL 7050



1MC, MODEL 7060



10MC, MODEL 7070

GATING COUNTERS

The counting interval of these instruments can be accurately controlled by a broad variety of input signals. Widely useful as a systems building block, several of these units will perform as EPUT meters or time interval meters when operated in conjunction with an independent source of time signals.



MODEL 5804

INDUSTRIAL TOTALIZING COUNTERS

Berkeley makes rugged counters with top speeds from 125 cps to 10,000 cps and capacities up to one billion counts. Model 5805 utilizes miniature magnetic amplifiers for long-term trouble-free operation.



100KC, MODEL 7151



1MC, MODEL 7161



1MC UNIV., MODEL 7351

PRESET EPUT METERS

These instruments will create direct digital indications of rotating speed, flow, pressure, temperature and similar physical quantities in any desired units—for example, rpm, gals/sec, psi, etc. Direct indication is made possible by a counting interval variable over a wide range in small increments.



MODEL 5420 SERIES



MODEL 5440 SERIES

COUNTER-CONTROLLERS

Counters which deliver output signals when selected numbers are reached are widely used for precise control of diverse operations. Output signals may be relay closures, sharp voltage pulses or changes in dc level. 5400 Series instruments operate at speeds up to 40,000 counts per second and deliver output signals at one or two preset totals. 5800 Series controllers utilize miniature magnetic amplifiers for maximum reliability in industrial control applications. Operable at speeds up to 5000 counts per second, these units are obtainable with from 1 to 12 preset points.



MODEL 5820 SERIES

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CIRCLE 8 ON READER-SERVICE CARD

NEWS

U.S. to Split Research Journal

The National Bureau of Standards will publish its Journal of Research in four sections after July 1 to meet the specialized needs of scientists, engineers and mathematicians. At the same time editorial scope of the publication is being broadened.

The Journal's content now is as broad as the Bureau's scientific program, embracing most of the physical sciences and branches of engineering. The new Journal is being divided as follows, with subscriptions available from the Government Printing Office:

Section A—Physics and Chemistry, issued six times a year, annual subscription \$4.

Section B—Mathematics and Mathematical Physics, quarterly, \$2.25.

Section C—Engineering and Instrumentation, quarterly, \$2.25.

Section D—Radio Propagation, six times a year, \$4.

Besides research reports, the revised journal will present reviews by recognized authorities and information on subjects closely related to the Bureau's basic mission. Much of the material that the Bureau has been publishing in nonperiodical form will be carried in the Journal.

Two of the Bureau's nonperiodical series—"Circulars" and "Building Materials and Structures Reports"—are being discontinued. Two new series are being started: "Monographs" and "Technical Notes."

FCC Spectrum Hearings to Affect Electronic Designers

The allocation of spectrum space between 25 and 890 mc is under re-examination in Washington, and the findings will have an impact on designers throughout the electronics industry.

Months of testimony before the Federal Communications Commission will involve:

■ **Television**—TV is now the largest area of spectrum and the most complex. Involved is uhf TV: 470-890 mc. The FCC has long tried, without success, to make uhf economically feasible on a broad scale. It is now considering other means of expansion beyond the 12 vhf channels.

■ **Industrial competition for uhf**—AT&T has asked the FCC to establish a mobile telephone service using 765-840 mc—the heart of uhf TV. Mobile equipment manufacturers contend AT&T wants to monopolize the mobile service; they are urging the FCC to let AT&T experiment for five years but not to authorize service on a regular basis. The broadcasting industry, on the other hand, argues that uhf space must be retained

until a better spectrum location is found for TV.

■ **Control of the spectrum**—The FCC has jurisdiction over only part of the 25-890 mc band. Other government agencies, primarily the military, control a large portion, much of it for aircraft communications, navigation, etc. The FCC is negotiating with these services to find out if they will swap some of their vhf spectrum for TV's uhf. This would give TV a more contiguous band. The shift in military equipment would cost billions.

■ **Congress, and its reactions**—The Senate Commerce Committee has criticized the FCC for not expanding TV and providing more competing stations. The House Commerce Committee has voiced concern over the split management of the spectrum by the FCC and other services.

■ **The Electronic Industries Assn.**—The EIA membership is responsible for most of the nation's electronics production. EIA is opposed to giving AT&T too large a foothold in the mobile field. It points to the following expected growth in mobile transmitter usage, and it wants its share: 695,000 transmitters in 1958; to 1,390,000 in 1963; to 2,650,000 in 1968; to 5,000,000 in 1978. EIA wants an additional 41 mc in the 25-890 mc region to take care of this growth.

It will be many months before the commission finally determines what rearrangements are in order.

New Letter Sorter Tested



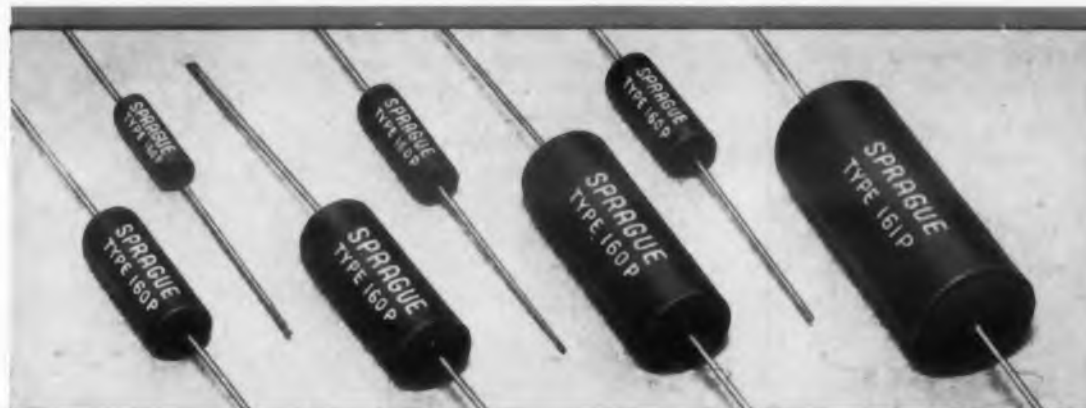
Electronic letter sorting is now receiving a trial in the United Kingdom. The operator of this Thrissell Engineering Co. device has no problem competing with the machine; it adjusts to his speed. Letters are fed by keyboard operation to a waiting compartment, where they are "remembered" electronically. If the operator thinks he has misread the address, he can cancel the keying by pressing a button. As he moves on to the next letter, the machine moves the previous one to banks of other memories for ultimate sorting. A skilled operator can handle 70 letters a minute.

ELECTRONIC DESIGN • June 24, 1959

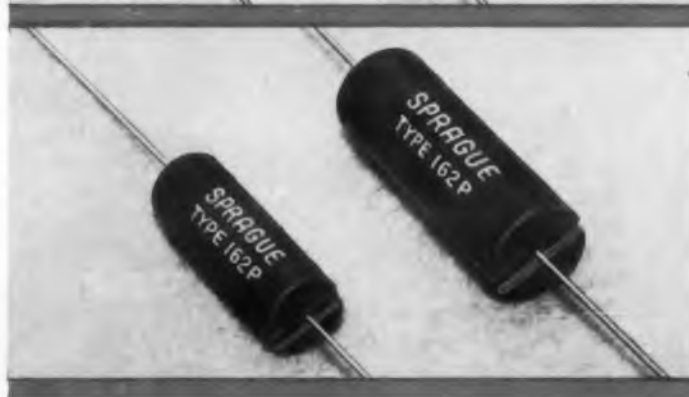
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gives new **BLACK BEAUTY[®]** series of small, low-cost capacitors outstanding performance characteristics

- withstand 105C operation with no voltage derating
- moderate capacitance change with temperature
 - excellent retrace under temperature cycling
 - superior long-term capacitance stability
- very high insulation resistance



NEW!... DIFILM Type 160P fully-molded case and Type 161P pre-molded case capacitors in 5/16" to 1" diameters for general commercial and entertainment electronics.



NEW!... DIFILM Type 162P slotted-base multi-purpose molded case capacitors for auto radios and other severe vibration applications. Slot prevents collection of moisture around leads when capacitor is end-mounted against chassis.



• New DIFILM Black Beauty Capacitors represent a basic advance in paper tubular capacitor design. DIFILM Capacitors combine the proven long life of paper capacitors with the effective moisture protection of plastic capacitors... by using a *dual dielectric of both cellulose and polyester film that's superior to all others for small, yet low cost, capacitors.*

• Just check the characteristics listed above. This overall performance is fully protected by HCX[®], an

exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section, further protected by an outer molding of humidity-resistant phenolic. *These capacitors are designed for operating temperatures ranging up to 105°C (221°F) ... at high humidity levels ... without voltage derating!*

For complete specifications on DIFILM Black Beauty Capacitors, write for Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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THE MARK OF RELIABILITY

NEWS

Meter Reads Out in Feminine Voice

A new voltage meter tells the operator its findings in a clear, feminine voice. The device is the talking Vocameter, developed by the Cubic Corp. of San Diego.

For readings by sight, there is also an edge-lighted digital readout.

The voice reports are called especially useful to technicians working on high-voltage measurement. Their eyes can remain on the work area as the voice announces: "Plus-nine-nine-eight-point-three-volts." Measurements can be relayed through earphones, a loudspeaker or a sound system.

There are 14 channels of voice storage in the Vocameter. Each can store about a half second of wordage. The exact wordage is up to the user. Normally 11 tape-storage channels are used for the digits 0 through 9 and the decimal point. Three other channels contain such words as "plus," "minus," "volts," "ohms," etc.

The meter gives new vocal readings automatically with each change in instrument reading. Information can be recorded in a voice of the user's choice, in any language or with any data for special applications.



Girl's voice calls out measurements made by this voltmeter. Unit has a 14 word vocabulary.

MIT Expanding Its Soviet Data

Soviet scientific literature will soon be offered on a greatly increased scale by the Massachusetts Institute of Technology. The institute has started an extensive exchange system with Russian libraries and will also become the New England depository for translations by the Office of Technical Services, U.S. Dept. of Commerce. OTS will send MIT about 10,000 Russian scientific articles and 50,000 abstracts a year for physics, biology and chemistry.

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The extreme prevalence of **hp** field representatives is a helpful thing. This means that engineering help, new instruments or repairs can be yours wherever, whenever — and in an unreasonably short time.

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Should an **hp** instrument malfunction (rare) your **hp** rep provides factory-level field service and parts—fast!

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(Field service and parts stations shown in blue)

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Atlanta 5, Ga., Bivins & Caldwell, Inc., 3133 Maple Drive, N.E., CE 3-7522. **Fort Myers, Fla.**, Lynch-Stiles, Inc., 35 W. North Shore Ave., WY 5-2151. **High Point, N. C.**, Bivins & Caldwell, Inc., 1923 North Main St., Tel. 2-6873. **Huntsville, Ala.**, Bivins & Caldwell, Inc., JE 2-5733 (Direct line to Atlanta).

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Sterling Company, 15310 West McNichols Rd., BR 3-2900. **Indianapolis 20, Ind.**, Crossley Associates, Inc., 5420 North College Ave., CL 1-9255. **Kansas City 30, Mo.**, Harris-Hanson Company, 7916 Paseo Blvd., HI 4-9494. **St. Louis 17, Mo.**, Harris-Hanson Company, 2814 South Brentwood Blvd., MI 7-4350. **St. Paul 14, Minn.**, Crossley Associates, Inc., 842 Raymond Ave., MI 6-7881. **Dallas 9, Tex.**, Earl Lipscomb Associates, P. O. Box 7084, FL 7-1881 and ED 2-6667. **Houston 5, Tex.**, Earl Lipscomb Associates, P. O. Box 6646, MO 7-4207.

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Toronto 10, Ont., Atlas Instrument Corporation, Ltd., 50 Wingold Ave., RU 1-6174. **Vancouver 2, B. C.**, Atlas Instrument Corporation, Ltd., 106-525 Seymour St., MU 3-5848. **Winnipeg, Mani.**, Atlas Instrument Corporation, Ltd., 72 Princess St., WH 3-8707.

OVERSEAS

Belgium, International Electronic Company, "INELCO S.A.", 20-24, rue de l'Hopital, Brussels, Tel.: 11-22-20 (5 Lines). **Denmark**, Tage Olsen A/S, Centrumsgarden, Room 133, 6D, Vesterbrogade, Copenhagen V., Tel.: Palae 1369 and 1343. **Finland**, INTO O/Y, 11 Meritulinkatu, Helsinki, Tel.: 62 14 25 and 35 125. **France**, Radio Equipments, 65, rue de Richelieu, Paris 2ème, Tel.: RICelieu 49-88. **Germany**, Hewlett-Packard S.A. Verkaufsbüro, Frankfurt am Main, Holzhausenstrasse 69, Telefon 55 47 27. **Greece**, K. Karayannis, Karitsi Square, Athens, Tel.: 23-213 (9 Lines). **Israel**, Electronic & Engineering Ltd., 6 Feieryberg Street, Tel-Aviv, Phone 4288. **Italy**, Dott. Ing. Mario Vianello, Via L. Anelli 13, Milano, Telef. 553-081. **Netherlands**, C. N. Rood N.V., 11-13 Cort Van Der Lindenstraat, Rijswijk (Z.H.), Tel.: The Hague-98-51-53 (6 Lines). **Norway**, Morgenstjerne & Co., Colletts Gate 10, Oslo, Tel.: 60 17 90. **Portugal**, Senatejo Industrial, Lda., Rua do Alecrim, 46-S/Loja, Lisbon, Tel.: 3 44 46—Expediente and 36 86 43—Gerencia. **Spain**, ATAI0, Ingenieros, A. Aguilera, No. 8, Madrid, Tel.: 23 27 42 and 57 84 51. **Sweden**, Erik Ferner, Björnsonsgatan 197, Bromma, Tel.: 87 01 40. **Switzerland**, Max Paul Frey, Hangweg 27, Köniz-Bern, Tel.: (031) 63, 36 44. **United Kingdom**, Livingston Laboratories, Retcar Street, London, N. 19, England, Tel.: Archway 6251. **Yugoslavia**, Belram Electronics, 43 Ch. de Charleroi, Brussels, Belgium, Tel.: 38. 12.40. **Australia**, Geo. H. Sample & Son Pty. Ltd., 17-19 Anthony Street, Melbourne, C. 1, Tel.: FJ4138 (3 lines), 280 Castlereagh Street, Sydney, Tel.: MA 6281 (3 Lines). **Taiwan (Formosa)**, Far-Eastern Company, No. 6 Nanyang Street, Taipei, Taiwan Tel.: 27876 and 31868. **India**, The Scientific Instrument Company, Ltd., 6, Tej Bahadur Sapru Road, Allahabad 1; 240, Dr. Dadabhai Naoroji Road, Bombay 1; 11, Esplanade East, Calcutta 1; B-7, Ajmeri Gate Extn., New Delhi 1; 30 Mount Road, Madras 2. **Japan**, Seki & Company, Ltd., Daini Taihei Building, No. 1 Kanda Higashi-Fukudacho, Chiyoda-Ku, Tokyo, Tokyo (866) 3136-8. **New Zealand**, Geo. H. Sample & Son (N.Z.) Ltd., 431 Mount Albert Road, Mount Roskill S.1, Auckland, Tel.: 89-439. **Union of South Africa**, F. H. Flanter & Co. (Pty.), Ltd., Rosella House, Buitencingle Street, Cape Town, Tel.: 3-3817. **Argentina**, Mauricio A. Suarez, Telecomunicaciones, Carlos Calvo 224, Buenos Aires, Tel.: 30-6312-34-9087.

First Tactical Airborne Plotter For ASW is All-Transistorized

Performance previously available only aboard ship or in fixed stations is provided by a plotting system for anti-submarine warfare now undergoing Navy flight tests.

With the system, a plane can track a submarine through information relayed by radar, sonobuoys, countermeasures and other detection equipment. This equipment feeds analog data to an operator who evaluates and relays it to the plane's plotter.

The plotter, which continuously plots the aircraft's ground track, calculates the sub's position in relation to the plane's. The relationship is indicated by a succession of lights on a screen in the cockpit. The plotter can also show location of a third station.

The pilot "flies" the plotter—he tries to bring two arrows together. He does not have to evaluate data, though he can easily read the sub's speed and direction of travel from the fixes on his screen. The plotter is miniaturized and completely transistorized.

Range of the tactical system is up to 200 miles. It is used with a navigating unit. Both devices are made by the Loral Electronics Corp., Bronx, N.Y. The company is now producing a computer for 1960 delivery that will replace the human evaluators and make the system fully automatic.



Plotter for anti-submarine warfare calculates path of plane and path of sub. Arrow of light, which can be seen at center of disc, traces plane's path. When data is picked up from sub, the arrow jumps to show location of sub in relation to plane. Included in controls is adjustment that keeps arrow from going off-screen.



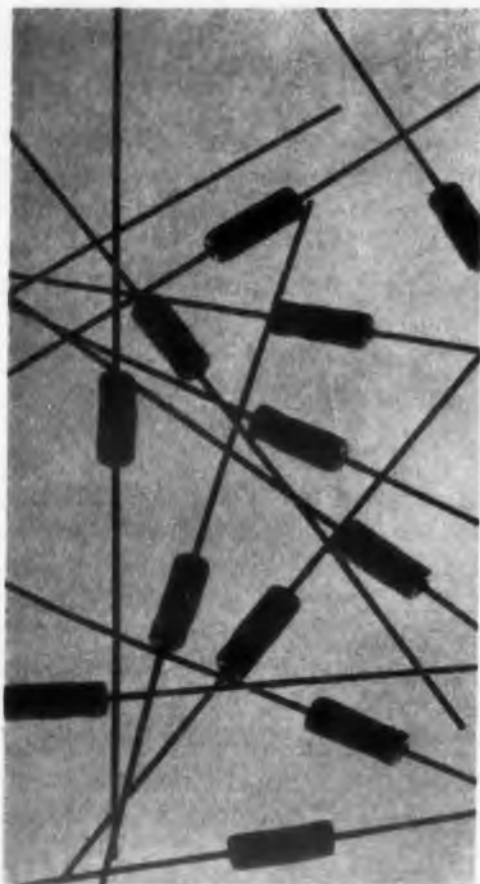
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device development project leader

If you are a man capable of heading a team of device physicists in the development of new and advanced transistors, diodes and other semiconductor devices, the Semiconductor Division of Hughes Products (Hughes Aircraft Company) can offer you an exceptional position. You should have a Ph.D. in Physics and several years experience in research and development. A substantial background in the theory of device design is essential.

The ultra-modern facilities of the Semiconductor Division in Newport Beach, Southern California, were just recently completed. This fully integrated division is responsible for semiconductor research, development, manufacturing, marketing and sales.

If you meet the requirements for the position of Device Development Project Leader, or if you're an engineer or physicist with semiconductor experience, please contact:

Mr. C. L. M. Blocher
Scientific Staff Representative
Hughes Semiconductor Division
500 Superior Avenue
Newport Beach 1, California

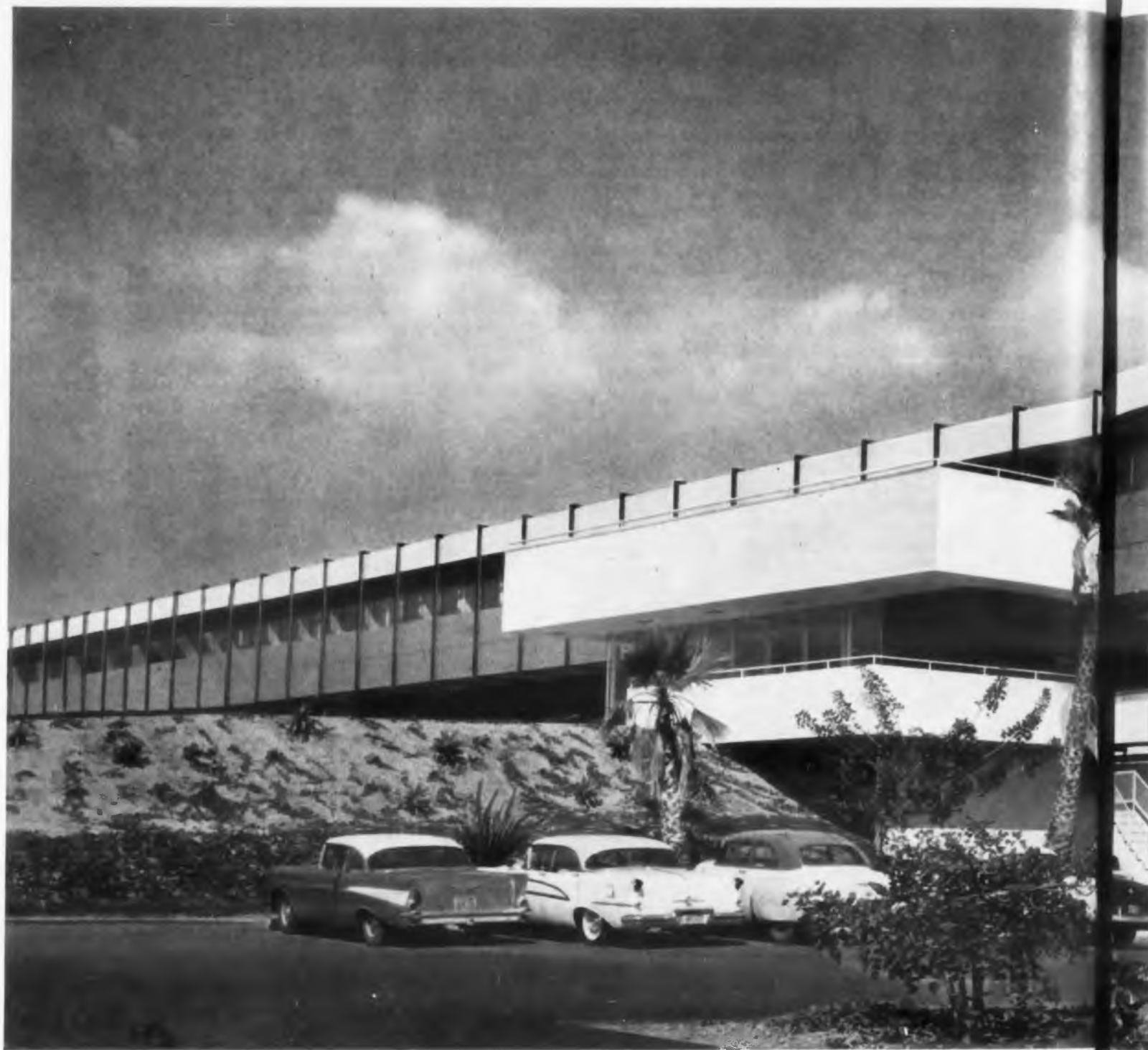


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CIRCLE 910 ON CAREER FORM, PAGE 63



THE HOUSE OF EM

The Semiconductor Division of Hughes Products has one goal: to give you the best performing semiconductors—both today and tomorrow. Here's how we are doing this:

1. Start with a better manufacturing facility—The new Hughes multi-million dollar semiconductor plant has 300,000 square feet of space. Hughes has installed over \$3 million worth of mechanized manufacturing equipment which will provide you with more uniform semiconductors... at a lower cost.

2. Encourage advanced thinking—A few of the projects now in progress: fundamental and device physics chemistry, new semiconductor

materials, basic research into electronic solids, new methods of crystal preparation, new techniques for fabricating advanced solid state devices.

3. Have a passion for reliability—Hughes is recognized for the ability to translate the latest advances into components which meet your strictest reliability needs. This reliability is the product of an integrated effort beginning in earliest development through final inspection.

These factors enable Hughes to bring you a number of products which make a significant improvement in the state of the art. To date these include: a complete line of silicon and germanium



Hughes new Semiconductor Facility at Newport Beach, California

SEMICONDUCTORS

diodes, including the new parametric amplifier and zener diodes; germanium and silicon alloy transistors and double diffused silicon transistors; low and medium power rectifiers; and silicon capacitors.

In addition, the Semiconductor Division is active in related fields... thermal relays and cast silicon domes. Many other startling devices are now in advanced state of development at the Semiconductor Laboratory.

*You can obtain information concerning any of the Hughes semiconductors from the Hughes field offices in **Boston** (phone WO 2-4824), **Newark** (phone MA 3-3520), **San Francisco** (phone DA 6-7780), **Syracuse** (phone GR 1-0163), **Philadelphia** (phone MO 4-8365), **Chicago** (phone NA 2-0283), and **Los Angeles** (phone OR 8-6125). Or write Hughes Products, Marketing Dept., Semiconductor Division, Newport Beach, Calif. In addition to Hughes sales offices, distributors are located in all major cities. For export write: Hughes International, Culver City, Calif.*

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CIRCLE 11 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1959

NEWS

Wiring Encased in Fiber Glass

Chance Vought is completely encasing dense aircraft wiring in rigid resin-impregnated fiber glass. Such bundles, with extra wires included and with ready-to-fit spare sections available, can be molded to follow structural contours of the aircraft. "Breakout" wiring leaving the main bundle is encased in a flexible plastic tubing.

According to the company, encased wires carry higher voltages at higher temperatures and overloads. The system is applicable to computers and other high-density equipment.

Two rigid, fiber-glass sections hold about the same number of wires as a conventional harness. Breakout wiring is encased in flexible tubing. Junction boxes ease replacement.



"Breakout" wiring is encased in flexible tubing. Junction boxes ease replacement.



Two rigid, fiber glassed sections hold about the same number of wires as conventional harness.

LEFT: STUD 7/16-11/16

CENTER: AXIAL LEAD TOP HAT

RIGHT: STUD INSULATED

COLUMBUS ELECTRONICS CORPORATION
 DOUBLE DIFFUSED SILICON RECTIFIERS
 COLUMBUS ELECTRONICS CORPORATION
 DOUBLE DIFFUSED SILICON RECTIFIERS
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Now ... an extensive line of
 high performance, hermetically sealed,
 silicon power rectifiers UP TO 35 AMPS.
 JEDEC types exceeding MIL specifications.

NEW

SINGLE unit VERY HIGH VOLTAGE silicon rectifiers exhibiting these desirable characteristics ...

HIGH VOLTAGE up to 2000 PIV	LOW FORWARD DROP 1.5 Volts, DC
EXTREMELY LOW LEAKAGE 1 μ A	FORWARD CURRENT up to 20 Amps.

WRITE FOR FULL DETAILS

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NEW

INSULATED STUD silicon rectifiers offering these quality features ...

- Simplify mounting
- Save assembly parts & costs
- Obtain efficient heat transfer
- Give greater design flexibility

AVAILABLE UP TO 10 AMPS PER UNIT AND UP TO 2000 VOLTS PIV.

CIRCLE 12 ON READER-SERVICE CARD

NEWS

Last Year Saw Drop in Component Shipments

Latest Department of Commerce figures (from the Electronics Division, Business and Defense Services Administration) show the following totals for the years from 1952 through last year.

Estimated Shipments of Selected Electronic Components¹
 (Millions of dollars)

	1952	1953	1954	1955	1956	1957	1958
Capacitors ²	200	220	198	218	212	216	192p
Relays for electronic applications ³	74	89	85	109	140	157	138p
Resistors for radio, TV, and other industrial and military electronic applications ⁴	123	139	130	148	171	192	177p
Semiconductor devices	19	26	26	40	90	151	210p
Transistors	2	5	9	13	40	68	112p
Crystal diodes ⁵	17	21	17	27	50	83	98p
Transformers and reactors (for electronic applications)	160	180	148	138	137	137	122p

¹ Includes intra-plant and inter-plant transfers.

² Includes both fixed and variable air capacitors.

³ Includes thermal, meter movement and motor driven relays.

⁴ Includes attenuators, voltmeter multipliers, varistors and thermistors.

⁵ Includes power rectifiers, diode type; light sensitive devices; and mixer crystals. Excludes selenium and copper oxide rectifier stacks.

p—Preliminary

Fluoride Insulation Stands High Temperatures



Bell Labs' scientists inspect a strip of fluoride-coated aluminum. The coating was applied in a few minutes by exposing the aluminum to an oxidizing carrier of fluorine at a temperature below 600 C. Aluminum fluoride films show resistances of about 7×10^8 ohms at temperatures as high as 500 C, and do not break down at 450 v.

Reactance-Amplifier Receiver for Moon Research Has 1 db Signal-to-Noise

Low noise in a new reactance-amplifier receiver delivered to the Army will improve moon radar research.

The receiver is the AIL Type 7329, built by Airborne Instruments Lab of Mineola, N.Y. It will be used in the Signal Corps' Diana Project, which is measuring the ion density path to the moon.

Transmissions to the moon on 151 mc have already been made by the Army. With the new receiver, experiments will be conducted on 413 mc. This will permit cross-checking of estimates made thus far.

With the reactance-amplifier operated in the two-port, difference-frequency mode, receiver noise of less than 1 db is obtained with commercially available reactance diodes, Airborne reports. The unit operates in either the sum-frequency mode or the two-port difference and has been used to receive signals from below 100 mc up to 1000 mc.

In the sum-frequency mode, bandwidths of 30 mc, and over-all receiver noise of about 2 db, are obtained at 400 mc. In the two-port difference frequency mode, bandwidths of 5 mc and noise of 1 db are said to be typical at 400 mc.

The Signal Corps reports these key advantages of the low-noise receiver:

- Increased radar range, in effect.
- Performance equivalent to that obtained with a larger antenna.
- Greatest improvement of the over-all system at the lowest cost.

Saturable Reactor as Ballast Dims Fluorescent Lamps

A system for dimming fluorescent lights has been developed that reportedly overcomes previous obstacles of flicker and expensive operation.

The technique consists of a series saturable reactor used as a dimming ballast. The manufacturer, Day-Ray Products, Inc., of South Pasadena, Calif., reports that the control of large lighting installations is possible, because control power can be much less than lamp power.

The system is made to start the lamp at any lighting level. In an aircraft installation, it operates a 170-ma lamp over a range of 0.35 ma to 200 ma on 400-cycle power. The low-current level is described as a compromise of cost, weight and dimming ratio in excess of 700 to 1.

Installations are being made on two new jet transports and some new military aircraft, the company reported.

2,000 VOLT SINGLE UNIT DOUBLE DIFFUSED SILICON RECTIFIERS

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SEMICONDUCTORS

CAN DELIVER

IMMEDIATELY

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quantities*

*Hermetically
Sealed,
Available in
Axial Lead Top Hat,
7/16" Stud and
Insulated Stud*



SPECIFICATIONS AND RATINGS

JEDOC NO.	PEAK INVERSE VOLTAGE	MAX. RMS VOLTAGE	MAX. D.C. CURRENT AT 25°C CASE TEMP.	MAX. 1 CYCLE SURGE CURRENT	FORWARD DROP AT 25°C	MAX. LEAKAGE AT 25°C @ RATED PIV	CORRESPONDING ISOLATED STUD JEDOC NO.
	VOLTS	VOLTS	AMPS	AMPS	VOLTS	MICRO AMP	
TOP HAT AXIAL LEAD							
1N2357	1400	900	.4	15	2	1	—
1N2350	1500	1050	.4	15	2	1	—
1N2359	1600	1120	.4	15	2	1	—
1N2360	1800	1260	.4	15	2	1	—
1N2361	2000	1400	.4	15	2	1	—
STUD 7/16"							
1N2362	1400	900	1	15	2	1	1N2363
1N2364	1500	1050	1	15	2	1	1N2365
1N2366	1600	1120	1	15	2	1	1N2367
1N2368	1800	1260	1	15	2	1	1N2369
1N2370	2000	1400	1	15	2	1	1N2371
1N2362A	1400	900	5	20	2	1	1N2363A
1N2364A	1500	1050	5	20	2	1	1N2365A
1N2366A	1600	1120	5	20	2	1	1N2367A
1N2368A	1800	1260	5	20	2	1	1N2369A
1N2370A	2000	1400	5	20	2	1	1N2371A
1N2362B	1400	900	10	25	2	1	1N2363B
1N2364B	1500	1050	10	25	2	1	1N2365B
1N2366B	1600	1120	10	25	2	1	1N2367B
1N2368B	1800	1260	10	25	2	1	1N2369B
1N2370B	2000	1400	10	25	2	1	1N2371B

THESE HIGH VOLTAGE RECTIFIERS ARE PART OF AN EXTENSIVE LINE OF DOUBLE DIFFUSED SILICON POWER RECTIFIERS

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	<p>RETRACTABLE SCREW FASTENERS Stand-off thumb screws from stock to eliminate costly, special fasteners. Installed quickly without special tools. Accommodate misalignment. Complete range of standard sizes.</p>		
	<p>ADJUSTABLE PAWL FASTENERS Pre-assembled, quickly installed. Accommodate variations in frame thickness up to 1/2 inch. One-quarter turn closes, additional turns increase grip pressure. Attractive appearance, long life. Moving or pre-set pawl. Miniature, intermediate and large sizes.</p>		 <p>MOVING PRESET</p>
	<p>ADJUSTABLE PAWL FASTENER Has twin-knob control. One knob controls pawl, pointer shows pawl position. Other knob controls amount of pressure to seal closure with uniform pre-set compression. Easily installed.</p>		
	<p>ADJUSTABLE PAWL FASTENER Compact and rugged. Eliminates rivets or bolts to save installation time. Three types cover grip range up to 3/4". Supplied either with integral metal and plastic knob, plastic knob or for your knob.</p>		
	<p>ARROWHEAD DOOR LATCH Requires only one hole to install. Operates on quarter turn. Holds under spring tension. Arrow shows pawl position; no pawl stops required. Uses minimum inside space.</p>		

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SOUTHCO FASTENERS

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LION

WASHINGTON REPORT



Ephraim Kahn

Better Component Design Needs Pushing

Need for encouragement of design engineering at the most basic level of electronics—the component—is starting to gain more and more attention from the Pentagon. Sparked by industry thinking on the point, a growing body of opinion is tending toward the view that a special group should be set up in the Defense Department to make at least a preliminary survey of the components problem.

The problem seems to be that basic components—the least glamorous part of a glamorous industry—are not being developed as rapidly as are some more esoteric devices. Yet, officials point out, it is the component that determines whether a weapons system will or will not function. To be sure, this is true of non-electronic components, too.

And there are those who think that the Defense Department might be wise to spend close to \$1 billion a year on research, development, testing and evaluation of components for aircraft, missiles, and space vehicles. At present, it is impossible to tell how much is being spent for research and development work on electronic and mechanical components. It seems clear that it is less than \$1 billion. But some funds that are nominally in other accounts are probably being "bootlegged" into R & D.

Object is to overcome the obsolescence that is overtaking many items long regarded as tried-and-true building blocks for weapons systems. As the systems become more complex and as performance requirements rise, it is becoming more and more apparent that there are too many weak links when off-the-shelf items are put to work in a brand new weapons system.

Components Research: A Special Function?

Financing of components research is going to present a big problem if the Defense Department decides to go in for it as a special function. Looking at the nature of many firms that make components for weapons systems, defense officials are struck by the relatively low capitalization of the average company. Demands on their limited capital are such that little can be devoted to long-term independently financed research and development. The money in hand is needed to keep

the business going from day to day. Even large companies, it is said, can't spare a lot of cash for research and development of components. After all, it takes a lot of money for a prime contractor on a weapons system merely to do what he has undertaken.

If this analysis is correct, it appears as though the logical source of funds for extensive research and development in components is either the Defense Department or one of the Armed Services. And even these appropriation-bound agencies are handicapped.

Conviction is growing, however, that steps should be taken to solve the problems that are sure to come up in the components field, particularly in non-electronic areas where the art has not, in most cases, been advancing too rapidly. Object is to strike a balance wherein systems manufacturers do not have to make compromises and components makers no longer have to sacrifice any quality to the price and timing requirements of their customers—the weapons system prime contractors.

Even in the components business, however, the ubiquitous question of patents has arisen. Some industry people are known to feel that the protection offered to their patentable devices by the Armed Services Procurement Regulation is insufficient.

DOD to Give Weapons Proposals the Hard Eye

Defense Department plans to get even tougher in selecting weapons development projects that merit its support. The Director of Defense Research and Engineering, Dr. Herbert York, has said that the "highest degree of selectivity must be exercised in reaching decisions to continue or discontinue the development of some of the major weapons systems."

Right now, Dr. York's organization is looking at the military's proposals for Research, Development, Test and Evaluation for fiscal 1960 with a very hard eye. DDRE's chief wants to "be in the position either to approve, disapprove, or modify these programs and projects" by the time the military departments and the Advanced Research Projects Agency submit their apportionment requests.

According to Dr. York, it is most difficult to be selective during the research and earliest design and development stages. "Fortunately," he says, "these stages are the least expensive." But later on, "in the costly advanced development and early production phases," Dr. York must make decisions "where a single item may not only involve an outlay of many millions of dollars but may also have a pronounced effect not only on military strategy but on the civilian economy as well."

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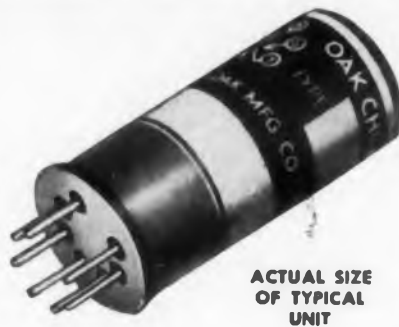
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All contact insulation and supports are metal-to-glass construction

Oriented ceramic magnet (patented design) eliminates parts, gives remarkable simplicity and ruggedness



MINIATURE SERIES M—SMALLEST, MOST RUGGED IN ITS CLASS

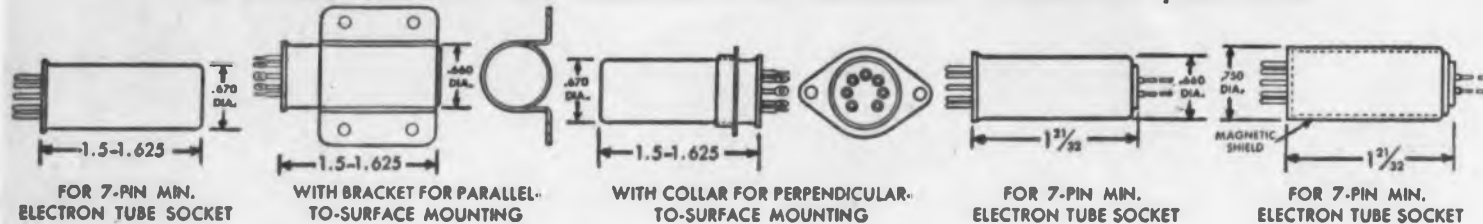
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SERIES 600—MIL C4856, Class B, Type 1. Capacity between switch terminals and ground, 15 uuf average. Contact symmetry, within 10°.

Weight, less than 1 oz. SERIES M—MIL C4856, Class B, Type 1, Grade 2. Capacity between switch terminals and ground, 3-5 uuf. Contact symmetry: 0-500 cps, within 10°; at 1000 cps, within 20°. Weight, less than 3/4 oz.

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WITH BRACKET FOR PARALLEL-TO-SURFACE MOUNTING

WITH COLLAR FOR PERPENDICULAR-TO-SURFACE MOUNTING

FOR 7-PIN MIN. ELECTRON TUBE SOCKET

FOR 7-PIN MIN. ELECTRON TUBE SOCKET

	SERIES 600					SERIES M For Shock and Vibration Conditions	
	Types { 607 NC-600 602 603	Type 610	Type 604	Type 612	Type 605	Types { 608 609 NC-600A	Types { M5-1 M5-2 M5-3
Nominal Drive Freq. and Voltage	400 ± 20 cps at 6.3 v	400 ± 20 cps at 6.3 v	380-500 cps at 6.3 v	400 ± 20 cps at 6.3 v	400 ± 20 cps at 6.3 v	60 ± 5 cps at 6.3 v Aperiodic from 10-100 cps	4-8 Volts, 10-1000 cps. Aperiodic. Coil Current 60 ma at 400 cps Coil Res. 85 Ohms
Phase Lag at Nominal Drive Freq. and Voltage	65° ± 5° at 400 cps (25° C)	65° ± 5° at 400 cps (25° C)	75° ± 10° at 400 cps (25° C)	90° ± 10° at 400 cps (25° C)	180° +10° -0° at 400 cps (25° C)	20° ± 5° at 60 cps (25° C)	10 cps: 10° ± 5° 60 cps: 15° ± 5° 400 cps: 55° ± 10° 1000 cps: 110° - 0° (25° C)
Contact Dwell Time at Nominal Drive Freq. and Voltage	150° min (25° C)	140° max (25° C)	150° min (25° C)	150° min (25° C)	160° ± 10° (25° C)	165° to 170° at 60 cps	160° to 170° (25° C)
Contact Rating Into Resistive Load (Maximum)	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 10 v at 2 ma INTERMITTENT: 15 v at 2 ma	CONTINUOUS: 50 v at 2 ma INTERMITTENT: 100 v at 2 ma	CONTINUOUS: 15 v at 2 ma INTERMITTENT: 50 v at 2 ma	CONTINUOUS: 10 v at 1 ma INTERMITTENT: 12 v at 2 ma
Life Expectancy (Optimum Conditions)	Up to 5000 hours	Up to 1000 hours	Up to 5000 hours	Up to 5000 hours	Up to 5000 hours	Up to 10,000 hours	Up to 10,000 hours
Switching Speed With DC in Coil	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 1 Millisecond	Less than 800 Microseconds	Less than 200 Microseconds

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MEETINGS

Calendar of Events

July

16-17 Radio Technical Commission for Aeronautics, RTCA, IRE, Room 1072, Bldg T-5, Washington 25, D.C.

August

4-6 Annual Convention of Society of Photographic Instrumentation Engineers, Ambassador Hotel, Los Angeles, Calif.

9-12 ASME-AICE Heat Transfer Conference, University of Connecticut, Storrs, Conn.

17 National Ultrasonics Symposium (PGUE), Stanford University, Stanford, Calif.

18-21 WESCON Show and Convention, Cow Palace, San Francisco, Calif.*

23-26 AIEE, 6th Electrical Conference of the Petroleum Industry, Wilton Hotel, Long Beach, Calif.

31-2 Semiconductors Conference, Metallurgical Society of AIME, Statler Hotel, Boston, Mass.

September

1-2 Conference on Chemistry in Aerodynamic and Space Flight, Air Force Office of Scientific Research, General Electric Co., University of Pennsylvania, Philadelphia, Pa.

1-3 14th National Meeting, Association of Computing Machinery, MIT, Cambridge, Mass.*

7-10 6th Annual International Meeting, The Institute of Management Sciences, (TIMS), Paris, France.

17-18 Engineering Writing and Speed Symposia, IRE, Boston, Mass. and Los Angeles, Calif.

18-19 3rd Technical Symposium, Cedar Rapids section IRE, Sheraton-Montrose Hotel, Cedar Rapids, Iowa.

18-20 8th Annual High Fidelity Show, International Sight and Sound Exposition, Inc., Palmer House, Chicago, Ill.

20-25 14th Annual Conference and Exhibit, Instrument Society of America, Chicago, Ill.

21-22 Standard Engineers Society 8th Annual Meeting, Boston Section, Hotel Somerset, Boston, Mass.

23-25 4th Annual Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, AIEE, IRE, Shoreham Hotel, Washington, D.C.

28-30 National Symposium on Telemetering, IRE, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif.

28-1 3rd Annual Industrial Film and A-V Exhibition, Oct. New York City, N.Y.

28-1 American Welding Society meeting, Sheraton-Oct. Cadillac Hotel, Detroit, Mich.

30-1 Industrial Electronics Symposium, Mellon Institute, IRE, AIEE, Pittsburgh, Pa.

* Includes meetings described herewith.

WESCON Show and Convention, August 18-21

The show will feature numerous exhibits which will fill the Cow Palace in San Francisco. Complementing the product lines will be papers covering all phases of professional group interests. A "new look" in the technical program is being planned this year which will limit each of the usual 40 daytime sessions to three full-length

papers in each. A second innovation will be the introduction of a "panel of peers," a group of experts in the field, invited to comment on the group of papers at the completion of each session. Registrants will be able to obtain and review all papers prior to their presentation through the Convention Record.

14th ACM National Conference, September 1-3

Conference of the Association of Computing Machinery will be held at the Massachusetts Institute of Technology, Cambridge, Mass. Technical papers to be presented will cover numerical analysis, data processing, automatic programming, language translation, digital and analog devices, and various applications of computers. Chairman of Local Arrangements is: Frank M. Verzuh, Computation Center, MIT, Cambridge, Mass.

Paper Deadlines

July 15: Paper deadline for the Fourth IRE Instrumentation Conference and Exhibit to be held November 9-11, 1959 at the Atlanta Biltmore Hotel, Atlanta, Ga. An informative abstract of approximately 200 words is required. Earlier submission of papers is requested although final deadline for acceptance of abstracts is July 15. Send titles abstracts to W. B. Jones, Jr., School of Electrical Engineering, Georgia Institute of Technology, Atlanta 13, Ga.

August 15: Submit by this date four copies of a 100 word abstract and a 1000 word summary of papers on any phase of computing for the 1959 Eastern Joint Computer Conference. The Conference will be held December 1-3, 1959. Forward abstracts to: J. H. Felker, Chairman, EJCC Program Committee, Bell Telephone Laboratories, Mountain Ave., Murray Hill, N.J.

August 3: Deadline for an original and four copies and an informative abstract of approximately 200 word for papers for the 1959 Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C., being held October 29-30. Papers to be presented should deal with material of an applied or developmental nature in the broad field of electron devices. Emphasis should be on the device itself, or important new device technology. Send abstracts to: Dr. J. A. Hornbeck, Bell Telephone Laboratories, Murray Hill, N.J.

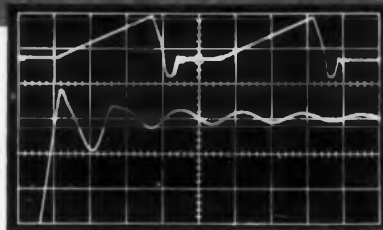
October 23: Deadline date for papers for the 1960 IRE Convention to be held March 21-24, Waldorf-Astoria Hotel and New York Coliseum, New York. Send a 100-word abstract in triplicate, including title of paper, name and address, and a 500-word summary in triplicate, including title of paper, name and address to: Gordon K. Teal, Chairman, 1960 Technical Program Committee, The Institute of Radio Engineers, Inc., 1 E. 79 St., New York 21, N.Y.

ELECTRONIC DESIGN • June 24, 1959

NEW DC-to-30 MC DUAL-BEAM Oscilloscope with Independent X and Y Deflection TYPE 555

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Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform.



Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope.

Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in type to facilitate instrument maintenance.

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Signal-handling versatility is provided by nine available types of plug-in preamplifiers, any combination of which can be used in the two fast-rise vertical channels. In addition to the many application areas opened with Tektronix plug-in preamplifiers, a three-channel or four-channel display is available through use of the time-sharing characteristics of Type C-A Dual-Trace Units in one or both channels.

Please call your Tektronix Field Engineer or Representative for complete specifications.

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INDEPENDENT ELECTRON BEAMS

Separate vertical and horizontal deflection of both beams.

FAST-RISE MAIN VERTICAL AMPLIFIERS

Passbands—dc-to-30 mc with Type K Units.

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All Tektronix Plug-In Preamplifiers can be used in both vertical channels for signal-handling versatility.

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Either time-base generator can be used to deflect either or both beams.

Sweep ranges—0.1 μ sec/cm to 12 sec/cm. 5 x magnifiers increase calibrated sweep rates to 0.02 μ sec/cm.

SWEEP DELAY—Two modes of operation.

Triggered—Delayed sweep started by signal under observation.

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10-KV Accelerating potential provides bright traces at low repetition rates and in one-shot application.

REGULATED POWER SUPPLY

All dc voltages electronically regulated.

Heater voltages also regulated.



PRICE, Type 555 without plug-in preamplifiers . . . \$2600
Includes Indicator Unit, Power Supply Unit, 2 Time-Base Units,
4 Probes, Time-Base Extension.

Type 500A Scope-Mobile . . . \$100
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holds 35 contacts.
Frames available
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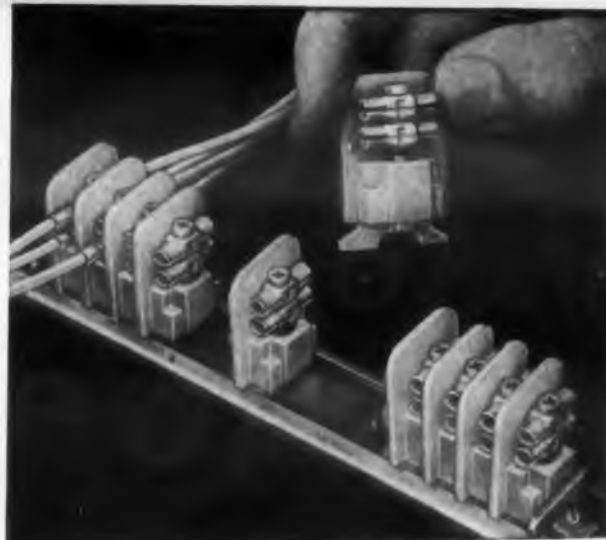
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with snap-in,
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True versatility in a
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per foot. Twist of a
screwdriver transforms
quick-disconnect con-
tacts to permanent
connections.



*Trade Mark

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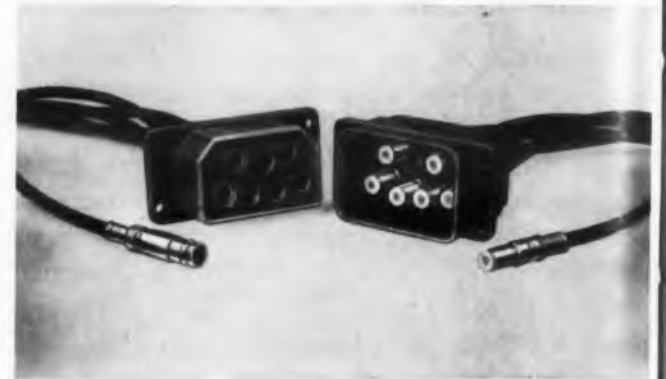
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NEW PRODUCT

Crimped Coax Hyfen Connector



ME7X-1 Rack and Panel Coax Hyfen

Utilizing the HYFEN® crimp-type snap-lock principle, the Omaton Division of the Burndy Corp. has developed a completely new solderless connector for joining coax or shielded cable. This connector is a revolutionary development because it simplifies a process which was extremely complicated involving many parts.

The versatility of the snap-lock principle of the HYFEN is utilized and allows contacts to be snap-locked into and out of receptacles as needed. The connector itself allows rapid connecting and separation of circuits, either in multiple or singly. The connector has already been adapted for use in a rack and panel HYFEN—the ME7X-1, and in a modular terminal block, the MODULOK®. Other variations can be made available. These two are already in use in critical circuits. The coax HYFEN matches the characteristics of the cable over a wide frequency range. In crimping this connector, the contacts can be located in any circumferential position relative to the crimping dies. This crimp, a measurable quality control, is made quickly and uniformly by high speed precision installation tooling.

This crimp-type connector prevents the possibility of heat damage to either insulation or conductors. In addition, the design provides for firm cable strain relief. The speed and ease with which this connector can be installed are additional features.

Burndy Corporation, Norwalk, Connect.

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ELECTRONIC DESIGN • June 24, 1959

For complete information, write: OMATON DIVISION

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In Europe: Antwerp, Belgium

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CIRCLE 18 ON READER-SERVICE CARD

EDITORIAL

Open Letter to All Local Newspaper Editors

Editor, The Long-Islander
313 Main St.
Huntington, N.Y.

Dear Sir:

I would like to take advantage of your Letters to the Editor column to urge college-bound high school graduates, who have abandoned engineering as a possible career, to reconsider. There was a sharp decrease in engineering enrollment last fall—11 per cent, compared to a 7 per cent increase in overall enrollment.

This drop off in engineer enrollment is largely due to a misunderstanding of what engineering is, according to a recent report by the Engineering Manpower Commission and the American Society for Engineering Education.

Blame for this decline is, according to Deans of Engineering, due primarily to misleading press reports. The Deans feel there has been a false appraisal of the long-range engineering opportunities by counsellors, students and parents because of numerous newspaper accounts of layoff of engineers during the 1957-1958 recession. There never has been any over supply of engineers, and it is not unusual for engineering seniors to receive four to nine job offers apiece before graduation.

Another reason for the lessened interest in engineering is increased concern about the rigors of the engineering curriculum, according to the deans. The report in describing this concern says: "Today's youth, living an easy life, has drummed into him the need for many years of hard study prerequisite to an engineering or science career . . . Faced with such prospects [of no higher salary] the young person may be selecting easier careers." Engineering education must be viewed as a good education for today's world, not just a way to a high paying job.

The report states that there is no shortage of engineering educational facilities at the freshman level and well-qualified applicants stand a very favorable chance of being accepted by the first college of their choice.

The nation and the world need engineers, not just to build missiles and defenses against missiles but to convert the earth's resources into food and products for a better standard of living for all peoples.

James G. Kuyper

P.S. to ED readers: Please feel free to send this or a similar letter under your own signature to your local newspaper.

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- Operational convenience with unique ESI Dekadial® range and multiplier settings and simple switching.
- **PRICE:** \$565.00.

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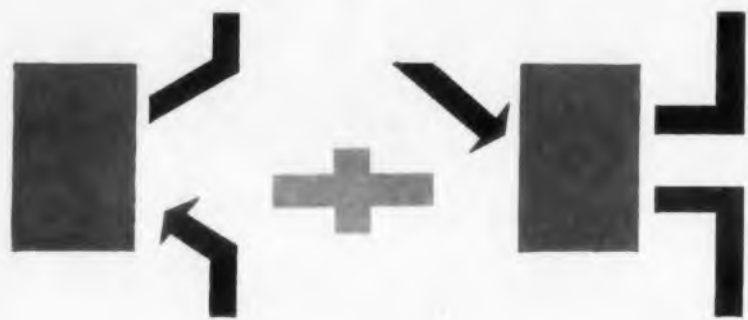
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CIRCLE 22 ON READER-SERVICE CARD



Transistor Hybrid Timing Circuit

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HYBRID MULTIVIBRATOR APPLICATIONS:

- Rectangular wave generators where ideal undistorted waveforms are required.
- Multivibrators where the ratio of the timing periods must be appreciably different from unity.
- Square wave generators where ideal symmetry is required.
- Timing circuits where periods greater than 1 msec are required and where the use of electrolytic capacitors is undesirable.
- Timing circuits where good temperature stability is required.
- Timing circuits which must operate to temperatures between 60 C and 100 C. The hybrid circuit using two germanium transistors can be more economical than a conventional circuit using two silicon transistors.
- One-shot multivibrators which must operate at high duty cycles.
- Multivibrators where independent adjustment of the two parts of the timing cycle is required.
- Multivibrators where it is important to avoid the danger of "lock-up" or non-oscillation.
- Circuits which must perform complex timing operations.
- Circuits where space economy is important. The hybrid circuit required fewer capacitors of smaller size.

One unijunction and two junction transistors are combined to provide highly desirable multivibrator characteristics. Examples of symmetrical, unsymmetrical, and one-shot types are given together with results obtained.

HYBRID MULTIVIBRATORS, using one unijunction and two junction transistors, provide ideal rectangular output, excellent timing stability, and independent adjustment of the length of both parts of the timing cycle. The junction transistors form a conventional flip-flop stage with the unijunction transistor performing the timing and triggering functions.

Transistor timing circuits are being applied in an increasing number of computer and control systems. Most of the timing functions can be performed by appropriate combination of two basic circuits; the multivibrator, or pulse generator, and the one-shot multivibrator, or delay generator.

In many applications, however, conventional transistor multivibrators¹ have a number of serious limitations which restrict their use in timing circuits and rectangular wave generators. The cross coupling capacitors must serve as the timing capacitors and thus are required to have large values if long timing periods or heavy loads are required. Frequently, the required values of capacitance are so high that electrolytic capaci-

tors must be used which severely limit the accuracy and stability of the timing periods. The coupling capacitors also result in considerable distortion of the collector voltage waveform so that optimum rectangular waveforms cannot be obtained. This is particularly true if there is an appreciable difference in the lengths of the two parts of the timing cycle.

Conventional Multivibrator Circuit

For the purpose of comparison, a typical multivibrator of conventional design is shown in Fig. 1. This circuit was designed to ensure oscillation to 75 C and assumes a maximum I_{CO} of 0.5 ma at that temperature. The measured period at 25 C was about 1.0 second, decreasing by about 25 per cent at a temperature of 75 C. The collector voltage waveform for this circuit, as shown in Fig. 1, is seen to deviate considerably from an ideal square wave.

Unijunction Transistor

In all of the hybrid timing circuits to be described, the unijunction transistor⁴ serves the dual function of a timing and a triggering source. The circuit used is the basic relaxation oscillator shown in Fig. 2. The characteristics and design of the unijunction transistor relaxation oscillator are described elsewhere^{2,3} and will only be summarized here.

The period of oscillation of the relaxation oscillator is determined by the values of R_T , C_T

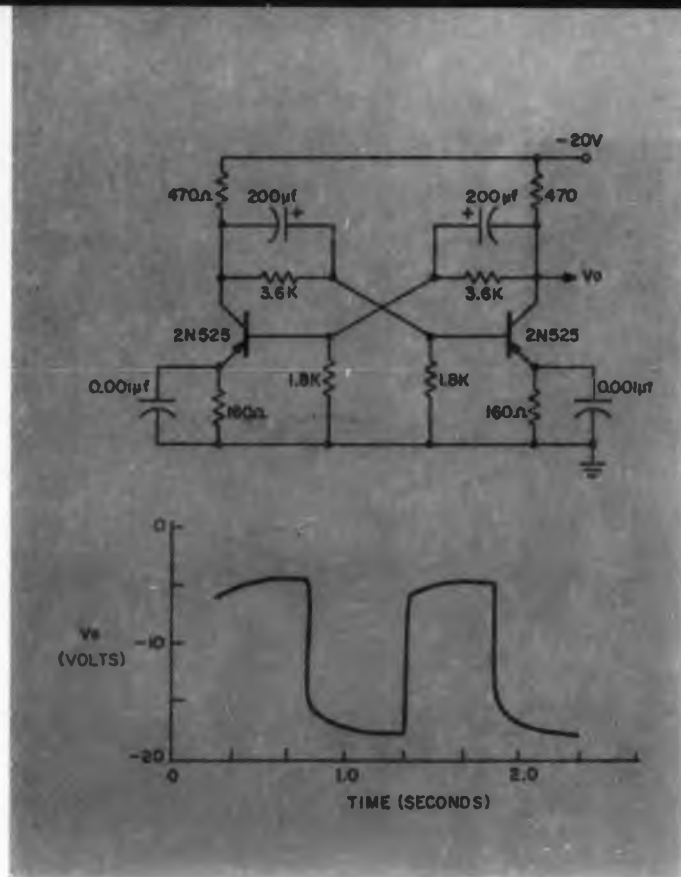


Fig. 1. Typical transistor multivibrator circuit with collector voltage waveform.



Fig. 2. Unijunction transistor timing and trigger circuits.

and the intrinsic standoff ratio, λ , of the unijunction transistor. The period is given with sufficient accuracy by the equation,

$$t = R_T C_T \ln \left(\frac{1}{1 - \lambda} \right) \quad (1)$$

Trigger pulses are developed across resistor R_A in Fig. 2. The value of R_A is determined primarily by the required pulse amplitude but should generally be made as small as possible consistent with this requirement. Values of R_A generally fall in the range from 1 to 100 ohms. For values of C_T greater than 1 μf , the trigger pulses have a sharp leading edge followed by an exponential decay. The time constant of the decay is $(R_A + R_S) C_T$ where R_S is the dynamic resistance of the unijunction transistor between emitter and base-one and generally lies in the range from 5 to 10 ohms. Trigger pulses of positive polarity may be obtained by using the circuit of Fig. 2A; trigger pulses of negative polarity may be obtained by using the circuit of Fig. 2B. When using the latter circuit, it is important to note that the current pulse flows through the supply; therefore, good regulation or isolation will be required to prevent detrimental effects on other circuits working from the same supply.

The resistor R_{B2} in the base-two circuit is used to reduce the peak power dissipation of the unijunction transistor during the discharge of the capacitor C_T and also to provide temperature compensation of the timing period. The interbase

resistance R_{BB} of the unijunction transistor increases with temperature at approximately 0.8 per cent/deg C so that R_{B2} will cause the peak point voltage of the unijunction transistor to increase with temperature; this, in turn, will cause the timing period to increase with temperature. The value of R_{B2} should be chosen to compensate for the temperature variations of R_T , C_T and the unijunction transistor, itself. The principal temperature variation in the unijunction transistor, of importance in timing applications, is a decrease in the peak point voltage ($R_{B2} = 0$) of 3 millivolts/deg C.

The final parameter of importance in the design of the relaxation oscillator circuit is the peak-point emitter current, I_P . The peak-point emitter current corresponds to the minimum current which must flow into the emitter of the unijunction transistor for it to fire. It is found that I_P is inversely proportional to the supply voltage and is generally specified at a supply voltage of 25 volts. This puts a maximum limit on R_T in accordance with the equation.

$$\frac{V_1 - V_P}{R_T} = \frac{(1 - \lambda) V_1}{R_T} I_P (\text{max}) \frac{25}{V_1} \quad (2)$$

The specified maximum value of I_P is 12 which gives,

$$R_T \frac{(1 - \lambda) V_1^2}{300} \quad (3)$$

where R_T is in megohms and V_1 is in volts. For a specified maximum timing period, this condi-

tion also determines the minimum value of C_T which can be used. Eq. 3 indicates that for long timing periods it is advantageous to use high supply voltages so as to reduce the value of C_T required. However, voltages above 35 v should be avoided; otherwise, the power dissipation will result in excessive heating of the unijunction transistor and will cause the emitter reverse leakage current to be a problem. For this reason, when high supply voltages are employed, it is wise to use unijunction transistor types with the highest values of interbase resistance. Improved performance can also be obtained by selecting unijunction transistors for low values of I_P , or by using a power supply with incomplete filtering. The ripple voltage from the power supply acts as a trigger for the unijunction transistor and can reduce the effective peak point current by a factor of 10 or more.

Symmetrical Multivibrator

The simplest version of the hybrid multivibrator circuit is the symmetrical multivibrator or square wave generator, shown in Fig. 3. In this circuit, the two pnp transistors are used in a simple saturating flip-flop designed in the normal manner^{1,5}. The unijunction transistor triggers the flip-flop from one state to the other by means of the negative trigger pulses developed across R_A . Collector or base triggering of the flip-flop can also be used, if desired, but the emitter triggering method shown in Fig. 3 is generally simpler

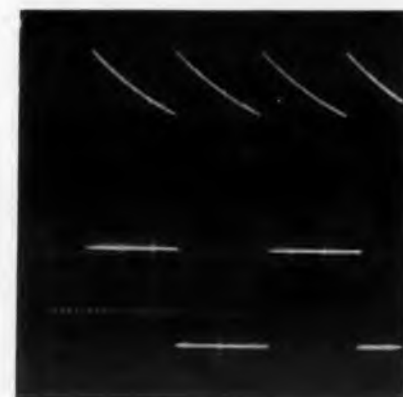
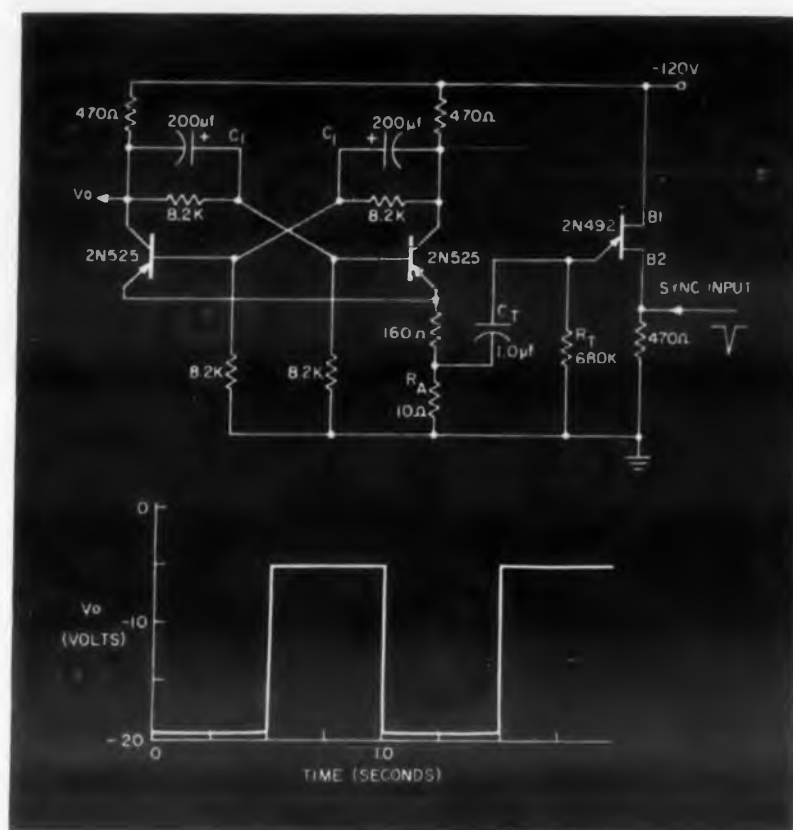


Fig. 3. (left) Typical hybrid multivibrator circuit with collector voltage waveform.

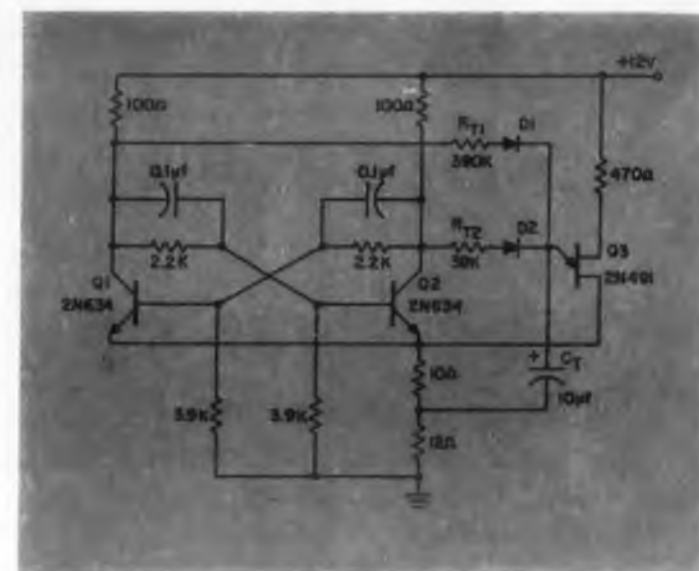


Fig. 4. Unsymmetrical multivibrator circuit.

and requires fewer components.

Note that the circuit of Fig. 3 is designed with the same supply voltages, load resistors, and period as the conventional multivibrator of Fig. 1. The circuit was designed to operate to a temperature of 75 C and actual tests indicated satisfactory performance to 84 C. The change in period between 25 C and 80 C was less than 3 per cent and it was found that most of this variation was due to the change in R_T . In comparing the circuit of Fig. 3 with that of Fig. 1, the improvement in the output voltage waveform is apparent. It will also be noted that the conventional circuit requires two 200 μ f capacitors whereas the hybrid circuit requires only one 1.0 μ f capacitor. This would permit the use of a paper capacitor in the hybrid circuit whereas the conventional circuit would require the use of electrolytic capacitors. Another apparent advantage of the hybrid circuit is that perfect symmetry of the waveform is obtained without requiring the use of a balance control.

If the use of a synchronizing signal is desired, it is best to use a negative trigger pulse at base-two as shown in Fig. 3. The trigger pulse width should be greater than 0.5 microsecond.

Most of the advantages of the hybrid multivibrator circuit occur where periods longer than 100 μ sec are required. However, by using smaller values of C_T , it is possible to operate the hybrid multivibrator at periods as low as 10 μ sec. At the lower periods it will usually be found necessary

to use nonsaturating flip-flops with the base triggered⁵.

Unsymmetrical Multivibrators

If an unsymmetrical waveform is desired, the circuit may be modified to that shown in Fig. 4. This circuit also illustrates the use of an npn transistor flip-flop. Two separate charging resistors, R_{T1} and R_{T2} , are connected to the collectors of the npn transistors as shown. Assume that initially transistor $Q1$ is off. The voltage at the collector of $Q1$ will then be about 12 v and voltage at the collector of $Q2$ will be about 2 v. The capacitor C_T will be charged through R_{T1} until the unijunction transistor fires; at this time, the flip-flop will be triggered to the opposite state and $Q2$ will be off. The capacitor C_T will then be charged through R_{T2} and the silicon diode $D1$ will isolate R_{T1} from the timing circuit. It is seen that R_{T1} and R_{T2} determine independently the lengths of the two parts of the timing period. The two periods for the circuit shown are about 4 sec and 400 msec. It is evident that if independent adjustment of the two parts of the period are not required, the circuit can be simplified by replacing R_{T2} with a 43 K resistor, removing $D1$ and connecting R_{T1} from the emitter of $Q3$ to the positive supply.

One-Shot Multivibrators

A one-shot multivibrator circuit may be easily obtained from the hybrid multivibrator circuit

of Fig. 4 by removing either of the timing resistors R_{T1} or R_{T2} . A typical circuit is shown in Fig. 5. Here, the timing resistor R_T is connected to the collector of $Q1$ and the quiescent state for the circuit occurs when $Q1$ is off and $Q2$ is on. A positive trigger applied at the base of $Q2$ will turn $Q2$ off and cause the voltage at the collector of $Q1$ to increase to about 20 v. The capacitor C_T will then be charged through R_T and at the end of the timing cycle, the unijunction transistor will fire and trigger the flip-flop to its quiescent state. Note that once the timing cycle is started by a trigger pulse at the base of $Q2$, additional trigger pulses at this input will not affect the timing cycle. Another important advantage of the circuit is apparent from the waveforms shown in Fig. 5. It is seen that at the end of the timing cycle all the voltages in the circuit have been restored to their initial values. For this reason, the timing period will be independent of the trigger rate and the duty cycle. The circuit shown was tested at a duty cycle from 0 to 99.5 per cent and the observed change in period was less than 0.4 per cent. This contrasts with conventional types of one-shot multivibrators where duty cycles are limited to less than 70 per cent to maintain timing accuracies of 5 per cent. It should be noted in the circuit of Fig. 5 that the resistor R_1 is used to bias the emitter of the unijunction transistor to about 2.0 v when the circuit is in the quiescent state. This ensures that the

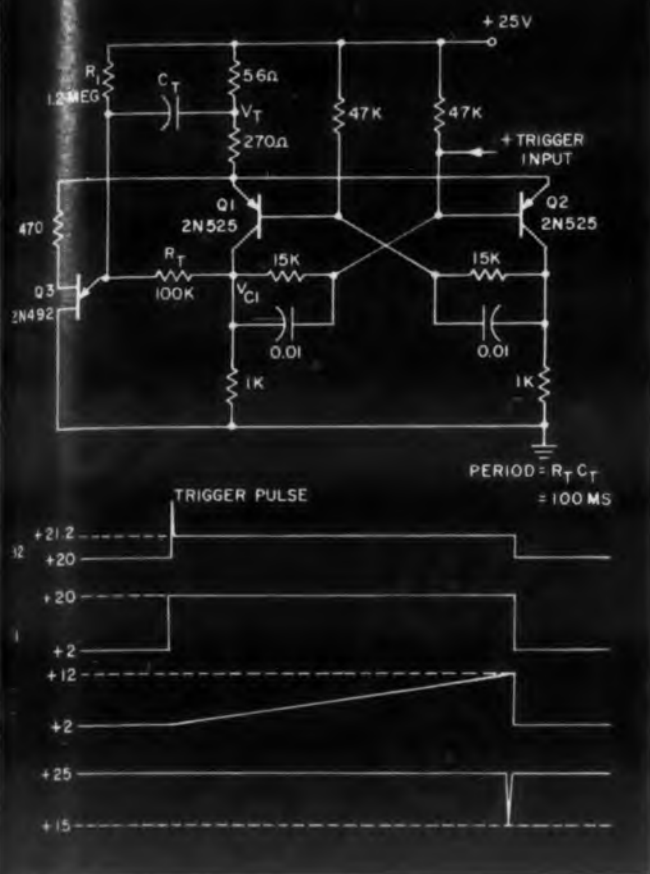


Fig. 5. Hybrid one-shot multivibrator circuit with typical waveforms.

emitter voltage returns exactly to its initial value at the end of the timing cycle.

Complex Timing Circuits

The nature of the circuits described is such that many complex timing functions can be achieved by simple intercombinations and variations of basic circuits. For example, a form of pulse-width modulation may be obtained with the circuit of Fig. 3 by connecting the lower end of R_T to a variable voltage source. The circuit of Fig. 4 may be modified to work with a ring counter with a separate timing resistor for each stage of the counter. This allows a different time delay for each stage. In a similar manner, a large number of useful timing functions, such as pulse length discrimination and frequency division, may be synthesized from the basic circuits. ■ ■

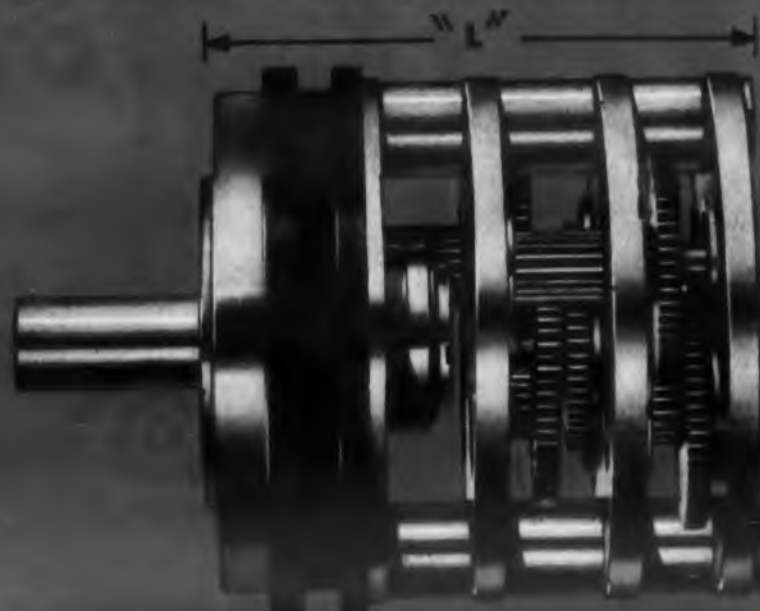
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	+0 -.0005		+0 -.0005		+0 -.0005		+0 -.0005		+0 -.0005	
Gear Ratio to Length "L"	Ratio	"L"	Ratio	"L"	Ratio	"L"	Ratio	"L"	Ratio	"L"
	17	0.750	31		0.781	36	40	0.812	60	
	42	0.812	93		0.954	108	140	1.000	240	
	104	1.008	280		1.054	324	490	1.100	960	
	253	1.070	840		1.116	972	1715	1.162	3840	
	615	1.204	2521		1.266	2916	6000	1.328	15,360	
	1494	1.347	7565		1.409	8748	21,000	1.487	61,440	
3629	1.421	22,696		1.500	26,244	73,500	1.600	245,760		
Moment of Inertia GM CM ²	.01		.018		.02		.05		.08	
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Black Ray

Spotlights Soils

MANY SOILS and contaminants form their own beacon lights when exposed to the light of this Blak-Ray lamp. This high intensity, near-ultra-violet lamp illuminates soils like solder flux, hydrocarbons, resins, and lint, and makes them fluoresce in brilliant colors, though they may be invisible in ordinary light.

The lamp, a product of Black Light Eastern Corp., 201-04 Northern Blvd., Bayside, N.Y., obviates expensive, time-consuming tools like the inspection microscope in many soil-searching applications.

The usefulness of the lamp depends on the fluorescence of many soils. Fortunately, most of the soils which trouble the electronics designer fluoresce. Fluores-

cent additives are available for contaminants which don't.

Often the contaminant is not a "soil" in the usual sense. It may be a very clean substance which isn't where it belongs. A highly refined damping fluid or a lubricating oil is such a "soil" when it leaks onto a wiring harness.

The lamp, available in bench-mounted or in portable models, can detect fluorescent particles on a non-fluorescent field. An example of the former is in revealing residual solder flux on a printed circuit board. The latter is exemplified in inspecting a damping fluid for tiny dust particles.

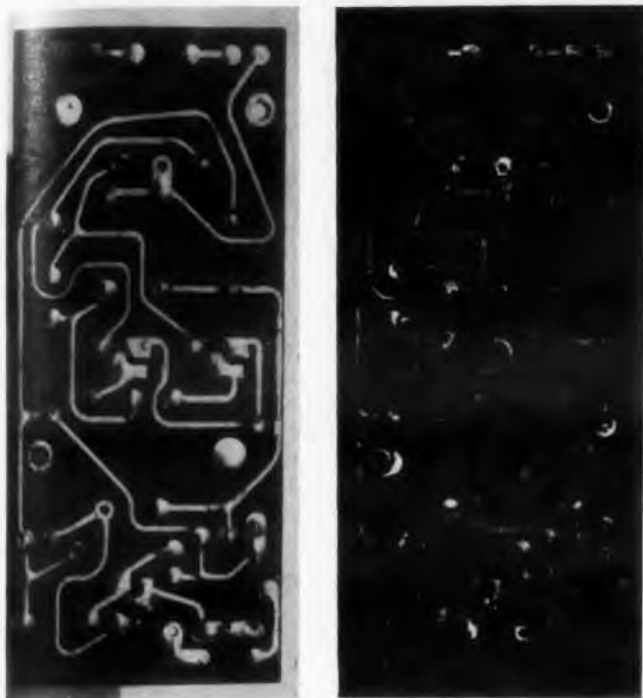
For production line inspection, the



Soils shine when exposed to the "black" light of this lamp.



Residual solder flux, almost invisible in ordinary light, glows brightly under the Blak-Ray.



A printed circuit board in normal light and in "black" light. The bright areas in the "black" light photograph show fluorescing residual solder flux.

Blak-Ray lamp is normally used near the cleaning apparatus so an operator can quickly check cleaned parts for residual contaminants. He can return soiled parts to the cleaner if necessary.

Most soils are readily detected under the lamp in normal ambient lighting. Higher contrasts, where desirable, can be obtained by shielding the parts from direct white light with a simple hood over the top and sides of the lamp.

Many Soil-Searching Applications

Some of the many uses of the lamp are:

For	To Detect
Printed circuit boards	Solder flux
Electronic sub-assemblies	Brazing flux, welding slag, lint
Instruments & meters	DC55 and lubricating oil leaks
Wiring harnesses	Fluorinated hydrocarbons
Gear trains	Many soaps and detergents
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CIRCLE 909 ON CAREER INQUIRY FORM, PAGE 63

Atmospheric Transmission In Infrared

In the design of infrared equipment, atmospheric transmission is perhaps one of the most variable quantities. It is predictable to a certain extent for given weather conditions, but the weather itself is the unpredictable element. Nevertheless, the IR system designer must make certain predictions for systems design purposes and thus, it is necessary to arbitrarily take an average weather condition and work from this reference. In this article, Thomas Altshuler discusses a procedure for calculating atmospheric transmission.



ATMOSPHERIC absorption of infrared is due to three independent phenomena. The first is molecular absorption, principally from water vapor and carbon dioxide. The second is due to scattering by water droplets such as mist, fog, and clouds. The third is due to absorption by solid particles such as dust and haze. For most applications in clear weather, only molecular absorption is important. In essence, the atmosphere acts like a window in certain spectral regions and is opaque to energy in other spectral regions.

Atmosphere is relatively transparent between 2 and 2.6 μ , 2.9 to 4.1 μ , 4.4 to 4.9 μ , and 8-13 μ , and relatively opaque in the excluded regions. However, the degree of transmission is a strong function of CO₂ and H₂O concentration in the air. H₂O, in particular, varies by large amounts with ambient temperature and altitude.

With the aid of Figs. 1 through 6 the molecular absorption of radiant energy can be calculated. Figs. 1 through 4 assumed the ARDC model atmosphere with the top of the troposphere at 11 km altitude. The CO₂ content was assumed to be constant at all altitudes and equal to 0.032 per cent by volume. A constant relative humidity was assumed in the troposphere and a constant mixing ratio in the stratosphere. The optical thicknesses of

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the gases were corrected for linear pressure broadening, and square root temperature broadening. Flat earth was assumed.

With these assumptions, the following procedure can be used to calculate atmospheric transmission T_A :

Let: d = equivalent sea level path length, km for CO₂ in infrared beam.

d_h = horizontal equivalent sea level path length, km, for CO₂ for 1 km actual path length.

d_v = equivalent sea level path length, km, for CO₂ in a vertical path from h to infinity.

h_o = observer altitude, km

h_t = target altitude, km

h = altitude, km

R = range, km

$R.H.$ = relative humidity. Take $R.H.$ value of 0.80 if not given in a specific problem.

T_A = transmission of atmosphere.

T_{H_2O} = transmission through water vapor in atmosphere.

T_{CO_2} = transmission through CO₂ in atmosphere.

W = precipitable centimeters water vapor in infrared path, corrected to standard temperature and pressure (STP).

W_a = precipitable centimeters water vapor

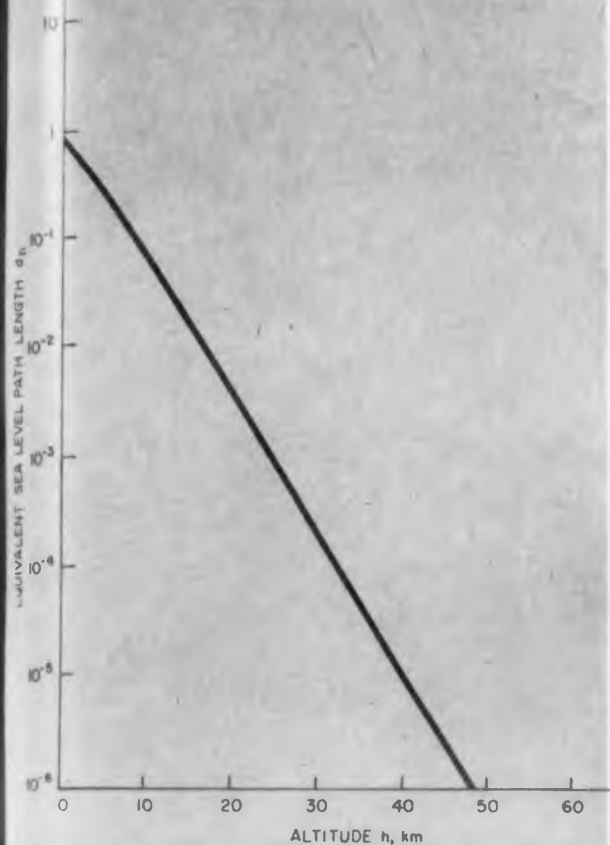


Fig. 1. Carbon dioxide horizontal optical thickness.

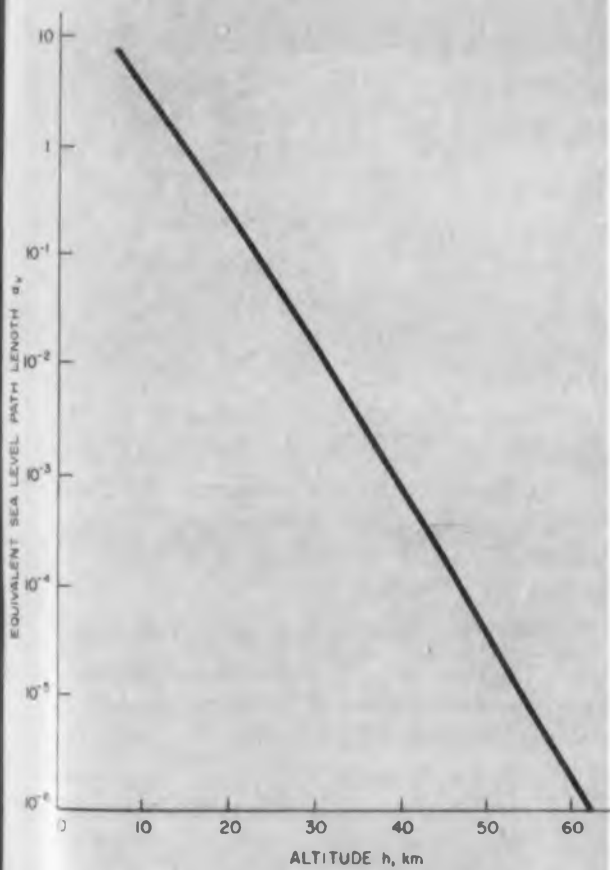
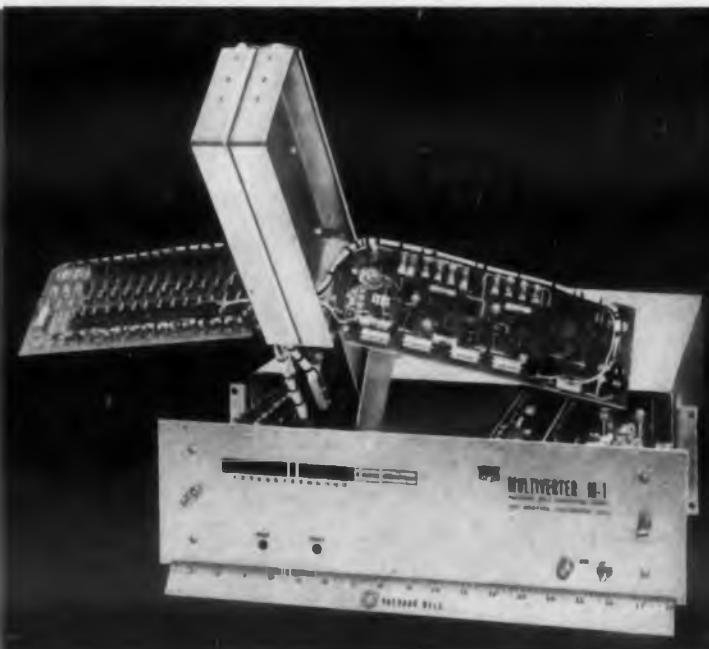


Fig. 2. Carbon dioxide vertical optical thickness.

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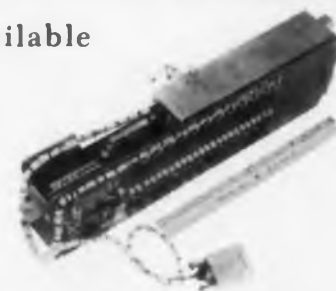
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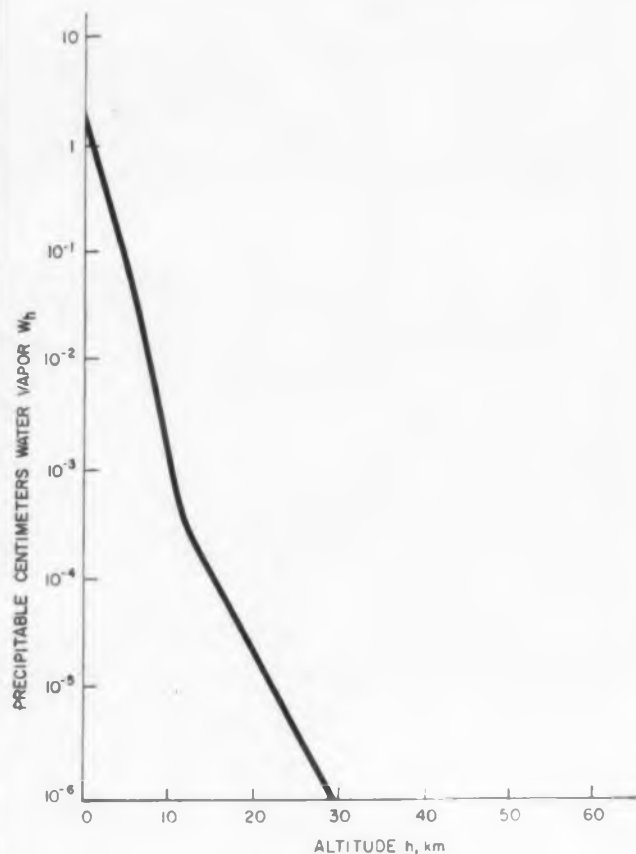


Fig. 3. Water vapor horizontal optical thickness.

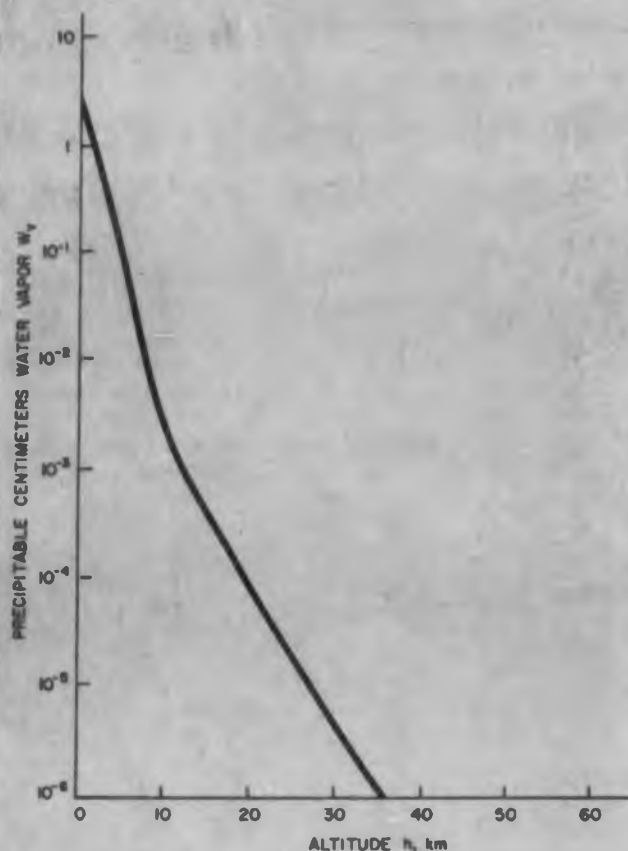


Fig. 4. Water vapor vertical optical thickness.

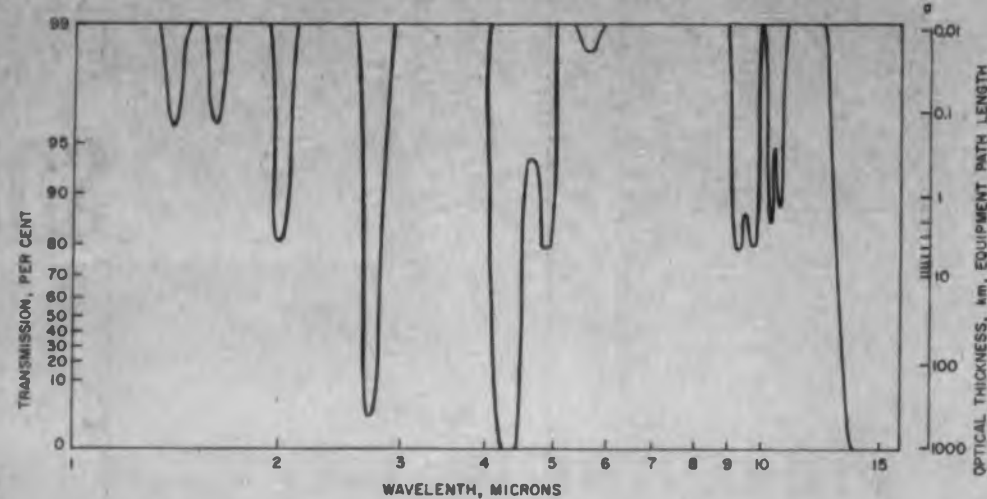


Fig. 5. Carbon dioxide transmission, $d = 10$ km.

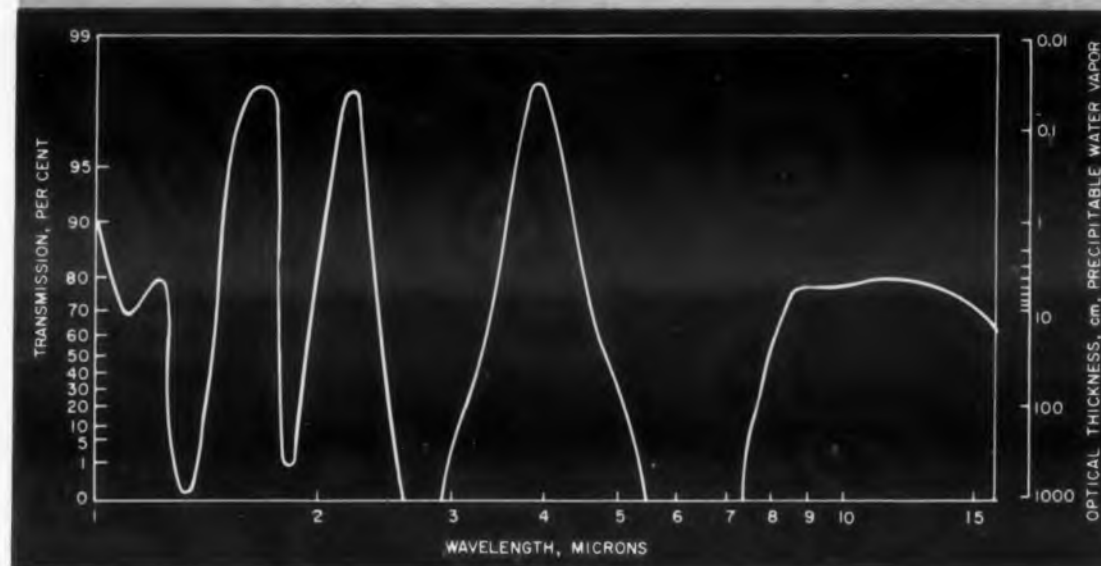


Fig. 6. Water vapor transmission, $w = 1$ cm.

in a horizontal path 1 km in length, corrected to STP.

W_v = precipitable centimeters water vapor in a vertical path from h to infinity, corrected to STP.

λ = wavelength, microns

1. To find d

(a) if $h_o = h_i$:

Read d_h in Fig. 1

$$d = d_h \times R$$

(b) if h_o does not equal h_i :

Read d_v in Fig. 2 for both h_o and h_i

$$d = \frac{(d_v \text{ for } h_o) - (d_v \text{ for } h_i)}{h_i - h_o} \times R$$

2. To find W

(a) if $h_o = h_i$:

Read W_h in Fig. 3

$$W = R.H. \times W_h \times R$$

(b) if h_o does not equal h_i :

Read W_v in Fig. 4 for both h_o and h_i .

$$W = R.H. \frac{(W_v \text{ for } h_o) - (W_v \text{ for } h_i)}{h_i - h_o} \times R$$

3. To find T_{CO_2}

Fig. 5 gives the transmission of carbon dioxide versus wavelength for $W = 1$ cm precipitable value of d , merely displace the curves vertically by the distance between the value of d on the "Optical Thickness" scale on the right hand side of Fig. 5 and the value 10 on the same scale. Thus, for $d = 30$ km, $T_{CO_2} = 64$ per cent for a wavelength of 4.9 microns.

4. To find T_{H_2O}

Fig. 6 gives the transmission of water vapor versus wavelength for $W = 1$ cm precipitable H_2O . For any other value of W , merely displace the curve vertically by the distance between the value of W on the "Optical Thickness" scale and the value 1 on the same scale. Thus, for $W = 0.2$ cm, $T_{H_2O} = 61$ per cent for a wavelength of 4.9 microns.

5. To find T_A (transmission of the atmosphere)

$T_A = T_{CO_2} \times T_{H_2O}$, all at the same wavelength. Thus, in our previous example

$$T_A = 0.64 \times 0.61 = 0.391 = 39 \text{ per cent. } \blacksquare \blacksquare$$

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NEW 4-pole micro-miniature relay
NEW Unimite relay

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DESIGN FORUM

Encoder pattern (actual size) will generate a binary output equivalent to the sine of the input shaft angle with a resolution of one part in 2^{10} . After octagonal edges have been trimmed, disc measures 3.5 in. diam.



Computer-Designed Encoders

USING A computer to design a 3.5 in. diam code disk for a shaft-to-digital encoder resulted in resolution of one part in 2^{10} . The least significant bit track of this code disk undergoes 1024 transitions as the input shaft makes one complete rotation.

Wes Stupar of Librascope, Inc., Glendale, Calif., designed a mathematical model of the transition angle relationships for the LPG-30 computer. The idea, he said, is that a computer's good accuracy cannot be used to best advantage unless its support equipment is at least as accurate. When the computer itself designs the support equipment, accuracy is aided.

Problems

To get an accurate correlation between analog input and digital output, brush transition from conducting to non-conducting segments must be closely controlled. Encoder-track leading and trailing edges must be precisely aligned along the radial line. Misalignment will result in the brushes making and breaking contact out of synchronization—with a resulting erroneous count.

In computing transition angles, brush contact area must be allowed for since switching brushes have finite lengths.

This width in the direction of motion means the brush will make contact with the approaching segment before the center point of the brush passes over the transition point. Conversely the brush will lose contact with the receding segment after the center has passed over the transition point, as in Fig. 1. Actual transition points are displaced half a brush contact length in both directions. To allow for this displacement, the theoretical transition angles must be modified.

Mr. Stupar's program is shown in Fig. 2. The actual transition angle of the mathematical model is Y' . Y is the theoretical transition angle, C_1 the rotating

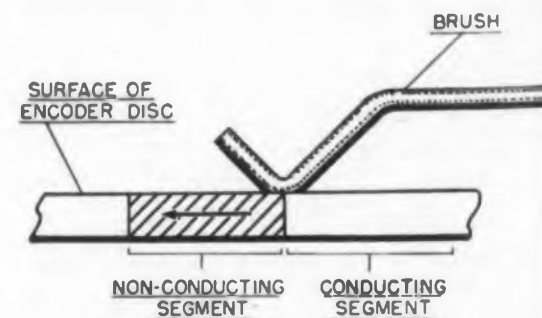


Fig. 1. Brush transition from conducting to non-conducting segment on disc track. Brush has finite length in direction of rotation, effectively increasing length of conducting segment.

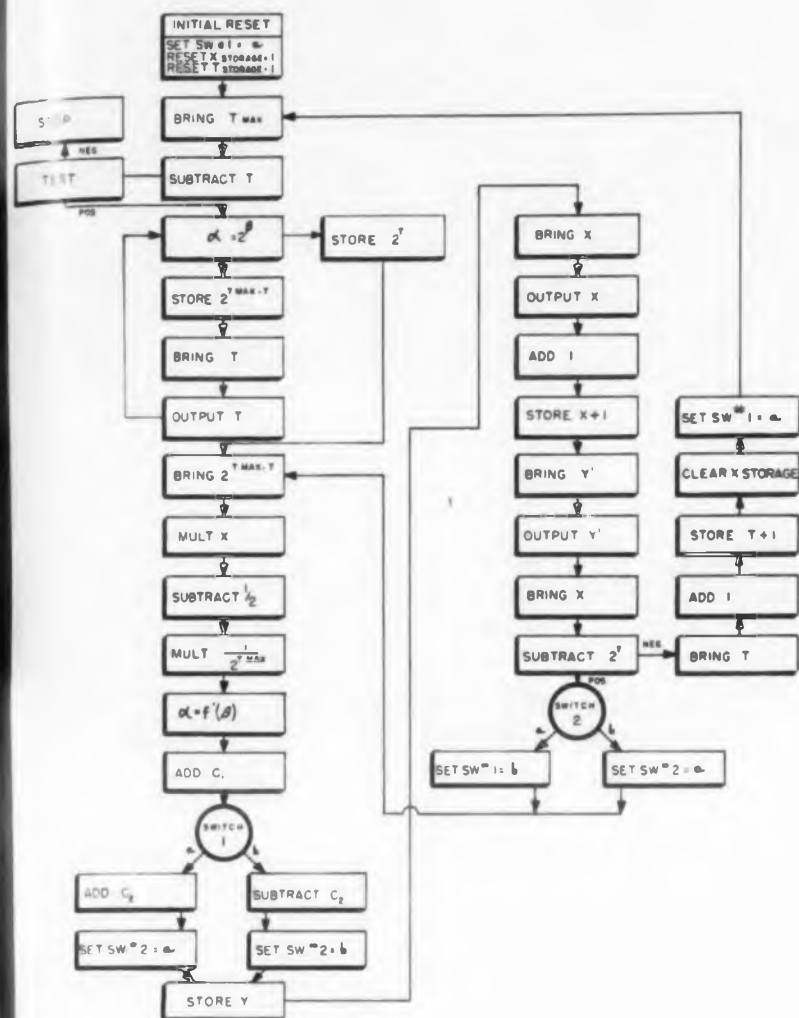


Fig. 2. Program set up on LGP-30 computer to calculate desired transition angles. Angles will be used to guide an optical jig borer, which will cut master pattern for encoder disc. In diagram, β is $(T_{max} - T)$.

constant, C_2 the brush contact length divided by two and X the transition number. The relationship between these parameters is given by

$$Y' = Y + C_1 - (-1)^X C_2$$

The theoretical transition angle Y is a function of the transition number X . More precisely, it is the angle whose function is the digital output at the transition point, since the purpose of the encoder is to generate the function of the angle.

Encoder disk tracks are numbered from one to T_{max} beginning at the center with the most significant bit track and ending with the least significant bit track. On any given track T , the number of transitions is 2^T —so the most significant bit track has $2^1 = 2$ transitions and the least significant,

The binary value of a function generated depends on the resolution of the encoder (T_{max}). For best accuracy, the transitions that define a particular conducting segment occur at points equidistant from the angle where the output exactly represents the function of the code disk. That is, Mr. Stupar explains, the function value X' used at the transition angle is a linear approximation of the value that exists at points between transitions. The relation-

ship for a track T is expressed

$$X' = [(X2^{(T_{max}-T)} - 1/2)/2^{T_{max}}]$$

which for the least significant bit track T_{max} becomes

$$X' = (X - 1/2)/2^{T_{max}}$$

Mr. Stupar's program for the LGP-30 constructs a table of actual transition angle vs the transition number for each bit track. For every X of every T , X' is calculated as above. Y is then calculated, bearing in mind that Y is the angle whose function is X' . Y' is found using the first equation.

Pattern Construction

The transition angles calculated by the computer are used at Librascope to guide an optical jig boring machine. A large master of the encoder disk is machined from a plastic stock, which consists of a white lamination between two black laminations. The top black laminate is cut, exposing the white according to the switching pattern required by the transition angle.

The resulting master is then photographed, and production encoders are etched in a printed circuit process.

For further information, turn to the Readers Service Card and circle 101.

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Density—

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Tensile Strength—

Annealed 70°F.; 47,000 psi.

Stress-To-Rupture—

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(argon) 18,800 psi.

500 hr. 2000°F.

(argon) 11,000 psi.

Other Properties—Ductile to brittle transition temperatures in annealed state are well below room temperature.

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FANSTEEL 82 METAL

Alloy—Columbium-tantalum-zirconium

Melting Point—4550°F.

Density—

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Tensile Strength—

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2000°F. in air; 29,600 psi.

2400°F. in air; 11,700 psi.

Stress-To-Rupture—

100 hr. 2000°F. (argon) 17,500 psi.

500 hr. 2000°F. (argon) 13,500 psi.

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Fig. 1. Photomicrograph of glass microballoons showing their spherical nature. Inset, top, shows how loose material may be poured.



Fig. 2. Ingredients and finished molded piece, resulting from a "pack-in-place" procedure.

Plastic Dielectrics . . . Based on Hollow Glass Microspheres

William R. Cuming

Emerson & Cuming, Inc.
Canton, Mass.

This article discusses applications of a material which offers a number of possibilities for producing low weight, high temperature, and accurately controlled dielectrics. It is free flowing powder resembling fine sand. Each particle is a hollow glass sphere of micron dimensions.

Glass microspheres for dielectric applications are usually bonded together to produce a foam. Additives such as metal flake or titanates can be included for dielectric property adjustment. Bonding agents can be organic or inorganic. Epoxide and silicone resins are among the organic materials used. Sodium silicate and aluminum phosphate are among the inorganic bonding

Table I—Foams Based on Hollow Glass Microspheres

Designation	Self Bonded	Epoxide Bonded ²	Epoxide Bonded ³	Polystyrene Bonded ³	Silicone Resin Bonded	Inorganic Bond using Silica Sol
Weight, lbs/cu ft.	12	20	23	32	25	25
Dielectric Constant 10 ⁹ to 10 ¹⁰ cps	1.25	1.45	1.55	1.67	1.6	1.55
Dissipation Factor 10 ⁹ to 10 ¹⁰ cps	0.002	0.01	0.01	0.001	0.002	0.004
Compressive Strength, psi	150	1010	1500	5000	750	350
Operating Temperature Range, °F	-70 to +1000	-70 to +300	-70 to +500	-70 to +350	-70 to +800	-70 to +1100
Commercial Designation	—	Eccofoam PT	Eccofoam DPT	Stycast Lo K	Eccofoam LM	—

1. Two component, room-temperature cured.

2. One component.

3. Cross-linked.

agents. Glass microspheres have been self bonded, i.e. no other material is added. Bonding takes place at the surface of each particle to adjacent particles.

Properties

Particle diameter is in the range from 30 to 300 microns; wall thickness is about 3 microns. Softening temperature is in excess of 1200 F. Bulk density is about 12 lbs per cu ft.

At microwave frequencies (3000 to 10,000 mc), glass microspheres, trade-named "Eccospheres," Fig. 1, have a dielectric constant of 1.2 and a dissipation factor of 0.002 as loose material (12 lb. per cu ft.). When self bonded into a rigid foam of the same density, the dielectric properties are, of course, the same. Thus, this sets the lower limit of the material at its present stage of development.

When glass microspheres are bonded together with a separate bonding agent, the density of the resulting foam is increased. In general, strength is improved. Dielectric constant increases. Dissipation factor is somewhat dependent upon that of the bonding agent. Service temperature of the foam may be limited by the thermal stability of the bonding material.

Properties of foams based on glass microspheres are given in Table I. Densities other than those given are possible by varying the binder to microsphere ratio. None of the foams listed in Table I contains loading material. By loading material is meant metal and/or titanate particles which, when dispersed throughout a foam, increase dielectric constant without a significant increase in weight. Loaded foams are often referred to as artificial dielectrics.

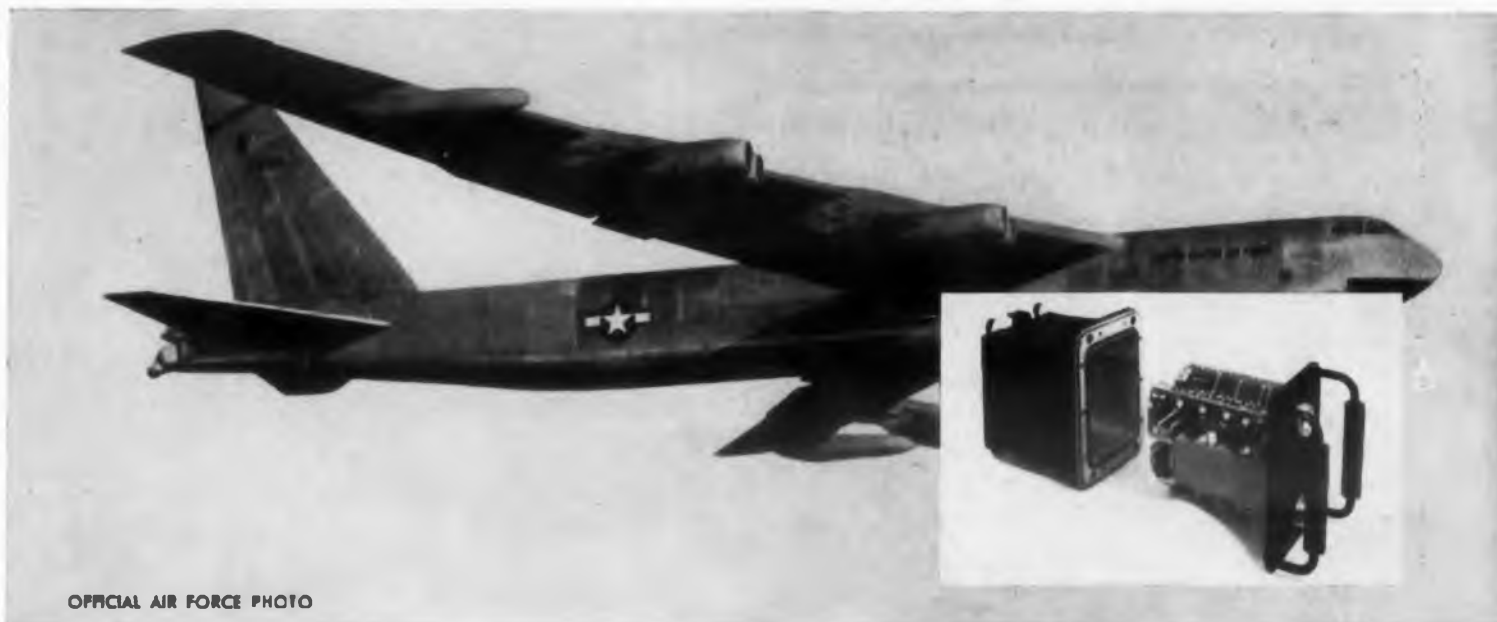
Making The Foam

In making the foams of Table I, the bonding agent is first prepared. This may be a liquid resin monomer, a resin in solution or, as in some inorganic systems, a colloidal aqueous suspension. Curing or gelling agents are added. The dry glass microspheres are then mixed in. For most foams, the resultant mix has the consistency of damp sand.

Exact proportions of glass microspheres to binder is determined experimentally in light of the final physical and electrical properties desired. The binder-microsphere mix is tamped or packed into a mold or cavity. The term "packed in place" is used to designate this type of foam. A small air hammer fitted with a flat plate may be used, or simply a hand tamping rod.

The mix is packed to maximum density; it fills the cavity completely and uniformly. A cure next takes place which welds the discrete particles together. Once cured, it can be machined. Molding to exact contour is also possible. Fig. 2 shows

IBM cools current deflection amplifier with Coolanol 45



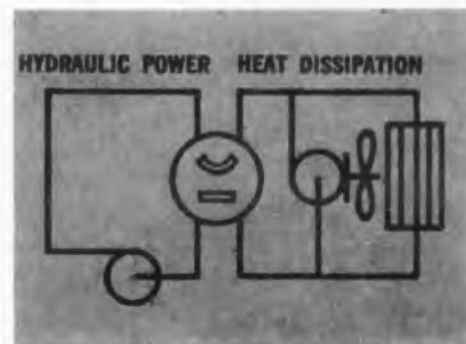
OFFICIAL AIR FORCE PHOTO

Coolanol 45 dissipates heat from the 360-watt Current Deflection Amplifier produced by IBM Military

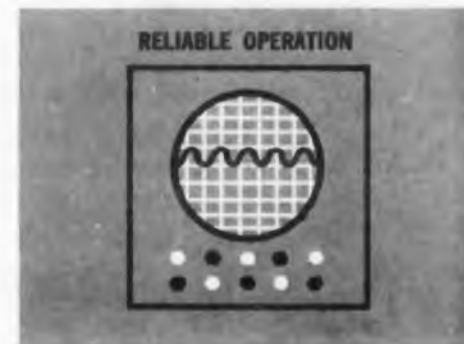
Products Division for the AN/ASB-4 bombing/navigation system—operational in the B-52 bomber.



For compact design . . . Coolanol 45 dissipates the increased heat created when you must pack more power into less space. Liquid-cooling allows miniaturization of components that must be lightweight, yet powerful enough for today's advanced system designs. It lends itself well to package systems of individual units which can be removed, serviced and replaced easily.



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Fig. 3. Disks and a sphere are typical shapes fabricated from glass microballoons.

a typical "pack in place" foam and the cured molded piece.

Artificial Dielectric Foams

For artificial dielectrics, finely divided metal flake is usually used. This is added to, and dispersed in, the binder prior to addition of the microspheres. Aluminum flake of micron dimensions is effective. For high temperature dielectrics, silver may be used since aluminum oxidizes rapidly in air about 700 F. Blocks or sheets of foam are again made by packing into a mold. If

dispersion of the loading material is thorough and packing is done with care, excellent uniformity of electrical properties is possible. Table II gives data on loaded foams.

A special case of the artificial dielectric foam is that in which the loading material is of high loss. In this instance, an absorber is produced. Carbon has been found to be an effective lossy material. By varying carbon content, it is possible to vary dielectric constant and dissipation factor of the foam. Graded free space absorbers have been produced by packing in place successive

Table II—Artificial Dielectric Foams Based on Hollow Glass Microspheres

Designation	One Component Epoxide Resin Bonded	Silicone Resin Bonded	Silicone Resin Bonded	Inorganic Bond Using Silica Sol
Loading Weight, lbs/cu ft.	Aluminum Flake 23	Silver Flake 25	Titanate 20 to 35	Titanate 20 to 40
Dielectric Constant and Dissipation Factor Range	2.5 and 0.013 to 7.0 and 0.03	2.0 and 0.008 to 3.5 and 0.02	1.7 and 0.002 to 3.0 and 0.007	1.7 and 0.002 to 3.0 and 0.007
Compressive Strength, psi	1500	700	600	500
Operating Temperature Range, °F	-70 to +500	-70 to +800	-70 to +800	-70 to +1200
Commercial Designation	Eccofoam Hi K 625 D	—	Eccofoam Hi K 650 T	—

layers of absorptive foam wherein properties varied in the proper manner from the front or incident surface to the rear. These, of course, could be used in radome nacelles to prevent unwanted reflections from nearby metal surfaces. Fig. 3 shows some typical shapes.

Uniformity

As indicated previously, foams based on microspheres are uniform from point to point and completely isotropic electrically. Techniques have been worked out so that dielectric samples can be taken from a packed mass of uncured foam. The samples are cured and measured for dielectric properties. If these are acceptable, the foam mass is cured. If dielectric properties are not acceptable, the foam mass is broken up and repacked.

Radome Cores

For radome applications, the foam can be packed into a layer for use as the core in a sandwich construction, or it can be packed into a honeycomb core. Dielectric constant can be adjusted to that of the skins of the radome. See "Artificial Dielectric Foams for Radome Core" by W. R. Cuming in the June 1957 Proceedings of the OSU-WADC Radome Symposium. This described the use of a loaded epoxide "pack in place" foam in making a radome. The same general procedures are possible for use of the other foams of Tables I and II.

At the present time, laminates and honeycomb are not available with temperature capability as high as that of some of the foams listed. Inorganic laminates and ceramic skins are under development. If these become available for use in sandwich structures, foams based on hollow glass microspheres will find utility as core materials. In the meantime, the foams are being used in antenna and microwave lenses and as dielectrics in wave guide systems. Electronic circuits and components are readily embedded in these foams for structural support. A wide variety of thermal insulating applications make use of the foams.

Development work is proceeding on higher temperature, lower weight and lower loss microspheres and suitable bonding and loading agents. Because of the versatility, inherent uniformity and good physical properties of the "pack in place" foam system, it is expected that it will find general acceptance in the dielectric materials field. ■ ■

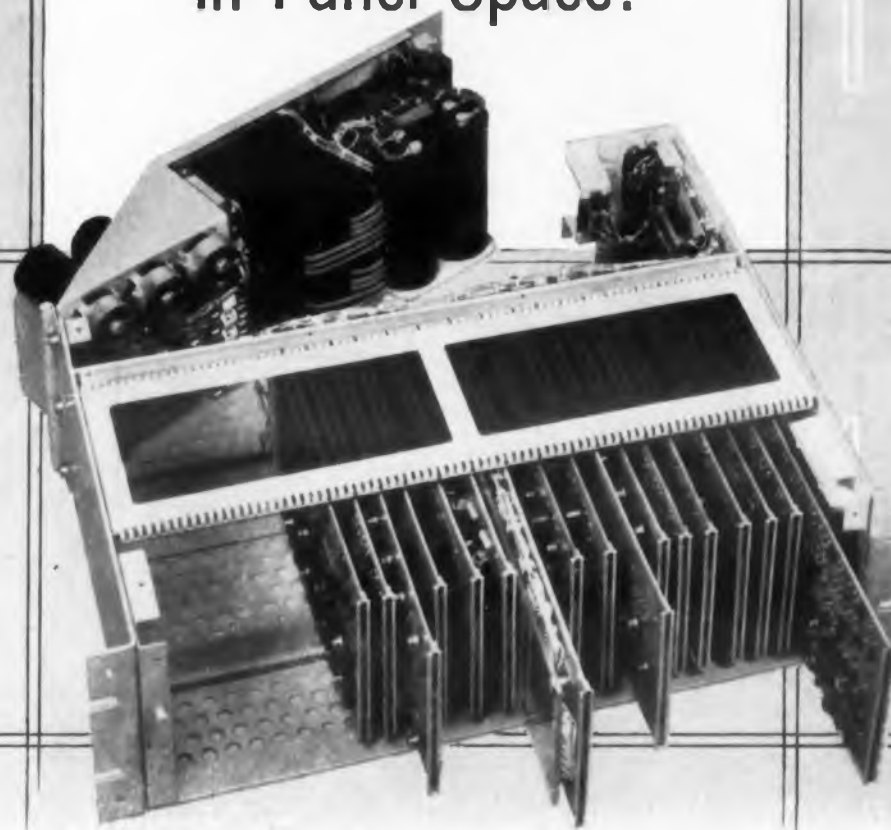
Acknowledgment

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- U. S. Air Force, Cambridge Research Center, Mr. Philip Blacksmith, Technical Monitor.
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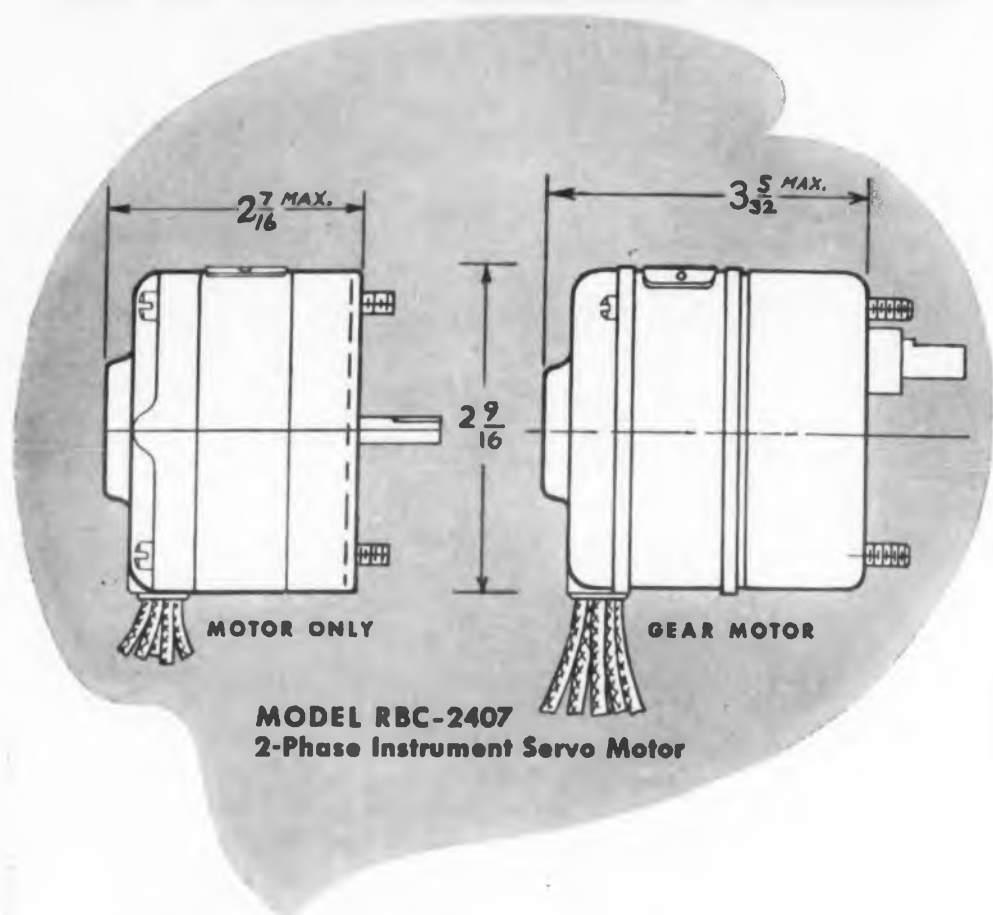
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Electrostatic Function Generator Follows Penciled Curves

USING unconventional electrostatic curve following techniques, this function generator provides simple, reliable operation. Departing from time-honored methods of generating curves, the instrument, manufactured by Research, Inc., 115 N. Buchanan Ave., Hopkins, Minn., avoids many weaknesses inherent in traditional cam-following or magnetic flux sensing systems.

Cam-Follower is Slow

In the cam-follower technique, an arm rides on a specially machined cam and positions a potentiometer slider. The voltage available at the slider varies with the cam's radius.

Weaknesses of this method are:

- It is not adequate for rapidly varying functions.
- It requires precise machining to produce a cam whose radius varies with the desired function.

The flux sensing system can follow a curve drawn on paper without touching

the paper or the curve. But the curve must be drawn with a special silver ink or a fine wire must be taped over the curve.

An inductive pickup probe is servo driven to follow the flux pattern set up by a high frequency current which is sent through the plotted curve. The servo motor which drives the probe also drives the shaft of a potentiometer which generates the function.

This method suffers from the fact that

- The probe tends to round off sharp corners as a result of unsymmetrical magnetic flux patterns.

- The method requires an rf power oscillator, a phase detector, a probe amplifier, a servo amplifier, and an inductive pickup probe.

Electrostatic System is Simple and Fast

The electrostatic system, called a Data Trak Function Generator, retains only the servo amplifier. Like the magnetic system

it can follow a curve drawn from an engineer's plotted data—but it does not require special inks.

A carbon pencil boundary is drawn on each side of the function to be followed. The two carbon lines form the plates of a capacitor. They are connected across a low voltage 60 cycle line to set up an electrostatic field.

An electrostatic pickup is servo-driven to follow the center of this field. To help the probe find the center of the field, the areas defined by the boundaries are made to appear as constant potential surfaces. This is accomplished by encircling the outer edges of the graph with electrostatic rings connected by graphite pencil to the nearest boundary as shown in Fig. 1.

The Data-Trak has some other advantages.

- An inadvertent break in the graphite boundary does not collapse the electrostatic field as it would the magnetic field about a "transmission line" carrying current.

- The desired function can be altered easily by erasing the pencil boundaries and drawing the new function level.

- A function can be cycled by wrapping the graph paper around a rotating drum as shown in Fig. 1.

- Rounding of sharp corners can be eliminated by "shading" the inside corner with a graphite pencil as in Fig. 2. The desired function can thus be reproduced to accuracies better than one per cent of full plotting scale.

For more information on this electrostatic curve follower, turn to the Reader-Service Card and circle 102.

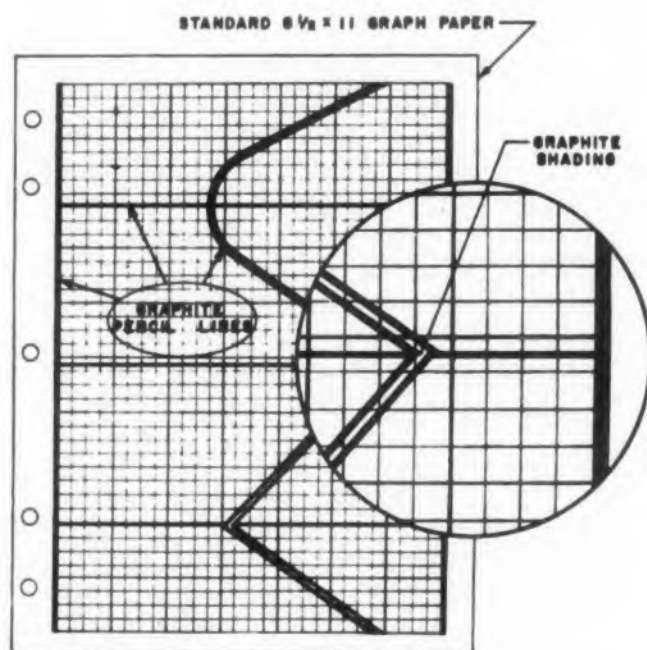
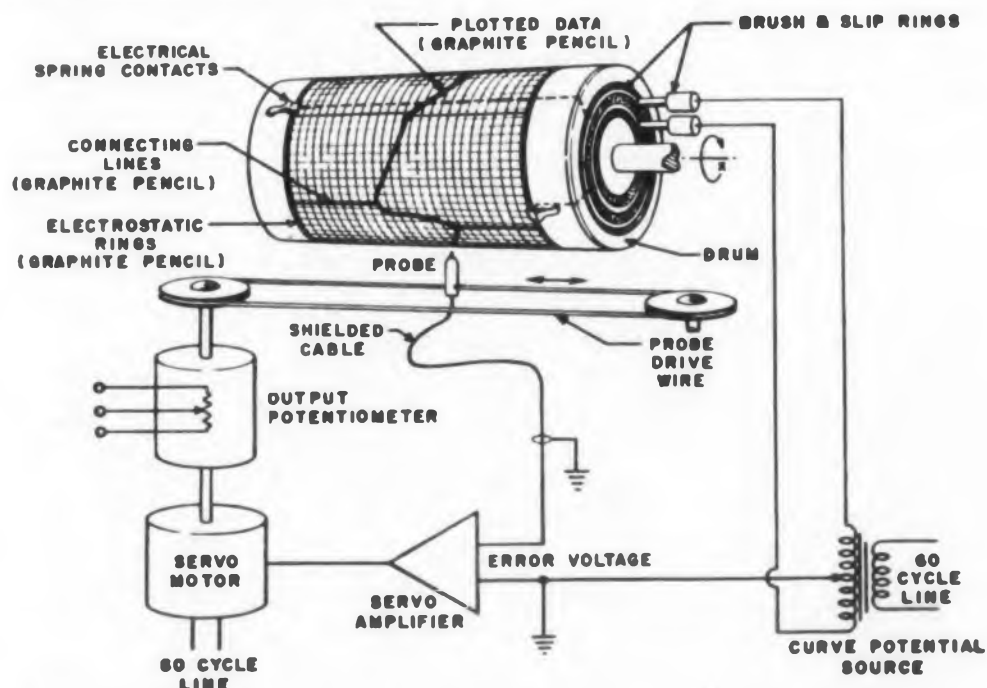


Fig. 1. (left) Simple circuitry of the electrostatic line follower. The probe never touches the paper.

Fig. 2. (below) A typical graph preparation. The magnified view shows how to compensate for rounding of sharp corners.



IMPULSE

A DIGEST OF NEW DEVELOPMENTS
IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE CORPORATION, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

CAR WITH RADAR. Latest auto experiment applies principles of radar to warn motorists of obstructions in the road. Black plastic cones, mounted on the car front, send out signals that are reflected by solid objects in the car's path, then cause a red light to flash inside the car. Motorists are forewarned of stalled vehicles ahead of them, as well as being told, electronically, of approaching too close to cars they are following. In the cones are two 10-inch aluminum reflectors, mounted four feet apart. Transmitter and receiver are concealed in front fenders. Device is sensitive to objects up to 1000 feet ahead. Warnings are made by flashing lights or by sound.

WHY SPACE SIGNALS FAIL. What happens to signals from outer space when they pass through the ionosphere and troposphere, especially in auroral zones? Radioastronomers are trying to find out—working at field stations from Boston to Palo Alto and at stations in Alaska, Greenland, the Aleutians, Sweden and Norway. Their tools: radio stars and the sun itself. First phase of the giant program is to map auroral zones (streams of particles that result from solar flares) and probe the state of ionosphere at various times. They hope to answer some important questions on the auroral effects of celestial, earth-based signals.

13 THERMOPLASTIC COLORS. Polyvinyl chloride thermoplastic compounds have grown in popularity with the coming of the Space Age, are now being used extensively in complex multiconductor cables (Rome has put as many as 163 conductors in a single jacket for one manufacturer). To thoroughly color-code vast cable constructions, Rome offers its PVC compounds, Rome Synthinol, in 13 solid colors. Further color coding is attained by spiral stripes or other approved coding methods. Synthinol's inherent flame resistance, when combined with toughness, abrasion resistance, high dielectric strength, and ozone resistance, makes it excellent for long-life insulation or jackets. All the facts are in Bulletin RCD-400, yours for the asking from Rome. Write IMPULSE, c/o Rome Cable, Rome, N. Y.

NEW COMMUNICATIONS MEDIA? Due to the great number of users, radio communication has distinct disadvantages today—says the Military. Frequency space is limited and easily jammed. Channels are unreliable. And there is no single type of communication circuit that is satisfactory for the entire globe. The USAF, which relies heavily on communications *without delays*, is trying to overcome these drawbacks by investigating the properties of low-frequency radio, sound, light, heat and nuclear radiation as means of communication. Various proposals are now under consideration.

CABLEMAN'S CORNER. Over the past few years, enormous strides have been made both in materials and manufacturing techniques associated with the wire and cable industry. To keep in stride with these changes, various military organizations have initiated steps to revise and bring up to date their specifications related to wire and cable. Military Specification MIL-W-16878C is already completed and issued. Draft copies of Military Specifications MIL-C-3432B and MIL-C-13777B have been issued and analyzed. These specifications are now in the final stages of acceptance and activation.

Now is the time to analyze your own specifications and requirements to see that they reflect the advanced thinking of the industry. Make sure your specifications are up to date and that the material you use is in accordance with the latest specifications. When you need cable, call on a cable specialist. Our number is Rome 3000.

These news items represent a digest of information found in many of the publications and periodicals of the electronics industry or related industries. They appear in brief here for easy and concentrated reading. Further information on each can be found in the original source material. Sources will be forwarded on request.

CIRCLE 31 ON READER-SERVICE CARD



"Maybe it will work" is too prevalent an attitude in papers on memory design. Authors Barnes and Schneider wrote this article to offset this attitude and to show the importance of proper attention to drive current tolerances.

In the photo, Robert Schneider (seated) is checking a sense amplifier of a direct-drive memory as George Barnes adjusts the simulated arithmetic and control inputs.

High Speed, Word-Organized Memory Techniques

R. P. Schneider and G. H. Barnes

Burroughs Research Center
Paoli, Pa.

THREE specific techniques for designing word-organized memories are described here, along with their advantages and disadvantages. These techniques differ mainly in their method of coupling the drive current to the selected memory word, so these coupling schemes are emphasized.

The word-organized memory can be defined as one electrically organized into words; the memory elements storing a given word are driven by a single selection element associated with that word, rather than by a pair of selection elements in a row/column selection matrix. The word-

organized memory has also been referred to as a "linear selection memory" or "word selection memory."

The first design technique uses square loop, metallic-tape cores to couple the drive current, by transformer action, to the memory cores storing a given word. The other two schemes use direct coupling.

Although these drive current configurations are applicable to memories built of other devices such as twistor, thin-film, and cryogenic memories, the discussion in this article is concerned with the complete switching of square loop ferrite cores

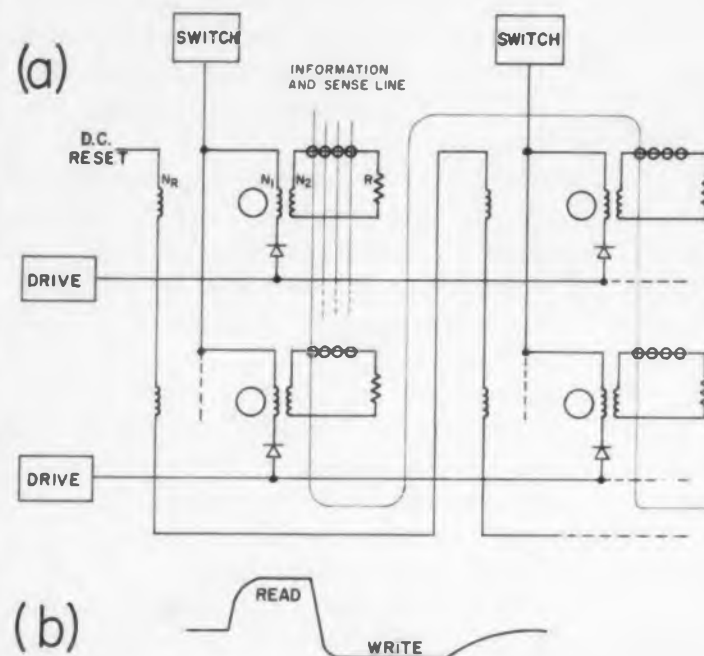


Fig. 1. A transformer coupled drive circuit with its output current waveshape.

of the type commonly used in coincident-current memories.

Transformer-Coupled-Drive Memory

A particular 512 word memory, now operating in a special purpose computer, uses read-write drive currents which are transformer-coupled to the memory words by a switch-core matrix. Each switch core is associated with one particular word in the memory. The switch-core arrangement is shown in Fig. 1a.

Matrix selection is not entrusted to the non-linearity of the switch cores; diodes are added to prevent possible parallel paths. The switch core associated with the word to be addressed is selected by the proper combination of transistor drivers and switches.

The selection of one of 16 transistor drivers and one of 32 transistor switches selects one of 512 switch cores. Each switch core has three windings: one winding receives the primary drive current; the second receives a dc reset current; and the third is the output winding to the 32-bit memory word and a swamping resistor.

During the read cycle, a current pulse in the primary winding of the switch core overcomes the dc reset ampere turns applied to this core and, in addition, supplies the full read current to the output memory core word.

Flux reversal occurs in the switch core during the read cycle. Reverse polarity write current flows at the end of the primary drive current, when the dc reset current returns the flux to its original direction. If the dc reset and output turns ratio is unity, and if magnetizing ampere turns are neglected, the write current will equal the dc reset current. The write current will continue to flow until the switch core is reset to sat-

uration in its original state. The output current waveform is shown in Fig. 1b.

This system uses square-loop permalloy switch cores, but pulse transformers may also be used. The latter scheme, used by R. E. McMahon,¹ is faster, but has poorer write current regulation, and must therefore use larger information drive currents.

Since the write current for the addressed word is stored during the read cycle, in the form of reversed flux, the word address may be changed immediately after the primary drive current disappears. The write current will be unaffected by an address change at this time.

The purpose of the swamping resistor is to insure a minimum switch-core switching time during the write cycle. Because the amount of flux switched during read must equal the amount of flux reversal during write, the maximum write time occurs when no memory cores are switched during a write cycle which follows a read out of all ONE's.

The design of the square-loop core transformer must satisfy a number of criteria. To prevent degradation of the read current pulse, the switch core should have sufficient flux that the primary drive current cannot saturate it. The voltage-time integral across the secondary (N_2) winding of the switch core can be stated, with reference to Fig. 1a, as

$$\int_0^{T_R} E dt = N_2 \Delta \Phi_R = M_R \Phi_M + I_R R T_R + L I_R$$

where $\Delta \Phi_R$ = flux switched during read time (T_R).

M_R = number of memory cores switched during read.

Φ_M = memory core flux.

I_R = output (read) current.

R = swamping resistor.

L = secondary line inductance.

The voltage-time equation during write is

$$\int_0^{T_W} E dt = N_2 \Delta \Phi_W = M_W \Phi_M + I_W R T_W + L (I_R + I_W)$$

The symbols used during write (W) are analogous to those in the read (R) equation. The reason for I_R in the last term of the write equation is that there is no time separation between the read and write pulse.

Since the flux switched during read is completely reset during write,

$$\Delta \Phi_R = \Delta \Phi_W$$

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SAMPLE ORDERS INVITED. WRITE FOR DATA.

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Electronic Tube Division Elmira, N.Y.

CIRCLE 32 ON READER-SERVICE CARD

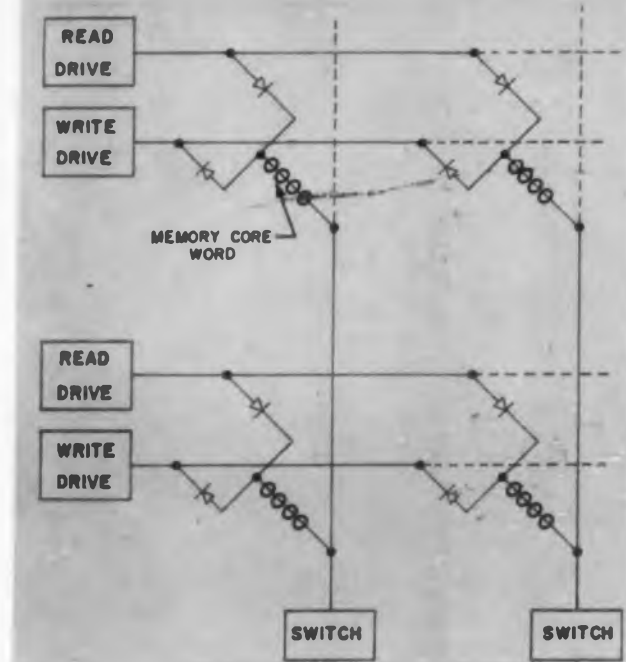


Fig. 2. A direct diode drive configuration which uses opposite polarity current drivers for read and write, and a bidirectional current switch.

the voltage-time statements for *read* and *write* can be combined, and the write time becomes

$$T_W = \frac{I_R}{I_W} T_R + \frac{(M_R - M_W) \Phi_M}{I_W R} - \frac{L}{R}$$

The memory core characteristics determine I_R and I_W , as well as the minimum T_W and T_R . In addition, a minimum T_R is required to satisfy the minimum T_W in the equation for T_W . The largest $(T_R + T_W)$ sets a maximum permissible repetition rate. Adjusting T_W to be slightly higher than that required by the memory cores will reduce the maximum T_W , and improve the repetition rate.

The output currents are related to the primary drive currents as

$$N_2 I_R = N_1 I_1 - N_R I_{DC} - F_R$$

and

$$N_2 I_W = N_R I_{DC} - F_W$$

where I_1 is the primary drive current through N_1 , $N_R I_{DC}$ is the dc reset ampere-turns, and F is the magnetizing ampere-turns. The number of turns N_1 , N_2 , and N_R are also dependent upon the magnitude of F_R and F_W .

In the design, F_R and F_W should be held to a very small percentage of the total ampere turns so that current tolerances are not adversely affected by the uncertainties of magnetizing ampere-turns in the square-loop cores.

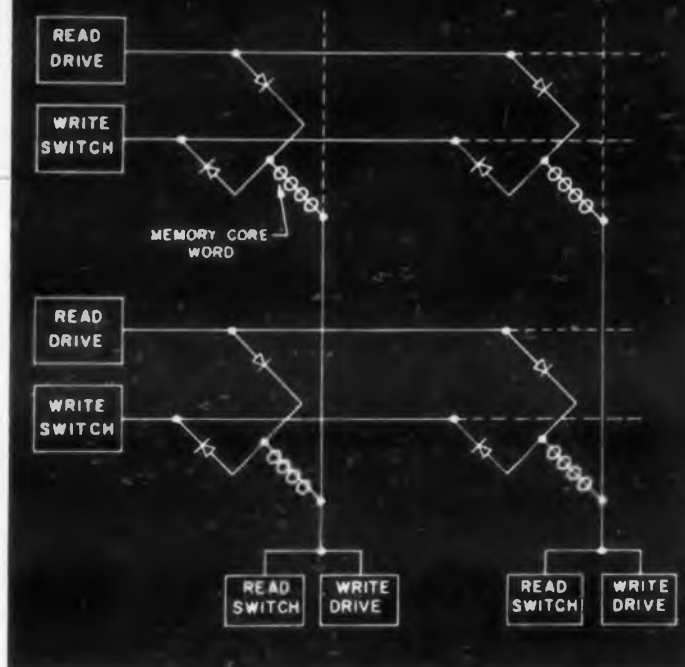


Fig. 3. A direct drive configuration which uses separate drivers and switches for read and write.

Distributed winding of N_1 , N_2 , and N_R is required to reduce leakage inductance and to improve coupling. Sector winding usually results in intolerable current waveshapes.

The temperature variation of flux in ferrite memory cores results in a temperature coefficient of drive current of approximately -0.3 per cent per deg C, to maintain an essentially constant core output and switching time over a temperature range of 0 C to 100 C. The pulse threshold current (that is, the current necessary to begin core switching) has a temperature coefficient of approximately -0.6 per cent per deg. C. Therefore, of a constant core output is desired, the noise immunity of the memory cores will effectively decrease as temperature increases.

This particular design, using ferrite cores of 80 mill outside diameter and 50 mil inside diameter, will operate well from 0 C to 55 C on a worst case basis. Excessive noise currents are predicted to occur at 90 C to 100 C. At 55 C, the worst case noise currents are only 75 per cent of the minimum allowable pulse threshold.

The read-write cycle time of this memory is 5.5 μ sec. The allowable amplitude tolerance on the read-write pulse is 10 per cent. The information current pulse tolerance is 15 per cent. The ferrite memory core specifications are relaxed by an amount approximately 5 per cent above that specified by the manufacturer. This change is made to eliminate core rejection after the cores are wired into memory planes.

The additional tolerances should absorb any

differences between procedures of the manufacturer and the testing section. The memory circuits use three transistor types, all germanium pnp, including two low-level types and one core-driver type.

Two Direct-Drive Memories

Two other word-organized memory drive techniques, which will now be discussed, use direct drive, eliminating the transformer coupling to the memory word. One of these techniques is shown in Fig. 2.

This scheme requires opposite polarity current drivers (one for *read* and one for *write*) and a bi-directional current switch. During the read cycle, one read driver and one bi-directional switch are selected. The current path created is through one memory word. During the write cycle, the corresponding write driver is selected, delivering write current through the same word, but in opposite direction.

This system lends itself to complementary transistor circuits such as npn read drivers and pnp write drivers. The width of the read and write pulses are dependent solely upon memory core switching time. Read-write cycle times of 2.5 μ sec are attainable on a worst case basis using conventional cores.

Diodes are required to block parallel paths in both the read and write drive lines.

A 16 word breadboard using this technique was designed with high-speed operation as the primary goal. The design was operated at a read-write cycle time of less than 2 μ sec. The speed was attained by using a high read current drive and an optimum write current versus information current ratio. The use of 50-30 mil ferrite cores eased the drive current requirements to obtain this speed.

An alternate direct-drive configuration is shown in Fig. 3. During the read cycle, one read driver and one read switch are selected. During the write cycle, the corresponding write driver and write switch are addressed. The current is delivered through the chosen path. Here the driver designs and the switch designs can be identical for both read and write. The memory circuitry can use all npn transistors or all pnp transistors.

A 512 word design based on this configuration had environmental tolerance and small size as primary goals. This memory was required to operate through a 150 C change in ambient temperature.

Because of the circuit complexities involved in making the drive currents temperature-insensitive over this wide temperature range, the memory elements were heated, and allowed to vary only over the upper 20 C change in temperature. No drive current compensation was used. The peripheral circuitry, requiring all silicon semi-

conductors, had to operate over the full 150 C spread in ambient temperature.

A great reduction in the size of the memory was achieved by using multiturn windings on the memory cores. Eleven turns of wire were placed through each 50-30 mil ferrite core. Four of these turns associated with the read-write drive line were placed individually on each core. Seven turns were accomplished by stringing cores on one seven-stranded wire.

Six of these were used for the information drive line, and one for sensing. The result was a reduction of over 50 per cent for the complete memory in the size and power required.

No power transistors were required with this design. This memory could operate with a read-write cycle time of 5 μ sec. All drive currents were worst case designed to 15 per cent.

Comparison of Drive Types

The advantages derived from switch-core drive are the core reliability and the lack of a need for write addressing. The reversed flux stored in the switch core during read automatically produces opposite polarity write current at the end of the read pulse.

The major disadvantage of the switch core is speed. A definite time is required to permit resetting of the switch core, this time being a function of the flux switched during read. Another disadvantage of switch core drive is the additional collector voltage requirement imposed on the driver transistor. The voltage that is developed across the dc reset winding during the write cycle, its transformer coupled to the primary drive line, and the driver transistor must be able to tolerate this additional collector voltage.

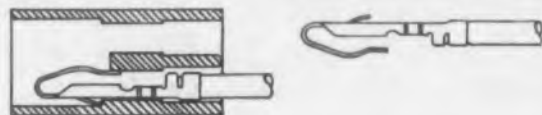
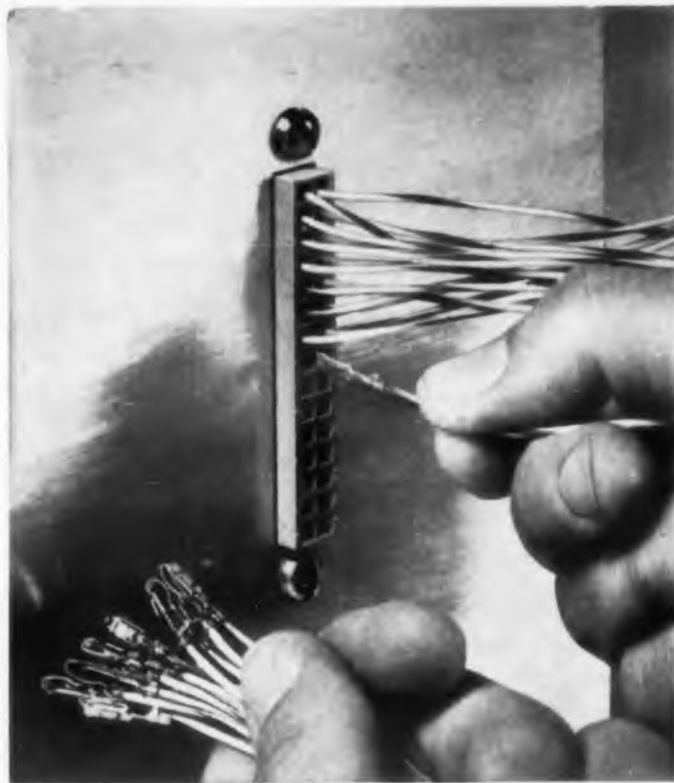
The direct-drive configurations allow faster operation because the write time is now limited only by the memory core specifications. However, write addressing is required with these schemes. The first direct-drive scheme requires positive and negative current drivers and a bi-directional switch. The second direct-drive scheme, allowing similar read and write driver and switch designs, requires separate read and write switches.

The Proper Choice

The proper choice among the three drive configurations is not obvious. Consideration must be given to such items as desired memory speed, component availability, memory size and cost, and the mode of operation as specified by the arithmetic and control section of the associated computer. ■ ■

Reference

R. E. McMahon, "Linear Selection Core Memory Techniques Using Transistors," Transistor and Solid State Circuit Conference, Feb. 1958.



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CIRCLE 33 ON READER-SERVICE CARD

Measure a Gain of a Million with a VTVM and a Scope

THIS technique is a direct means of measuring gain by an output and input measurement with commonly available laboratory instruments. The method is independent of meter calibration and requires only a vacuum tube voltmeter with an output amplifier such as the Hewlett-Packard 400C, and an oscilloscope such as the DuMont 304.

General Procedure

Hook up the equipment as in Fig. 1, with the output of the meter feeding the oscilloscope through a simple filter. First, place the meter input lead at e_i and set the meter attenuator to give a maximum undistorted signal on the oscilloscope.

The signal level into the scope is $|K|e_i$ where $1/K$ is the attenuation indicated by the meter range switch. (For the Hewlett-Packard, if the signal is less than one millivolt, K is 50 db. Thus, the signal at the input appears at the output terminals at a 50 db higher level).

Adjust the oscilloscope by means of its attenuators, to yield a peak-to-peak display that touches the ends of the reticule's calibration marks. Do

not touch the fine attenuator after this. Note the settings of the meter attenuator and scope coarse attenuator.

Switch the meter to a safe scale and put the probe at e_o . Adjust the meter attenuator for maximum undistorted display on the scope. The test amplifier gain is then the sum of the absolute meter scale readings. This assumes the scope coarse attenuator was not touched and the picture

obtained is as large as it was when the probe was at e_i . This will rarely be so; so follow the next procedure.

If the test amplifier gain exceeds 90 db the display will extend beyond the face of the scope and it will be necessary to operate the oscilloscope coarse attenuator to permit the entire picture to be viewed. Merely add 20 db to the meter reading for each step of the scope attenuator.

If the resultant picture does not extend to the ends of the reticule, subtract an amount equal to the difference. Thus, use -6 db for half-scale display, -2 db for 80 per cent of full scale, etc.

A typical example is given in the table.

Filter Design

Between scope and vtvm in Fig. 1 is a filter whose design depends on the measurement to be made. The choice is dictated by the frequency to be measured. If there is excessive high frequency hash on the scope use Fig. 2a. Choose C so that $1/2\pi fC = 50$ K at f at least two octaves removed from the test frequency, f_o .

Choose Fig. 2b when the hum level in the circuit is excessive and when f_o is less than 15 cps or greater than 240 cps. At fifteen cycles or 240 cycles the filter insertion loss may be taken as 2 db which is added to the gain.

It is worthwhile to note that it is not necessary to read the meter face except to note that a particular reading is not off scale, since this would distort the voltage at the output terminals.

The technique eliminates calibration errors as well as errors due to non-sinusoidal waveshapes and noise. The combination thus permits measuring amplifier gains for irregular waveforms within the frequency range of the test equipment. The response of the equipment used was approximately 10 cycles to 100 kc. It could have been extended to dc through use of a dc vacuum tube voltmeter with an output amplifier.

Emanuel Katell, Sr. Project Engineer, Reeves Instrument Corp., Garden City, L.I., N.Y.

Typical Gain Measurement

Probe At	Scope Scale Switch At	Meter Switch At	Display
e_i	1	-40 db	At extremes of reticule
e_o	10	+40 db	30 per cent short of reticule extremes (-3 db)
Net gain =			-40 db +40 db + 20 db - 3 db = 97 db.

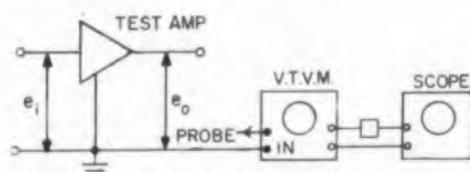
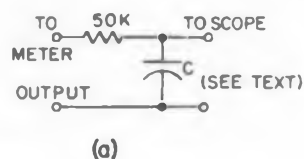
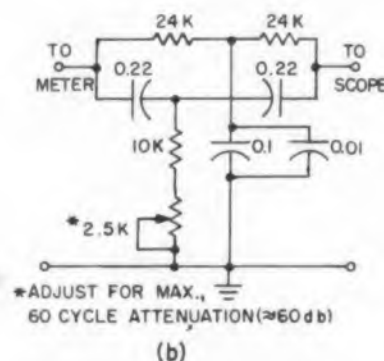


Fig. 1. Basic test set-up for measuring large gain.



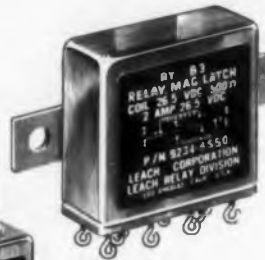
(a)



(b)

Fig. 2. The filter between the vtvm and scope in Fig. 1. Use the circuit of (a) to eliminate excessive high frequency hash, and the circuit at (b) to knock out excess hum.

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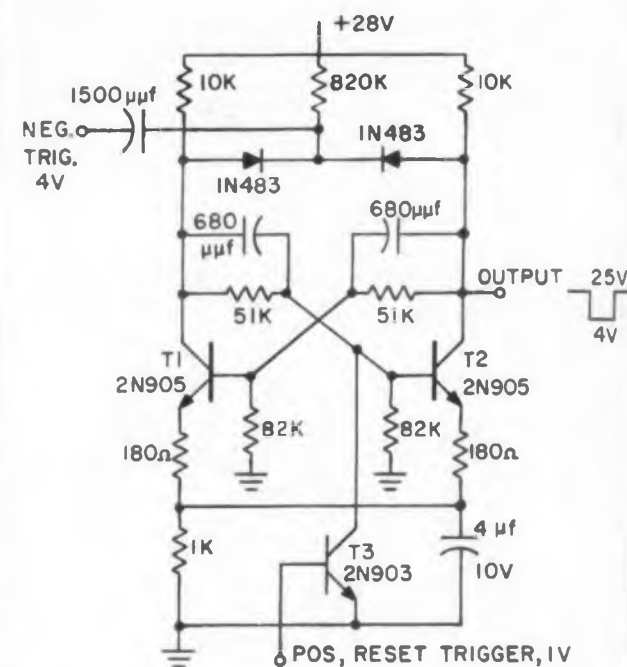
CIRCLE 35 ON READER-SERVICE CARD

IDEAS FOR DESIGN

One-Way Trigger For Bistable Multi

We have a bistable multivibrator which flips every time it is triggered. Our problem was to reset the multi at specified time intervals so it would always start in the proper state. If it missed a trigger, it was to be reset in the proper sequence.

Our solution calls for a minimum number of parts and does not interfere with the circuit operation. It eliminates the possibility of resetting the wrong side of the multi. If the multi is in the proper state, the reset trigger has no effect.



The reset trigger in this multi will turn off T2 if it is on. The trigger has no effect if T2 is off.

The positive reset trigger returns the base of T2 to ground through the saturation resistance of the reset transistor T3. This action cuts T2 off if it was on when the reset trigger was applied. If it was off, no change in output takes place.

Paul Margolin, Project Engineer, Allen B. D. Mont Labs., E. Paterson, N.J.

Zener-VR Team Makes Better Voltage Regulator

VR tube voltage regulators fail to regulate when the supply voltage is too low to ignite the VR tube. An obvious solution is to replace the VR tube with an equivalent Zener diode. But the higher voltage Zener diodes are very costly.

An economical solution lies in using a low voltage Zener in series with the VR tube. The Zener has no voltage drop till the VR tube conducts whereupon the Zener and the tube regulate together.

For example, assume 90 volts are required

across a load. A VR90 requires 125 v to fire. If the VR90 is replaced by a VR75 and a 15 v Zener, the combination will start at 105 v and regulate at 90, as required. The 15 v (500 mw) Zener is inexpensive.

As another example, a VR105 and a two watt, 45 v Zener will regulate at 150 v and fire at 113 v. This combination has advantages over the VR150 in never permitting the regulated load voltage to exceed 150 v, and in regulating as soon as the voltage reaches 150 v.

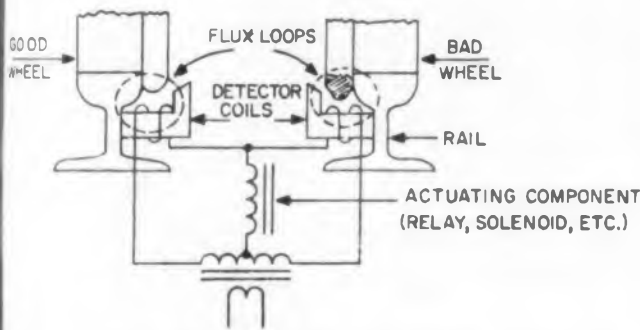
Laurence G. Cowles, *Electronic Engineer, The Superior Oil Co., Bellaire, Tex.*

Flux Loops Spot Bad Wheels On the Fly

Here's a simple circuit to detect broken flanges on railroad wheels. The concept can be extended easily to checking other symmetrical, ferrous, moving parts.

Since it is highly unlikely that both wheels on an axle will have a part of their flanges missing from exactly the same location, a method which compares one wheel with the other will indicate when there is a bad wheel.

Since the wheels are ferrous, a comparison of magnetic properties provides adequate sensitivity, and is unaffected by most environmental conditions.



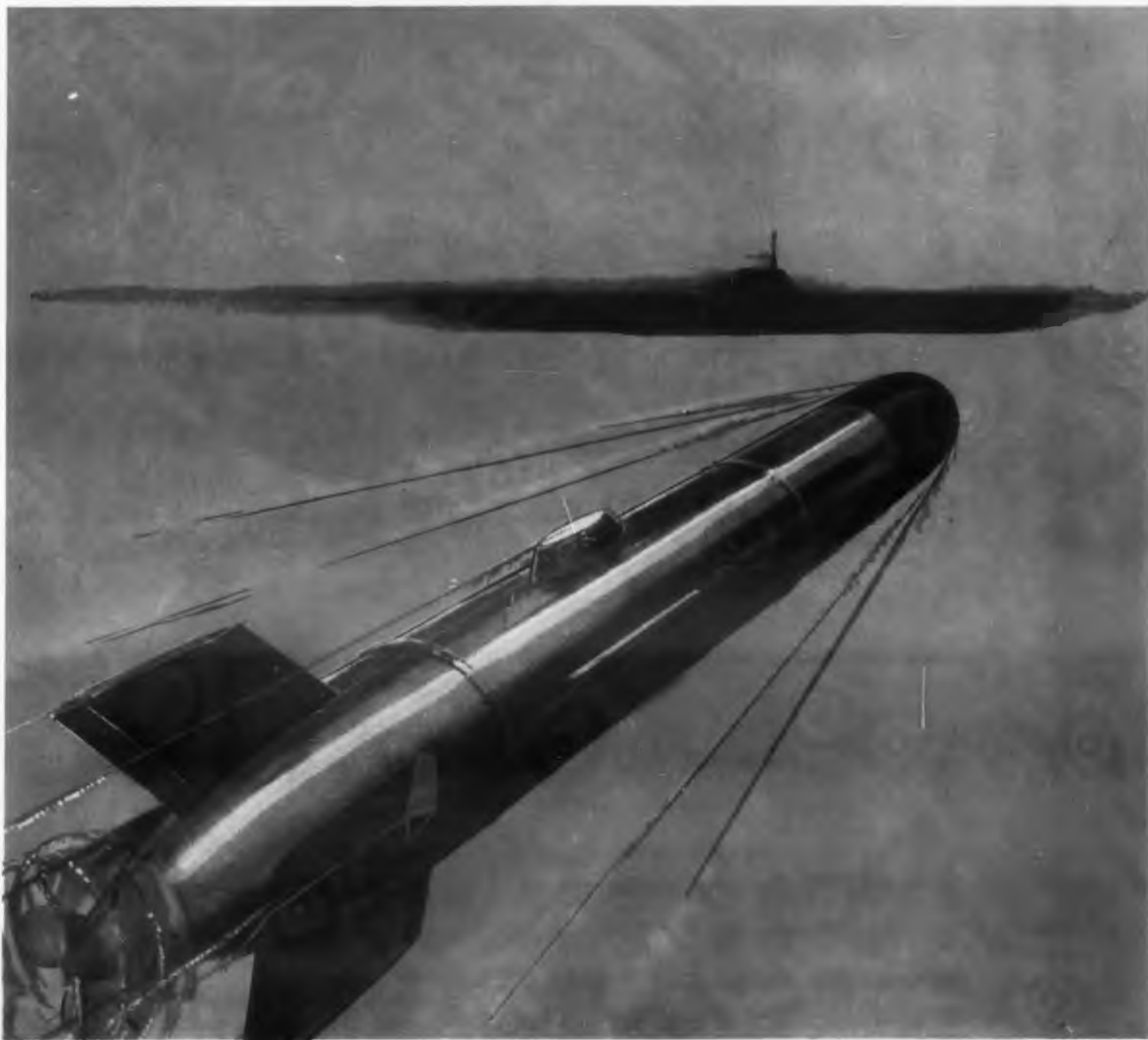
Bad wheel detector compares wheel flanges. The good flange provides . . . a small magnetic air gap. The bad flange provides a large one.

Several variations of bridge or balance circuits can be used. The common feature of all of them is that no current flows through the actuating component till there is a difference in the magnetic paths.

Thus, when one wheel has a broken flange, different currents flow through the two detector coils and current then flows through the actuator. The actuator can be part of a signal circuit, or it can cause paint to be sprayed on the axle carrying the bad wheel.

The circuit shown is a simple, non-resonant one, with a 60 cycle power supply. The actuator is in the center-tap lead.

Robert A. LeMassena, *Senior Engineer, Minneapolis-Honeywell, Heiland Div., Denver, Colo.*



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8-2-8

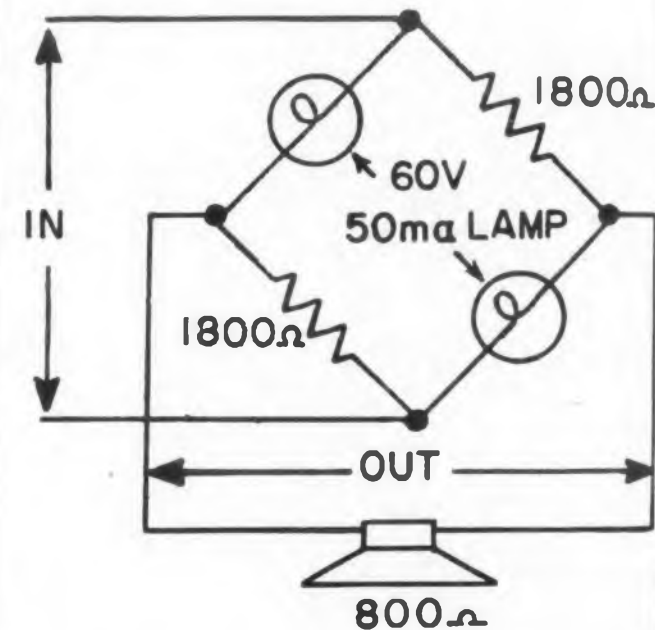
IDEAS FOR DESIGN

Light Bulbs For Dynamic Compression

Dynamic compressors have been used for ages, but they worked on the variable-gain vacuum-tube principle, in a circuit akin to audio AVC. The resulting distortion was unacceptable in many applications.

Philips, of The Netherlands, has a different solution. They use the variation in the resistance of incandescent lamps when they heat.

The figure shows the essentials of the circuit. The output of an audio power stage is applied to a loudspeaker through a bridge. The loudspeaker is of the high-impedance, direct-drive type where there is no output transformer.



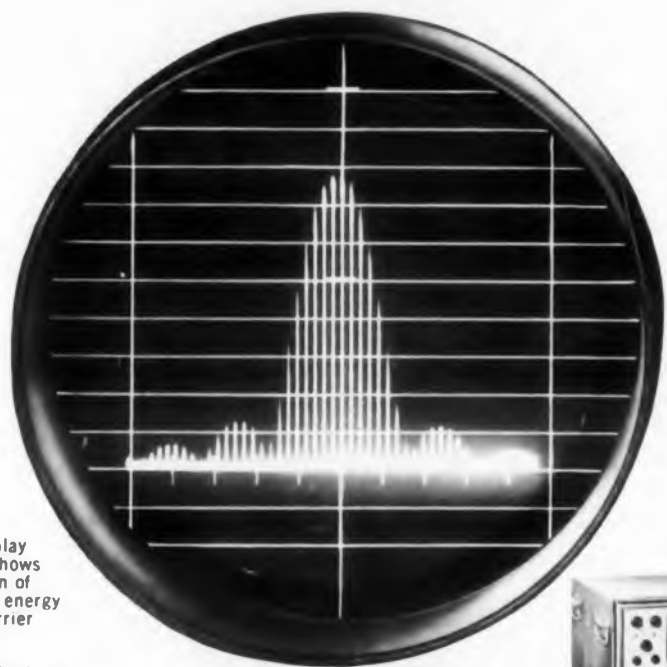
This dynamic compressor uses light bulbs as the volume-varying element. By changing the resistors in the bridge, one can convert it to a dynamic expander.

When the lamps are cold, their resistance is about 200 ohms, and a good part of the output voltage appears across the loudspeaker. When a strong audio signal comes in, and the output power goes up, the lamp filaments heat up and their hot resistance reaches 1200 ohms. The bridge is then much closer to equilibrium and only a small part of the output voltage appears across the speaker.

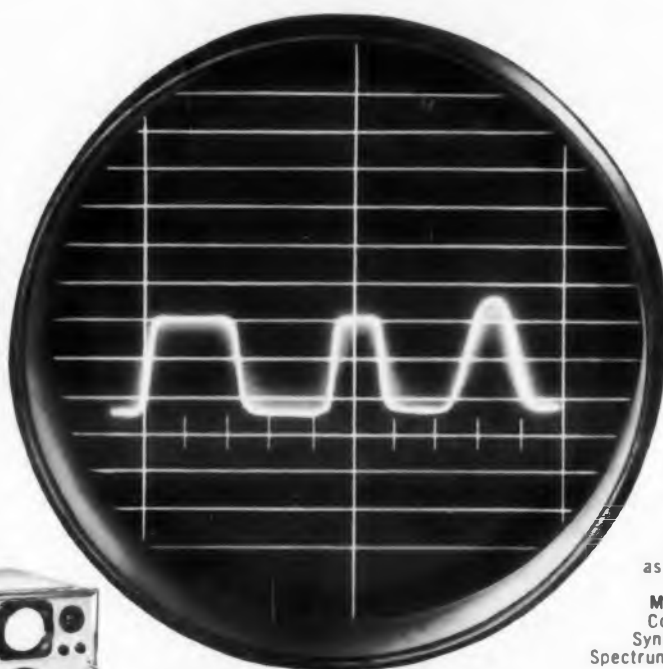
Notice that, by reversing the unbalance of the bridge, for example by using two 150 ohm resistors instead of 1800 ohm units, the circuit is transformed into that of a dynamic expander.

Dr. A. V. J. Martin, Carnegie Institute of Technology, Pittsburgh, Pa.

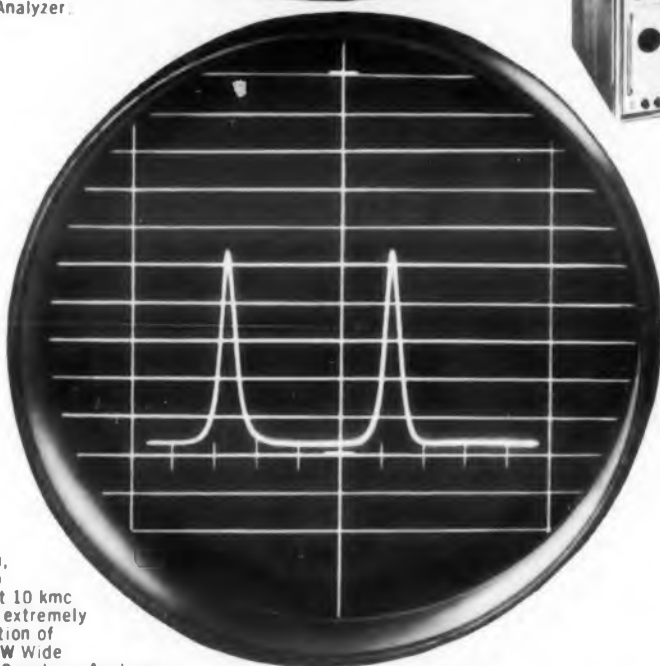
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ELECTRONIC DESIGN • June 24, 1959



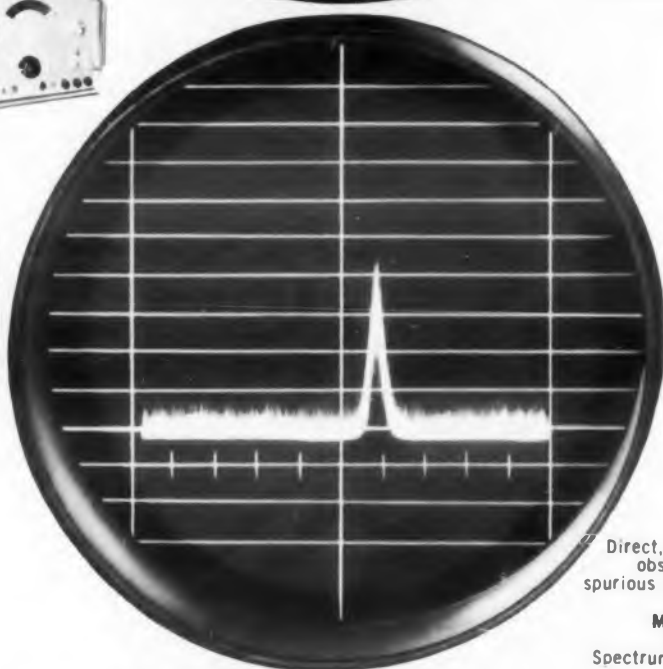
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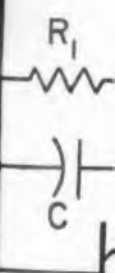


Fig. 2. Sh
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Roy P. Fe
o., Baltimo
38 ON REA

ELECTRONI

Modified Multi Starts Every Time

Conventional transistorized multivibrators, like the one in Fig. 1, are not always self-starting. An overload, or mere chance when power is applied, can cause both transistors to conduct at the same time. If this happens, the transistors saturate and loop gain drops to near zero.

Oscillations cease and do not start unless something is done to raise the loop gain and restore oscillation. From the viewpoint of reliability, the conventional multivibrator is simply not reliable.

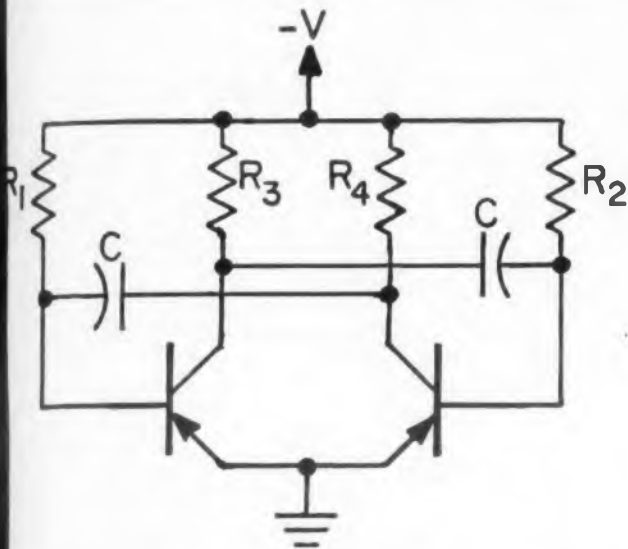


Fig. 1. Conventional multivibrator may not start oscillating when power is applied.

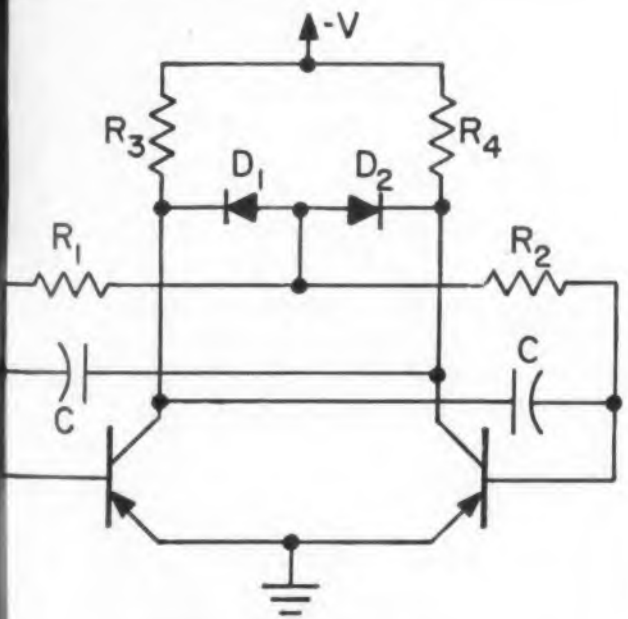


Fig. 2. Slightly modified multi always works.

Fig. 2 shows a multi with two diodes and with the base return resistors slightly rearranged. In this circuit, if the two transistors try to conduct simultaneously, the voltage drop across R_3 and R_4 reduces the base current of the transistors till they come out of saturation. When they do, the loop gain rises to a very high level and oscillations are restored.

Roy P. Foerster, Senior Engineer, The Martin Co., Baltimore, Md.

SEE 38 ON READER-SERVICE CARD

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with the NLS 50 Go/No-Go Voltage Comparator

Here's a new method for determining whether or not an input voltage is within prescribed limits . . . and to do so quickly, easily and accurately! Just set the front panel dials of the NLS 50 Voltage Comparator to read any two voltages within the range of ± 0.001 to ± 999.9 volts. Apply the voltage under test and in 90 milliseconds the NLS 50 gives a clear go/no-go indication of voltage tolerance. Watch the limit lamps on the front panel. If the green "Between Limits" lamp lights, the applied voltage lies within the pre-set limits. If either of the red lamps light—"Upper Limit" or "Lower Limit"—the voltage under test is too high or too low.

With a sensitivity of 0.005% and its limit settings precise to $\pm 0.01\%$, the NLS 50 Voltage Comparator outperforms any other type of voltage limit detector. It's transistorized, too . . . for reliability and ruggedness. And it's so compact . . . the only limit detector complete in one package. Comparison amplifier, limit setters, reference supplies and range multiplier are all included in the one instrument, a 3½-in. high unit that fits conveniently into a standard 19-in. rack.

In addition to giving visual warning to the operator, the NLS 50 gives go/no-go commands to such electrical devices as cut-off relays, sorting chutes, data printers, tape or card

punches, and audible warning equipment. Extremely versatile, the instrument may be used as a high-accuracy voltmeter without modification and may be adapted easily to detect resistance limits.

The broad applications of the NLS 50 Voltage Comparator include the following:

- Automatic checkout of missiles and electronic systems.
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CIRCLE 39 ON READER-SERVICE CARD

NLS — Digital Instruments That Work . . . And Work . . . And Work!

Higher-Temperature Capacitors:

New Dielectric Materials Help Break the Heat Barrier

By Marc F. Warmuth, Staff Engineer, Airborne Accessories Corporation

Special Mylar*, Teflon† and mica constructions permit continuous operation up to 600°F

Three new types of special high-temperature motor-starting capacitors, utilizing Mylar, Teflon and mica dielectric respectively, have been developed recently by Airborne. The Mylar and Teflon types are wound of very thin metallized film for greatest possible miniaturization. The mica type is wound of a sandwich of aluminum foil and thin, pure mica ribbon, metallized mica not being procurable. All are encapsulated with thermoplastic polyamide or thermosetting epoxy resins (depending on temperature range) in sealed, cold-drawn steel cans with fused glass terminals. This construction provides low inductance units of exceptional mechanical sturdiness and environmental resistance.

As an alternate construction for less demanding applications, encapsulation in epoxy sleeves, with leads brought out through potted ends, is also available.

Mica for highest temperatures

The great advantage of mica as a dielectric is its ability to maintain its physical and electrical characteristics at temperatures up to 1000°F. All dielectric materials undergo severe reductions in

insulation resistance at high temperatures, but with mica the critical value is reached around 600°F. Full voltage ratings up to this point are thus permitted. And with the right epoxy resin impregnant, mica capacitors are well able to withstand overtemperatures without damage... if not simultaneously subjected to full rated voltages.

Mica capacitors are three to four times larger than Mylar or Teflon units of comparable capacitance and voltage rating. This is because a greater thickness of dielectric must be used in addition to a separate layer of aluminum foil.

Mylar and Teflon for intermediate high temperatures and small size

Mylar can be worked continuously up to 300°F and Teflon up to 400°F. For applications below these limits, but above the normal 185°F limit of more conventional insulating materials, metallized Mylar and Teflon offer high dielectric strength. They make possible wound capacitors of very small size with good voltage ratings and excellent capacitance-to-volume ratios.

A further advantage of metallized Mylar and Teflon capacitors is their self-healing characteristic. The short occurring when the dielectric is ruptured

instantly burns the thin metallic coating back from the edges of the rupture, making further flashover impossible. Yet the amount of metallic coating burned away is so minute that hundreds of such self-healings have little effect on capacitance. Resistance to overvoltages can thus be considered excellent. Resistance to overtemperatures, on the other hand, is not an outstanding characteristic of Mylar or Teflon—a design factor to keep in mind.

Summary

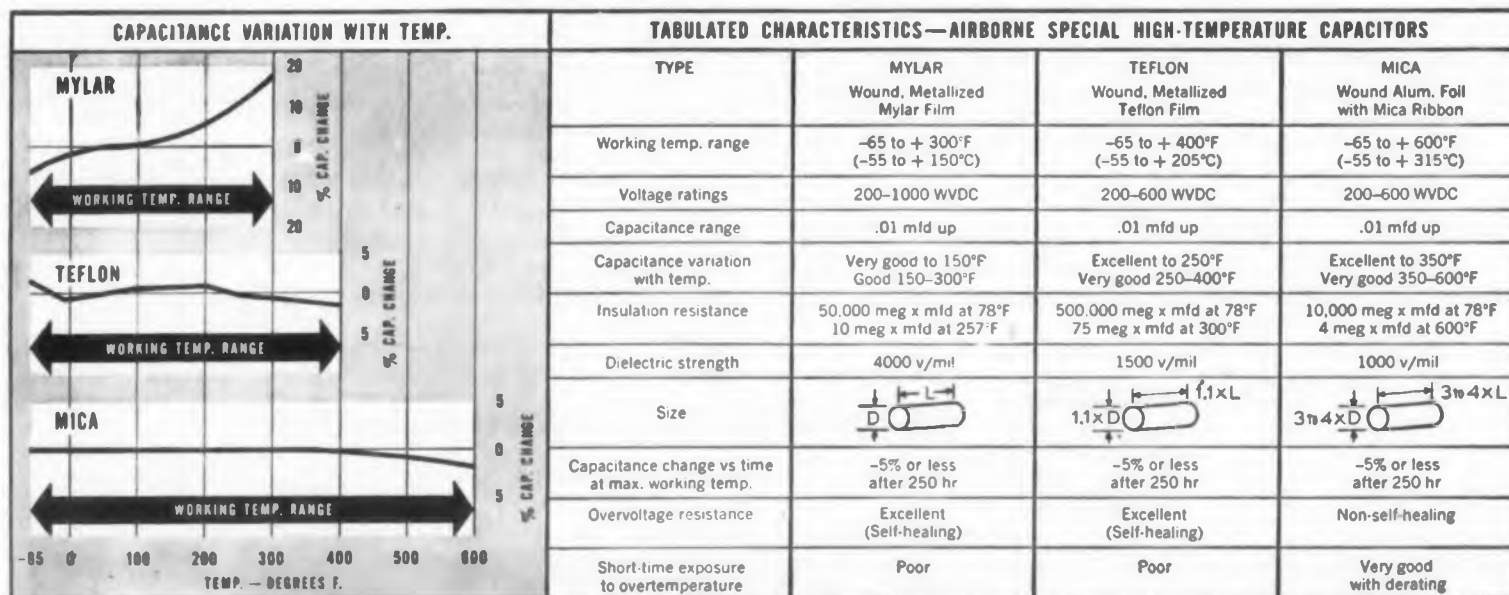
MYLAR: For intermediate high temperatures, high voltage and smallest size. Continuous operation at 300°F with ratings up to 1000 WVDC. Capacitance variation with temperature good, but not as good as that of Teflon or mica types.

TEFLON: For intermediate high temperatures and small size. 600 WVDC up to 400°F without derating.

MICA: For highest temperatures. Continuous operation, 600 WVDC without derating up to 600°F. Higher temperatures possible with derating. Larger in size than equivalent Mylar or Teflon capacitors.

For proposals on your specific capacitor requirements, write AIRBORNE ACCESSORIES CORPORATION, HILLSIDE 5, N. J.

*DuPont's tm for its polyester film
†DuPont's tm for its tetrafluoroethylene resin

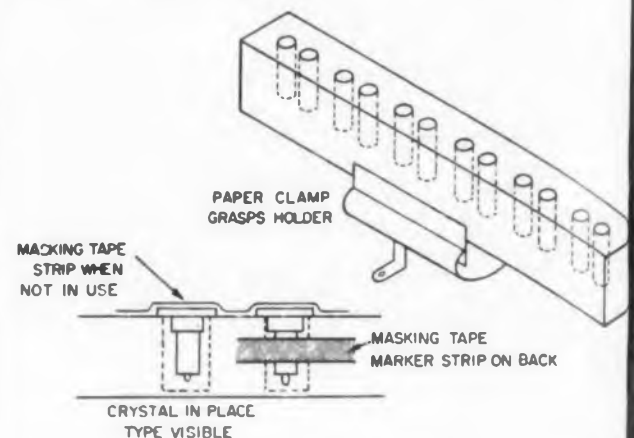


CIRCLE 40 ON READER-SERVICE CARD

IDEAS FOR DESIGN

Drilled Clear Plastic Keeps Diodes Shipshape

In many labs, crystal diodes always tend to get lost, damaged, or simply mixed up. The method shown here is a simple one for keeping the diodes out of the way of harm, and for keeping matched pairs in proper order.



Holes, drilled in Lucite, keep diodes in order and safe while an ordinary paper clamp keeps the holder upright on the bench. Masking tape keeps the diodes in place and helps identify them.

Holes are drilled in a clear strip of Lucite or other clear plastic to allow the diodes to fit the way into the material. The plastic should be clear enough to allow reading the markings on the diodes without removing them. The holes should be drilled in pairs so matched crystals are close together.

A strip of masking tape, over the holes, will keep the diodes in place, while another strip, across one surface of the diode holder can be used for marking.

The plastic strip can be mounted on the workbench with an ordinary paper clamp, as shown in the figure.

Morton Stillman, General Electric Co., Ithaca, N.Y.

A Better Driver For Cathode Followers

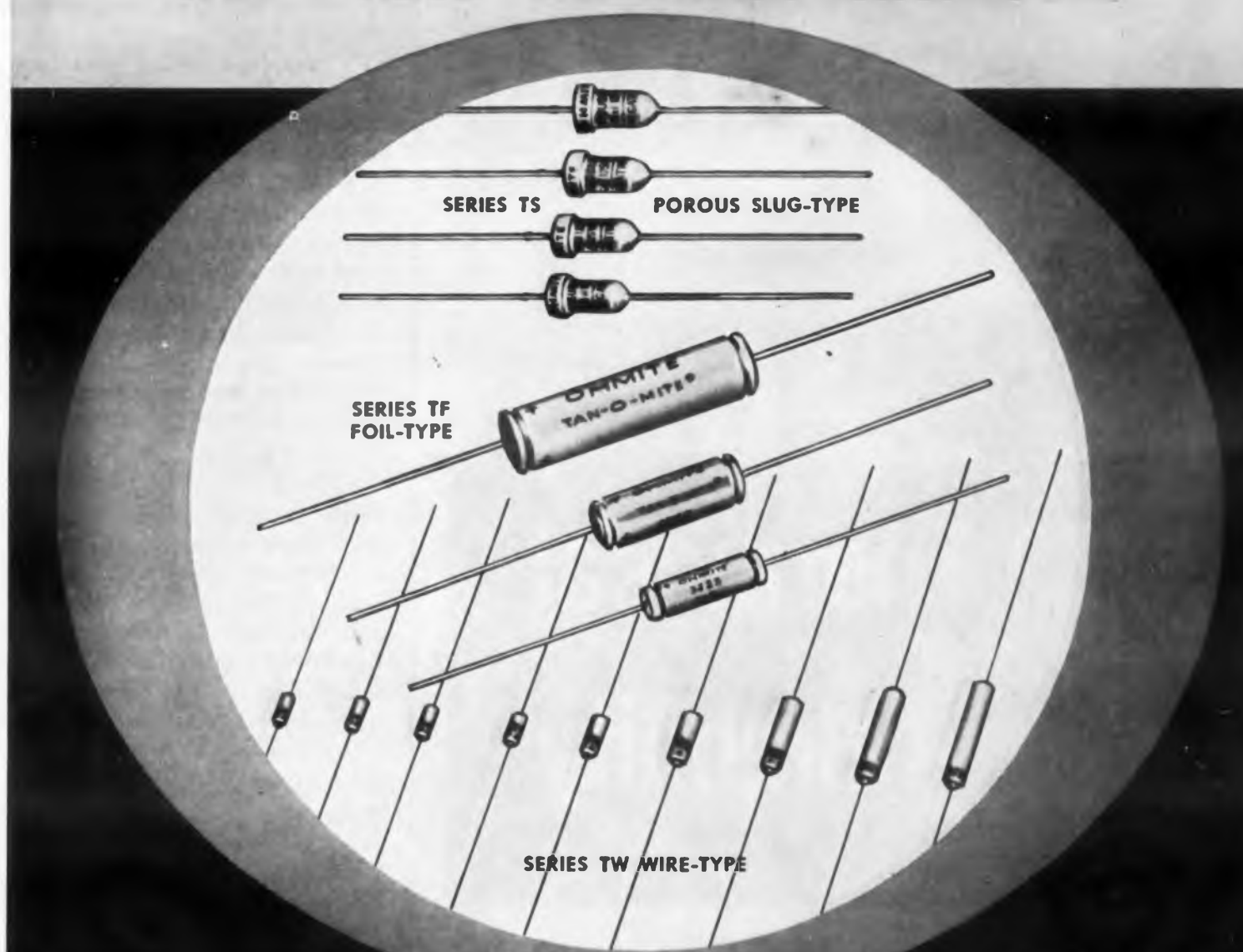
For high fidelity use and many other applications, a cathode follower output stage is almost ideal except for one grave disadvantage; it requires a tremendous voltage input because its voltage gain is less than unity.

To supply this large swing at low distortion levels, several techniques are in common use:

1. Transformer coupling with a step-up voltage ratio. Unless the transformer is very expensive iron core distortion is severe at low frequencies and the low- and high-frequency response suffers.
2. The conventional RC coupled stage. This

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

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

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

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CIRCLE 41 ON READER-SERVICE CARD

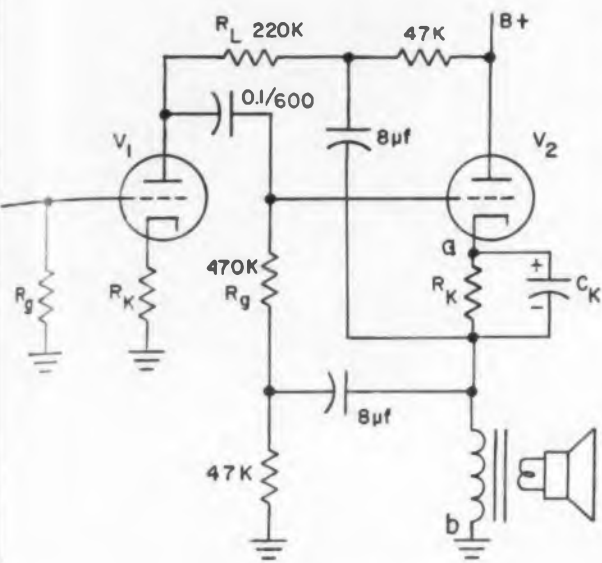


Fig. 1. This cathode follower and its driver do not require expensive iron nor extreme values of B plus.

requires a very high plate supply, often about 1000 v.

3. Impedance coupling with a choke in the plate circuit of the driver stage. But unless the choke is very expensive, iron core distortion results with the coupling transformer.

Driver Sees Large E_{bb} and R_L

In the circuit of Fig. 1, the driver tube sees a plate load resistance many times its physical value, and a plate voltage effectively several times larger than E_{bb} . Thus the dynamic loadline is more nearly horizontal and its intersection with the e_b axis occurs at a higher than E_{bb} voltage.

Since the driver (a high or low mu triode) has a gain of 10 or more, its input can be driven, at low distortion, with any conventional RC coupled stage.

The 8 μ fd capacitors swing R (the parallel combination of the plate load and grid leak) so it looks like a higher resistance. Then $R' = R(A + 1)$ where A is the gain of the driver stage at its operating point.

When the grid of V_1 swings negative (toward cutoff), the cathode of V_2 becomes more positive, thus raising the effective plate voltage of V_1 .

John A. Mooney, Associate Aircraft Engineer, Lockheed Aircraft Corp., Marietta, Ga.

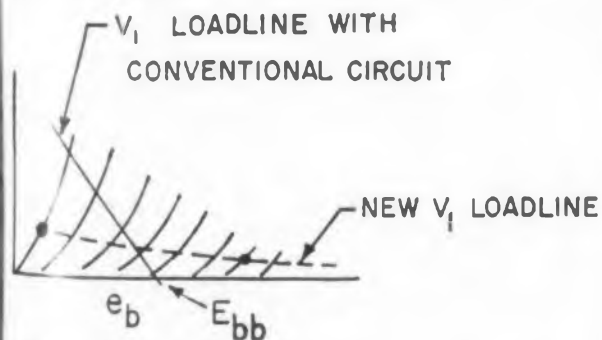


Fig. 2. The virtual load line for the cathode follower driver shows how the tube sees a large plate load resistance and a high E_{bb} .

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... fail-safe overheat protection

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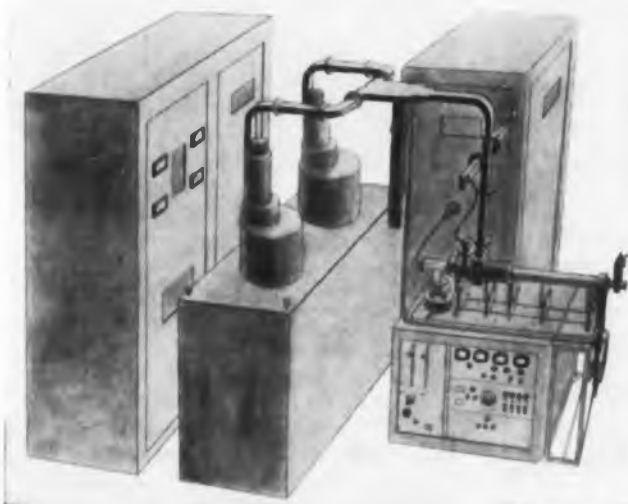
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Complete Radiation Lab Service

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Hughes has gained a background in the design and construction of radiation facilities by building its own underground "hot" laboratory and has obtained data on the effects of nuclear radiation upon electric components by using Linac accelerators and pulse reactors to "flash test" parts used



Flash Tester—A gamma Linac, most powerful of its kind, will "flash test" components and other equipment by bombarding them with short, intense pulse equal to the radiation of an atomic or hydrogen bomb. The traveling wave type of linear electron accelerator operates at 10,000,000 volts or more, and uses microwave energy to accelerate electrons against a target of heavy metal, producing a gamma environment for testing parts.



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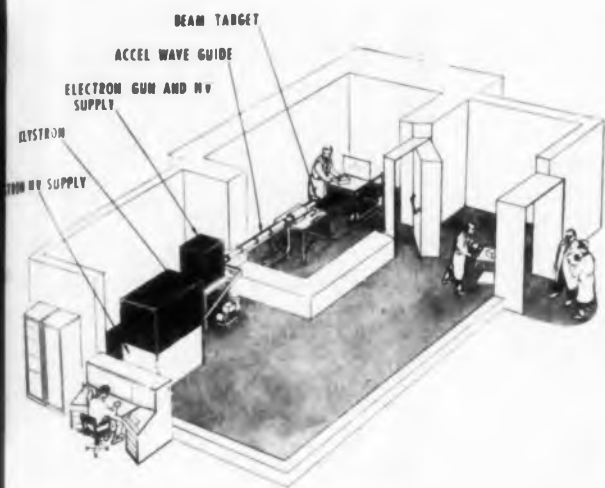
Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 43 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1964

FREQUENCY STANDARDS



Radiation Labs—Shown in sketch of typical gamma facilities is a Linac linear electron accelerator designed to produce a very intense pulse of gamma rays. A beam of electrons is directed at a heavy-metal target, such as tungsten, producing a gamma ray environment for testing components of other test specimens which are placed in front of target. Before Linac is turned on, technicians leave the shielded room to operate the accelerator from a control console, where they can read information on the intensity of radiation and the function of equipment under test.

the armament control systems of the U. A. Air Force's all-weather jet interceptors. Hughes Aircraft Company, Nuclear Electronics Dept., Research Laboratories, Building 20, Dept. D, Mail Station 1515, Florence and Teale Streets, Culver City, Calif.

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Newest addition to the extensive Environmental Testing Laboratories of Acton Laboratories, Inc. is a complete Radio Interference Testing Facility. Qualification testing of equipment to various military and Federal Communications Commission specifications is provided along with consultant services to design engineers on eliminating radio interference problems from their projects. Facilities include Empire Noise and Field Intensity Meter Model NF-105 for measurements in accordance with specifications: MIL-I-6181B, MIL-I-60378A, MIL-I-11683A, MIL-I-11748A, MIL-I-6910A. With this equipment, Acton Laboratories can provide field intensity measurements, interference measurements in accordance with commercial and military requirements, antenna pattern analysis, determination of harmonic spurious frequency output of transmitters, oscillator radiation of receivers, and determination of shielding effectiveness. The shielded enclosure is 10' x 20' x 8' with opening 6' wide and 7' high to permit sizable devices to be moved for testing.

For details, write L. Bower, Acton Laboratories, Dept. ED, 533 Main St., Acton, Mass.

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PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3 3/4" H.* Wght., 4 oz.

Frequencies: 240 to 1000 cycles

Accuracies:—
Type 50 ($\pm 0.02\%$ at -65° to 85°C)
Type R50 ($\pm 0.002\%$ at 15° to 35°C)

Double triode and 5 pigtail parts required

Input, Tube heater voltage and B voltage

Output, approx. 5V into 200,000 ohms

*3 1/2" high
400 - 1000 cy.

CIRCLE 610 ON READER-SERVICE CARD

PRECISION FORK UNIT
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Size 1 1/2" dia. x 4 1/2" H.* Wght. 8 oz.

Frequencies: 200 to 4000 cycles

Accuracies:—
Type 2003 ($\pm 0.02\%$ at -65° to 85°C)
Type R2003 ($\pm 0.002\%$ at 15° to 35°C)
Type W2003 ($\pm 0.005\%$ at -65° to 85°C)

Double triode and 5 pigtail parts required

Input and output same as Type 50, above

*3 1/2" high
400 to 500 cy.
optional

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TRANSISTORIZED, Silicon Type

Size 1 1/2" dia. x 3 1/2" H. Wght. 7 ozs.

Frequencies: 400 — 500 or 1000 cycles

Accuracies:
2007-6 ($\pm 0.02\%$ at -50° to $+85^{\circ}\text{C}$)
R2007-6 ($\pm 0.002\%$ at $+15^{\circ}$ to $+35^{\circ}\text{C}$)
W2007-6 ($\pm 0.005\%$ at -65° to $+125^{\circ}\text{C}$)

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

CIRCLE 612 ON READER-SERVICE CARD

FREQUENCY STANDARD
TYPE 2001-2

Size 3 3/4" x 4 1/2" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles

Accuracy: $\pm 0.001\%$ at 20° to 30°C

Output: 5V. at 250,000 ohms

Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

CIRCLE 613 ON READER-SERVICE CARD

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 20 KC.

M—Power Amplifier, 2W output.

P—Power supply.

CIRCLE 614 ON READER-SERVICE CARD

FREQUENCY STANDARD
TYPE 50L

Size 3 3/4" x 4 1/2" x 5 1/2" High
Weight, 2 lbs.

Frequencies: 50, 60, 75 or 100 cycles

Accuracies:—
Type 50L ($\pm 0.02\%$ at -65° to 85°C)
Type R50L ($\pm 0.002\%$ at 15° to 35°C)

Output, 3V into 200,000 ohms

Input, 150 to 300V, B (6V at .6 amps.)

CIRCLE 615 ON READER-SERVICE CARD

FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7 1/4" High
Weight, 14 lbs.

Frequencies: 50 to 400 cycles
(Specify)

Accuracy: $\pm 0.001\%$ from 20° to 30°C

Output, 10 Watts at 115 Volts

Input, 115V. (50 to 400 cycles)

CIRCLE 616 ON READER-SERVICE CARD

FREQUENCY STANDARD
TYPE 2121A

Size
8 3/4" x 19" panel
Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
 $\pm 0.001\%$ from 20° to 30°C

Input, 115V (50 to 400 cycles)

CIRCLE 617 ON READER-SERVICE CARD

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8 3/4" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cycles

Accuracy: ($\pm 0.002\%$ at 15° to 35°C)

Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

CIRCLE 618 ON READER-SERVICE CARD

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

Watch Master
Timing Systems

Telephone: PLaza 7-1430

580 Fifth Ave., New York 36, N. Y.

CIRCLE 610-618 ON READER-SERVICE CARD

RESOLVERS—WHEN AND HOW YOU WANT THEM AND AT MASS PRODUCTION PRICES



Checking resolver chains in E-P Dead Reckoning Computer System.

From twenty years' experience in designing and manufacturing resolvers, we have developed the means of predicting exactly how resolvers of various mechanical and electrical characteristics will perform in your system under any given operational conditions.

Nothing could be surer. You tell us the system performance you need. We analyze the requirements and supply the resolvers which will help bring you that performance. If none of our many standard resolver models fills the bill, we'll build "specials" that will.

Because we make, as standard items, just about every type of resolver and other synchros, we can usually deliver quickly and at volume production prices. Available are frame sizes 8, 10, 11 and 15. We also make cascaded resolver chains, using resolvers as small as frame size 10 with accuracy of 1/6° without using booster amplifiers.

MORE FOR YOUR MONEY. Our unique ability to pre-determine performance—and then to "tailor-make" to your needs—means that you get maximum value for your component dollar. Write for details.

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.



"FOR PRECISION
COMPONENTS THAT DO
THE JOB BETTER—TRY THE
**BENDIX
SUPERMARKET**"



CIRCLE 96 ON READER-SERVICE CARD

SERVICES FOR DESIGNERS

Free Film on Design Machines



A new 16 mm color sound film, "Engineered Screw Machine Tooling Applications," produced by Brown & Sharpe Mfg. Co. of Providence, R. I., features eight practical applications of the latest design automatic screw machines. Utilizing close-up views and slow motion, some of the sequences detail the relative position of tooling during close timing operations. Standard and special attachments with explanations of the tool engineering involved in their practical application are featured. Running time is 35 minutes. This film is available on a no-charge loan basis from the producer.

Brown & Sharpe Mfg. Co., Dept. ED, Machine Tool Div., Providence 1, R.I.

CIRCLE 97 ON READER-SERVICE CARD

Machining "Unmachinable" Materials

The Ultrasonics Division of Connecticut Instrument Corporation is offering a new service—Ultrasonic Impact Grinding. This machining technique may be used for drilling, broaching, shaving, slicing, dicing, engraving and shaping materials previously impossible to machine by conventional methods, including glass, quartz, silicon, tungsten, germanium, hardened steel, stellite, sapphire, and alumina. Applications of the process cover ceramics, glass, transistor components, precious stones, and die making.

Well equipped with ultrasonic machine tools together with a completely equipped tool making facility, the company will assume responsibilities for other phases of the component fabrication including securing of raw material. Sales engineers are available for consultation on machining problems. The company's Ultrasonic Division is set up to turn out volume production of components—

P.S. and don't forget these other quality products at the

BENDIX "SUPERMARKET"

With our greater variety and greater volume of the precision components listed below, we have become the "supermarket" of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

400-CYCLE SYNCHROS

(Frame sizes: 8, 10, 11, 15, 22)

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Transmitters

GYROS

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and Vertical Gyro Transmitters
• Stable Platforms

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cision Induction Tachometer
Generators • Rate Generators

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Azimuth Counters • Cam Compensators • Clutched Synchros • Dual-Speed Synchros • External Slip-Ring Synchros • Follow-Up Mechanisms • Miniature Differential Gear Assemblies • Servo Assemblies

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Airborne Radar Antennae •
Ground Antenna Pedestals

YCBTBS

You Can't Beat The Bendix
"Supermarket". Try us.

Eclipse-Pioneer Division



Teterboro, N. J.

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COMPONENTS THAT DO
THE JOB BETTER—TRY THE
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CIRCLE 98 ON READER-SERVICE CARD

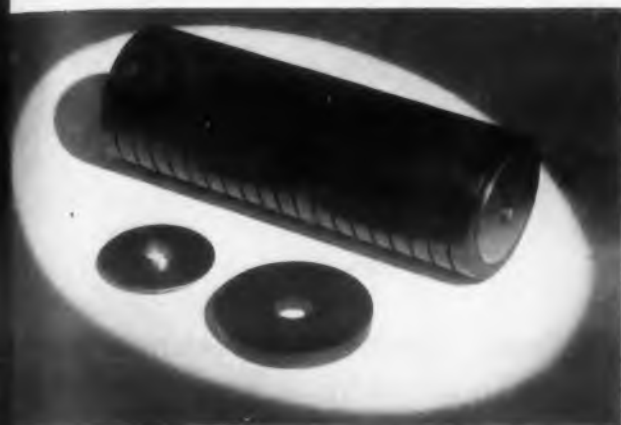
and will undertake the whole project if desired—obtaining material, supervising machining operations, etc.

Connecticut Instrument Corporation, Dept. ED, Ultrasonic Div., Wilton, Conn.

CIRCLE 99 ON READER-SERVICE CARD

Custom-Made Arrays

Kearfott Company's Solid State Physics Laboratory now provides a unique service to the electronic tube industry by designing and manufacturing a wide variety of permanent magnet periodic focusing arrays specifically tailored to the user's traveling wave tube requirements. Because



complete formulating, sintering, and machining equipment is available in the lab, arrays having properties providing compensation over virtually any ambient temperature range specified may be readily supplied.

A typical array utilized Kearfott's PM-3 material together with specially designed pole pieces, resulting in a design which is both smaller and lighter than other arrays of equivalent magnetic field strength. Pole pieces may be provided according to specification.

G. Toker, Kearfott Company, Inc., Dept. ED, 500 Main Ave., Clifton, N.J.

CIRCLE 107 ON READER-SERVICE CARD

Computer Research Lab Available

Laboratory facilities at Washington University, St. Louis, will be opened soon to private industry and the Government for research in computers and computing devices.

The laboratory, which will be in full operation at the beginning of the fall semester, will stress studies of digital computers, network analyzers and electronic control devices for computers. The facilities include electronic and electrical measuring, testing and recording apparatus; electrical instruments for low and high frequencies; power and signal sources for high and low frequencies, and electronic computer apparatus.

Computing Devices Research Lab., Engineering Laboratory Building, Dept. ED, Washington University, 6740 Millbrook Blvd., St. Louis 5, Mo.

CIRCLE 108 ON READER-SERVICE CARD



how many Resistors have you soldered recently?

It's no trick today to obtain resistors that give everything you need in the way of conventional characteristics such as load life, resistance-temperature, temperature cycling, and so on.

But what a whale of a difference when it comes to "solderability"! Try the different makes for yourself and see. Whether you solder by hand or by automatic dipping, you'll find that Stackpole Coldite 70+ resistors solder lots better, lots faster and lots more surely.

Just hit 'em with solder and they stay soldered—because they're the only resistors whose leads get an extra final solder dip *in addition* to the usual tin-lead coating. You get faster production, fewer rejected assemblies. And there's less chance of trouble developing after your products reach the field.

COMPARE THESE "SPECS"!— Write for Stackpole Resistor Bulletin giving complete scorecard for Coldite 70+ (cold-molded) resistors in relation to MIL as well as commercial specifications. And remember that they give you unmatched solderability in the bargain—at no extra cost!

Electronic Components Division STACKPOLE CARBON CO., St. Marys, Pa.



Ceramag® ferromagnetic cores • Slide and Snap switches • Variable composition resistors
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Brushes for all rotating electrical equipment
Hundred of related carbon, graphite, and metal powder products.

STACKPOLE
Coldite 70+
fixed composition resistors

CIRCLE 109 ON READER-SERVICE CARD



A personal and (let us hope) encouraging message to an
ELECTRONICS ENGINEER IN A QUANDARY:

When Dame Destiny crooks her finger at you and says, "Let's go with Bendix in Kansas City, old boy!" you face a set of small problems that are well worth solving . . .



There is an excellent possibility that very soon we shall be offering you the position you've been waiting for. It could be a position at a higher level than the one you now hold and—have little doubt about this—you'll be tempted.

You may, during this period of decision, suffer torments like the engineer we picture above. (We sympathize with him . . . most of us have been through it ourselves.) We'd like to help you then but we know that you yourself must measure these personal cataclysms and weigh them against the advantages of your professional future here. We can only suggest that Kansas City abounds with other potential playmates or sweethearts, other teams hopefully waiting for a star player, and—who knows?—your new drapes may need only slight alteration to fit Kansas City windows.

We're supremely confident that *somehow* you will find the resolution and ingenuity required to solve these problems if we give you sufficient incentive.

So let's talk about incentive.

Because Bendix, Kansas City, is a long term prime contractor for the AEC, we can say little here about our products except that they are advanced electronic, electro-mechanical devices designed and manufactured to extraordinarily high levels of reliability. After only ten years we have become the city's largest manufacturer, and we're still expanding. Recently-inaugurated programs make most likely that we can offer you a position that will fully utilize your talents in design, production or supervision.

You should find our salary offer of more than passing interest.

In general, we need *electronic engineers* with at least a BS degree, although

in some openings a degree in *physics* is acceptable. Experience should range upwards of 5 years.

We welcome *design and development engineers* qualified in the design and development of miniaturized airborne electronic equipment, radar, servo, video, IF amplifiers or vacuum tube applications.

Automation engineers with a degree EE or physics would be well-advised to learn about our current major expansion into fully automated testing of electronic assemblies.

Vacuum tube application engineers will find us attentive when they speak of their work in ruggedized sub-miniature tubes, planar triodes, thyratrons or special purpose microwave tubes.

Reliability engineers (preferably with an electrical degree and at least 7 years experience, including some statistical work) will discover that our ever-increasing emphasis on reliability assures them a place in the sun.

We wish we could present all the facts you'll need to weigh, but we find we've barely started. There's much more to say . . . how the Bendix environment stimulates professional creativity and personal progress, how this area provides pleasant, easy-going, economical living, educational advantages, cultural and recreational facilities, etc. . . . but these can wait. For the moment let us simply assure you that—in far less time than you think—you and your family will feel at home here.

We're ready to get very specific regarding your financial incentive. We must first hear from you. May we, soon?

Write Mr. T. H. Tillman, Professional Personnel, Bendix, Box 303-JB, Kansas City, Missouri.



KANSAS CITY DIVISION

CIRCLE 900 ON CAREER INQUIRY FORM

DESIGNING YOUR FUTURE

Signposts For Engineers On the Road to Management

G. A. Barnard, 3rd

Ampex Corp.
Redwood City, Calif.

Top posts as managers are beckoning talented engineers today. But the switch is not without pitfalls. It entails surrendering some of the orientation instilled by scientific training, some of the relentless curiosity of the engineer to want to know everything about a tangible "thing." The managerial role carries with it a strong portion of the intangible. This may not be worthwhile for some engineers. Others may find it challenging. This article will help you evaluate whether you are suited for a career in management.

CAN engineers become good managers?

A problem receiving considerable attention today is that of providing enough management and supervision within the middle ranks of expanding defense industries. The initial reaction is to divert operating personnel into managerial posts. Such personnel are usually engineers.

That engineers can become good managers is being demonstrated more and more as a growing number of executive positions are filled. This is particularly true in mechanical and electrical manufacturing. In the relatively young electronics industry, for example, engineers are assuming top executive positions in a wide range of companies.

Personal Qualities Essential

Like successful executives in other fields, engineers who have excelled possess qualities that include not only comprehension of the technical problems of their business but personal characteristics

that fit them for dealing with time, money.

To some management experts, the additional qualities spell "administrative ability," and some extremists have even said that these are the only important requirements of an executive. The engineer will find that most of these management qualities are not unique to a man of professional business training but can be developed.

Requirements Listed

What are the requirements for becoming a good executive? Here are some salient points:

A good executive is achievement-minded. To be satisfied with his work, he feels he must be accomplishing something worthwhile. By his own example and enthusiasm, he instills in his subordinates this same desire to achieve. When he feels that he can handle one job, he seeks additional responsibility, and he expects those under him to do the same.

He recognizes the need for lines

authority. He accepts and respects the authority above him, so long as it is applied fairly and according to principle; when it is otherwise, he makes his constructive criticisms through proper channels. He delegates his authority to those under him, and when he makes assignments, they are well defined.

He is a good organizer: his own affairs are always kept in good order and his actions well-planned. In leading an activity, he maintains clear direction, leaving no doubts about the goals to be reached and the methods for arriving at them. He strives for communication between his group and his superiors.

Decisions . . . Decisions

He is decisive. Not only does he analyze a problem and implement its solution, but he also recognizes there are times when making a decision is more important than the decision itself.

He has a genuine interest in aiding his company's growth. He is conscious of the profit in every undertaking.

He maintains a broad perspective of activities in his company and the industry. Although his interests range wide, he limits most of his action to activities that are the most immediate and practical.

He is a good teacher. He conducts his subordinate group in such a way that it can run itself without him. He strives to have each man know the essentials of every other man's job, including that of the manager. He allows neither himself nor any of his men to become indispensable, and where procedures are intricate and potentially confusing, he insists

that they be recorded and kept readily available.

At all times he maintains the highest integrity. He knows there may be occasions when it is prudent to refrain from making a commitment or when bluffing is the wisest strategy, but when direct action is called for, he is always honest. His own interests are secondary to those of his group.

Positive Approach Stressed

The positive approach is one of his biggest assets. He receives suggestions with an open mind and never rejects them without concrete reasons.

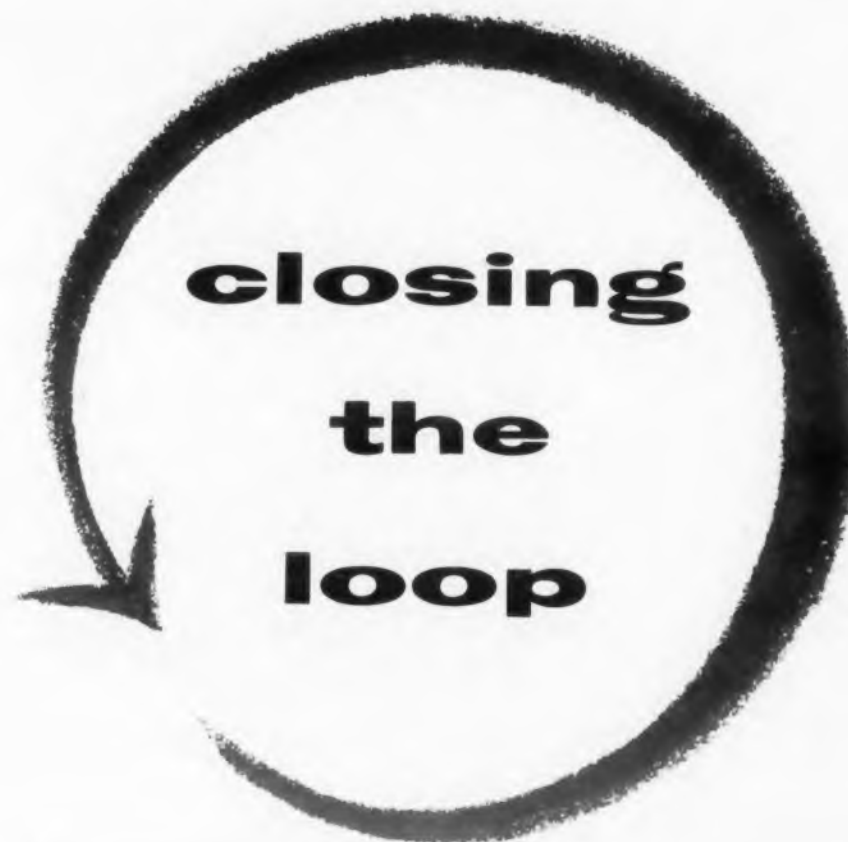
All will admit that many of these attributes are personal outlooks developed by men of stature, regardless of their field of specialty, whether exact and specialized or broad and loosely defined. A few of these characteristics, however, are not always included in an engineer's formal training or technical experience. He often tends to think only of the technical requirements of his work, while the competent manager must think of the economic implications, the way the end product is used by consumers and how it is produced by employees. The best technical product may not sell as well as one that sacrifices a few mechanical refinements for ease of use or for early marketing.

New Viewpoint Needed

Such considerations are usually taken care of outside of the engineering department, and the engineer is accustomed to accepting them as restrictions on his work. But when he assumes a role in management, he will be forced to accept this other side of the picture. Recognition of this point early in his career will help him attain a managerial point of view.

Usually an engineer organizes his technical affairs orderly, but it may be difficult for him to communicate these ideas to those above or below him who are not technically trained. The realization that management may not think in the same technical terms that he does should spur the engineering-trained man to use everyday language in his reports, recommendations and requests, so his word will be heeded. Sometimes this is necessary even between two different scientific fields, such as between the human engineering psychologist and the electrical project engineer.

(continued on following page)



At Motorola in Phoenix, engineers find unique opportunities for personal and professional growth in an atmosphere that encourages initiative and independence. Organized on a project basis, your engineering assignments begin with the original design, follow through development and production stages, and conclude only with final field evaluation. As an engineer, you are responsible for "closing the loop". The effectiveness of this *project approach* is borne out by Motorola's achievements in the military electronics field. If you are a creative engineer interested in the opportunity to carry your ideas through to completion, and if you like the idea of living in the brightest, healthiest climate in the United States, write today to Kel Rowan, Dept. B-7.



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CIRCLE 901 ON CAREER INQUIRY FORM

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Please send resume in complete confidence to:
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Engineering Employment Manager, Dept. 12 F-4

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Farmingdale, Long Island
New York

Please write direct to advertiser mentioning **ELECTRONIC DESIGN**

DESIGNING YOUR FUTURE

One of the engineer's strongest points as a manager is this trained ability to attack problems analytically. But such considerations as personnel relations or predicted market conditions are not always subject to cold logic. The engineer-manager may find he needs to do some investigation outside working hours to develop an appreciation of this seemingly nebulous aspect of his job.

Are all of the manager's activities aimed at aiding the company as a whole? Not unless he is thoroughly familiar with the over-all aims of the company. Usually, with minor variations, these can be expressed simply as an effort to make a consistent profit. This basic goal is easy to overlook when one is striving to perfect his engineering output—to serve the highest technical ideals of his calling.

Must Learn to 'Guess'

Strengthening his ability to see in broad perspective is the engineer's main task in aiming his career toward management. By all his exact formal training and all his experience in producing a precise product, he has learned to concentrate on details, to rely on mathematical proof and to back up every decision with facts. In taking a management position, he must learn to do the opposite: to continue to be decisive but without the comfortable security of tangible reasons for everything he does. Many of his actions will now be based on "if," and his definitive actions will be based on "educated guesses."

For many engineers, assuming such an attitude is distasteful, and early recognition of these management responsibilities can save them the discontent of pursuing the wrong course; at the same time their companies will not face losing good engineers, only to gain uncertain managers.

To alleviate such potential personnel problems, many technical companies now offer equal advancement opportunities for engineering and management talent. Separate career ladders are established, with comparable salaries and privileges. Individuals who are qualified may be transferred laterally between the professional and supervisory positions. But high-caliber engineers or scientists who have little inclination toward administrative activities need not change to receive equal rewards. ■ ■

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CIRCLE 902 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • June 24, 1968

CAREER OPPORTUNITIES BROCHURES

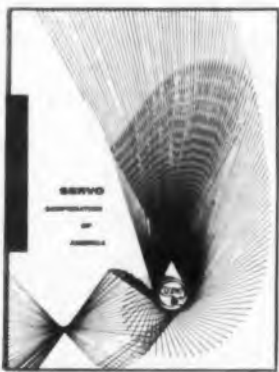
SEPD

IBM Special Products Division

The Special Products Division of IBM, less than two years old, emphasizes its growth and development potential for the engineer applicant. The work of SEPD is described generally and nine areas of activity in which they operate are listed. A typical project is described and the follow-through is spelled out. Opportunities existing now for the engineer in the electronic-computer field are itemized. Copies of the illustrated brochure from: Mr. T. P. Bianco, Special Engineering Products Division, IBM, Dept. ED, North Hamilton Street, Poughkeepsie, N.Y.

CIRCLE 870 ON READER-SERVICE CARD

Servo Corporation

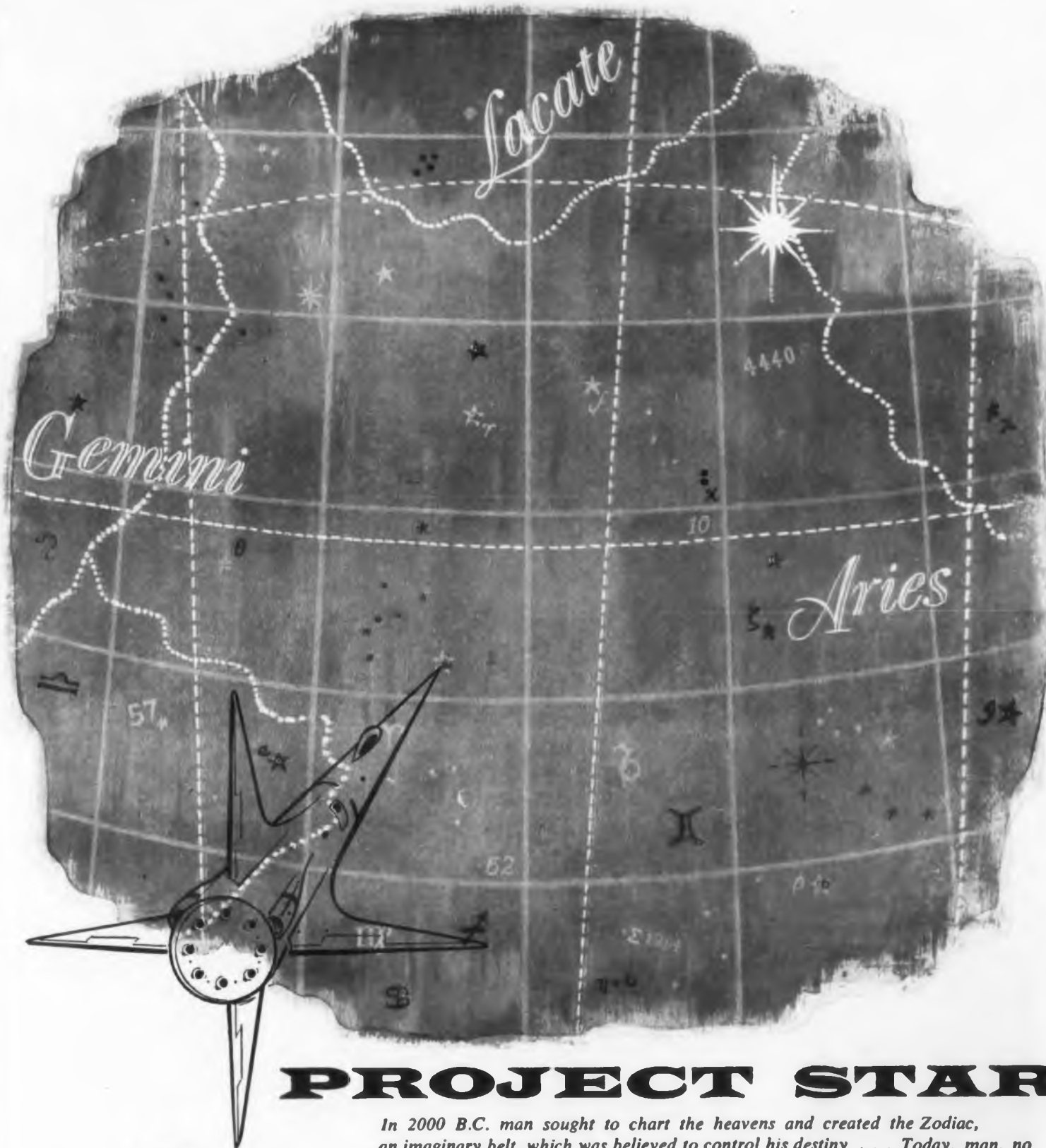


"Spectrum of Capabilities" presents the research, development and manufacturing capabilities of the organization. A chart showing areas in which Servo Corp. has been "first" introduces the reader to the actual accomplishments, areas of specialization and specific fields of application. Products of the company are itemized alphabetically. There is a brief description of production facilities, research and test facilities, quality control and inspection procedures, field service and training facilities. Servo Corporation is interested in staff engineers, development engineers and design engineers in each of the areas of specialization listed in the front of the booklet.

Felix Gardner, Supervisor, Employment Services, Dept. ED, Servo Corporation of America, 200 Junco Turnpike, New Hyde Park, N.Y.

CIRCLE 871 ON READER-SERVICE CARD

CAREERS



PROJECT STAR

In 2000 B.C. man sought to chart the heavens and created the Zodiac, an imaginary belt, which was believed to control his destiny . . . Today, man, no longer willing to surrender his fate to the stars . . . seeks to explore them instead.

America's determination, to win the race for space is evidenced by the formation of projects such as Airborne's STAR (Space Technology and Advanced Research). Here in our Laboratory a hard core of scientists and engineers are designing electronic systems for space vehicles. These programs are not company proposals, but firm orders of continuing duration for customer hardware. The esoteric nature of each piece of equipment places a premium on technical skill and ingenuity, as normal engineering procedures become overwhelming problems when transferred to the unworldly vacuum of space.

Project STAR is a culmination of our long-standing interest in electronic research and development. Space technology, and other new challenging areas open to electronic engineers at Airborne, have created select positions in the following fields:

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General Benefits Program and Relocation Expenses. Send resume to Howard J. Gresens who will arrange a technical interview at your convenience.

CIRCLE 903 ON CAREER INQUIRY FORM



AIRBORNE INSTRUMENTS LABORATORY

A DIVISION OF CUTLER-HAMMER, INC.

160 Old Country Road, Mineola, L. I., N. Y.
Pioneer 2-0600

CAREER OPPORTUNITIES

Emerson Electric Manufacturing Co.



"Talent Grows at Emerson Electric of St. Louis" is a generously illustrated photo story of the people behind this company. Myriad on-the-job illustrations provide a self-explanatory description of work and life with Emerson Electric in the St. Louis area. A laconic summary of company history, commercial products, work in electronics-avionics, and future growth potential is narrated throughout the booklet.

The Emerson Electric Manufacturing Co., Dept. ED, 8100 W. Florissant Ave., St. Louis 21, Mo.

CIRCLE 873 ON READER-SERVICE CARD

Ramo-Wooldridge



"An Introduction to Ramo-Wooldridge" emphasizes detailed descriptions and illustrations of current work projects. The activities include: Digital Computers, Controls and Information Processing, Communications and Navigations Systems, Infrared Systems, Electronic Reconnaissance and Counter-measures, Basic Research and Manufac-

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TI's new semiconductor solid circuits measure less than $\frac{1}{4} \times \frac{1}{8} \times \frac{1}{32}$ of an inch and incorporate up to 12 integral electronic components. Complete multivibrator circuit shown. In addition to extreme size and weight reduction, reliability also has been greatly increased.

join TI engineers in such challenging programs as micro-miniaturization

TI develops new semiconductor solid circuit with component densities up to 34 million per cubic foot!

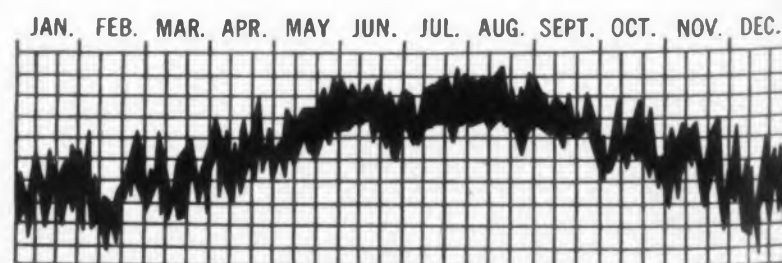
From one of many stimulating research and development programs at Texas Instruments comes another major "first" . . . new semiconductor solid circuits! Born from TI-sponsored research studies, the basic concept was carried through to reality by the Semiconductor-Components division. Utilizing TI developments in semiconductor manufacturing techniques (controlled masking, etching, diffusion), TI has formed diode and transistor elements, as well as passive elements of resistance and capacitance, to provide a complete circuit function normally requiring up to 12 components!

Such significant developments naturally result from TI's great emphasis on creative ability and freedom of professional expression. You'll find many challenging opportunities at Texas Instruments where such technological advances are a frequent occurrence. At the Apparatus division, weight and size are critical factors in its missile and aircraft electronic and electromechanical systems. You may explore new possibilities for making these systems even smaller and more reliable using the new semiconductor solid circuits. Or, with the GeoSciences and Instrumentation division, you may exercise this new concept in circuitry to create new and more compact commercial and industrial instrumentation.

A rewarding opportunity awaits you in one of the many programs now in progress at TI's Central Research Laboratory, Semiconductor-Components, Apparatus, and GeoSciences and Instrumentation divisions.

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turing. A brief outlook for the future and a complete listing of senior staff members is included.

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Director of Personnel, Howard J. Gresens, Airborne Instruments Laboratory, Dept. ED, Mineola, L.I., N.Y.

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Republic Aviation Corp., Dept. ED, Farmingdale, Long Island, N.Y.

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Arinc Research Corporation

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Arinc Research Corp., Dept. ED, 1700 K St., N.W. Washington 6, D.C.

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CIRCLE 907 ON CAREER INQUIRY FORM

ELECTRONIC DESIGN • June 24, 1958

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Study the employment opportunity ads in this section, and circle the numbers at the bottom of the form that correspond to the numbers of the ads that interest you.

ELECTRONIC DESIGN's Reader Service Department will make photocopies of your standardized resume and send it to all companies you select . . . *the same day the resume is received.* (ELECTRONIC DESIGN will detach the circle number portion of the form, so that no company will know how many numbers you circled.)

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Readers who desire only company brochures should use the regular Reader Service card.

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What The Russians Are Showing

... Sputniks



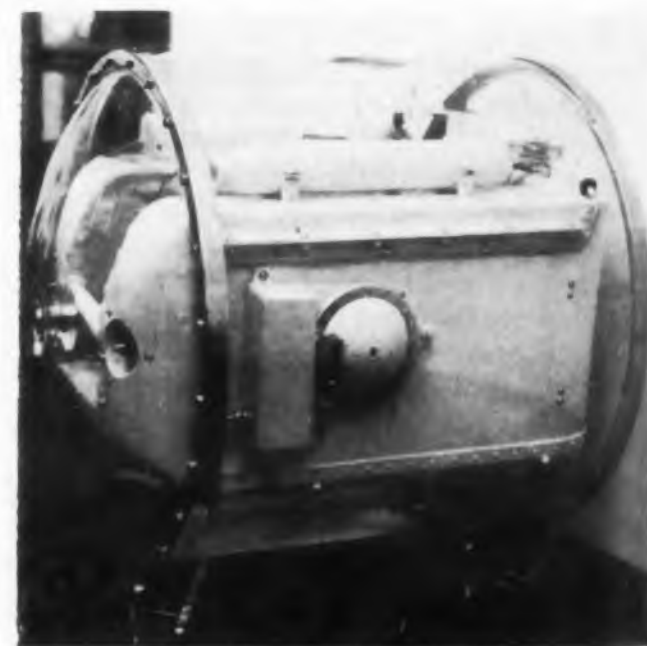
A model of Sputnik I is the first thing a visitor sees when he enters the Academy of Sciences Pavilion at the Agricultural and Industrial Exhibition in Moscow. Mounted on a sweeping arm that projects over the visitor's head, it gives a diaramic effect of space, with a backdrop showing a deep blue skyline with Moscow's tallest buildings in the background. Sputnik I trails its four long antennas.



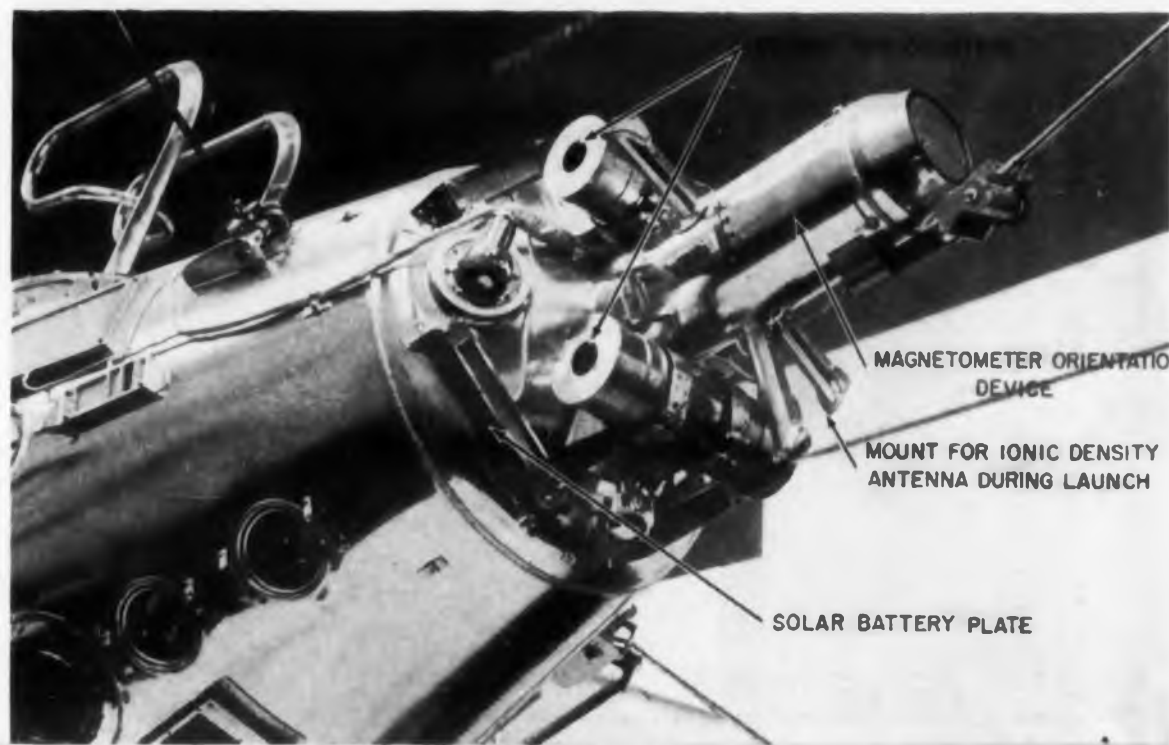
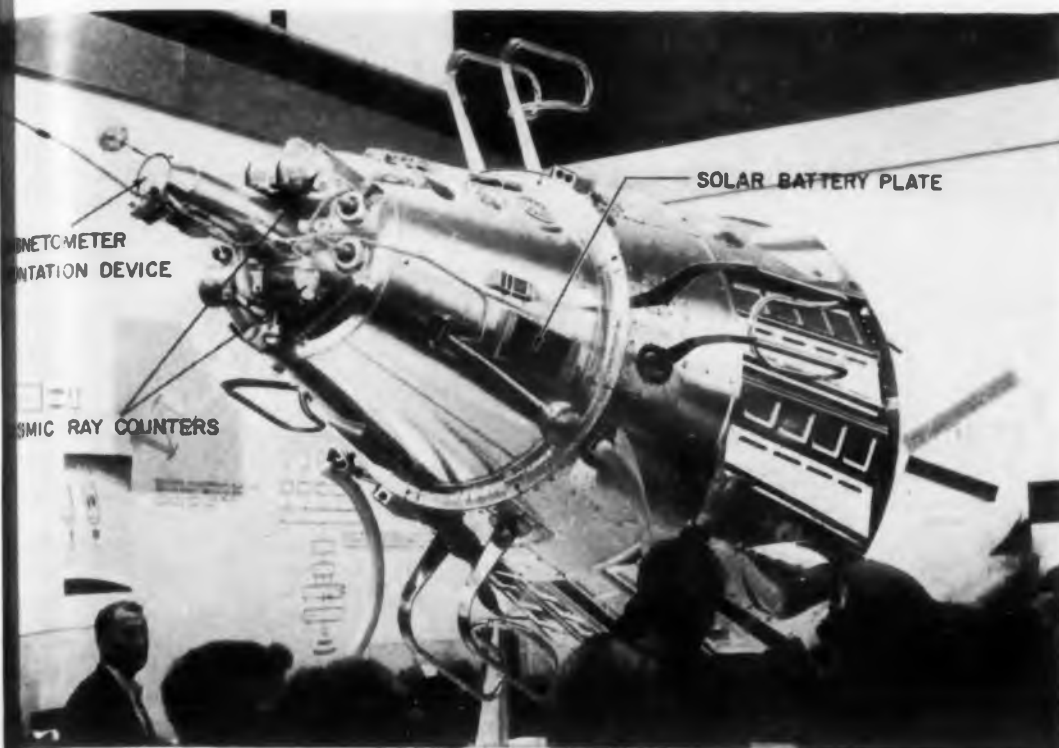
Models of Sputnik II and III are in a large room next to the entrance hall. Shown in this photo is Sputnik II. It carried a small dog into space. The cylinder housing the dog was in the base of the unit (with window). The spherical cylinder above it was a pressure tank for operating some of the equipment. The large spring at the top was for pushing the cap free of the unit after it went into orbit.

Here, in pictures, is a story of one of Russia's most boastworthy achievements—Sputniks. The pictures were taken at the recent Agricultural and Industrial Exhibition in Moscow where visitors could admire models representing man's first successful venture into space.

These revealing pictures were brought here by Mr. Richard E. Stockwell of Avco Manufacturing Company, Cincinnati, Ohio.



The doghouse in Sputnik II. The cylinder on top of the unit is an oxygen tank. The dog faced to the left and fitted snugly inside, so she couldn't turn around. The area occupied by the dog was fur-lined for comfort. She was fed automatically by a trip-mechanism, timed to feeding hours. A small fan circulated the air.

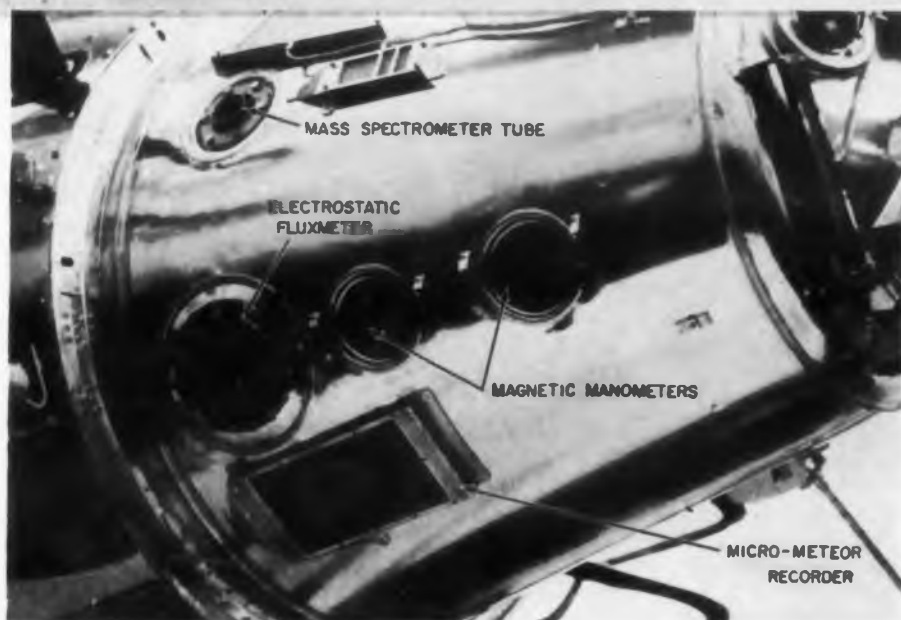


Sputnik III on display. The model is about eight feet long and nearly six feet across at the base, indicating that the Russians had to use a very large rocket to shoot Sputnik III into orbit.

There were no signs of any effort at miniaturization, and there was lots of evidence that standard, unrefined items of equipment had been adapted to Sputnik III's needs. Simplicity, always a commendable factor in Soviet design, was used here too. Extra thrust was used to compensate for the lack of refinement.

Close-up of the nose of Sputnik III shows the cosmic ray counters or photo-multipliers, the small solar battery plates arranged around the nose, and the casing on a magnetometer.

This model is not an exact duplicate of Sputnik III. Most of the metallic parts appeared to be of a light aluminum alloy which had been shined to a high lustre. One of the guides at the Exhibit identified the magnetometer as an "orientation device" that had been used to put Sputnik III into orbit.



Close-up of another part of the nose shows an opening for a recessed mass spectrometer tube used to study the ion composition of the ionosphere. A radio frequency mass spectrometer was used to determine the mass spectrum of positive ions.

Two magnetic manometers measured pressure encountered at low and high altitudes.

Two electrostatic fluxmeters (one shown here) measured the satellite's own electric charge and the intensity of the electrostatic fields in the upper layers of the atmosphere. The Russians said this device could be opened and closed 1500 times per second. The plate immediately below the fluxmeter was not described, but is believed to be a meteorite recording device.



The magnetometer encased in the nose of Sputnik III. The Russians described it as "an instrument whose measuring pickups are automatically oriented towards the earth's magnetic field, whatever the orientation of the satellite."

This capability was demonstrated with the unit shown here behind a plastic case. A guide opened the case, plugged in the magnetometer, and waved it about in an arc.

An electromagnet on the underside of the wheel caused it to react to even the slightest movement. The Russians explained that this was a part of Sputnik III's guidance system as well as a device for measuring the magnetic field in outer space.

(Continued on p. 66)

FIRST

Miniature 10 amp relay

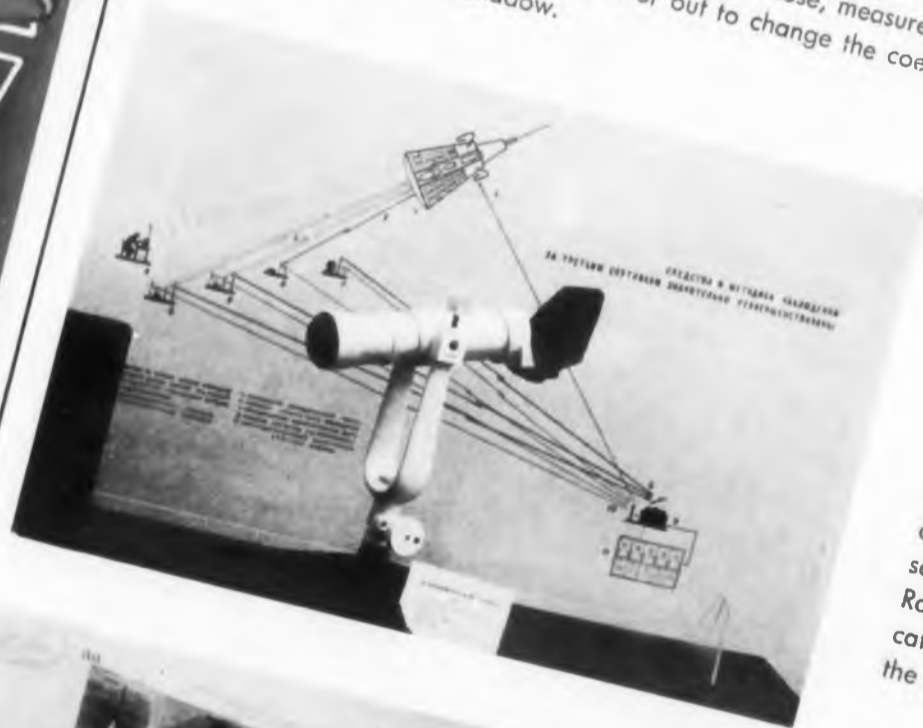
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BR-7 SPECIFICATIONS: Meets Mil R5757C and Mil R25018.

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Sputnik III from the side and rear. Three different antenna types were used for messages to and from ground stations. Several micro-meteor impact plates were used in the base, as well as a solar battery plate (not shown here). Three antennas, equally spaced around the nose, measured ionic density. Eight pairs of adjustable flaps could be swung in or out to change the coefficient of radiation moved in and out of the earth's shadow.



Optical equipment used to track Sputnik III. The schematic on the wall shows how a central control point directed messages to the satellite and, in turn, received them through a series of ground stations. Radar tracking is indicated by the figure on the left.



Historical pictures of early Russian rocket launching efforts, schematics of Sputnik tracking techniques, and the Exhibit shelves around the satellite carried samples of the equipment used to record messages from the Sputniks. There are also models of early Russian rockets.



High altitude rocket (above) used to study the upper atmosphere. Data gathering equipment, encased in the nose, was recovered by parachute, as shown in the background photo.

Early high altitude dog flights (below) used this rig, recovered by parachute. The dog's head was in the plastic globe, and its body in a pressure suit.



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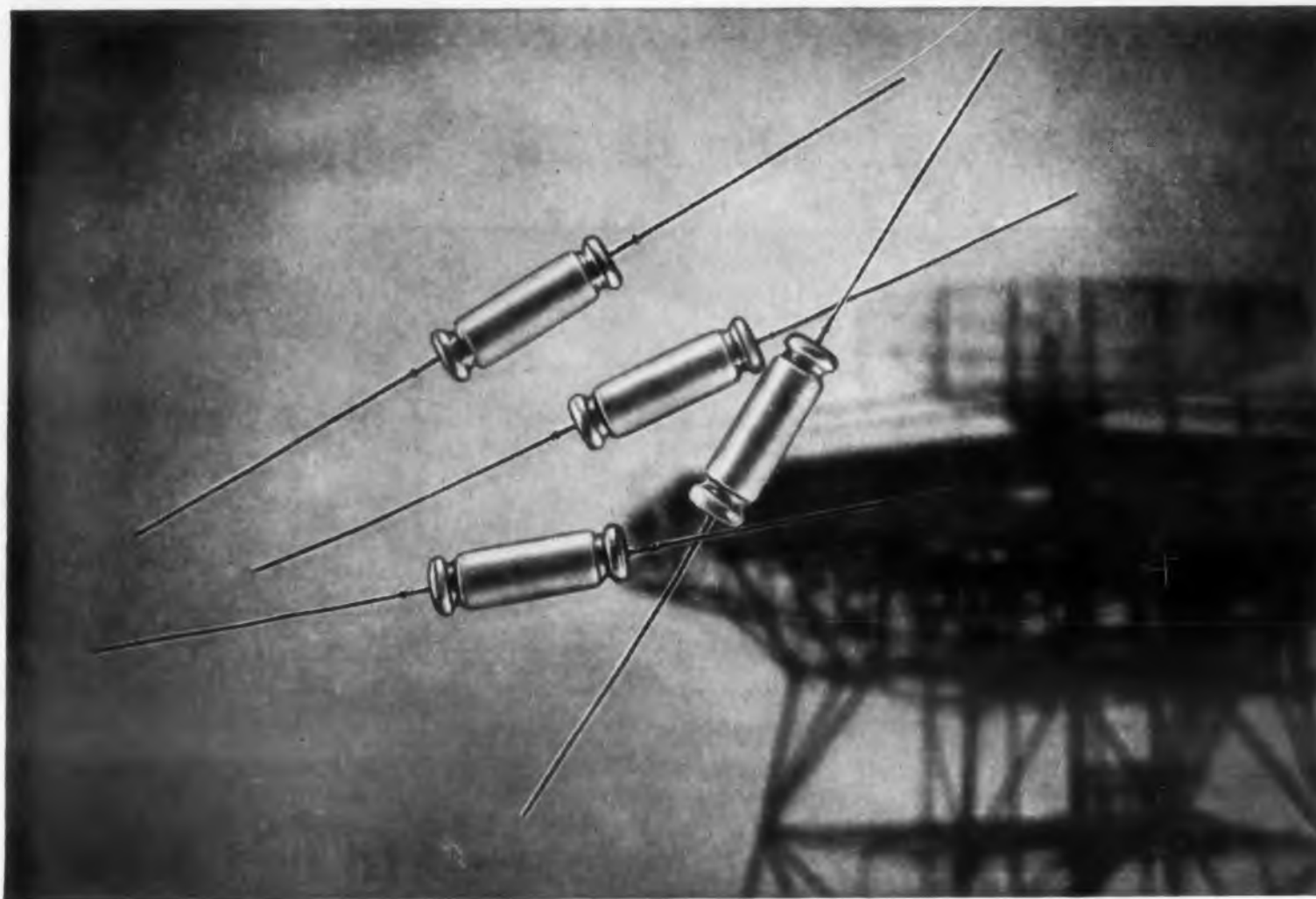
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CIRCLE 49 ON READER-SERVICE CARD

RUSSIAN TRANSLATIONS

Nonlinear and Parametric

ELECTRONIC DESIGN's serial translation of Professor Kharkevich's monograph concludes in this issue. The complete translation in book form will soon be available. For more information, turn to the Reader-Service Card and circle 80

Part 21

A. A. Kharkevich

(Translated by J. George Adashko)

Chapter 4

Parametric Phenomena

42. Frequency Division

In many cases an oscillator of a given frequency is available while a lower frequency, particular, a frequency n times smaller, is required. The operation of obtaining $1/n^{\text{th}}$ of initial frequency is called frequency division. Most frequently encountered is division by 2, obtaining half the frequency.

Frequency division, i.e., the production of fractional frequencies called subharmonics, is possible in nonlinear resonant circuits and in certain other nonlinear circuits. In this section we consider

Phenomena in Radio Engineering

struction and operation of a parametric frequency divider.

Consider a circuit consisting of a sinusoidal voltage source

$$E = E_m \cos 2\omega t$$

and an alternating admittance

$$Y = Y_0 (1 + m \sin \omega t)$$

The current in such a circuit is

$$I = EY = E_m Y_0 \left(\cos 2\omega t + \frac{m}{2} \sin 3\omega t - \frac{m}{2} \sin \omega t \right).$$

We note the presence of a current component having half the source frequency. In addition, there are components having the source frequency, and one-and-a-half times the frequency, 3ω . These components are filtered out and the oscillations of frequency ω used to control the admittance, we have the basic circuit of a divider, as shown in Fig. 146. The divider circuit must thus

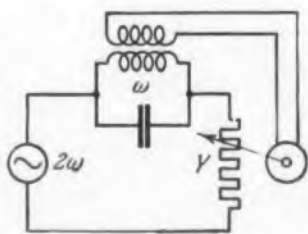


Fig. 146. A basic frequency divider.

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	BV _{CEO} volts	BV _{CEB} (R = 10K) volts	h _{FE} (V _{CE} = 6V, I _C = 1 ma)	
			Min.	Max.
2N652	45	30	100	250
2N651	45	30	50	125
2N650	45	30	25	70
T _J = 100°C Operating & Storage P _C = 200 mw				
COMMERCIAL AUDIO 85°C OPERATING				
	BV _{CEO} volts	BV _{CEB} (R = 10K) volts	h _{FE} (V _{CE} = 6V, I _C = 1 ma)	
			Min.	Max.
2N1193	40	25	100	250
2N1192	40	25	50	125
2N1191	40	25	30	70
T _J = 85°C Operating & Storage P _C = 175 mw				

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Nominal Spot Size (trace width)	0.002 inch	
Deflection	27 v/inch (nominal)	150 v/inch
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Writing Speed	3 x 10 ¹¹ trace widths/sec.	

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CIRCLE 51 ON READER-SERVICE CARD

RUSSIAN TRANSLATIONS

contain a feedback element, which causes the parameter (specifically the admittance) to oscillate at the fractional frequency.

The variable admittance may be the transconductance of a triode, which is a function of the grid voltage. If the characteristics of the tube are specified in the form

$$I_a = f(U)$$

the presence of a quadratic term in the function f results in a transconductance that is linear with the grid voltage. Let

$$f(U) = a_0 + a_1U + a_2U^2$$

then

$$S = \frac{dI_a}{dU} = a_1 + 2a_2U.$$

The simplest circuit employing this possibility is shown in Fig. 147. This circuit differs from the ordinary tuned-plate oscillator only in the presence of an ac source E in the grid circuit. The circuit of Fig. 147 does not differ in principle from the regenerative receiver, or in general from any potentially self-oscillating system acted upon by an external source. The source frequency is 2ω .

The tank circuit is tuned to half this frequency, ω . The grid voltage is the sum of the source voltage E and the voltage induced in the coupling coil. To be able to actually generate the half-frequency voltage, certain conditions must be satisfied; these will now be derived in simple form.

The circuit of Fig. 147 can be considered as some sort of an oscillator operating at half the frequency. To determine the excitation conditions of this oscillator, we use the phase and amplitude balance conditions. For this purpose, let us open the circuit at the point indicated by the dotted line in Fig. 147 and redraw it as shown in Fig. 148. Assume that the input voltage is

$$U_1 = U_m \sin \omega t$$

The grid voltage becomes

$$U_g = U_1 + E = U_m \sin \omega t + E_m \cos 2\omega t.$$

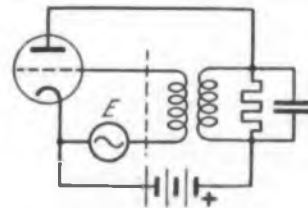


Fig. 147. A simple half-frequency oscillator.

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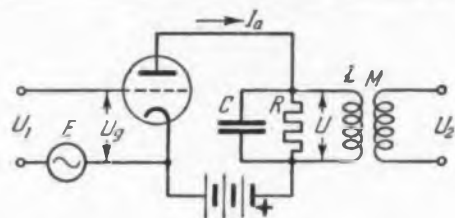


Fig. 148. The circuit of Fig. 147, redrawn with the grid circuit open.

The plate current is

$$I_a = f(U_g) = a_0 + a_1(U_1 + E) + a_2(U_1 + E)^2.$$

If the tank circuit is tuned to ω , the voltage components with different frequencies will be practically eliminated, and we obtain for the voltage of frequency ω

$$U = I_a R = R(a_1 + E_m a_2) U_1.$$

The output voltage is

$$U_2 = \frac{M}{L} U = kU$$

where $k = M/L$ is the coupling coefficient. Thus

$$U_2 = kR(a_1 + E_m a_2) U_1$$

To be able to maintain oscillations at a frequency ω in the closed circuit (i.e., in the circuit of Fig. 147, which we now restore by connecting the input and output terminals of the circuit of Fig. 148), we must satisfy the condition

$$U_2 > U_1$$

hence

$$kR(a_1 + E_m a_2) > 1. \quad (1)$$

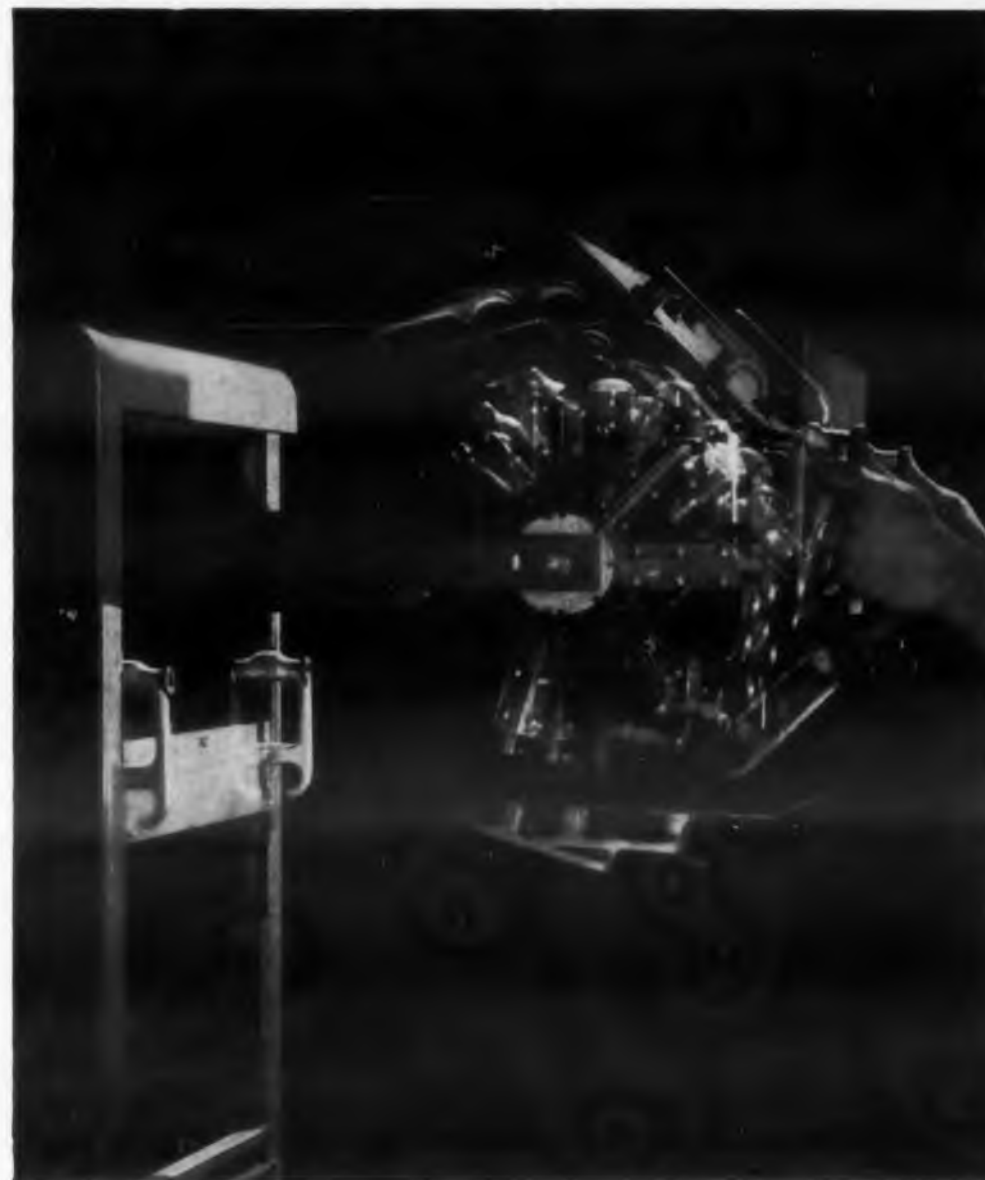
This indeed is the excitation condition for the circuit of Fig. 147, operating as a frequency divider. However, we must at once make the following important remark concerning this condition. Formula (1) shows that the circuit can be excited when $E = 0$, i.e., if

$$kR a_1 > 1. \quad (2)$$

The meaning of this relation becomes quite clear if we examine the circuit of Fig. 147: if the source voltage E is eliminated, we have an ordinary oscillator, capable of oscillating at the frequency ω (to which the tank circuit is tuned).

Formula (2) is none other than the self excitation condition for this type of oscillator. Consequently, for the circuit of Fig. 147 to be excited as a divider and not as an oscillator, the following two conditions must be satisfied simultaneously:*

*Division is possible also in an excited oscillator. In this case the mechanism of the phenomenon is different, for we deal with locking-in on a subharmonic. We shall not discuss this case.



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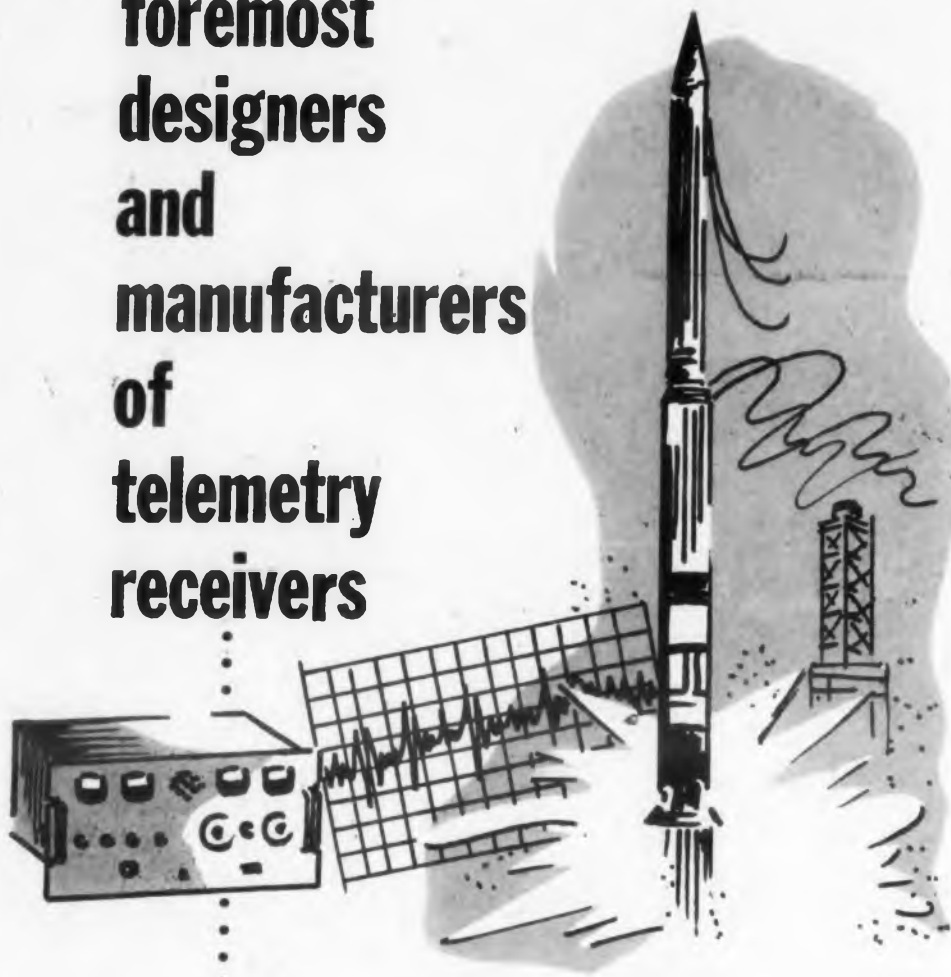


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$$\left. \begin{aligned} kR(a_1 + E_m a_2) &> 1 \\ kR a_1 &< 1 \end{aligned} \right\} \quad (3)$$

A few other remarks are also in order. First, the phase balance condition is satisfied in our analysis automatically, since, on the one hand, we choose $U_1 = U_m \sin \omega t$, and $E = E_m \cos 2\omega t$ (i.e., we choose, beforehand, suitable initial phases for the two voltages), and on the other hand we assume that the tank circuit is tuned to exact resonance. A more detailed analysis shows that division is possible within a certain range of detuning.

Secondly, the way we state the problem we can establish only the excitation condition, but cannot find the steady-state amplitudes. The point is that by considering only the quadratic term of the characteristic (the term necessary to produce division) we reduce the parametric problem to a linear one. A steady state is possible, as is known, only in a nonlinear system.

To investigate the steady state condition it is necessary to include at least a third-power term in the expression for the characteristic of the triode. A more detailed investigation of this type serves as the basis for the theory of the so called "second-order resonance."

In conclusion we must also note that simultaneous satisfaction of both conditions (3) is difficult in practice. The ability of the circuit of Fig. 147 to operate as an ordinary oscillator is one of its shortcomings. Regenerative frequency dividers, to which the next section is devoted are free of this shortcoming.

43. Regenerative Frequency Division

A characteristic of parametric excitation is that oscillations can be generated at a frequency other than the frequency at which the parameter is varied. In particular, as we have seen, it is most easy to excite oscillation at a frequency

$$\omega_0 = 1/2 \omega$$

where ω is the frequency of variation of the pa-

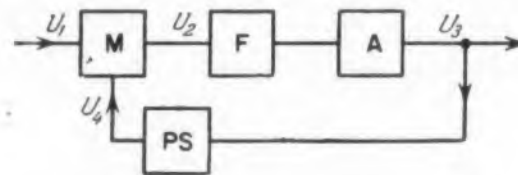


Fig. 149. Block diagram of a regenerative frequency divider.

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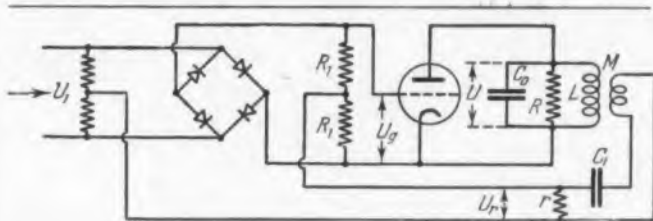


Fig. 150. A ring modulator serves as the multiplier in this frequency divider.

parameter. This circumstance can be used for frequency division.

Let us examine the block diagram shown in Fig. 149. The input voltage U_1 is applied to multiplier M , to which a voltage U_4 is also applied. The output of the multiplier U_2 is proportional to the product of the two inputs U_1 and U_4 .

The voltage U_2 is filtered by filter F , amplified by amplifier A , and the amplifier output voltage U_3 is fed back through phase shifter PS to the multiplier. We shall show that such a circuit is capable of dividing the frequency in two. Let the input voltage be

$$U_1 = \sin \omega t.$$

Assume that the frequency division takes place, so that

$$U_4 = \sin \omega t$$

then

$$U_2 = U_1 U_4 = \sin \omega t \sin 2 \omega t = \frac{1}{2} \cos \omega t - \frac{1}{2} \cos 3 \omega t.$$

The filter blocks the triple-frequency component, so that its output is $\frac{1}{2} \cos \omega t$. If the voltage gain of the amplifier is 2,

$$U_3 = \cos \omega t.$$

i.e., the output frequency is half the frequency of the input. If the phase shifter now introduces a 90 deg phase shift, we get

$$U_4 = \sin \omega t$$

as assumed beforehand. Circuits such as shown in Fig. 149 are called regenerative frequency dividers. This term implies the essential presence of feedback from the output of the circuit to its input.

It should be noted that the above analysis shows only that frequency division is possible with the aid of a regenerative divider. But this does not determine conditions under which the division actually takes place. Nor does it permit us to observe the essential features of the phenomenon.

One of these features is that the division begins only at a fixed value of the input voltage U_1 . To examine these important details, let us consider some specific circuit, for example, that shown in Fig. 150. The multiplier in this circuit is a ring modulator (see Section 12). We shall assume that

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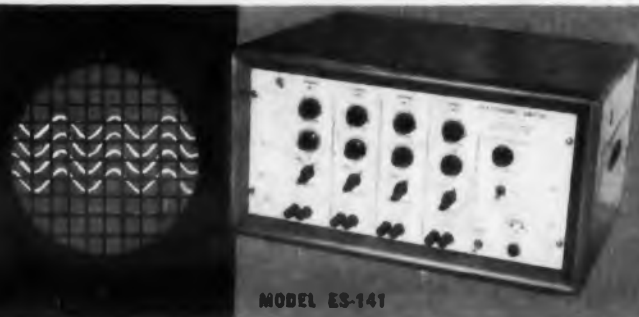
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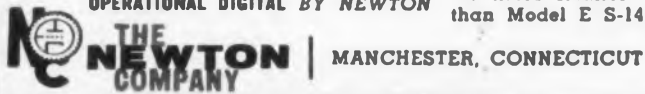
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it performs pure multiplication of the voltages applied to it. We write the current equations for the plate circuit of the triode

$$C_0 \frac{dU}{dt} = \frac{1}{R} U + \frac{1}{L} \int U dt = SU_r \quad (1)$$

where S is the transconductance. The voltage induced in the feedback coil is

$$e = M \frac{dI_L}{dt} = \frac{M}{L} U \quad (2)$$

The voltage acts in the rC_1 network. The voltage across r is

$$U_r \cong rC_1 \frac{de}{dt} \quad (3)$$

(provided the capacitor voltage is much greater than U_r). The rC_1 network serves as the phase shifter. The voltage U_r is applied to the multiplier: this indeed is the voltage designated earlier as U_4 . Next, the voltage picked off the ring modulator is equal to (see Section 12)

$$U_2 = U_0 = 4R_1a_2U_1U_4 \quad (4)$$

From (2), (3), and (4) we obtain

$$U_0 = 4a_2rR_1C_1 \frac{M}{L} U_1 \frac{dU}{dt} = kU_1 \frac{dU}{dt} \quad (5)$$

Inserting this value into (1) and grouping the terms containing dU/dt , we obtain an equation with variable coefficients

$$(C_0 - kSU_1) \frac{dU}{dt} + \frac{1}{R} U + \frac{1}{L} \int U dt = 0 \quad (6)$$

This is the equation for the current in a tank circuit whose capacitance varies with the input voltage. If the input voltage varies as

$$U_1 = U_m \sin 2\omega t$$

we have for the effective capacitance

$$C(t) = C_0 - kSU_m \sin 2\omega t = C_0 \left(1 - \frac{kS}{C_0} U_m \sin^2 2\omega t \right)$$

It is now clear that the mechanism of regenera-

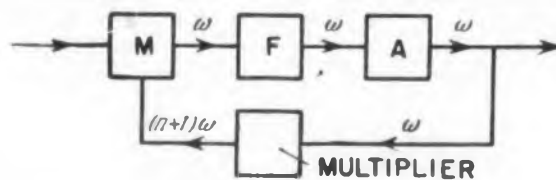


Fig. 151. In this regenerative divider the feedback element is an $(n+1)$ multiplier and the input frequency is $n\omega$.

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ve frequency division reduces to that of para-
metric excitation of oscillation. In our case the
excitation condition

$$n > 2d$$

becomes

$$\frac{kS}{C_0} U_m > 2d$$

$$U_m > \frac{1}{2} \frac{d}{a_2 \omega_0^2 r R_1 C_1 M S} \quad (7)$$

Let us recall the meaning of the quantities con-
tained in this formula: ω_0 is the natural frequency
of the tank circuit and equals $(LC_0)^{1/2}$, d is the
damping of the tank circuit, a_2 is the coefficient of
the nonlinear element of the ring modulator, R_1 is the
modulator load resistance (remember that in de-
riving (4) we assumed this resistance to be small
compared with the internal resistance of the mod-
ulator itself), r and C_1 are the feedback-loop re-
sistance and capacitance (remember that rC_1 must
be much less than $1/\omega_0$), and M is the coefficient
of mutual inductance.

Equation (7) gives the input-voltage amplitude
at which the divider circuit goes into operation.

In the preceding analysis we attempted to
choose the most favorable feedback phase, and
therefore used a suitable phase shifter in the
feedback loop. This is not essential: the divider
will also operate at different phase relationships,
but a suitably increased input voltage must be
used for the excitation. Practical circuits usually
contain no special phase shifting networks.

Various versions of regenerative-divider circuits
are possible. One modification of the circuit of
Fig. 149 results in a divider operating at any
desired frequency fraction.

If the feedback element is a multiplier with
ratio $(n + 1)$ (Fig. 151), and if the input fre-
quency is $n\omega$, the output frequency is ω . The fre-
quency of the output of the multiplier in the
feedback loop is $(n + 1)\omega$.

Multiplication of the two frequencies $n\omega$ and
 $(n + 1)\omega$ produces the sum and difference
 $(n + 1)\omega$ and $(n + 1)\omega - n\omega = \omega$, the latter
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REFLECTIONS which occur at flange connections of waveguide sections can be traced to several causes. The approximate formulas for the reflection factors caused by each of these individually, and in combinations, are summarized. The reflections at the flange connections of rectangular guides are caused by the following:

(1) Two sections may have different cross-sectional dimensions due to manufacturing tol-

erances. This is the principal cause of reflections and cannot be eliminated by careful assembly.

(2) Two sections with identical cross-section may be displaced (offset) parallel to each other.

(3) Two sections with identical cross-section may be twisted with respect to each other and/or the symmetry axes may be "kinked" with respect to each other.

The approximate formulas for the reflection factors due to these effects are given in the Table. The expressions for r_a are applications of the appropriate iris formulas and are experimentally confirmed. In the table a is the nominal shorter dimension of the guide, b is the width.

The effect of kink is negligible for $\alpha \leq 1$, the reflection factor due to the several other causes occurring simultaneously can be estimated from the formula.

$$r = [r_j^2 + (r_t \pm r_a)^2]^{1/2}$$

Abstracted from an article by U. V. Kienlin and A. Kuerzl, *Nachrichtentechnische Zeitschrift*, Vol. 11, No. 11, November 1958 pp 561-564.

Phototransistor Action

PHOTOEFFECTS at a p-n junction can be represented as an ideal current source. In the equivalent circuit of the photodiode, Fig. 1, the current source appears in parallel with a "dark" p-n junction in the region of operation where the photoelectric effect and the rectifying effect can be superposed.

The volt-ampere characteristics of a p-n photodiode is shown in Fig. 2 with light intensity as a parameter. Since, for $v = 0$ (short circuit), the p-n diode portion of the internal circuit has high back resistance, the contribution to the total current of the photoeffect is the short circuit current I_s at every light intensity. As indicated on Fig. 2, I_s is related to the open circuit voltage, v_o , through the (dark) diode characteristics.

Two types of operation for the photojunction are distinguished, depending on whether the diode voltage is connected in the reverse or in the forward

direction. These two situations correspond to operation in the first and second quadrant of Fig. 2 respectively.

Using the representation of Fig. 1, a phototransistor can be represented as the combination

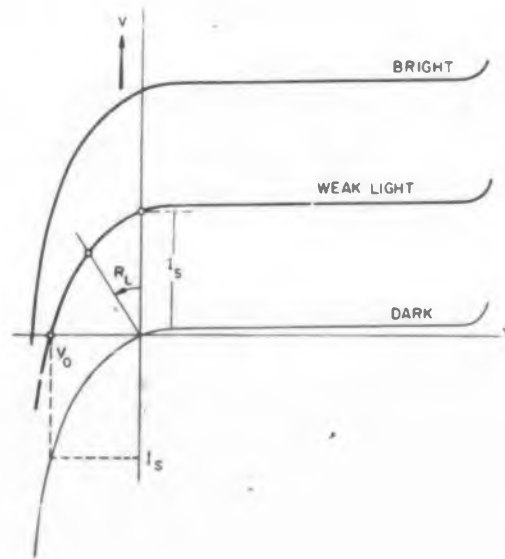


Fig. 2. Voltage-current characteristics of a p-n junction with light intensity a parameter.

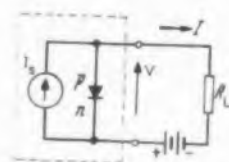


Fig. 1. The p-n photojunction is represented as the parallel combination of an ideal current source and the "dark" junction.

of a photodiode and an ordinary transistor by either Fig. 3 or Fig. 4.

In Fig. 3 the photoelement is on the collector side. Denoting the current amplification factor in the emitter configuration by a' , the collector current I_c is given by

$$I_c = (1 + a') I_{ph} \quad (1)$$

In Fig. 4 the photoelement is on the emitter side and the collector current is

$$I_c = a' I_{ph} \quad (2)$$

Although Eqs. 1 and 2 appear very similar, the collector current in two cases, for equal light intensities, will be very different because the control

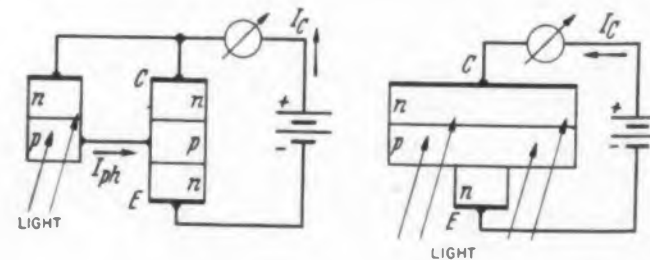


Fig. 3. The combination of photodiode and "dark" transistor as used to represent a transistor whose collector side is illuminated.

Reflection Factors Due to Flange Connections

Cause	Reflection factor (approx.)	Remarks
Cross-section imp: a, b , joined $a + \Delta a; b + \Delta b$	$r_j = \frac{1}{2} \left(\frac{\Delta b}{b} - \frac{1}{n^2} \frac{\Delta a}{a} \right)$	$n^2 = 1 - (f_c/f)^2$ $f_c =$ cutoff frequ.
Capacitive displacement cross sect. at flange: $a(b-d)$	$r_d = \frac{\pi^2}{2} \frac{b}{\lambda_g} \left(\frac{d}{b} \right)^2$	$\lambda_g =$ guide wave length
Inductive displacement cross Sect. at flange: $(a-d)b$	$r_d = \frac{\pi^2}{4} \frac{\lambda_g}{a} \left(\frac{d}{a} \right)^2$	
Twist through angle α	$r_t = \frac{1}{2} \sin^2 \alpha$	$f/f_c = 1.5$
Bank angle α in H plane	$r_{kH} = 0.15 \alpha^{2.5}$	
Bank angle α in E plane	$r_{kE} = 0.1 \alpha^{2.5}$	



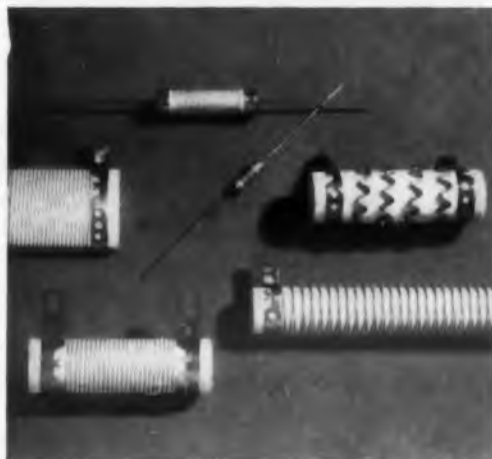
tough tests for incoming material



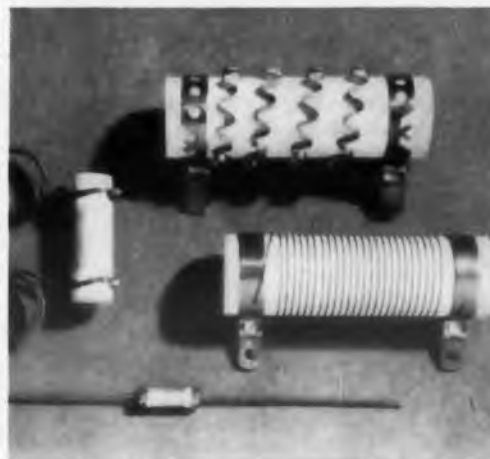
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photocurrent I_{ph} is different in the two cases. In Eq. 1 (Fig. 3) I_{ph} is virtually equal to I_s since operation is in the first quadrant of Fig. 2. For Eq. 2 (Fig. 4) the photocurrent is much smaller since the photoelement must act against the base-emitter voltage, i.e. operation is shifted into the second quadrant. It is concluded that the illumination of the p-n junction on the collector side is substantially more effective than on the emitter side since only in the former case the total photocurrent is amplified.

Abstracted from an article by A. Hoffman, Zeitschrift fuer Angewandte Physik, Vol. 10, No. 9 September 1958, pp 416-418.

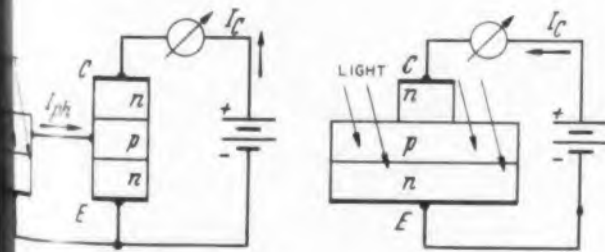


Fig. 4. The combination of photodiode and "dark" transistor as used to represent a transistor with illuminated emitter side.

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Torque: 1/4 oz.-in.
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Weight: 5 ounces
Speed: 300 RPM to 1/6 RPH
Torque: 30 oz.-in. @ 1 RPM
Length: 7/8 inch



WITH
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GEAR TRAIN

PATENTS

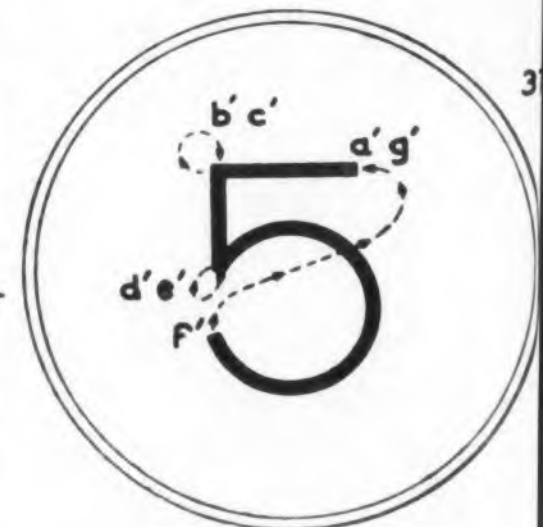
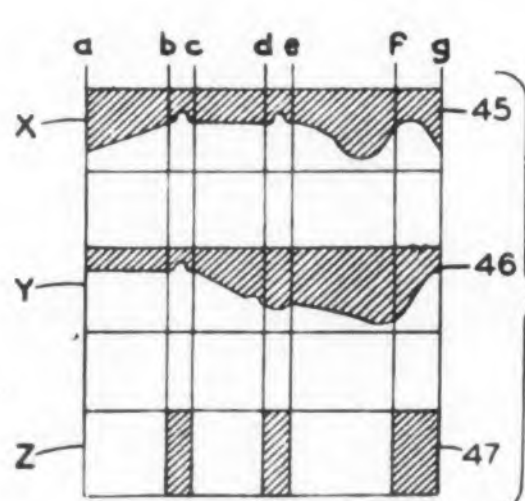
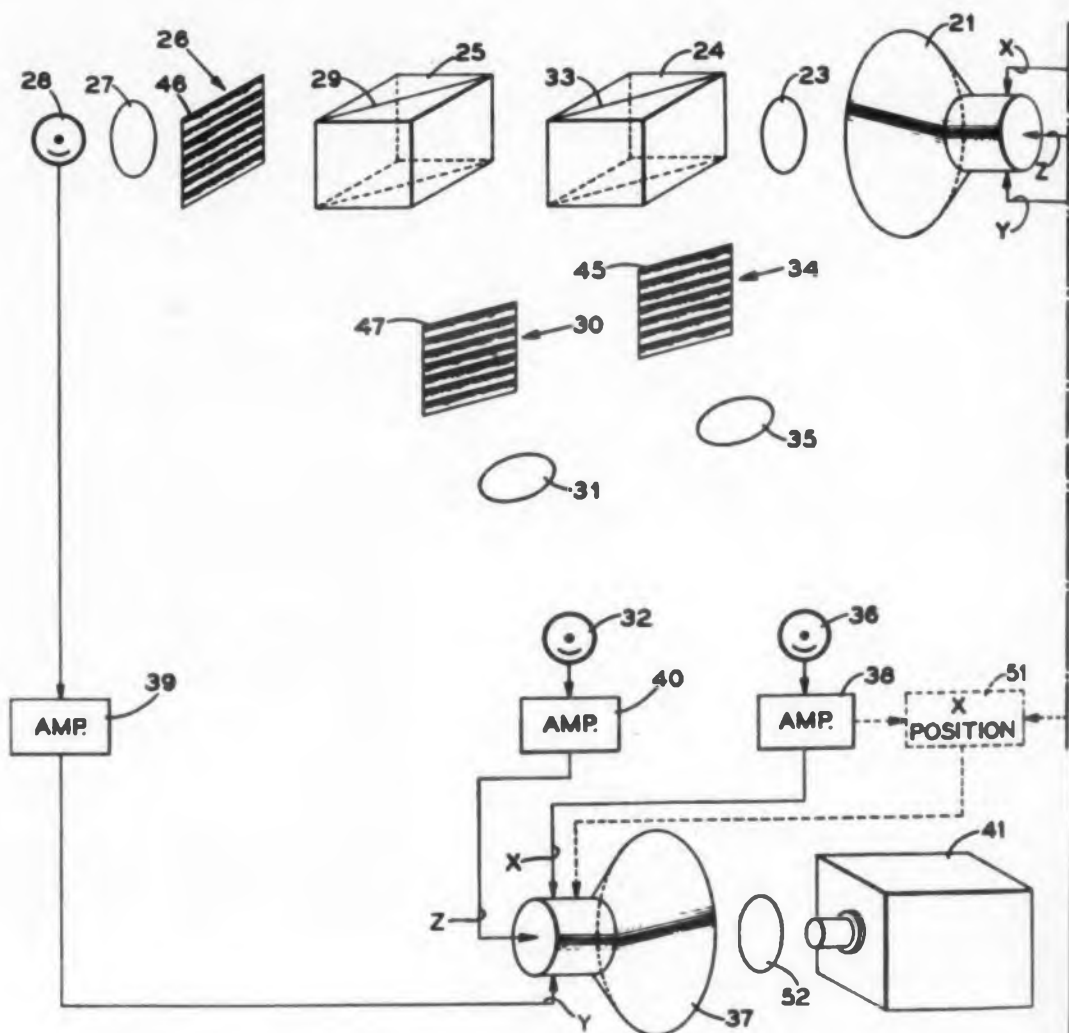
Cathode Ray Character Tracer

Patent No. 2,872,669. Reynold B. Johnson, William C. Dersch. (Assigned to International Business Machines Corp.)

Three-dimensional flying spot techniques are used to trace selected characters on a monitoring oscilloscope.

The scanning light beam is generated by CRT 21 and the light splits to pass

through slides 34, 26, and 30, containing line density patterns exemplified by 46, and 47 respectively. Phototubes 28, and 32 are excited to produce the x and y deflection waveforms and the intensity control signal. A typical transmission pattern which produces the fifth digit is shown. In a similar manner, the slide may be coded and the scanning adjusted to produce any chosen display.





BOOKS

Solid State Magnetic and Dielectric Devices

Editor, **John W. Katz**, Editor, **John Wiley & Sons, Inc.**, 440 Fourth Ave., New York 16, N.Y., 542 pp, \$13.50.

The authors present a complete account of the solid state devices and comments with the exception of the transistor. The volume begins with a classical treatment of magnetization and polarization—the essential electric properties—and then shows the general application of these principles to electrochemical phenomena, to square loop material, and to microwave frequencies. The remaining chapters are concerned with certain magnetic and dielectric devices.

The first four chapters present the majority of theoretical background: Electro-

static and Magnetostatic Field Theory, Origin of Magnetic and Dielectric Properties, Electrostrictive and Magnetostrictive Systems, and Nonlinear Magnetic and Dielectric Materials. The succeeding seven chapters present specific applications of magnetic and dielectric devices: Electromechanical, Small Signal, Ferrites at Microwave Frequencies, Magnetic and Dielectric Amplifiers, Digital Techniques Employing Square Loop Materials, Magnetic Recording, Magnetic and Dielectric Measurements. Four appendices cover Reciprocity in Linear Systems, Tensor Dielectric Constant of a Plasma, Magneto-resistance, and Parametric Devices. Tables and an index supplement the volume, while each chapter is summarized in a preface.

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BOOKS

Magnetic Amplifier Engineering

George M. Attura, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 220 pp, \$7.50.

Presented in the language of the electronic circuit and systems engineer, this volume offers guidance on theory, operating principles, and practical application of all types of magnetic amplifiers. Basic information on electric and magnetic variables is given and their interrelation through the questions of Faraday and Oersted are described. Special characteristics of the magnetic amplifier reactor are clearly discussed, and the magnetic amplifier reactor is contrasted with the performance of the linear inductor.

Against this background the various types of amplifiers are analyzed. A consistent analytical method applicable to all types of magnetic amplifiers is presented and specific types are treated from the same general basis.

Special topics not previously covered in a work of this kind include: hybrid circuits, bidirectional output amplifier, volt-

second analysis of saturable reactor winding and test specifications for toroid reactors, experimental testing of reactor detailed mathematical analysis of the location of the reactor-rectifier amplifier.

Symbolic Logic and Intelligent Machines

Edmund C. Berkeley, Reinhold Publishing Co., 430 Park Ave., New York 2, N. Y., 203 pp, \$6.50.

The principles, methods and purposes of symbolic logic and Boolean algebra, which the programming of intelligent machines is based, are explained in practical manner. Answers to basic questions toward ideas and terms needed to understand the subject as a whole are logically developed. The material on symbolic logic abounds in comparison and examples, as does the discussion of intelligent machines. The design and principles of both small and large machines are included, along with specific problems that confront these machines. The role of symbolic logic in the programming of automatic computers and such complex devices as robots complete this volume.



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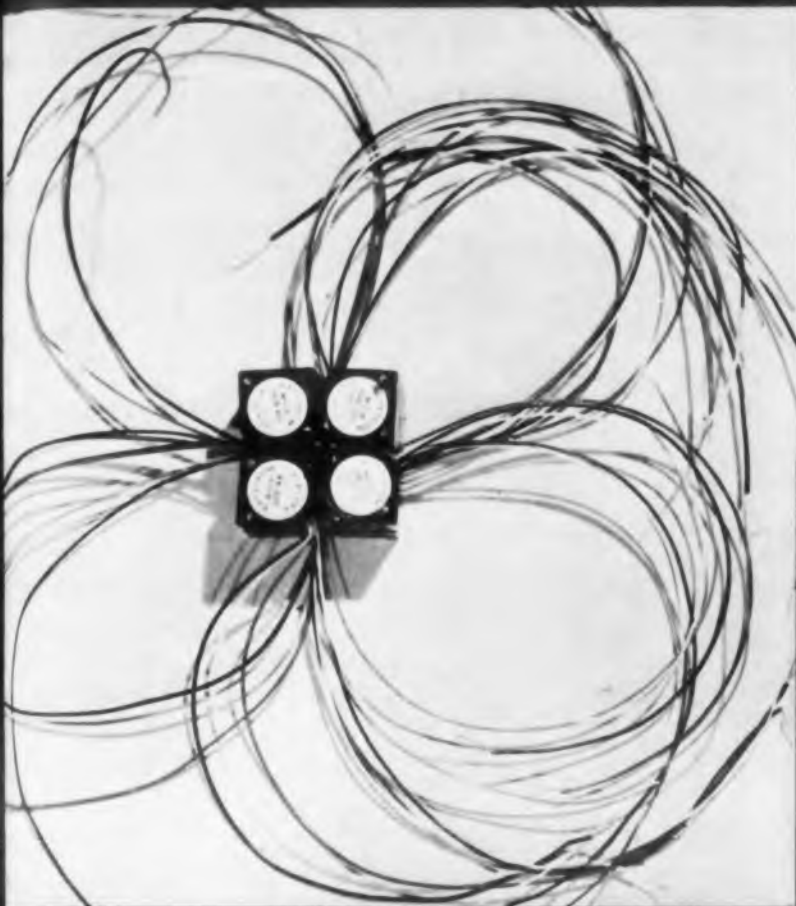


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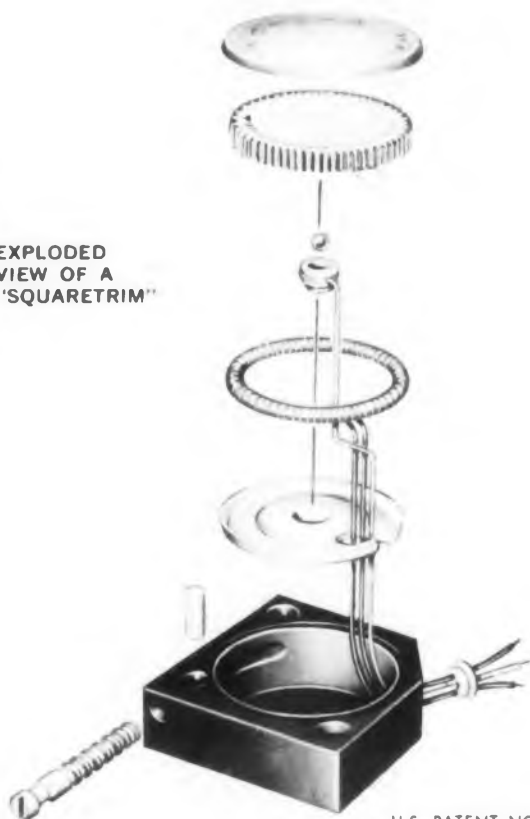
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Dielectric strength.....	500 v. AC, 1 minute

MODEL NUMBER	PHOTOS—ACTUAL SIZE	RESISTANCE
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MODEL 301		100Ω
MODEL 303		100Ω
MODEL 311		20K to
MODEL 313		10Ω to
MODEL 315		10Ω to
MODEL 318		10Ω to
MODEL 308		10Ω to

ENVIRONMENTAL

Vibration.....	20g, 10 to 2000 cps; exceeds MIL-E-5272A, Proc. I.
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10 Ω to 50K	1.0	150°C	.086%	Yes	1/2x1/2x.187
10 Ω to 50K	1.0	150°C	.086%	Yes	1/2x1/2x.255
100 Ω to 150K	1.5	150°C	.070%	Yes	3/4x3/4x.280
20K to 1 meg.	0.5	85°C	Infinite	No	1/2x1/2x.187
10 Ω to 50K	1.5	200°C	.086%	Yes	1/2x1/2x.187
10 Ω to 50K	1.0	150°C	.086%	Yes	1/2x1/2x.218
10 Ω to 50K	1.5	200°C	.086%	Yes	1/2x1/2x.255
10 Ω to 50K	0.5	140°C	.14%	Yes	.32x.28x1.25

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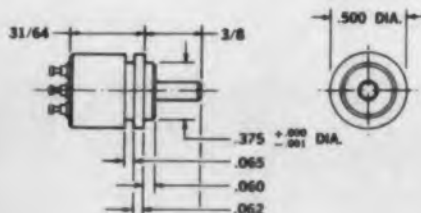


SUBMINIATURE PRECISION POTENTIOMETERS

MODEL 304 SUBMINIATURE SINGLE-TURN POTENTIOMETER



Model 304, actual size.
Bushing and locking versions also available.



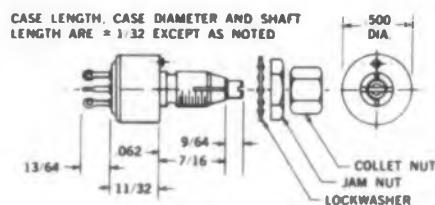
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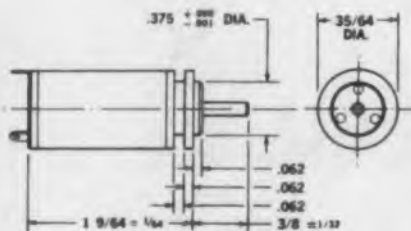


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Model 341, actual size.
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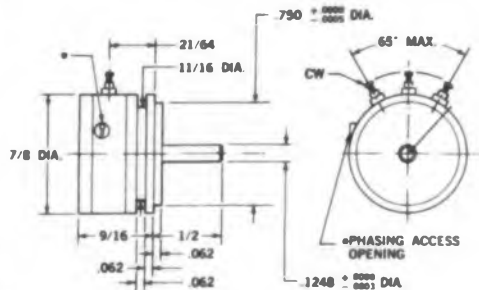


Series features stability in smallest package of its type. Range 1K to 200K. Built to withstand severe vibration or shock, to eliminate the backlash problem, and to reduce phase shift to negligibility. Linearity available as low as 0.05%. Double wipers eliminate intermittents and effectively double the resolution. Machined aluminum case affords high power ratings over extremely wide temperature range (operates to 140°C). Separate means for positioning wiper carriage lengthens service life by ending resistance element wear. Also available in 3 and 5 turns.

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Electromechanical Energy Conversion

David C. White, Herbert H. Woodson,
John Wiley & Sons, Inc., 440 Fourth Ave.,
New York 16, N. Y., 646 pp, \$12.50.

The authors start from the fundamentals of analytical dynamics to establish a sound base for understanding the interactions in an electromechanical system. These fundamentals are then used to analyze typical energy converters. The essential concepts of electromechanical energy conversion are illustrated by the analysis of several simple transducers. In recognition of the importance of dynamic behavior in system design this book favors thorough treatment of dynamic characteristics of energy converters, feedback control system theory, and their interrelations.

To illustrate and utilize the unity that exists in the analysis of machines, a two-phase model of an electric machine, classified as the generalized machine, is developed and its equation of motion derived and used in all the machine analyses of later chapters. The technique of applying constraints to general dynamic equations is used in a detailed treatment of the

dynamics of commutator machines, induction machines, and synchronous machines.

The Physics of Electricity and Magnetism

William Taussig Scott, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 635 pp, \$8.75.

This book provides a thorough explanation of the basic theory of electricity and magnetism, treated in a rigorous manner from the viewpoint of a physicist. The author uses a modern atomic approach to describe phenomena such as metallic conduction and the production of chemical and thermal emfs. The analysis of magnetic fields starts with the Lorentz force law, and Maxwell's equations are introduced as an integral part of the text, with a chapter at the end on their applications. Concepts are presented one at a time, and each is developed with examples before the next is introduced.

The fully descriptive yet mathematical treatment (using vector notation and intermediate calculus) serves as a smooth transition to more advanced work in physics.

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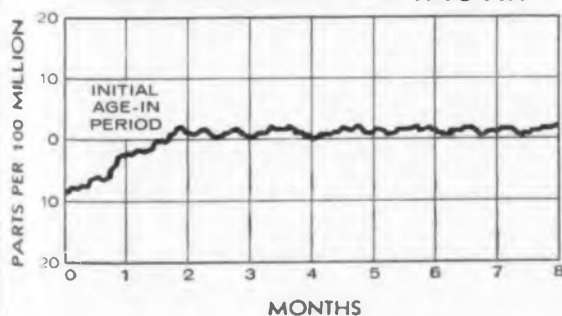
Oven: Long life; booster and control thermostats hermetically sealed.

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LONG TERM STABILITY OF JKTO-P1A



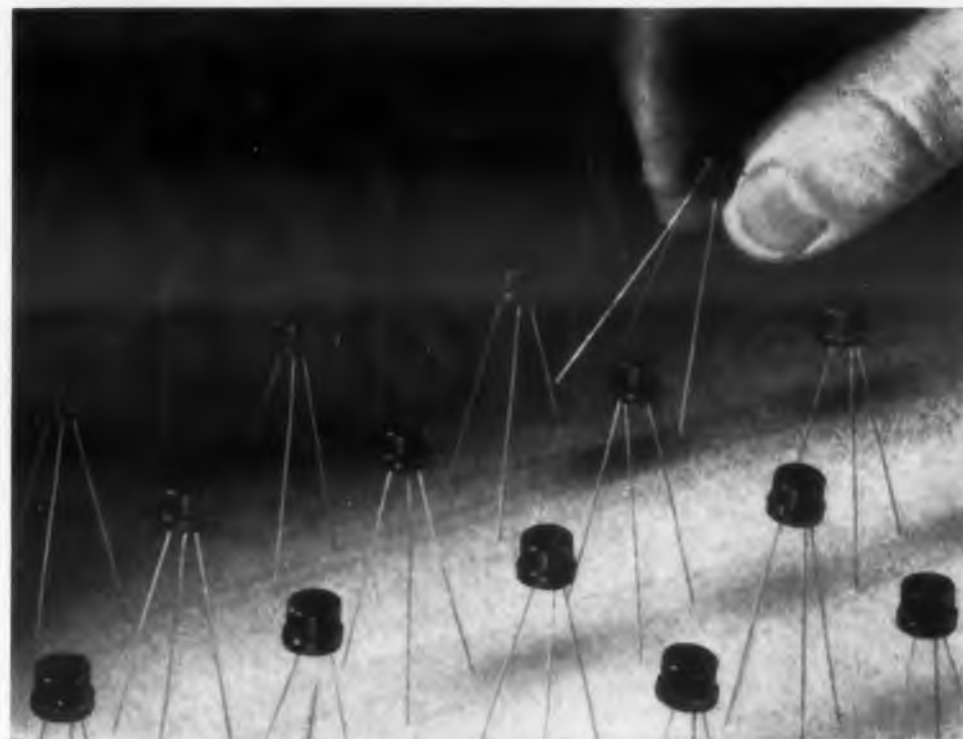
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ELECTRONIC DESIGN • June 24, 1959

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Eliminating the internal connection between transistor and case allows circuit isolation. Long life and stable operation are assured by welded construction and a vacuum-tight seal.

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	Vce Vdc	Ic mAdc	Pc mW	Ib mAdc	T Storage °C	Tj °C
2N1008	-20	300	400	30	-65 to +85	85
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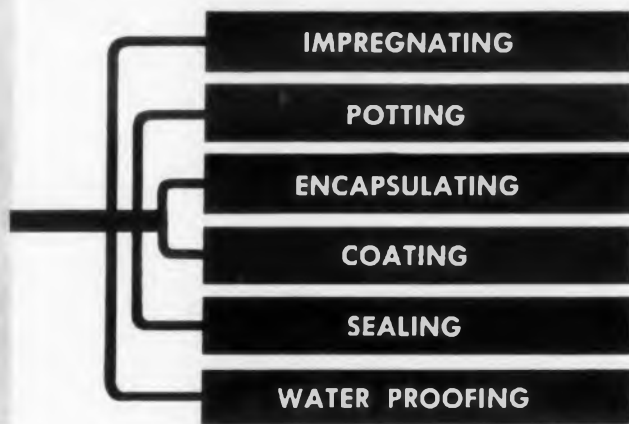


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BOOKS

Electrical Measurement Analysis

Ernest Frank, McGraw-Hill Co., Inc., 330 W. 42 St., New York 36, N. Y., 443 pp, \$8.75.

The purpose of this book is to develop in the student the attitudes and comprehension necessary for the analytical solution of problems arising in electrical measurements. Methods, concepts, and analysis techniques are emphasized. With a minimum of qualitative material, the material has been selected to illustrate basic measurement concepts, while omitting many specific topics.

Methods of measurement are classified into two major categories: null and deflection methods. Illustrations in each category are developed in mathematical detail. Special attention is given to ideas of measurement errors and their statistical treatment. Particular attention is given to the compensation theorem. Error-analysis techniques are emphasized in the treatment of ohmmeters, potentiometers and bridges. Square-wave response of galvanometers is analyzed from both

a steady-state and transient point of view.

Topics covered in detail include statistics and errors; fundamental force ideas from a modern viewpoint, and the relationship between force and field energy. Treatment of data with emphasis on line graphs as an analysis tool; and technique of error analysis. Problems are grouped at the end of each chapter and answers are given at the end of the book.

Electronic Digital Computers

Charles V. L. Smith, McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y., 443 pp, \$12.00.

A comprehensive picture of the basic principles embodied in the computing machines in use today is presented in this book, which provides the reader with a sound and thorough account of what electronic digital computers are and how they function.

From the treatment of the basic logic and arithmetic notions to the discussion of the circuits and devices by which the basic functions are physically realized, and



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the description of the major units of a representative machine, everything important to the form and function of electronic digital computers is taken up here.

Dictionary of Guided Missiles and Space Flight

Ed. Grayson Merrill, D. Van Nostrand Co., Inc., Princeton, N. J., 688 pp, \$17.50

This dictionary defines and explains the most commonly used terms in the guided missile and space flight fields today. Reflecting the work of leading professionals, combines their endeavors to facilitate the establishment of a common language in the selected field by offering a compendium of commonly used terms.

Terms defined include current and historical guided missiles and spacecraft; their systems used for guidance and control, propulsion, armament and launching; the components that make up these systems; and all related terms from aerodynamics, astrodynamics, electronics, astronomy and physics. Included are terms for types of antennas, circuits, radar systems and propellants, as well as the important laws, relationships, equations, environments and concepts which

govern utilization in design.

Illustrations and discussions are provided for important terms. A comprehensive cross-referencing plan is included.

The Theory and Design of Magnetic Amplifiers

E. H. Frost-Smith, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 487 pp, \$12.50.

This book is the first of a series on Automation and Control Engineering, which is planned to cover as comprehensively as possible this wide field in the most economical way for the control engineer. The aim of the first volume is to give an account of the theory of magnetic amplifiers and to link up the theory with the design in a way which it is hoped will be of value not only to the professional engineer, but also to the university student. Many of the theoretical aspects are supplemented by short numerical examples and, in addition, a number of complete designs are carried out in one chapter. Some typical problems to which magnetic amplifiers have been applied successfully are discussed in another chapter. A list of principal symbols is contained in the preface.

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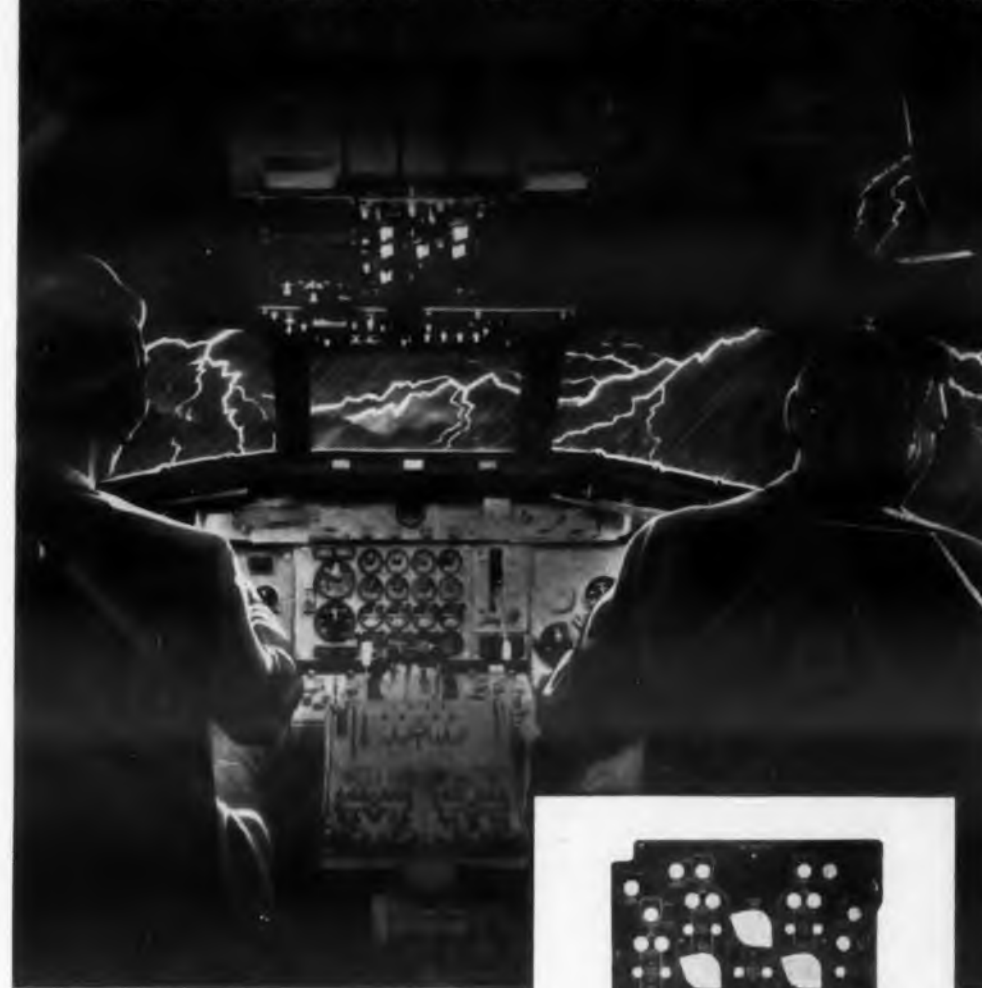
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ON CAREER INQUIRY FORM PAGE 63

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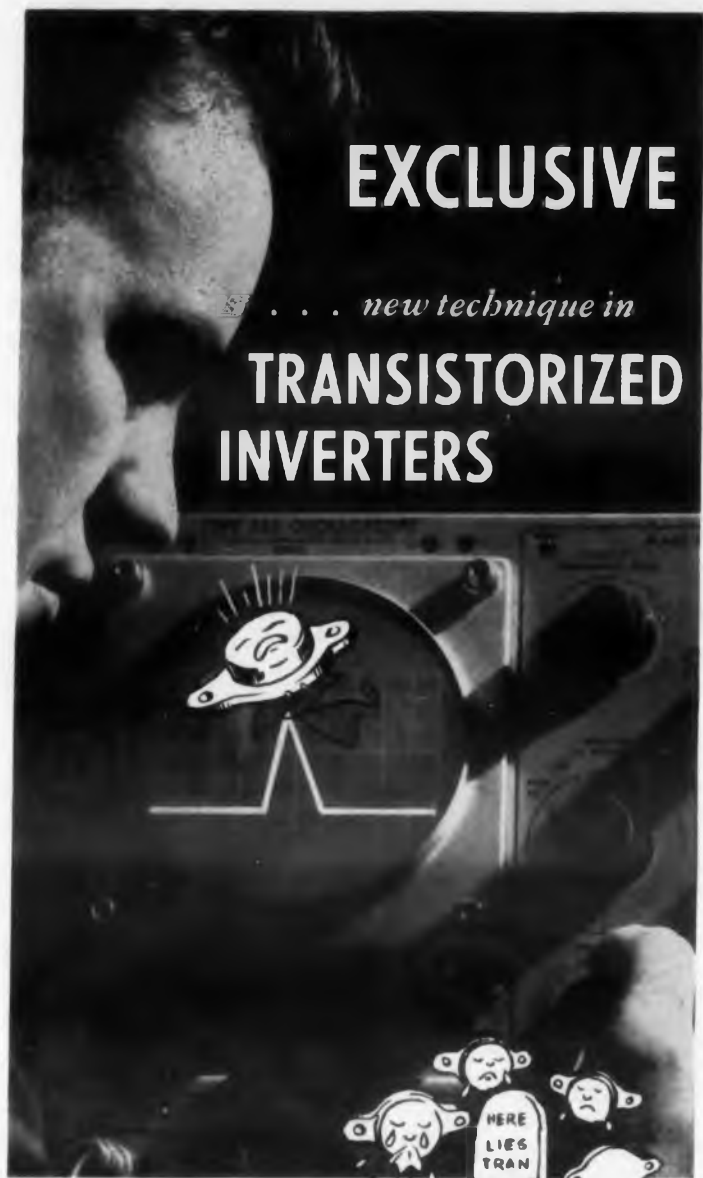
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REPORT BRIEFS

Radio Interference

The purpose of this memorandum is to examine some of the consequences of radio interference for the operator. By knowing what these consequences are one can be prepared to understand the penalties for not adequately solving interference problems. The principal conclusion to be reached is that the penalties of letting an operator cope with the results of radio interference are sometimes much greater than design engineers recognize. *Detection of Aircraft by Radars Subjected to Radio Interference*, John D. Coakley, Dunlap and Associates, Inc., Stamford, Conn., May 57, 18pp, Microfilm \$2.40, Photocopy \$3.30. Order PB 135 736 from Library of Congress, Washington 25, D.C.

Design of Shaped Response Microwave Filter

An array of microwave filters was designed and developed to provide instantaneous frequency indication over the 8000 to 10,000-mc band. The range is covered with cosinusoidal functions of frequency about their center frequencies. The bandwidth of each filter is 220 mc from zero to zero. The filter is composed of cascaded LC-coupled cavities separated by $\lambda/4$ connecting lines. *Design of Shaped Response Microwave Filter*, W. R. LePage and A. T. Villeneuve, Syracuse U. Research Inst., N. Y., May 31, 1956, 106 pp, Microfilm \$5.70, Photocopy \$16.80. Order PB 135376 from Library of Congress, Washington 25, D. C.

A Ferrite Rod Antenna

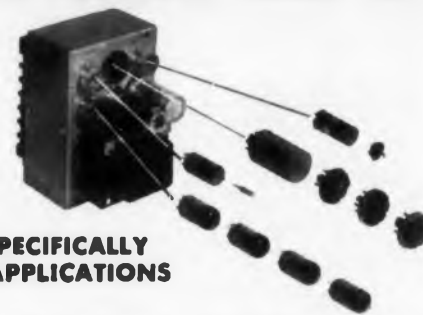
The radiation characteristics at X-band of a ferrite rod antenna are studied. The antenna consists of a ferrite rod supported axially in a circular waveguide which is terminated in an infinite ground plane. The rod extends out of the waveguide above the ground plane. Radiation patterns as a function of dc biasing magnetic field on the ferrite are shown for both linearly and circularly polarized energy propagating in the TE_{11} mode in a circular waveguide and continuing on the extending ferrite rod. *A Ferrite Rod Antenna*, A. B. Johnson and D. J. Angelakos, Electronics Research Lab., U. of California, Berkeley, 13 Aug 57, 25pp, Microfilm \$2.70, Photocopy \$4.80. Order PB 135 099 from Library of Congress, Washington 25, D.C.

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ELECTRONIC DESIGN • June 24, 1957

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Self-Adjusting Control System

Application of a self-adjusting procedure to a control system with Gaussian random inputs and subject to limiting is considered. A self-adjusting control system is defined as a feedback control system which is capable of adjusting its own compensation (by means of an external computer) in accordance with some criterion, here assumed to be the minimization of the system mean-square error. The purpose of such adjustment is to provide partial compensation for variation in the parameters of the controlled component and for variations in the statistics of the input. *Self-adjusting Control System, Robert R. Bairnsfather, Instrumentation Lab., Mass. Inst. of Tech., Cambridge, May 56, 53pp, Microfilm \$3.60, Photocopy \$9.30. Order PB 135 698 from Library of Congress, Washington 25, D.C.*

Stabilization of Computer Circuits

The objective of this study was the elimination of reduction of time dependence of output errors in continuous computers by use of special circuitry which would generate correcting factors as functions of the errors. A general theory of stabilizing circuits was formulated and applied to the functions of the harmonic oscillator and the direction cosine generator. It was proved analytically that a stabilizing circuit would bring marked improvement in the generation of these functions. The result was demonstrated experimentally in both cases. *Stabilization of Computer Circuits, E. Hochfeld, University of Chicago for Wright Air Development Center, U. S. Air Force, Nov. 1957, 39 pp, \$1.00. Order PB 151255 from OTS, U. S. Dept. of Commerce, Washington 25, D.C.*

Regulated Power Supply

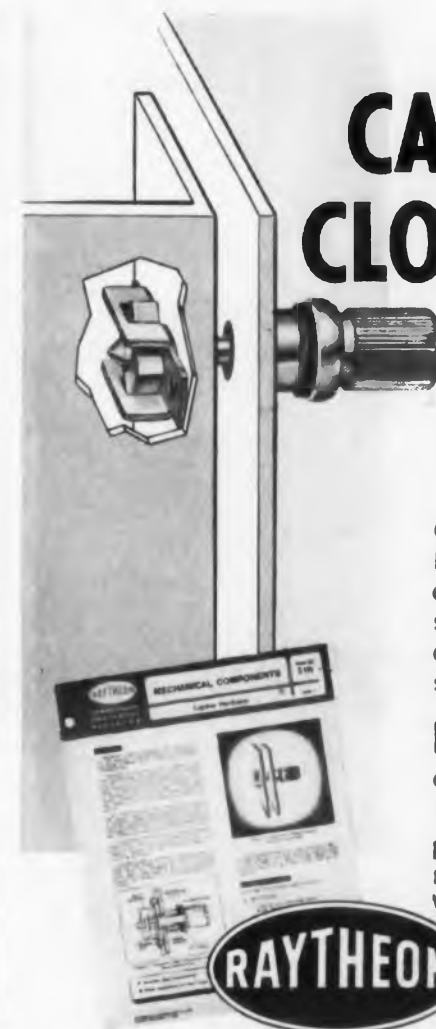
A careful study of power supplies with the aim of developing a standard series of unitized regulated power supplies has shown that all the characteristics of a regulated power supply may be predetermined by circuit design and/or analysis. The study also showed that few present power supply designs will meet present-day general-use requirements completely. The report presents methods of analyzing and testing power supply characteristics. These methods are intended to serve as a basis for further work in the design of a family of standardized power supplies. *Regulated Power Supply Analysis And Design, W. Ellis, J. P. Ward and D. M. Lowe, Naval Electronics Lab., San Diego, Calif., Mar. 4, 1957, 103 pp, \$2.50. Order PB 151121 from OTS, Washington 25, D.C.*

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Methods described in this publication are primarily for use in the band of 300 to 400 mc. Copies of this 10-page bulletin are available from the Government Printing Office for 15 cents each. Request Catalog No. C13.4:598.

DOD Technical Documentation

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A collection of the keynote address, remarks, and presentations given to acquaint Department of Defense contractors with the new uniform provisioning documentation requirements established by Department of Defense Instruction 3232.7. This instruction is included at the end of the publication. Copies of the 194-page publication are available from the Government Printing Office for \$1.00. Order Catalog No. D4.2:D65.

Components

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Describes preferred instrument components and illustrates their major characteristics. These components were developed for the Bureau of Ordnance primarily for fire control instruments, and computing and navigational systems, as well as for missiles. Copies of this 288-page publication are available from the Government Printing Office for \$4.75. Order Catalog No. D215.9:1755.

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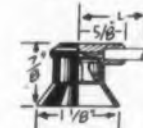
Clip this out — keep handy for part numbers and specs on connectors below for either 1/4" or 3/8" top caps. Prefix 90 for 1/4"; 91 for 3/8". Lead wire 18" long from center of cap or length to your specs.



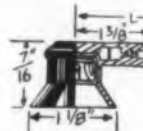
#90 or 91SCCSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout.



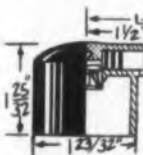
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ELECTRONIC DESIGN • June 24, 1959

Markings

MIL-STD-130A, IDENTIFICATION MARKING OF UNITED STATES MILITARY PROPERTY, 8 SEPTEMBER, 1958

The item marking requirements for identification purposes are established by this standard. The markings are required for stocking and replacing of parts, subassemblies, assemblies, units, sets, and all other items of supply.

Canadian Standards

The 1959 issue of the CSA List of Publications has just been published. All currently available CSA standards are listed according to subject. In addition, publications of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) are listed. Copies of this list are available without charge from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada.

Airborne Radio

Minimum performance standards for the following were issued by the Radio Technical Commission for Aeronautics on February 10, 1959:

- 226-58/DO-92, AIRBORNE LORAN A RECEIVING EQUIPMENT OPERATING WITHIN THE R-F RANGE OF 1800-2000 KC (Price 30 cents per copy)
- 26-59/DO-94, PORTABLE AIRCRAFT EMERGENCY COMMUNICATIONS EQUIPMENT OPERATING WITHIN THE R-F RANGE OF 118 TO 250 MC (Price 30 cents per copy)
- 25-59/DO-93, AIRBORNE SELECTIVE CALLING EQUIPMENT (Price 30 cents per copy)

Copies of these publications may be obtained from Radio Technical Commission for Aeronautics, Room 1072, Building T-5, 16th & Constitution Avenue, N.W., Washington 25, D.C.

Transformers and Inductors

MIL-T-27A, TRANSFORMERS AND INDUCTORS (AUDIO, POWER, AND PULSE) AMENDMENT 2, 2 JANUARY 1959

The criteria for self-extinguishing tests for flammability are now defined. The definition for working voltage has been revised to read: The working voltage is defined as the maximum instantaneous voltage stress that may appear under the normal rated operation across the insulation being considered. This insulation may be between windings or between windings and the core or case. A higher dielectric strength test potential for individual windings may be used, if so specified by the manufacturer, to simplify testing procedures at sea level and high altitude. The high-altitude dielectric strength test potential for units rated less than 50 working volts is now specified as 100 v.

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- 10 cps to 100 kc
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- 0.02 μ s rise time
- 50 v into 50 ohms



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Write for Catalog 1958-59ED



Model 3450B
MEGACYCLE PULSE GENERATOR

Representatives
in Major Cities

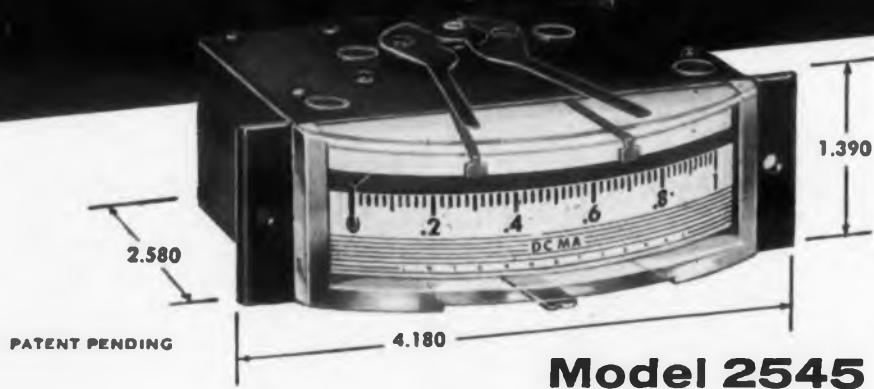


Electro-Pulse, Inc.

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CIRCLE 89 ON READER-SERVICE CARD

NEW ELECTRONIC CONTROL METER



Operates WITHOUT Contacts at the Switching Points!

Offering You these Important Advantages:-

- **ONLY MINIATURIZED CONTROL METER** . . . now available without contacts.
- **MORE RELIABLE SWITCHING** . . . with elimination of contact resistance, arcing and corrosion. Signal does not depend on pointer contact.
- **FULL-SCALE USE** . . . of indicating meter always available, regardless of control point settings.
- **MORE ACCURATE READINGS** . . . with indicating circuit completely isolated from the switching circuit.
- **SIMPLEST SYSTEM** . . . with no need for pull-in or locking coils and no re-set mechanism.
- **EXTERNAL ZERO ADJUSTER**

for Applications like these--

- Automatic Process Control
- Missile Check-out
- Nuclear Instrumentation
- Machine Tool Control

Switching is accomplished by a metal shield attached to the pointer passing between 2 mutually coupled coils of a self-contained, transistorized oscillator-detector-amplifier. Positions of the 2 control points are manually set by means of external arms. Provides the same scale length as conventional 4½" meters. Accuracy held to ±2% of full-scale for dc and ±5% for ac.

Write FOR ENGINEERING DATA SHEETS ON ELECTRONIC CONTROL METER AND: Side Indicators; 1½" Ruggedized Meters; 1" and 1½" Panel Meters; 1½" VU, and Db Meters; Sub-Miniature Rotary and Lever Switches; Miniature Multitesters.



MINIATURIZATION HEADQUARTERS
international instruments
 INCORPORATED
 P.O. BOX 2954, NEW HAVEN 15, CONN. • Cable: "INTERINST"

CIRCLE 90 ON READER-SERVICE CARD

NEW LITERATURE

Connectors 91

The DS series of miniature electrical connectors with snap-in contacts and crimp-type terminations are described in the DS catalog. Detailed instructions on contact crimping, insertion and removal are also covered. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Transistors 92

Brochure G-100 describes custom quality transistors for original equipment manufacturers. It is a four-page, illustrated folder with a chart insert having tabulated specifications on the firm's most popular EIA-registered transistor types. The chart shows case style, polarity, and gives detailed data on cut-off characteristics, dc and switching characteristics, and small signal characteristics of each numbered type shown. Types are grouped by classification, and identified by name in an application cross-index. General Transistor Corp., 91-27 138th Place, Jamaica 35, N.Y.

Instrument Components

Master catalog #20, 416 pages, consolidates all previous catalogs and supplements. It lists over 10,000 items, including gears, shafts, collars, couplings, speed reducers, differentials and other precision items available from stock. Also included are detailed drawings, complete specifications and prices. PIC Design Corp., 4 Atlantic Ave., East Rockaway, L.I., N.Y.

Magnet Wire

High temperature ceramic insulated magnet wire for service up to 1000 F described in this eight-page brochure. The brochure contains basic information on the original research as well as recent engineering data. Included in the brochure are the electrical insulation values of the various types of insulation available at elevated temperatures. The brochure contains charts and diagrams. See Metals Corp., 7 Intervale St., White Plains, N.Y.



NEW! HI-POWER COAXIAL CALORIMETRIC POWER METER

DIRECT READING—5 to 50 KW
 DC—1000 MC • VSWR less than 1.3

These power meters are greatly simplified Calorimeters which use water to carry the heat away, for economy of space and cost.

The instrument is fully self-contained, portable, water cooled and requires only connection to the power line and water supply. It does not use any flow meters, thermometers or any other controls. There is only the "ON" and "OFF" switch for the operator to use on the front panel, when a measurement is to be made. A sensitive thermopile and microammeter measure the power dissipated in the R.F. load. The microammeter is calibrated in watts, is direct reading and can be remotely located.

The radio frequency load has a low VSWR between DC to 1000 MC. This feature makes it possible to calibrate this instrument at 60 cps against an accurate laboratory type wattmeter, and then use it at any frequency up to 1000 MC. Thus an accuracy of 2% can be easily accomplished. This recalibration is necessary only when measurements are made at extreme temperatures or when wear is suspected.

This calorimeter is particularly recommended for field service where a rugged and yet accurate Power Meter is required for use by unskilled personnel.

Model	Power Rating	Connector	Max. VSWR	Water Supply
CX-5	5 KW	1-5/8"	1.3	1.5 G.P.M.
CX-10	10 KW	3-1/8"	1.3	3 G.P.M.
CX-20	20 KW	3-1/8"	1.3	6 G.P.M.
CX-50	50 KW	6-1/8"	1.3	15 G.P.M.

WRITE FOR COMPLETE INFORMATION

ELECTRO IMPULSE Laboratory

208 River Street

Red Bank, New Jersey

Phone: SHadyside 1-0404

CIRCLE 95 ON READER-SERVICE CARD

Iron-Nickel Alloys

110

Entitled "Directory of U.S. Producers of the Iron-Nickel Alloys," this booklet is designed to help those with the responsibility of obtaining information on, or procurement of, the iron-nickel alloys where their end-use depends on special thermal expansivity, thermo-elastic or special magnetic properties. It lists compositions, the manufacturers, and forms available to industry. The International Nickel Co., Inc., Readers Service Section, 67 Wall St., New York 5, N.Y.

HP Motors

111

A wide range of fractional horsepower geared motors, turntables, transmissions and cup dispensers are illustrated and described in a series of bulletins being distributed in a file folder. Complete specifications and dimensional drawings are included. Merkle-Korff Gear Co., 213 North Morgan St., Chicago 7, Ill.

Square-Loop Tape Cores

112

These three engineering bulletins provide a complete set of data on the firm's

square-loop tape cores for magnetic amplifiers and speciality transformers. Performance characteristics are given in bulletin No. DN-2000. Standard core sizes are in bulletin No. DN-2001, and magnetic characteristics of standard cores plus other technical data are given in bulletin No. DN-2002. Dynacor, Inc., 10431 Metropolitan Ave., Kensington, Md.

Inertia Switches

113

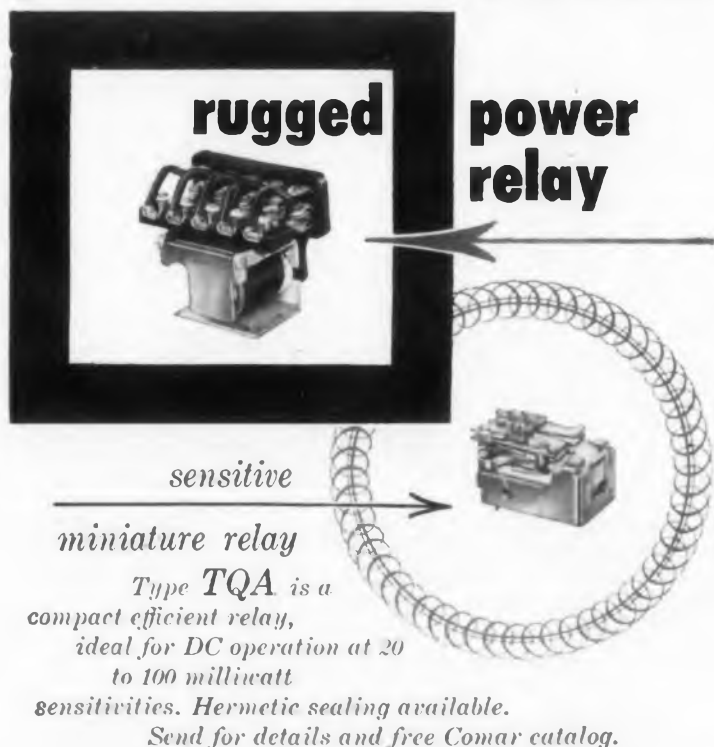
In four pages this catalog covers a new operating principle used in the design of the firm's inertia switches. Pictorial material, descriptive text, electrical characteristics and application information are included in the catalog. Inertia Switch, Inc., 311 West 43rd St., New York 36, N.Y.

Time Delay Relays

114

Bulletin AWH TD-501 describes a precision time delay relay for military applications. Included in the bulletin are illustrations, applicable military specifications, wiring diagram, and outline and mounting dimensions. The A. W. Haydon Co., Waterbury, Conn.

TYPE U general-purpose low cost power relay. Single coil construction, box-type magnetic field, movable contact springs. Contact forms from 1C to 5C. For AC or DC.



rugged power relay

sensitive miniature relay

Type TQA is a compact efficient relay, ideal for DC operation at 20 to 100 milliwatt sensitivities. Hermetic sealing available. Send for details and free Comar catalog.

COMAR ELECTRIC COMPANY
3349 ADDISON STREET
CHICAGO 18, ILLINOIS
RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

CIRCLE 115 ON READER-SERVICE CARD

MASSA METERITE

THE FIRST
MODULAR
2 Channel

PORTABLE RECORDING SYSTEM



MASSA METERITE
Model BSA 200
Basic System Assembly
with Preamplifiers

Outstanding Features

- INTERCHANGEABLE PLUG-IN PREAMPLIFIERS — Low, Medium, High Gain DC; AC; Chopper; Carrier and Servo
- EXTENDED FREQUENCY RANGE — Full Scale Amplitude to 100 cps. Reduced Amplitudes to 200 cps available
- RECTILINEAR MOTION — Free of Curvilinear Distortion
- 6 CHART SPEEDS — Covering the Range .5 to 200 mm/sec
- INK OR ELECTRIC WRITING — Ink, using hermetically sealed disposable ink cartridges. Electric, using auxiliary power supply and electric styli
- TRANSISTORIZED DRIVER AMPLIFIERS — Differential and Single Ended
- LIGHTWEIGHT — Approximately 35 lbs.

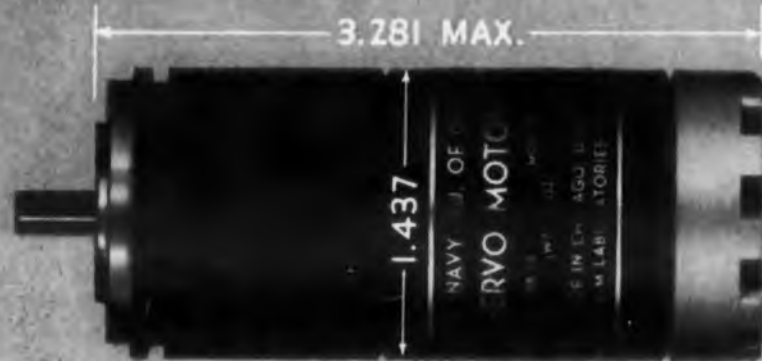
Multi-Channel Systems Are Also Available
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HINGHAM, MASSACHUSETTS

CIRCLE 116 ON READER-SERVICE CARD

3 More Servo Motors



BuOrd Mark 12 Mod 0 SERVO MOTOR Tachometer
Generator 115 volts / phase, 4500 RPM (min).



BuOrd Mark 16 Mod 0 SERVO MOTOR Tachometer
Generator 115 volts / phase, 4500 RPM (min).



BuOrd Mark 16 Mod 3 SERVO MOTOR Tachometer
Generator for transistor operation 115 volts fixed
phase 36/18 volts control phase, 4500 RPM (min.)

Built to all applicable Government Specifications—
in production... available
for prompt delivery.


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manufactured by the Components Division of
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For complete
information on
these and all
SERVO MOTORS,
write for G-M
PROCUREMENT
SPECIFICATION
NO. 665.

CIRCLE 117 ON READER-SERVICE CARD

NEW LITERATURE

Control Relays 118

Bulletin 4470, four pages, describes multi-pole solenoid type HR industrial control relays. Features, applications and design features are covered. Technical data is provided in a table and dimensions of the units are given. Ward Leonard Electric Co., 115 MacQuesten Parkway South, Mount Vernon, N.Y.

Wires And Cables

The color coding of the following types of wires, cables and cords is included in publication WC-1959: asbestos, asbestos-varnished cloth and asbestos-thermoplastic insulated wires and cables; textile coverings for flexible cords; and POSJ flexible cords; rubber-insulated wires and cables. Send \$0.30 to National Electrical Manufacturers Association, 155 East 44th St., New York 17, N.Y.

DC Motors 119

In six pages data sheet 107-1 covers the firm's line of aircraft, missile and ord-

nance dc motors. All electrical and physical data is provided in tabular form and pictures of the motors are included. Schematic drawings of the units and special motor designs are described. Le... Inc., Grand Rapids Div., 110 Ionia Av... N.W., Grand Rapids 2, Mich.

Electrolytic Capacitors

Bulletin 3205, 8 pages, describes the firm's extended-life miniature tubular aluminum electrolytic capacitors. Standard units are listed with electrical and physical characteristics, and their catalog number. Graphs showing the performance of the capacitors and other technical data are provided. Sprague Electric Co., North Adams, Mass.

Thermocouple Wire

This catalog describes a new line of thermocouple wire. The 4-page, illustrated bulletin presents in tabular form an all new line of the most commonly used wires with respect to gauge, type, color coding, and insulation combinations available. Harco Laboratories, Inc., Olive St., New Haven, Conn.

PACE
THE METER OF PRECISION

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equipment manufacturers' specifications



PACE meters are custom produced in production quantities to meet individual O.E.M. specifications. Rigid quality control and closely maintained atmospheric conditions assure the highest order of commercial panel instrument performance and reliability.

A wide selection of stock **PACE** meters is also conveniently available at leading electronic parts distributors for your laboratory models and prototypes.

► Illustrated: Model 45-P clear plastic 4½" meter, one of a family of acrylic-cased instruments, directly interchangeable with standard phenolic-cased units of similar size. **PACE** also offers a wide range of phenolic-cased meters in 2½" to 7" sizes.

Write for latest technical catalog. Prices quoted promptly upon receipt of your specifications.

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Canada: Atlas Radio Corp., Ltd., 50 Wingold Avenue, Toronto 19, Ont.

CIRCLE 122 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1959

Transistor Data 123

Voltage breakdown, the major cause of transistor failure, and leakage currents are discussed in Transistor Kinks, Vol. 1, No. 1, four pages. Five types of voltage breakdown and their effects on transistors are discussed. Three leakage currents which are closely related to breakdown voltage are also defined and covered. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

Components 124

This four-page brochure covers tantalum capacitors and micro-miniature relays. Called Easy Guide To The Selection Of GE, it lists capacitors in numerical sequence in microfarads, provides a five-step guide in the selection of relays, and includes legend, case sizes and tolerances. Schweber Electronics, 60 Herricks Rd., Mineola, L.I., N.Y.

Resistors 125

Catalog sheet DC8 describes the firm's Multi-Range resistor line. These resistors have four separate 10 w wirewound re-

sistors all encased in common steatite housing. The complete line comprises only five basic units, but provides 200 fixed resistance values. Pictures, prices and a tabulation of the units available are covered. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.

Differential DC Amplifier 126

Model 114A differential amplifier is discussed in this two-page data sheet. Descriptive material, operating characteristics, circuit description and the unit's specifications are included. Cohu Electronics, Inc., Kin Tel Div., Box 623, San Diego 12, Calif.

Metal Stampings 127

Lugs, clips, terminals, and hundreds of other standard parts are illustrated in sketches and plan drawings in this 56-page catalog. Small metal parts offered are hot-tinned for easy soldering. Special parts can also be hot-tinned to reduce soldering costs and insure a satisfactory bond. Zierick Mfg. Corp., 110 Beechwood Ave., New Rochelle, N.Y.

METAL FABRICATIONS TO CLOSE TOLERANCES

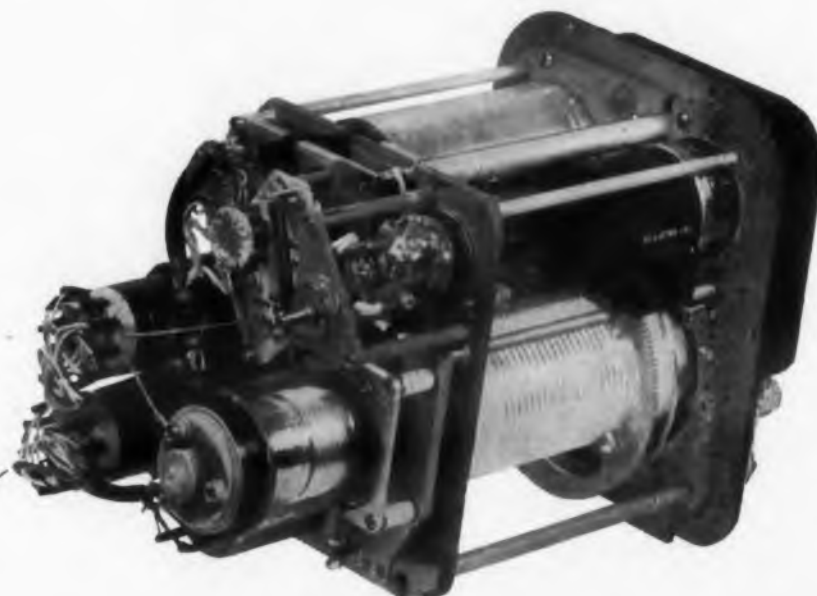
Industrial designers demand close tolerances and accurate, fast production. The Falstrom Company, one of America's leading metal fabricators, has been meeting these demands for almost 90 years. Growing with industry, Falstrom is constantly adding to its extensive metalworking facilities. Falstrom fabricates consoles, chassis, weldments, in stainless steel, aluminum, magnesium and other metals.

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CIRCLE 128 ON READER-SERVICE CARD



JENNINGS VACUUM RELAYS AND CAPACITORS

...when reliability counts



Jennings Vacuum Relays and Variable Capacitors play an important role in the Air Force's "Project Sideband," aimed at constant radio contact on intercontinental missions.

The high standards of reliability and performance required by the Air Force were more than met by Collins Radio Company's new 1 KW SSB system for "Project Sideband." The airborne end of the system, designated ARC-58, includes an automatically tuned antenna coupler. Jennings vacuum relay, RB3, and vacuum variable capacitor, USLS 465, are used in the coupler to match the 52 ohm impedance of the equipment with the antenna.

Jennings vacuum components were chosen for their recognized ability to withstand high voltage in limited space applications. The Type RB3 vacuum

transfer relay is designed to meet peak voltages of 15 kv and rf currents to 15 amps yet it is only 3 1/4 inches long. The relay also has an auxiliary set of low voltage contacts for control purposes designed to operate after and release before the high voltage set. The Type USLS 465 is only 5 inches long and will withstand 10 kv at its minimum capacity of 5 mmfd and 5 kv at its maximum capacity of 465 mmfd. Both units will withstand 10G vibration to 500 cycles, 30G shock, and 50 hours salt spray.

Send for catalog literature on Jennings complete line of vacuum capacitors and relays.



USLS-465
VACUUM
VARIABLE
CAPACITOR



TYPE RB3
VACUUM
TRANSFER
RELAY

JENNINGS RADIO MANUFACTURING CORPORATION
970 McLAUGHLIN AVE., P. O. BOX 1278 SAN JOSE 8, CALIF

Jennings

CIRCLE 129 ON READER-SERVICE CARD

Where only the **best** is good enough
 . . . you'll see



electronic instruments

In basic electronic instruments for lab or test work, *less* than the best may be a dangerously bad bargain. Unexpected limitations — of reliability, range, precision — can throw out weeks of work on today's jobs, and can make tomorrow's tougher jobs untouchable. The *best* instrument of its type is probably a bit more expensive, but it's worth buying . . . because you can believe in it today, and will rely on it tomorrow. An example is the Krohn-Hite Model 440-A wide range push-button oscillator illustrated here.

Exactly because K-H instruments *are* good enough even for tomorrow's most critical work, they are increasingly chosen today where true reliability and precision are needed.

Oscillators — .001 cps to 520 kc, dial or push-button tuning, less than 0.1% distortion, sine wave and square wave outputs.

Power Supplies — zero to 600 volts dc, zero current to 1 ampere, regulation .001%, ripple less than 100 μ v, internal impedance 0.1 ohm to 100 kc.

Power Amplifiers — 10 to 50 watts, dc to 1 mc, transformer or direct coupled, 0.005% distortion.

Tunable Electronic Filters — variable from .01 cps to 200 kc, band pass, band rejection and servo types.

Write for your free copy of the new Krohn-Hite Catalog



Krohn-Hite CORPORATION

580 Massachusetts Avenue,
 Cambridge 39, Mass.

CIRCLE 130 ON READER-SERVICE CARD

NEW LITERATURE

Midget Screw Lampholders 131

A data sheet describing Tynylite midget screw lampholders is now available. It gives full details about lamp sizes, availability of both soldered terminals and wire leads, suggested brackets for specific uses, and lampholder dimensions. Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill.

Magnetic Recorder-Reproducer 132

The specifications, operational characteristics and design features of the new Mincom 7-track Video Band Magnetic Recorder/Reproducer are described in this 2-color, 4-page brochure. The bulletin includes color photographs of actual oscilloscope traces, calibrated in micro-seconds per centimeter, showing the equipment's quality reproduction of transient phenomena occurring at frequencies from 400 cycles to one megacycle. Minnesota Mining & Mfg. Co., Mincom Div., 2049 S. Barrington Ave., Los Angeles 25, Calif.

Magnetic Core Storage Products 133

Specifications for standard ferrite core and core product lines are included in the condensed illustrated catalog, SL-106. The four-page brochure describes ferrite storage and switch cores, core arrays, sequential and conversion types of core storage buffers, transistorized computer memory modules, and Data Translators designed to provide compatibility between data systems utilizing different codes and formats. Telemeter Magnetics, Inc., 2245 Pontius Avenue, Los Angeles 64, Calif.

Switch-Indicator Devices 134

"Series 2 Lighted Indicator and Pushbutton Switch Devices" is the title of Catalog 67, 20 pages. The catalog describes units which were designed for efficient control panels. Split pages allow quick selection and comparison of the operator units, indicator units and switch units in the new series. Dimensional drawings, photographs and technical information are provided. Micro Switch, Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Coaxial Cables, Connectors 135

Complete data on Spir-o-line coaxial cable and Spir-o-lok connectors is included in catalog 591. The catalog, which also includes related transmission components, provides complete performance data graphs and charts, specifications, ordering and shipping information, installation instructions and all other data needed by design engineers. Prodelin Inc., 307 Bergen Ave., Kearny, N. J.

your avionic
**TESTING
 PROBLEMS**
 SOLVED!



Radome Boresight Error

The CTI Radome Boresight-Error Measuring System satisfies MIL-R-7705A(ASG), including type radomes. Boresight error is automatically recorded directly in milliradians with an accuracy of \pm milliradian. Percent transmission and antenna patterns with or without the radome are plotted. Available from S through K_a bands of infrared. Model 150C for monopulse and conical scan, Model 150B for bombing-type and other shaped-beam radars.



Flight and Altitude Simulation

Three-Axis Flight Simulator reproduces roll, pitch and yaw positions, velocities, and accelerations for accurate analysis of flight control systems and inertial guidance platforms in the laboratory. Dynamic Altitude Simulator (not shown) produces 0-to-10-cps altitude fluctuations through range of \pm 700 feet at levels up to 80,000 feet.



Quality Control and Ground Support

Only automatic testing can assure the reliability of electronic equipment where time, manpower or accuracy is critical. Used for pre-flight, maintenance, and production tests, CTI devices locate faults and incipient failures in seconds. Model 180 Tape-Programmed Supertester for circuits of systems; Model 165 Cable Tester for wiring businesses; custom equipment to your requirements.

Write for full information

Engineers: Career opportunities are available at CTI

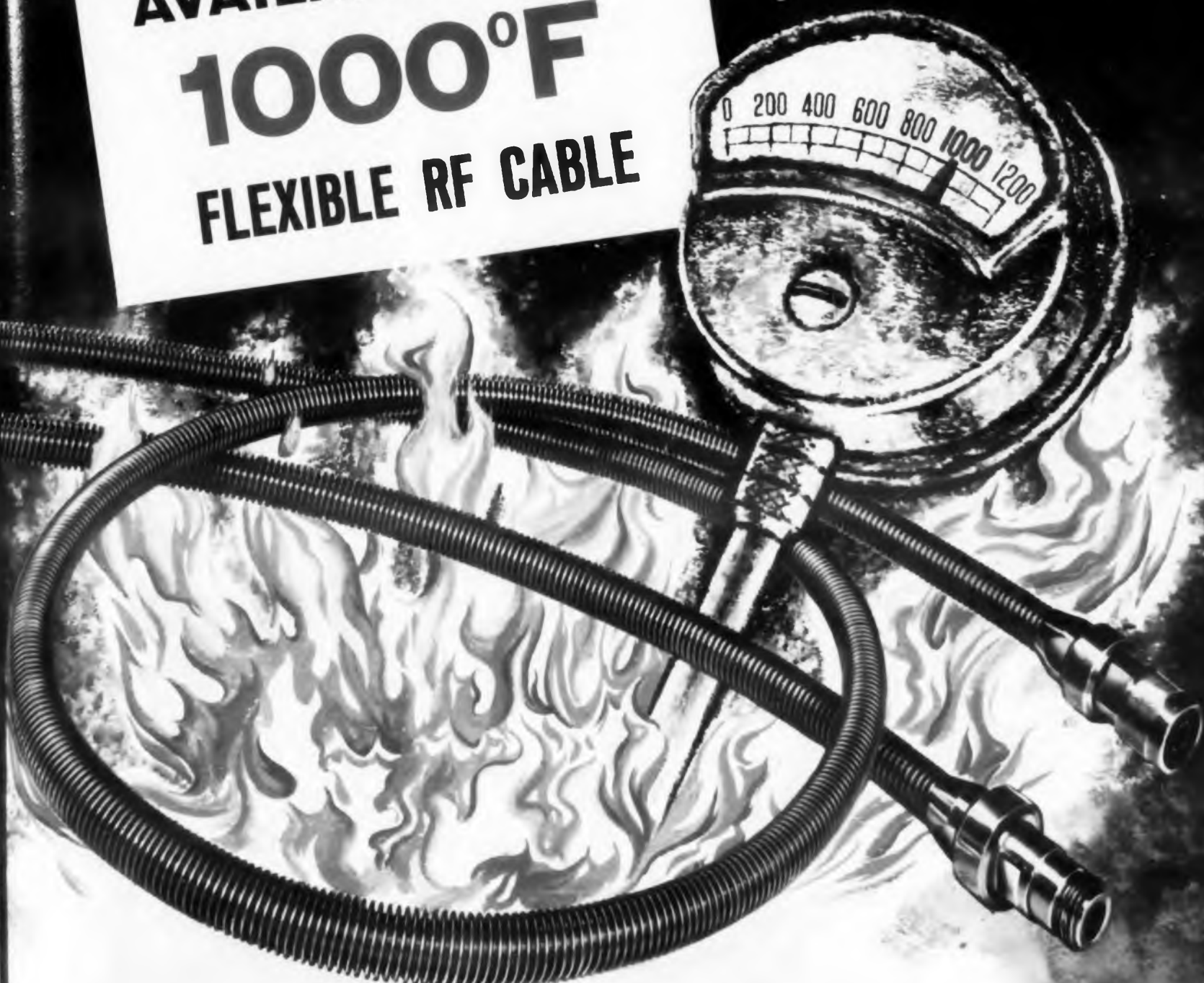


Foremost in Automatic Testing

CIRCLE 136 ON READER-SERVICE CARD

CIRCLE 137 ON READER-SERVICE CARD

AVAILABLE NOW
1000°F
FLEXIBLE RF CABLE



DATA

- Altitude Insensitive—Moisture Resistant**
- Resistant to Shock and Vibration**
- Resistant to Nuclear Radiation**
- Connectors: Series N, C and SC**
- Impedance: 50 Ohms**
- Capacitance: 30.0 $\mu\mu\text{f}/\text{ft}$.**
- Velocity of Propagation: 69.0%**
- Voltage Breakdown: 3500 Volts RMS**
- Maximum Operating Voltage: 1000 VRMS**
- Weight: Cable, 17.5 pounds per 100 feet**
- Connectors, 2½ ounces each**



CABLE & WIRE DIVISION

A flexible RF cable that will operate continuously at 1000°F is ready *now* for missile, aircraft, spacecraft and other ultra-high temperature applications. Capable of short time excursions to higher temperatures, the cable is a sealed RF transmission system complete with connectors. It is available in standard lengths up to 200 feet. (Patent Pending)

Delivery: Three to four weeks!

AMPHENOL CABLE & WIRE DIVISION

South Harlem Ave. at 63rd St., Chicago 38, Illinois

- Send additional engineering information.
- Have AMPHENOL Representative contact me.

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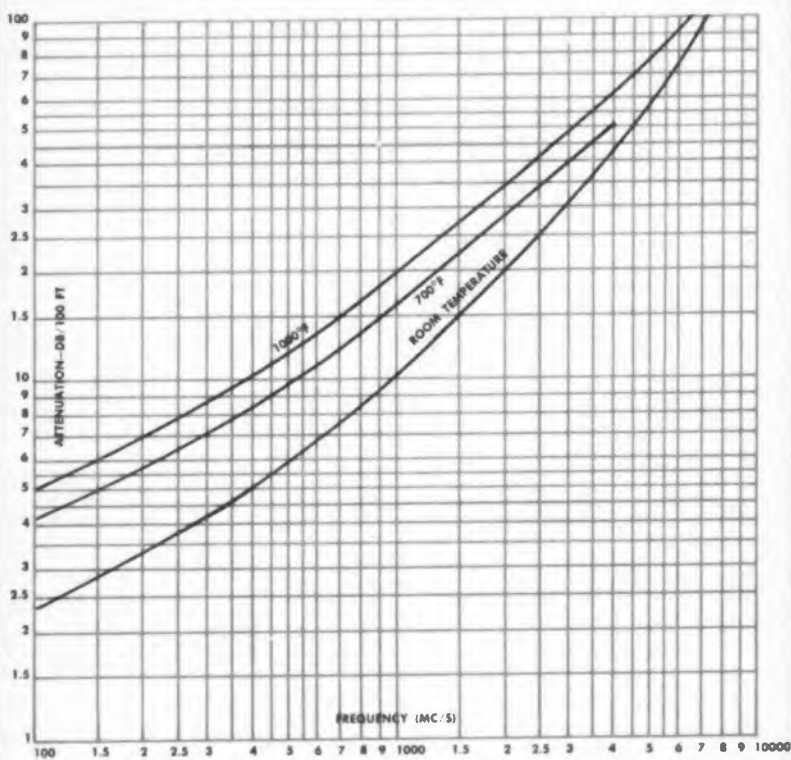
1000°F FLEXIBLE RF CABLE

PHYSICAL CHARACTERISTICS

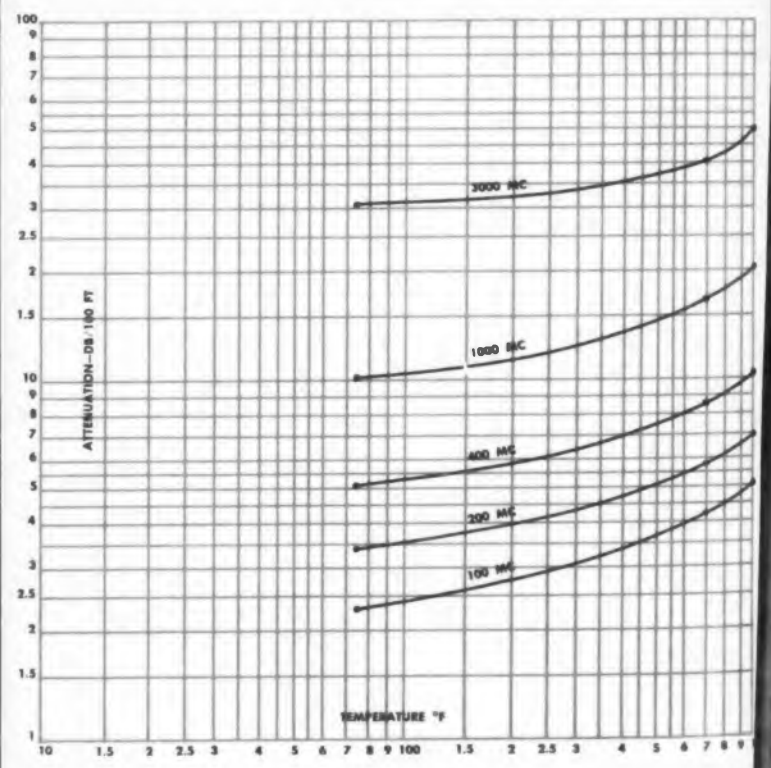
DESCRIPTION	CONSTRUCTION DETAILS
Inner Conductor	Stranded coated oxygen-free, high-conductivity copper wire.
Cable Core	Modified semi-solid silica.
Outer Conductor	Single braid, AWG size 32 coated oxygen-free, high-conductivity copper wire.
Jacket	Flexible special metal alloy. Nominal overall diameter: .525".

FLEXING CHARACTERISTICS

Cable can be bent on a 10X mandrel (bend diameter=10X diameter of cable).
 Cable dielectric shows no deterioration after 30,000 cycles of bending over
 10X mandrel in accordance with specification MIL-C-915.



ATTENUATION VS. FREQUENCY AT ROOM TEMPERATURE,
 700°F and 1000°F



ATTENUATION VS. TEMPERATURE AT VARIOUS FREQUENCIES

(See Other Side)



CABLE & WIRE DIVISION

Chicago 38, Illinois

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 CIRC 138
 CIRC 137

Measure to within
 ± 0.01 C
 from -190 to +500C



with L&N's Type G-2 Mueller Bridge

When used with the L&N 8163 Platinum Resistance Thermometer, this Type G-2 Mueller Bridge provides a standard of temperature throughout the range of -190 to +500 C with an accuracy in ohms equivalent to ± 0.01 C.

Invaluable in the advanced research laboratory, the G-2 facilitates the making of a variety of highly accurate temperature measurements . . . of specific heats; of boiling and freezing points of many chemicals; and in calorimetry, for the precise determination of heats of combustion of coals, gases, oils, etc.

LIST NO.—8069-B TYPE G-2 MUELLER BRIDGE, normally available for immediate delivery.

Measuring Arm—0 to 111.111 ohms in steps of 0.0001 ohm.

Constant Temperature Chamber — With thermostatically controlled heater; holds resistors of measuring circuit constant within ± 0.01 C at about 35 C.

Ratio Arms—1,000 ohms each. Adjustable to equality.

Milliammeter—Range 0 to 5 ma. Indicates current in the resistance thermometer.

Limit of Error—Within a few ten thousandths of an ohm or a few parts in a hundred thousand, whichever is larger, provided bridge and resistance thermometers are calibrated in terms of same resistance unit at six-month intervals.

Case—Polished mahogany with cover; 7 1/4" (h) x 21 1/4" (w) x 13" (d).

Price: \$3760.00 f.o.b. Phila. or North Wales, Pa. (subject to change without notice). Specify List No. 8069-B when ordering from L&N, 4908 Stenton Ave., Philadelphia, Pa. or nearest L&N office.



CIRCLE 138 ON READER-SERVICE CARD
 CIRCLE 137 ON READER-SERVICE CARD

Multistylus Recorder 139

Bulletin A-100 describes the theory, application and specifications of the new model 3-100A Radicorder multistylus recorder. The 8-page brochure details the basic theory of fixed-styli recording technique and electrosensitive chart characteristics. It shows actual applications in data systems as a quick-look monitor, high-speed digital printer, and data editor. Operating characteristics and construction details are illustrated. Radiation, Inc., Melbourne, Fla.

Recorders and Controllers 140

Spec. Sheets 51-1102G1 to 5 describe a line of electronic circular chart flow rate recorders and controllers. Included are operating specifications, mounting information, and performance characteristics. Fischer & Porter Co., 846 Jacksonville Road, Hatboro, Pa.

Antenna Calculator

An improved version of Gabriel's original "Antenna Calculator" has been developed to simplify computations for determining the parabolic antenna parameters for microwave antenna systems. The calculator scales include frequency, wavelength, beamwidths, gain, return loss, vswr, wind-loading, focal length, and other scales relating to parameters for parabolic antennas. A spectrum scale has also been included for band designation and frequency bandwidth. *The calculator costs \$2.00. Gabriel Electronics Div., The Gabriel Co., Dept. ED, 135 Crescent Road, Needham Heights, Mass.*

Wires and Cables 141

In six pages this condensed catalog lists coaxial cables, military hookup wire, multi-conductor cables, appliance wire, miniature and audio wires and cables, high voltage and frequency wires, antenna loop, rvc-300 apparatus and annunciator (bell) wire, also television transmission lines—primary and secondary lead-in cable, "paralead" and "airsac" lead-in wire and TV rotor cable. These cables are available in a variety of conducting, insulating, jacketing, shielding and armoring materials. Chester Cable Corp., Oakland Ave., Chester, N. Y.

Circuit Breaker Catalog 142

Electrical characteristics, dimensions and pictures are provided in this 8-page catalog on high rupture capacity, miniature and commercial type circuit breakers. Wood Electric Co., 244 Broad St., Lynn, Mass.

New Helipot Potentiometer Catalog

Yours for the asking
 ... a compendium of the
 industry's most complete line
 of precision pots... single-turn
 and multi-turn... all-metal
 and economy models... high
 temperature and standard range.

Complete technical data... even
 environmental specs... in comparative,
 tabular form to help you pick
 the pot that suits your circuit best.

Need associated turns-counting
 dials... delay lines... trimming pots?
 They're here too.

Ask for Data File C62

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94

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CIRCLE 499 ON READER-SERVICE CARD

NEW LITERATURE

Counting Units 145

This 4-page Bulletin, illustrates and describes Sodeco Single-Decade Counting Units. In addition to giving the usual construction and electrical data, the bulletin describes the various auxiliary contacts and executions which make possible the use of these counters in the solution of a wide variety of counting, telemetry and automation problems. Some typical schematics are given showing applications including forward counting, subtraction, predetermined counting, transmission of numbers with addition, and forward counting with zero reset. Landis & Gyr, Inc., 45 West 45th St., New York 36, N.Y.

Transistor Switching Circuitry 146

Entitled "Notes On Transistor Switching Circuitry," this 14-page booklet contains graphs, block diagrams, and specifications of such equipment as: shift registers; binary counters; ladder networks; pulse sorters; electronic switches; amplifiers; and power supplies. Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa.

Equipment Data Sheets 147

Complete specifications, descriptions and pictures are included in Product Data Sheets 101-5, 102-10, 117-7, 117-8 which cover, respectively, rotary actuator 6116A-1, series 313 miniature linear actuator, series 2009C single resolver, and series 2010C triple resolver. Lear, Inc., P. O. Box 688, Grand Rapids, Mich.

Telemetry Receiving Systems 148

This reference bulletin has been prepared to aid engineers in planning telemetry receiving systems. The Miniature FM Telemetry Receiving Systems bulletin illustrates typical systems and describes individual building block components: receivers, subcarrier discriminators, master controls, record-monitor-mixers, and other units. Tele-Dynamics, Inc., 5000 Parkside Ave., Philadelphia 31, Pa.

Ovens, Environmental Cabinets 149

Bulletin 1951, four pages, two-color, illustrates and describes various types of Blue M oven and environmental cabinets. Dimensions, electrical and operating characteristics, and pictures are included. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

TUBE PROBLEM:

When the 6AF4 tube was replaced in UHF TV tuners, servicemen sometimes got a big surprise. Reason: the tubes were not standardized, and a replacement was likely to bring in one channel where another should have been.

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ELECTRONIC DESIGN • June 24, 1964

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Distributor Co.
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TORONTO, CANADA—Electro Sonic
Supply Co. Ltd.
543 Yonge St., WALnut 4-9301

WASHINGTON, D.C.—Silberne Radio
& Electronics Co.
3400 Georgia Ave., N.W.,
TUCKerman 2-7800

CIRCLE 151 ON READER-SERVICE CARD

Probes, Transducers, Tubes 152

Illustrated short form catalog, No. 115811, is mainly devoted to the company's line of temperature transducers, or temperature "probes," with a brief section devoted to deiced pitot-static tubes and precision pressure transducers. The catalog covers 52 items in 10 pages with pictures. Rosemount Eng. Co., 4900 W. 78th St., Minneapolis, Minn.

Cooling Packages 153

Four electronic cooling packages are described in this loose-leaf catalog folder. The cooling packages are designed for use in electronics systems requiring air-liquid coolant mediums, and are particularly adaptable to systems utilizing liquid-cooled power tubes in both airborne and ground installations. Included in each catalog page is a picture of the unit described, along with full specifications. Pesco Products Div., Borg-Warner Corp., 24700 N. Miles Road, Bedford, Ohio.

Short Form Rectifier Catalog

This 16-page catalog gives ratings, electrical characteristics and descriptive data on 405 types of silicon and selenium rectifiers and diodes. Specifications cover more than 140 types of silicon cartridge rectifiers, and more than 130 selenium rectifier and contact protector types. Write on letterhead requesting "Short Form Catalog," International Rectifier Corp., El Segundo, Calif.

Transistor Equipment, Components 154

Transistor equipment and components are covered in this 12-page, 1959, catalog. Included are: a new line of power supplies; the latest types of transistorized converters, a tiny plug-in transistorized i-f amplifier, an expanded line of miniature rectifier transformers for use in transistor power supplies, and several new pieces of transistor test equipment, including an alpha meter, beta meter, and noise figure meter. Ferrotran Electronics Co., Inc., 693 Broadway, New York 12, N.Y.

Cabinet Racks and Slide Assemblies 155

Catalog 59 contains 28 pages of illustrations, descriptions, technical specifications, and prices of universal cabinet racks, rack type slide assemblies, type C and type A racks, and utility desk assemblies. Complete information is supplied on accessories, fittings, and panels. This catalog is available on request. Please address inquiries to: Par-Metal Products Corp., 32-62-49 St., Long Island City 3, N.Y.



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CIRCLE 156 ON READER-SERVICE CARD

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CIRCLE 157 ON READER-SERVICE CARD

NEW LITERATURE

Rectifier Tubes and Circuits 158

A chart designed to simplify the selection of a combination of a rectifier circuit and a mercury-vapor rectifier-tube type for any application requiring dc voltage up to 21 kv and direct current up to 60 amp is given in application notes AN-179. The note, six pages, also contains a table of the electrical quantities involved in the design of rectifier-type dc power supplies and gives the values of these quantities for the rectifier circuits shown in the chart. Radio Corp. of America, Commercial Engineering, Harrison, N.J.

Speed Reducers 159

Bulletin 97 describes the firm's new series 8 and 9 miniature fixed ratio speed reducers. The units are available in over 400 fixed ratios. In four pages the bulletin covers applications, mounting data, cut-away pictures of the units, dimensional data and ordering information. Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Fasteners

A full range of sizes and types in A and MS fasteners are among the new items covered in this 24-page catalog. More than seven thousand items and sizes in stainless steel fastenings are available and include cap screws and bolts, nuts, washers, machine screws, wood screws, set screws, sheet metal screws in slotted and Phillips head, rivets, cotter pins, piano hinges, pails, funnels, scoops, and screw machine products. Star Stainless Screw Co., 699 Union Blvd., Paterson 2, N.J.

Rectifier Handbook

This 128-page engineering handbook on rectifiers is divided into four parts. The first part deals with the principles of semiconductors. The second contains application data on selenium, silicon, and germanium rectifiers. Zener voltage regulators and photocells and sun batteries are discussed in the third and fourth parts. Graphs, pictures and tables are included. Send \$1.50 to: International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.



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CIRCLE 161 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 195

Insulation Material 162

Technical data on varnishes is provided in this bulletin. The data is presented to show how the firm's laboratory and field work has proved, according to standard tests, that two types of varnishes meet the Class F rating. John C. Dolph, Monmouth Junction, N.J.

Selection of Instruments 163

How to select and use electrical measuring instruments in experimental laboratories is described in this illustrated literature. The 8-page reprint, No. Z-32, describes and explains the type, range, and rating of instruments and accessories used in standards, power, and electronics laboratories. The reprint includes discussions on instrument accuracy and effects of overloads; dc and ac measurements; typical instruments and accessories such as voltmeters, ammeters, wattmeters, multipliers or series resistors, shunts, current and potential transformers; and the making of data. Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N.J.

Photosensitive Devices, CR Tubes

This 32-page illustrated catalog on the firm's photosensitive devices and cathode ray tubes presents technical data, basing diagrams and brief text descriptions of more than 130 tube types. Photographs and representative types are shown throughout the publication. Covered for the first time in this catalog are image-converter tubes; photoconductive cells, new varieties of storage tubes; new cathode-ray tubes; new camera tubes; new single-unit phototubes; and new multiplier phototubes including ultra-violet and infrared-sensitive types. For form CRP D-105A send 30¢ to Radio Corp. of America, Tube Div., Harrison, N.J.

Condenser Microphones 164

A new condenser microphone series is discussed in this 24-page Technical Review. Major advancements in measurement microphone design are described and the exact measurement of the free field corrected is covered. B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

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A300	300	70	58	30
A500	500	50	50	58
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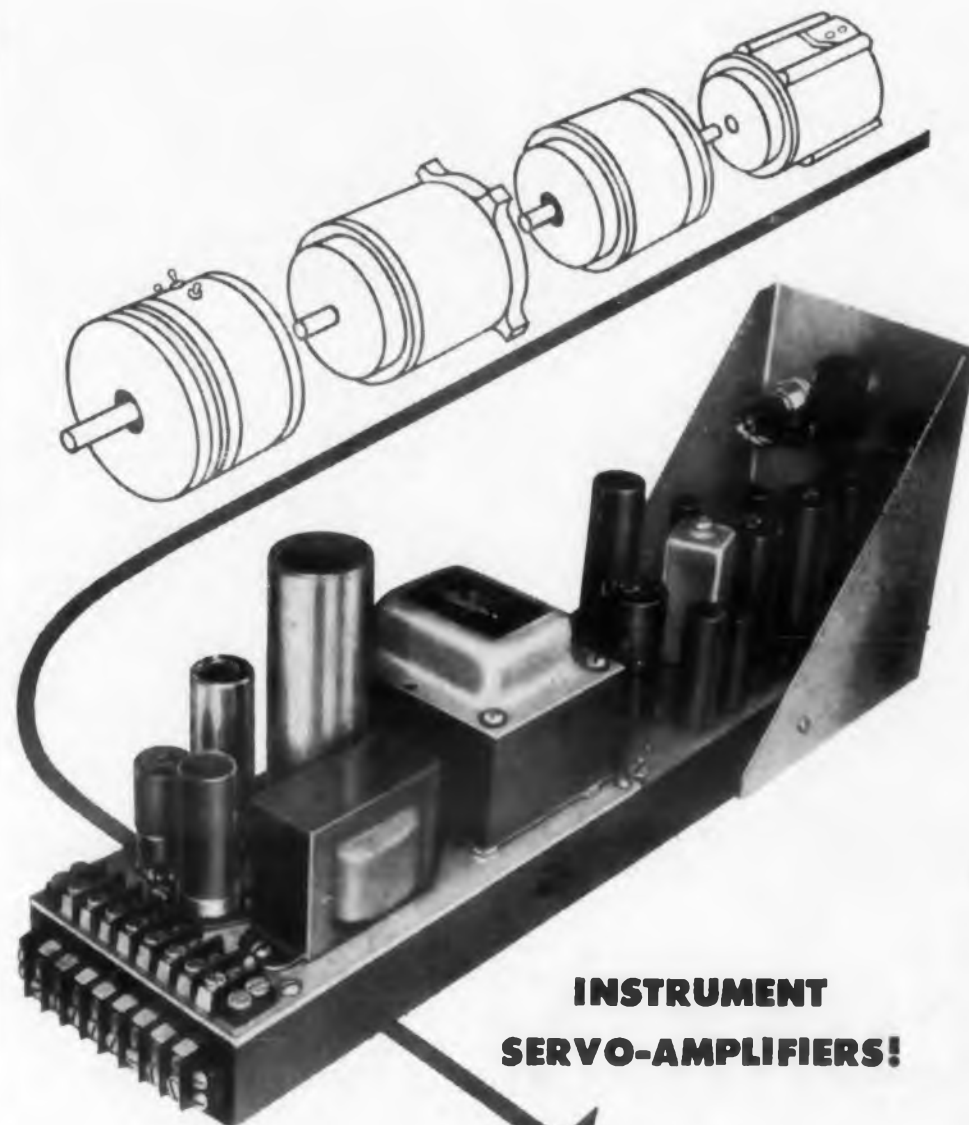
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**INSTRUMENT
SERVO-AMPLIFIERS!**

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INSTRUMENT SERVO COMPONENTS

This new line of Instrument Servo-Amplifiers, coupled to an already established family of DIEHL Instrument Servomotors, Tachometers and Gear Reducers, further expands the new DIEHL concept of furnishing high quality servo components in modular form.

These units have been designed so that a true servomotor-amplifier combination featuring faster SERVO response is at last available from a single source of supply.

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- Standard rack mounting.
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TWX 370 — Wallingford, Conn.



NEW LITERATURE

High Tensile Fastenings

168

Presented as an aid to the selection of appropriate nut and bolt combinations for high tensile applications, this Design Manual No. 5825 is a 38-page booklet offering high tensile fastener design considerations; reproductions of all relevant NAS and MS bolt specifications; three tables cross referencing 160,000 psi, 180,000 psi and 220,000 psi bolts and other compatible elastic stop nuts; and a complete set of high tensile self-locking fastener standard drawings. Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N.J.

Digital Instruments

169

This four-page, illustrated bulletin No. 19-36 describes a complete line of digital instruments. The line includes voltmeters, ratiometers, ohmmeters, preamplifiers, input scanners, and a variety of accessories for driving card punches, tape punches, and printers. Kin Tel Div., Cohu Electronics, Inc., Box 623, San Diego 12, Calif.

Microminiature Relay

170

Bulletin 160-1 gives technical data on crystal case relay, Series 160. The tiny, 0.5 oz, relay was designed for airborne and portable equipment. It is hermetically sealed in compact gas-filled case with a hot tin dip finish and provides a minimum of 100,000 operations. Wheelock Signals, Inc., Long Branch, N.J.

Pulse Transformers, Delay Lines

171

Catalog TRO19, 6-pages, provides data on pulse transformers and delay lines. Listed in the catalog are physical sizes on standard styles, ratios and widths available from stock. Also given are various transformer case styles available, blocking oscillator test circuits, exciting current tests and other data. The Gudeman Co., 340 West Huron St., Chicago 10, Ill.

Power Connectors

172

This illustrated bulletin gives specifications, outline dimensions and general information on Series 14 power connectors with closed ring entry contacts. This series is available in 7, 9, 10, 15 and 19 contacts. The closed entry design provides increased reliability and assures a low millivolt drop under constant and uniform insertion pressure. Solder cup, turret top or taper pin terminations are available. Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N.Y.

NEW!



Model 412
Shown actual size (approx. 1 cu. inch)

Avion System-Standard transistor servo amplifier

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Gain: 2500 ± 5% with 10-volt signal output
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Primary Power: 28 volts d-c, +10% or -5%

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CIRCLE 173 ON READER-SERVICE CARD

METAL FILM RESISTORS



NEW! This precision low noise metal film resistor meets and exceeds requirements with temperature coefficient of plus or minus 50 ppm/°C independent of resistance value. Standard tolerance plus or minus 1 per cent. Type WHM-.125" long, x .406" diam. — is equivalent to MIL Style RM 75, maximum voltage rating 500V. Type WFH-.781" long x .250" diam. — equivalent to MIL Style RM 70, maximum voltage rating 350V.

Enclosed in specially designed hermetically sealed plastic casing (patent pending) to protect precision resistor element.



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Type H. For electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms. Voltage rating to 15,000 volts. Low temperature and voltage coefficient. Seven sizes, from 3/4" to 3" long, of which 2 meet requirements of MIL-R-14293A. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs with 2% tolerance.



Selenium Rectifiers

175

In eight pages this catalog contains basic characteristics of selenium rectifiers with temperature derating table as well as an overload and allowable currents-under-various-forced-cooling curves. One page is devoted exclusively to general design information on rectifier circuits. The catalog also contains a code designation chart, a dc voltage chart and bracket dimensions in chart form. Shown for the first time is a practical method for computing the overall length of a selenium rectifier stack. Rectico, Inc., 963 Frelinghuysen Ave., Newark 12, N.J.

Connectors

176

This four-page folder has been prepared to assist buyers and engineers in the selection of Amphenol connectors. Photographs and condensed description are designed to facilitate ease of securing the correct type. Schweber Electronics, 60 Herricks Rd., Mineola, L.I., N.Y.

Power Supplies

177

Bulletin No. 721 describes and illustrates an integrated series of regulated transistorized power supplies. Specifications are given for over 40 different models. Two categories are covered: wide range models and narrow range models. Wide range models have a continuously variable main voltage control and a vernier control for adjusting the output to any value from 0 v to some higher limit. Narrow range models cover a range of several volts each side of a popular nominal value. Ten different voltage ranges are available. Electronic Measurements Co. of Red Bank, Eatontown, N.J.

Automatic Systems

178

Techniques in automatic systems such as sorting, inspection, counting, positioning and weighing are described in this four-page brochure. Pictorial material and an explanation of automation services are included. Atronic Products Inc., Industrial Equipment Div., Bala-Cynwyd, Pa.

Ceramics

179

Chart No. 591 provides in tabular form the properties of several types of ceramics. Among the properties listed are: volume resistivity; dielectric constant; power factor; loss factor; and thermal conductivity. Ceramics listed include: steatite, forsterite, zircon; titania, cordierite; and machinable ceramics. Graphs are included. American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn.

RF BROADBAND PREAMPLIFIERS



HRB Model 530 Preamplifier with power supply in relay rack mounting enclosure.

A COMPLETE LINE OF LOW NOISE BROADBAND PREAMPLIFIERS COVERING THE FREQUENCY RANGE OF 1 TO 600 Mc

PREAMPLIFIER PERFORMANCE DATA

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50-150	3-5	515	22	515NK	44	515NS	66
50-300	5-7	530	15	530NK	30	530NS	45
125-250	5-7	1225	22	1225NK	44	1225NS	66
140-280	5-7	1428	22	1428NK	44	1428NS	66
150-300	5-7	1530	22	1530NK	44	1530NS	66
250-500	6-8	2550	14	2550NK	28	2550NS	42
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Compact, easy to mount Adjust-A-Volts give smooth, continuous control with no waveform distortion.

Specifications	100BU	300BU	T21U	T51U	500BU	3000BU
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Load Rating (KVA)	.165	0.4	0.36	0.90	1.0	4.0
Output Voltage	0-132V	0-135V	0-135V	0-135V	0-135V	0-135V
Max. Current (Amp.)	1.25	3.0	3.1	7.8	7.5	30
Rated Current (Amp.)	1.25	3.0	2.4	6.0	7.5	30

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CIRCLE 181 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Wire Marking Machine

Handles Teflon

Air operated model KW-7 wire marking machine is designed to mark thinner insulations and Teflon along with other types.

Kingsley Stamping Machine Co., Dept. ED, 850 Cahuenga Blvd., Hollywood 38, Calif.

CIRCLE 182 ON READER-SERVICE CARD

Induction Heating Generator

For growing semiconductor material



Available at any output frequency from 200 kc to 3 mc, the model L4E-C-2 induction heating generator is adaptable to refining and growing semiconductor material and to inert atmosphere brazing of precision nuclear and electronic components. The unit has a power input of 230 or 460 v, single phase, 8 kva at full load output. Its stepless electronic power output control is continuously variable from 0.5 to 4 kw.

Reeve Electronics, Inc., Dept. ED, 609 W. Lake St., Chicago 6, Ill.

CIRCLE 183 ON READER-SERVICE CARD

Glass Diode Sealing Machine

Processes up to 1500 units an hour

Machine No. 3117 seals up to 1500 glass diodes an hour. It performs the following fully automatic sequence: loading both cat whisker wire and diode body; assembling the cat whisker with its beaded lead wire; assembling the body of the diode which contains the crystal and its lead wire; providing contact between the cat whisker wire and the diode body with precise tension and spacing; making the final seal; and unloading the finished diode. The machine handles all types of glass diodes.

Kahle Engineering Co., Dept. ED, Union City, N.J.

CIRCLE 184 ON READER-SERVICE CARD

**VITREOUS-ENAMELED
RESISTORS**



SPECIAL RESISTOR FOR YOUR DESIGN

Stab-on terminals and a square hole positive-lock mounting... typical the special resistors available from General Electric. No matter what your needs, G-E resistors can be designed your exact requirements. For your resistor catalog, follow reader service instructions below. General Electric Co., Roanoke, Virginia.

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CIRCLE 185 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1964

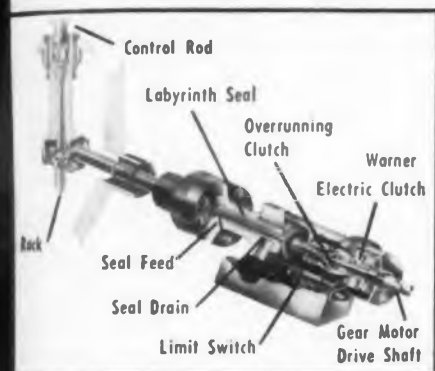
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Electric clutch performs dual function in control rod drive for nuclear reactor

Ingenuity is illustrated in the way Warner EF-400's are applied in this control rod drive in the Alco-built packaged power reactor at Fort Belvoir, Va. They provide both free-wheeling emergency release and automatic positioning of rods that operate as a "throttle" to control rate of reactivity.

During normal operation, clutches are constantly engaged—lowering and raising rods of neutron-absorbing material to carefully calibrated positions within the reactor. Motor



torque is transmitted by the rotor which is pushed and running free on a thru shaft, to the armature, mounted to the outer member of an overrunning cam-type clutch. Rods are positioned by the electric clutch acting through the overrunning clutch.

In "scramming," the electric clutch flux circuit is de-energized, instantly breaking the connection between drive motor and control rod shaft. This lets the rods drop into the reactor. At the same time, the drive motor starts rotation in a downward direction. And, any obstruction of the rod causes engagement of the overrunning clutch, which then transmits full motor torque to the control rod drive shaft.

Reliability tests put the Warner clutch through 60,000 scam cycles. In another test, rods were left in one position for periods of up to two months and then "scrammed" to see if temperature, humidity, or pressure affected reliability. (It didn't.)

Warner stationary-field clutches

If you need dependable, split-second operation and precise control for positioning, over-load protection, no-load starting, smooth acceleration, or precise synchronization of low-torque drives, Warner fractional horsepower or miniature electric clutches may be the answer.



WANT MORE IDEAS? Warner will show you factual case histories demonstrating how electric brakes and clutches can be used to solve your problems.

WARNER ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

CIRCLE 186 ON READER-SERVICE CARD

Crystal Orientation Device

Rapid and accurate



This measuring instrument assures accurate orientation of silicon and germanium crystals for transistors, diodes, and other semiconductor devices. Easy to operate, it permits the cutting, preparation, etching, and evaluation of a crystal in 15 min.

Sylvania Electric Products Inc., Chemical and Metallurgical Div., Dept. ED, Towanda, Pa.

CIRCLE 187 ON READER-SERVICE CARD

Wave Soldering Equipment

For printed circuits

Designed for printed circuit soldering, the Adawave attachment can be installed in existing solder pots. It provides a continuously recirculating wave of solder which gives linear contact soldering with minimum distortion and delamination. It also eliminates icicles and cold joints and reduces rejects and rework.

Wellesley Engineers, Dept. ED, Wellesley, Mass.

CIRCLE 188 ON READER-SERVICE CARD

Wire Straightening Machine

Aligns and cuts transistor leads



The model AL3NS Radialead Straightener automatically straightens, cuts, and preforms transistor leads. It can align them to the proper center distance so that the components will always exactly match the holes in a printed circuit board. A simple change of head adapts the unit for different job functions.

Design Tool Corp., Electro-Machinery Div., Dept. ED, 772 Bergen St., Brooklyn 38, N.Y.

CIRCLE 189 ON READER-SERVICE CARD

Count Control

COMPONENTS
FOR AUTOMATING INDUSTRIAL PROCESSES

featuring

adjustable count
automatic reset
10 ampere switches



model HZ4 MICROFLEX RESET COUNTER

Use to control an operation for a preset number of counts. Has spring reset to "0." Dial ranges 19, 400 and 1,000 counts.

Ask for bulletin 720.



model HZ200 ADD-SUBTRACT COUNTER

Add-Subtract counter — operates from ADD pulses which trip switch at maximum limit — and SUBTRACT pulses which trip switch at "0" limit.

Ask for bulletin 740.



model MT STEP SWITCH

Use for sequence control from pulses — 19 contacts — 60 cycle coil-break out cam lugs.

Ask for bulletin 780.



model HZ6 MICROFLEX REVOLUTION COUNTER

Use to control an operation as a function of mechanical movement — drive shaft can be mechanically connected to machine, spindle, conveyor, etc.

Ask for bulletin 730.



model HM MULTIFLEX (Multiple Circuit) TIMER

Use for sequence control of 1 to 7 circuits. With shaft drive for mechanical connection to an external drive mechanism.

Ask for bulletin 130.

Write us regarding your count problem. Services of Sales Engineers in 25 district offices are available without obligation. Address Dept. ED-659.



EAGLE SIGNAL CORPORATION
INDUSTRIAL DIVISION • MOLINE, ILLINOIS
Eagle Timers Save Time — Save Money

CIRCLE 190 ON READER-SERVICE CARD



**Be sure the
TEFLON*
you buy
has the
Qualities
you need**

Processing can radically change Teflon properties

Take flex life as an example. The Teflon sheet illustrated was quenched to 50% crystallinity, resulting in an excellent flex life of 60,000 cycles. However, through lack of process control, it might have been cooled more slowly, giving a 56% crystallinity and a flex life of 40,000 cycles . . . A LOSS OF 20,000 CYCLES OF FLEX LIFE!

You can be sure of proper processing by specifying Teflon stocks made by Garlock's Plastics Division, the United States Gasket Company. U.S.G.'s years of experience with fluorocarbon resins guarantees you the right properties every time. This, plus assurance of fast delivery anywhere, makes Garlock your prime source of Teflon sheet, rod, tape, tubing, bars, cylinders. Find out more by calling one of Garlock Packing Company's 26 sales offices and warehouses throughout the U.S. and Canada.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

**United
States
Gasket**

*DuPont Trademark
for TFE Fluorocarbon Resin

Plastics Division of
GARLOCK

CIRCLE 191 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Name Plate Equipment

For production quantities

Designed for mass production of Fotofoil etched anodized panels, dials, and name plates, this equipment includes an automatic Fotofoil vacuum printer, a complete processing center, and specialized fabrication equipment for shearing, rounding corners, punching holes, blanking parts, and applying adhesive to the Fotofoil.

Miller Dial & Name Plate Co., Dept. ED, 4400 N. Temple City Blvd., El Monte, Calif.

CIRCLE 192 ON READER-SERVICE CARD

Portable Power Supply

For resistance welding



A medium range capacitance-discharge power supply, the model 1034 delivers up to 160 w-sec of energy in less than 0.002 sec. It is designed to permit distortion-free welding for mechanical filters, component packaging, semiconductor construction, relays, and honeycomb and brazing foil assemblies. The unit is portable and operates from any 115 v line.

Weldmatic, Div. of Unitek Corp., Dept. ED, 380 N. Halstead Ave., Pasadena, Calif.

CIRCLE 193 ON READER-SERVICE CARD

Punching Press

Has interchangeable punches and dies

The model 1012 Unipunch precision press can be provided with 37 round punches and 74 dies which are rapidly interchangeable. In addition to punching round and shaped holes and notching corners and edges, the unit may be used for punching extruded and countersunk holes, small louvers, and lanced holes. Small die sets may be installed for making stampings, and threaded nut inserts may be pressed into sheets or parts.

Punch Products Corp., Dept. ED, 3800 Highland Ave., Niagara Falls, N.Y.

CIRCLE 194 ON READER-SERVICE CARD

STRAITS TIN REPORT

New developments in
the production, mar-
keting and uses of tin



Tinned sheet steel, available up to 22 gage, has the strength of steel, and good formability in addition. The coating also serves as an excellent paint base and doesn't require a primer coat. For these reasons it is widely used in the automotive industry for air cleaners, oil filters, covers, vents and hot-air ducts.

Modern pewter is nontarnishing and nontoxic, contains no lead, and does not darken or lose its surface finish. It contains 93% tin, 6% antimony, and 1% copper. Surface finish ranges from a bright, high polish to a subdued satin texture. It can be cleaned with soap and water. Frequent polishing is not necessary.

De-icing problem? Perhaps this is the answer. Years ago a transparent electroconductive coating, containing tin, was developed for aircraft. The thin tin-oxide film is applied to glass. A low current passing through the coating generates sufficient heat to de-ice the glass, now standard equipment on most commercial and military planes.

Phosphor bronze, a tin-copper alloy containing up to 10% tin is used in over 30 different aircraft applications. Typical uses are for bushings, bearings, springs, valves, contact thermostats and switches.



Write today for more data on these items for a free subscription to TIN NEWS—a monthly bulletin on tin supply prices and new uses.

The Malayan Tin Bureau

Dept. 12F, 1028 Connecticut Ave., Washington 6, D.C.

CIRCLE 195 ON READER-SERVICE CARD

Electroaurotechnics

We are justly proud of our reputation for solving tough problems, of our application procedures for electro deposition of gold and gold alloys, and the development of our superior soluble precious metals, among which are:

INDUSTRIAL 24 Kt GOLD

(aqueous) the world's purest soluble gold, specified and used by many leaders in the Missile, Atomic and Electronic fields.

PROSENE 999★ 24 Kt Acid Bright Gold

The first NEW development in gold electroplating in over 100 years. It produces electroplates both hard and ductile using ONLY ONE addition agent operating at room temperature under POSITIVE and simple control. ☆ Patent Pending

H.G. BRIGHT 23+ Kt GOLD

The only bright gold operating with less than 1/10 ounce free cyanide per gallon at room temperature, offering variable hardness to fit your specifications . . . at a non-premium price.

RHODIUM SULPHATE T.P.

A superior rhodium concentrate of high purity offering low stress deposits and tight grain structure.

Full information on these superior soluble metals is available upon request . . . also the complete resources of our laboratories, and the most experienced Precious Metal Plating metallurgists in the world are at your service, without obligation. Phone, TWX, wire or write.

Technic

INC

39 Snow Street
Providence, R. I.

JACKSON 1-4200

Chicago Office
7001 North Clark Street

CIRCLE 196 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1959

Rotary Marking Machine

Handles 1500 units an hour



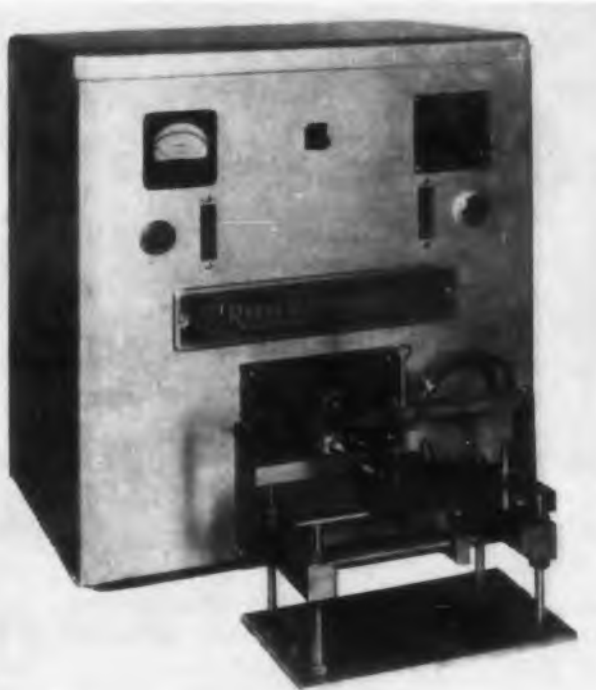
Air operated from a standard plant air line of 75 psi or more, the model 9A-14 rotary marking machine has a 14 in. stroke and handles 1500 or more parts an hour. It will mark the full circumference of a 4 in. diameter part or 2/3 of the periphery of a 6 in. diameter part. It will also do serial numbering and fixed marking in alternate rotations. The machine can be adapted for marking flat parts with the substitution of a roll die for the flat die. Dimensions are 51 x 18 x 14 in.

Acromark Co., Dept. ED, 411 Morrell St., Elizabeth, N.J.

CIRCLE 197 ON READER-SERVICE CARD

Induction Soldering Machine

Seals frequency control crystals

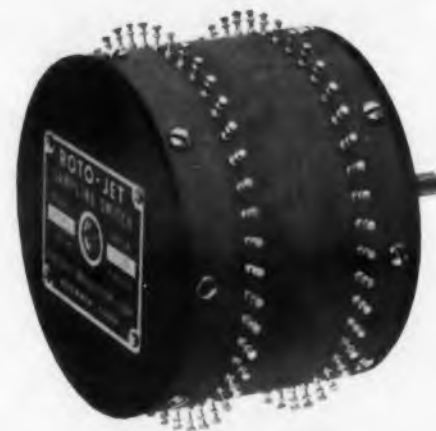


This induction soldering machine is designed for hermetic sealing of frequency control crystals and similar electronic components. It has a two-station slide fixture so that while one station is being heated for soldering, the other can be unloaded and reloaded. Soldering time is 5 to 15 sec depending on the size and shape of the can. The unit is 21 x 30 x 21 in. and weighs about 200 lb. Power requirements are 120 or 240 v, single phase, 60 cps.

Reeve Electronics, Inc., Dept. ED, 609 W. Lake St., Chicago 6, Ill.

CIRCLE 198 ON READER-SERVICE CARD

HIGH SPEED SWITCHING



NEW ROTO-JET®

SEQUENTIAL SAMPLING SWITCH

MAKES MORE THAN 3,600 CLOSURES/SECOND

No commutator to cause noise and wear! Contacts are closed by a rotating jet of air! New self-cleaning ROTO-JET represents the most outstanding development in long life, high speed switching in many years.

At low power levels, signals of 1, 2, and 3 millivolts can be directly transmitted free of measurable noise. Flexible, versatile, module contact design enable ROTO-JET to be built with any number of contacts required for a specific application.

Here is the long awaited innovation in high speed sampling and switching where a large number of voltage-generating elements must be connected successively to a single load. ROTO-JET is the perfect solution for directly commutating signals from thermocouples; strain gages; light-sensitive devices; and similar low level, high impedance elements employed in computers, telemetering systems, and complex process control. For full details, write for new Bulletin No. 8.030.

Just compare!

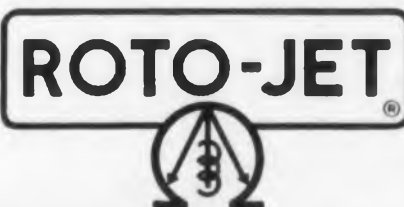
ANY SAMPLING SPEED—Sampling or switching speeds up to 40 revolutions per second.

SPLIT-SECOND CONTACT—Closing time less than 60 microseconds; opening time less than 80 microseconds.

2-POLE SWITCHING—Easily supplied to any phase angle.

POSITION INSENSITIVE—Mounts in any position; no effect on precision operation or performance.

NO MAINTENANCE—Wiperless contact design. Routine cleaning of contacts accomplished while switch is operating simply by increasing air pressure for several seconds.



ELECTRIC REGULATOR CORPORATION
Norwalk, Connecticut

Manufacturers of REGOHM® Regulators, MAGOHM® Magnetic Amplifiers, and GOVDHM® Diesel Generator Governors.

CIRCLE 199 ON READER-SERVICE CARD

ONLY ACOUSTICA ULTRASONIC CLEANERS HAVE MULTIPOWER!



MAJOR BREAKTHROUGH IN ULTRASONIC TECHNOLOGY!



In determining which ultrasonic cleaner to buy, remember that all ultrasonic cleaners are not alike. There is variation in uniformity of cavitation. There is variation in the transducer — and the transducer is the heart of an ultrasonic cleaner. The Multipower transducer developed by

Acoustica research, multiplies the power and efficiency of ultrasonic action. Cleaning is faster, labor costs are lower.

Acoustica ultrasonic cleaners are engineered and produced to the finest standards, unequalled in quality and value. Off-the-shelf in capacities from 1 to 75 gal. or custom built to 5000 gal. Expert Acoustica engineers can help you with your cleaning problems.

Send for further information.

acoustica

LEADER IN ULTRASONIC RESEARCH AND DEVELOPMENT

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NEW YORK
LOS ANGELES

Acoustica Associates, Inc.
Dept. ED, Fairchild Court, Plainview, N. Y.

Send information describing advantages of Acoustica ultrasonic cleaners.

Name _____
Company _____
Address _____
City _____ Zone _____ State _____

CIRCLE 200 ON READER-SERVICE CARD

PRODUCTION PRODUCTS

Vacuum Resistance Furnace

Operates at temperatures to 2400 C

The model 2915 vacuum resistance furnace handles production as well as laboratory work and can operate at temperatures to 2400 C. It can be used for heat treating, brazing, sintering, and testing both reactive metals and ceramics. It is completely self-contained with furnace chamber, pumping system, power supply, and controls in one cabinet and can be operated at absolute pressures of 10^{-5} mm of mercury or under inert atmospheres. Vacuum is achieved by a 30 cfm rotary gas ballast pump for roughing operation and a 6 in. high vacuum oil diffusion pump for evacuation in the high vacuum ranges.

NRC Equipment Corp., Dept. ED, 160 Charlemont St., Newton 61, Mass.

CIRCLE 201 ON READER-SERVICE CARD

Polyurethane Foaming Machines

Deliver 0.5 to 250 lb per min



Mobile, low cost, precision foaming machines, Stafoamers automatically meter and mix rigid, semirigid, and flexible Stafoam polyurethane. This material can be used for thermal, sound, and electrical insulation; for vibration damping; and for electronic component potting. Series P, C, R, SM, and B Stafoamer models have ratio limits between 11.07 to 1 and 2 to 1; viscosity maximum ranges of 20 kc; and compressed air requirements of 80 to 100 psig. All are 70 x 38 x 32 in. Resin and catalyst flow are varied by gear changes except in SM models, which use variable drive for catalyst flow. Power requirements are 220 v ac, 60 cps, three phase in models P40B and P80B, single phase in all others. Foam delivery varies from 0.5 to 250 lb per min, depending upon the model.

American Latex Products Corp., Dept. ED, 3341 W. El Segundo Blvd., Hawthorne, Calif.

CIRCLE 202 ON READER-SERVICE CARD

PRECISION ENGINEERED

Sub-Miniature Pilot Lights

... facilitate the solution of
miniaturization problems.



Example: Here are 2 Dialco units with but a tiny difference in o.d. of bushing: A refinement that helps to save space and weight where every fraction counts.

DIALCO

On your next miniaturization project, consult DIALCO for the Pilot Lights. You will quickly find the proper unit for use with either tiny Incandescent bulbs (T-1 3/4); or with sub-miniature Neon bulbs (NE-2D).

TWO-TERMINAL units are fully insulated. SINGLE-TERMINAL units are for use on grounded circuits. Also DIMMING or NON-DIMMING sub-miniatures for every requirement. Meet all applicable Military Specifications.

Samples for design purposes on request at once — no charge.



Foremost Manufacturer of Pilot Lights

DIALIGHT

CORPORATION

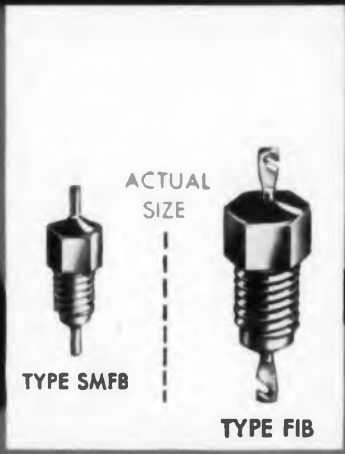
46 STEWART AVE., BROOKLYN 37, N. Y.
HYacinth 7-7600

Dialight Corp., 46 Stewart Ave., Brooklyn 37, N. Y.
 Send brochures on Sub-Min. Pilot Lights
 Brochures on other Dialco Pilot Lights

Name _____
Position _____
Company _____
Address _____

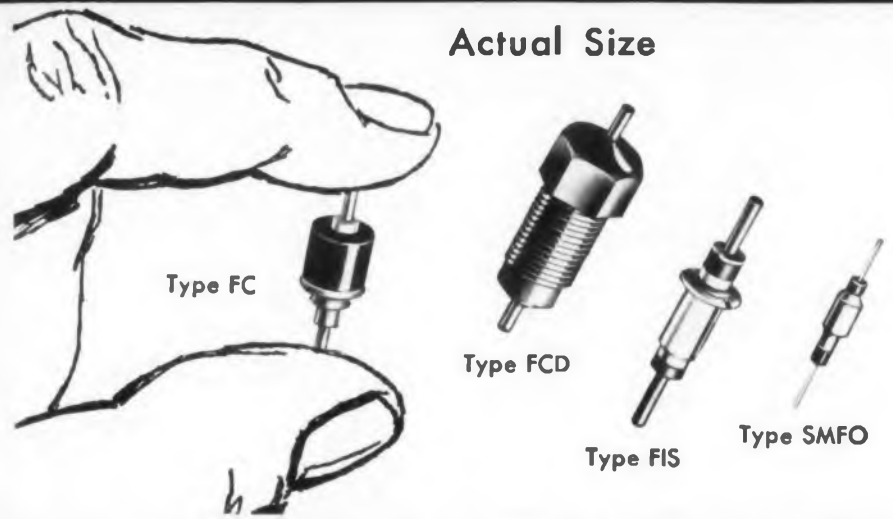
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Broad Band High Frequency Filters

Allen-Bradley cascaded ceramic feed-thru filters provide effective filtering up to and beyond 5,000 MCS

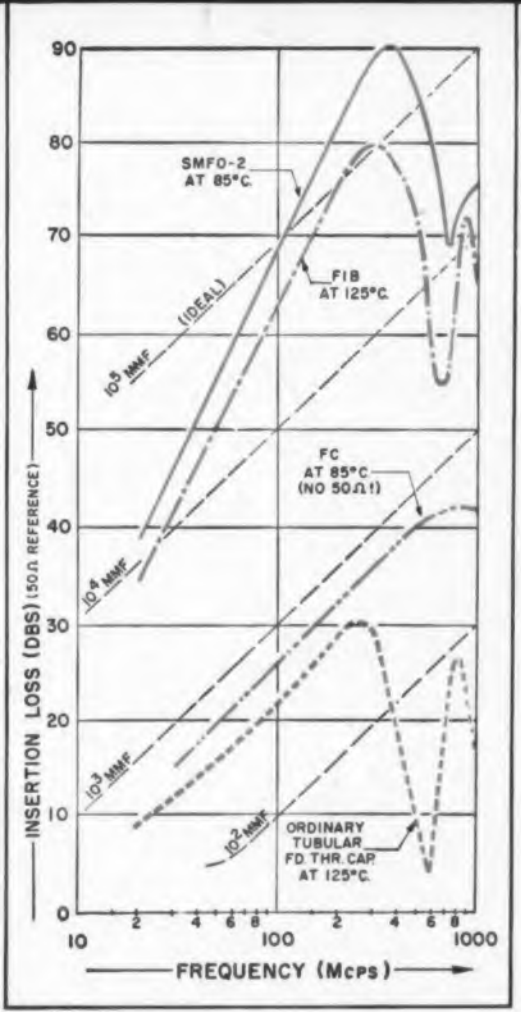


Actual Size

Here's an entirely new concept in ultra-high frequency filtering—Allen-Bradley's new ceramic feed-thru filters. Their high insertion loss—up to 60 db—effectively prevents feedback and radiation from low power circuits operating in the frequency range from 50 mcs to 5000 mcs.

Astounding in performance, these new A-B filters are actually superior to the theoretical *ideal* capacitor over a wide frequency range. Note, in the graph at right, their effective filtering increases with frequency—and they have none of the undesirable resonance characteristics of standard tubular capacitors. In addition, A-B filter elements provide far greater effective capacitance values than practical with conventional capacitor designs. Filters are available in voltage ratings up to 500 v DC at 125°C. Send for Technical Bulletin 5410.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
 In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

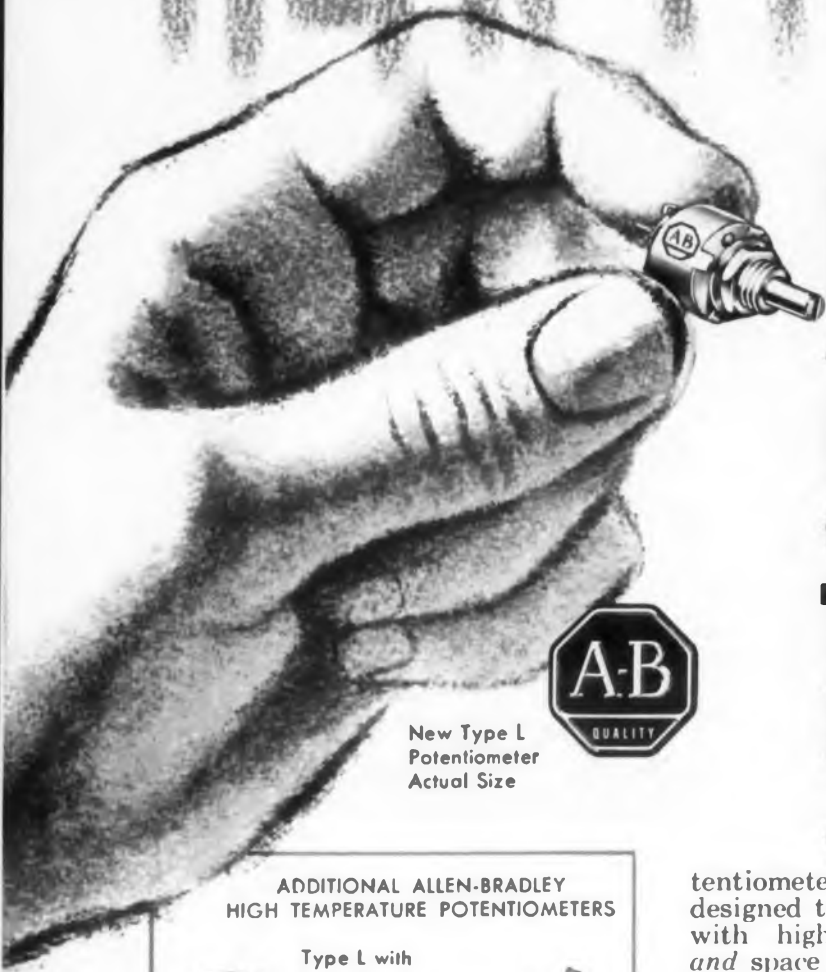


3-59-E

ALLEN - BRADLEY

Quality
 ELECTRONIC
 COMPONENTS

HEAT PROBLEMS?



New Type L Potentiometer Actual Size

NEW

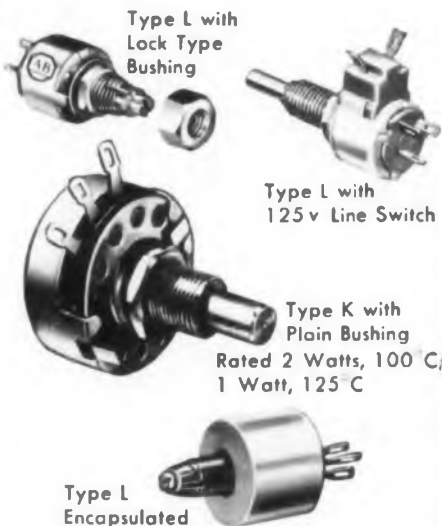
Allen-Bradley

POTENTIOMETERS

for use in

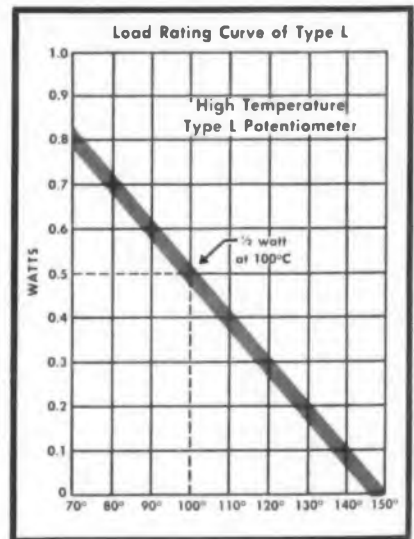
TEMPERATURES UP TO 150°C!

ADDITIONAL ALLEN-BRADLEY HIGH TEMPERATURE POTENTIOMETERS



This new Allen-Bradley potentiometer—the Type L—is especially designed to solve problems associated with high ambient temperatures—and space conservation. Although extremely compact—0.5 inch in diameter—the Type L control has a conservative rating of 0.5 watt when operating in an ambient temperature of 100°C. And, it provides reliable performance when operated at a temperature of 150°C—under “no load” conditions. (See graph at right.)

The new Type L control features the same solid, hot molded resistance element that has proved unequalled for long life, smooth operation, and low “noise” characteristic in Allen-Bradley’s popular Type J, Type K, and Type G potentiometers. When temperature and space problems in your designs plague you, this new A-B “high temperature” potentiometer is a reliable answer. Please send for complete information, today.



AMBIENT TEMPERATURE °C.
Load Capabilities of Type L below the Critical Resistance Value. Type L Far Exceeds the Requirements of MIL-R-94B.

ALLEN-BRADLEY

Quality Electronic Components

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

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Micro
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2 amps. at
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what size reliable RELAYS do you need

Micro-miniature 44

SPDT and DPDT contacts rated 2 amps. at 28 VDC and 115 VAC, non-inductive. Operate time, 5 ms. max.; release 3 ms. max.—wide choice of mountings; vibration and shock resistance to meet military specifications.



Subminiature 33

Fast acting-contact combinations to 6 arms per stack, 12 per relay. Contact ratings to 5 amps. Operate sensitivity (SPDT) 250 mw. min.



Miniature 11

Contact combinations to 8 arms per stack; 16 per relay. Contact ratings to 5 amps. Operate sensitivity (SPDT) 150 mw. min.



Small 22

Contact combinations to 12 arms per stack; 24 per relay. Contact ratings to 15 amps. Operate sensitivity (SPDT) 100 mw. min. TIME DELAY: operate to 65 ms; release to 150 ms.



Medium 66

Contact combinations to 12 arms per stack; 24 per relay. Contact ratings to 15 amps. Operate sensitivity (SPDT contacts) 60 mw min; TIME DELAY: operate to .15 sec; release to .25 sec.



Above relays available with contacts ranging from bifurcated gold alloy for low level switching to heavy duty power; plug-in mounted; with snap action contacts; open, dust tight or hermetically sealed; to meet applicable military specs. Tell us what you need or send for catalog

MAGNECRAFT

Electric Company

3350D W. Grand, Chicago 51, Ill.

CIRCLE 205 ON READER-SERVICE CARD

CIRCLE 204 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1959

Ultrasonic Cleaners

Multipurpose



Consisting of a generator and a matching transducerized tank, Circosonic ultrasonic cleaners may be used for cleaning gears, bearings, and instruments; removing excess solder flux, fingerprints, line waxes, and grease from parts; and many other purposes. Outputs range from 60 to 1000 w and tank capacities are 1 to 20 gal. Tuning is continuous over a wide range, and the generators are equipped with a selector switch so that two transducerized tanks may be operated from the same generator.

Circo Ultrasonic Corp., Dept. ED, 50 Terminal Ave., Clark, N.J.

CIRCLE 206 ON READER-SERVICE CARD



Multipurpose Furnace

Grows crystals

The model MF-90 furnace provides complete heat treating and experimental facilities in one apparatus. It may be used in a horizontal or vertical position at temperatures to 1100 C and is provided with an anticipating controller, a Variac, and an ammeter. A clock motor is mounted for growing single crystals by the Bridgman technique. The furnace cores may be replaced in two minutes with the furnace at operating temperature.

Materials Research Corp., Dept. ED, 47 Buena Vista Ave., Yonkers, N.Y.

CIRCLE 207 ON READER-SERVICE CARD

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When you notify us of a change in job or in any part of your address, we are forced to cancel your subscription unless you:

- Restate in writing your qualifications to receive *ELECTRONIC DESIGN*, either by letter, on the Reader Service Card, or on an ordinary change of address card.
- Include your old as well as new address (even if you are only correcting an address).

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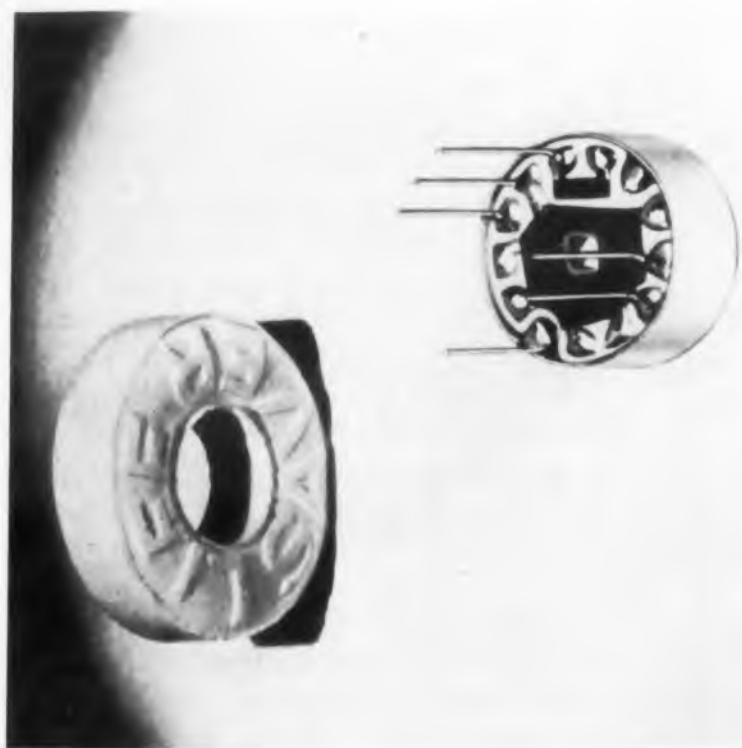
ELECTRONIC DESIGN

a HAYDEN publication

830 Third Ave., New York 22, N.Y.

NEW PRODUCTS

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



Tiny Amplifier Has Military Uses

Measuring 0.531 in. in diameter and 0.228 in. in height, including the hermetically sealed case, the TA-12 four-stage amplifier has 12 resistors, 5 capacitors and 4 transistors. It weighs 1/16 oz, and has both industrial and military applications. Gain of the unit is from 73 to 78 db at 1 kc with a 1000 ohm load. Having a nominal input impedance of 2000 ohms, its signal to noise ratio is 42 db below 1 v. At 300 cps the frequency response is down 6 ± 3 db; it is down 4 ± 2 db at 3000 cps.

Centralab, Division of Globe-Union, Inc., Dept. ED, 900 East Keefe Ave., Milwaukee 1, Wis.

CIRCLE 208 ON READER-SERVICE CARD



Multiturn Pots Have Film Elements

Having virtually infinite resolution because their resistive element is of the film type, the model 783 and 7810 potentiometers are three and ten turn units, respectively. Case diameter is 7/8 in, and linearity is 0.025% at any resistance value. Life expectancy is in excess of 10 million shaft revolutions at speeds over 200 rpm.

Computer Instruments Corp., Dept. ED, 90 Madison Ave., Hempstead, L.I., N.Y.

CIRCLE 209 ON READER-SERVICE CARD



Drum Head Handles 64 Channels

Track width of the model HD 14-64x metal drum head, designed to handle 64 channels, is 0.024 ± 0.0005 in. Track spacing from center to center is 0.0625 in. and gap length is 0.0005 in. The maximum deviation from head to base to back of any stack is ± 0.001 in., and gap scatter is ± 50 μ m. Specifications of this unit may be modified to suit particular requirements.

J. B. Rea Co., Inc., Dept. ED, 2202 Broadway, Santa Monica, Calif.

CIRCLE 210 ON READER-SERVICE CARD

Creative Microwave Technology

Published by Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Mass., Vol. 1, No. 4

NEW KILO-LINE RECORDING STORAGE TUBES SPECIALLY DESIGNED FOR SCAN CONVERSION

To meet the need for low-noise, high-resolution devices for frequency and scan conversion, Raytheon scientists and engineers have developed two new storage tubes: the single-gun QK-685 and the dual-gun QK-703. These tubes are now available in production quantities.

Both types incorporate a specially designed tetrode electron gun for higher resolutions — 1,000 TV lines at 50% modulation — and better control over beam cut-off than conventional triode guns. A new multiple collimating lens improves background uniformity and results in shading-to-signal ratios of less than 10%.

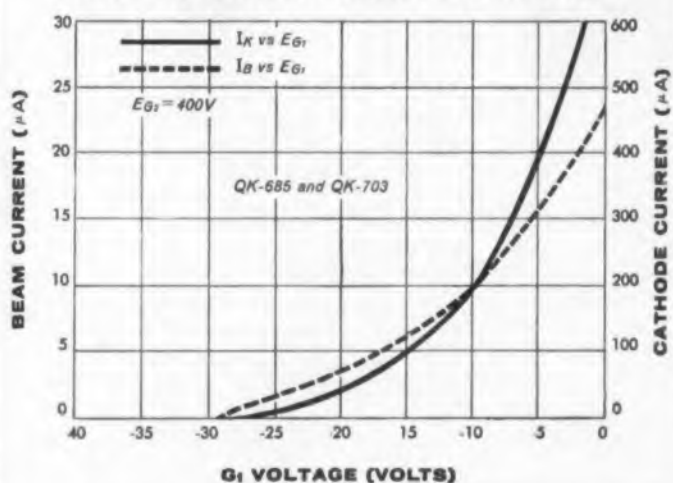
The ability of the dual-gun type to read and write simultaneously makes this tube particularly applicable to slow-down video and conversion from PPI to TV scan patterns for "Bright Display."



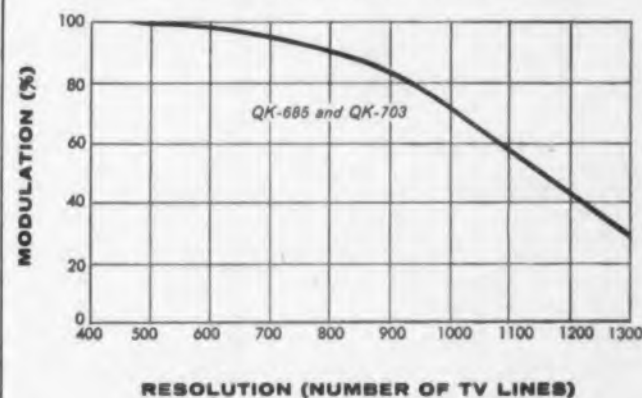
Typical Operating Characteristics

	QK-685 and QK-703
Anode Voltage	4,000 Vdc (Max.)
Resolving Power	1,000 Lines (Nom.)
Magnetic Focus	700 Lines (Nom.)
Electrostatic Focus	QK-685—10 $\mu\mu\text{f}$ (Nom.)
Output Capacitance	QK-703—20 $\mu\mu\text{f}$ (Nom.)
Maximum Deflection Angle	30°

GRID TRANSFER CHARACTERISTICS



TYPICAL RESOLUTION CURVE



Excellence in Electronics



You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Manufacturing Company, Waltham 54, Massachusetts

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY



Servo Plotter Works Automatically

Servo systems are checked out automatically with this servo plotter. It reproduces test results in graphic form on linear plot paper and provides, among others, Bode, Nichols and Nyquist plots. The unit produces a selection of 40-point curves within 12 min.

Republic Aviation Corp., Dept. ED, Farmington, L.I., N.Y.

CIRCLE 211 ON READER-SERVICE CARD



Resistors Are Quickly Changed

Designed for quick interchangeability on computer boards, or wherever required, the series EP encapsulated wirewound resistors have binding post terminals. The lugs are available with either silver or gold plating. Maximum resistance of the units is up to 25 meg; wattage rating is from 0.5 to 2.5 w.

Kelvin Electric Co., Dept. ED, 5907 Noble Ave., Van Nuys, Calif.

CIRCLE 212 ON READER-SERVICE CARD

CIRCLE 213 ON READER-SERVICE CARD



NOW

3

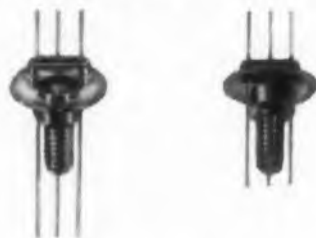
**NEW TRANSISTOR
BASE ASSEMBLIES**



TYPE 519

SPECIFICATIONS

- .071 Pin Circle
- .018 Pin Diameter
- .500 Pin Below Flange
- .138 Eyelet Body Diameter
- .200 Eyelet Flange Diameter
- .010 Kovar Mat'l
- with or without ground pin or blind pin



TYPE 520

SPECIFICATIONS

- .100 Pin Centers
- .018 Pin Diameter
- .500 Pin Below Flange
- .443 Flange Diameter
- #6-32NC Copper Stud
- .012 Kovar Mat'l



TYPE 521

SPECIFICATIONS

- .100 Pin Circle
- .018 Pin Diameter
- .500 Pin Below Flange
- .166 Eyelet Body Diameter
- .210 Eyelet Flange Diameter
- .008 Kovar Mat'l
- with or without ground pin or blind pin

These new transistor bases supplement Constantin's expanding line of semiconductor base designs now numbering well over 500 configurations.

By far the largest existing selection, many of these designs are available on open tooling.

Original Equipment Manufacturers:

Design and Packaging Engineers: Let us help solve your problems. The engineering, facilities, skills and experience responsible for these designs stand ready to help you grow.



L.L. Constantin & Co.

RT. 46, LODI, N. J.

SADDLE BROOK, N. J.

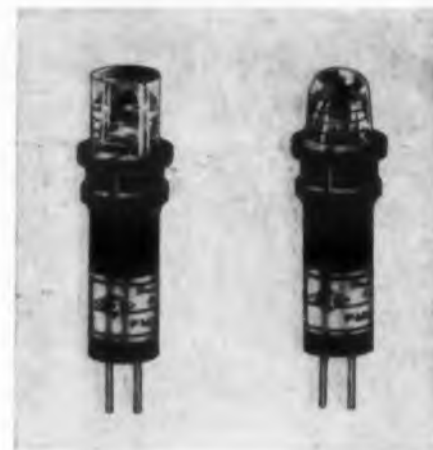
**MANUFACTURING
ENGINEERS**

CIRCLE 214 ON READER-SERVICE CARD

NEW PRODUCTS

Panel Lights

Mount in front



Front mounted series FML lights require no rear panel access for mounting or replacement. They have a collet type body that is locked in place by a lens which acts as a compression ring. Connections are made with collet terminals, wire wrap, or soldering. The units are available with a variety of lamps and mount in 3/8 in. holes on 1/2 in. centers. The lenses, clear or colored, have molded-in diffusing rings.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

CIRCLE 215 ON READER-SERVICE CARD



**Tantalum
Capacitors**

Rated 1 to 300 μ f

Type SRM and SCM capacitors are solid electrolyte, sintered tantalum anode units with capacity ratings from 1 to 330 μ f and voltage ratings from 6 to 35 v. They have low dc leakage current and standard capacity tolerances of ± 10 and $\pm 20\%$, respectively. Type SRM units operate from -80 to $+125$ C, while type SCM are designed for -80 to $+85$ C operation and have a slightly higher dissipation factor.

Texas Instruments Inc., Semiconductor-Component Div., Dept. ED, P.O. Box 312, Dallas, Tex.

CIRCLE 216 ON READER-SERVICE CARD

Sweep Generator

Provides center frequencies from 1 to 900 mc



Sweep generator model HD-1 has a dual oscillator assembly that provides a continuous spectrum of center frequencies across the 1 to 900 mc range. Sweep widths may be varied from 200 kc to 100 mc over the heterodyne range and from 0 to 6% of the center frequency for all frequencies over 400 mc. An age circuit continuously samples the swept signal and maintains a level output flat within 5% across the entire sweep width. The rf output is 1 v peak to peak over the high range and 0.5 v peak to peak over the low. This voltage may be reduced in steps by a front panel turret attenuator. The horizontal sweep signal is 20 v peak to peak with a repetition rate equal to a 50 or 60 cps line frequency.

Teleonic Industries, Inc., Dept. ED, Beech Grove, Ind.

CIRCLE 217 ON READER-SERVICE CARD

Test Set

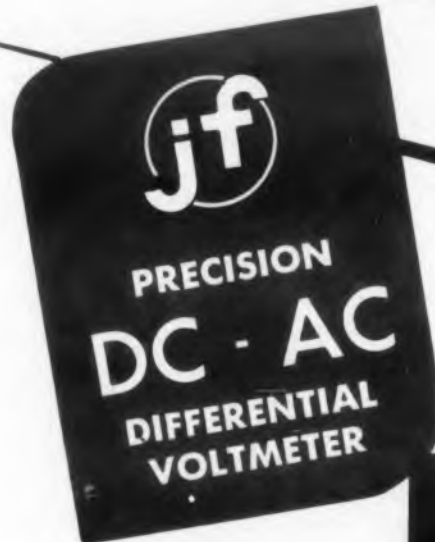
For diode pulse recovery



Used with a suitable square wave generator and oscilloscope, the model ND-1 standard diode pulse recovery test set measures: forward bias current from 2 to 40 ma; inverse voltage from 5 to 50 v; load resistance from 500 to 3000 ohms; load capacitance from 10 to 100 μ f; and inverse enhancement current from 5 ma to 50 μ a. Military designation is JAN-265. The unit has built-in test clips and interconnecting cables and is supplied with resistance and capacitance standards.

The Indikon Co., Inc., Dept. ED, 76 Coolidge Hill Rd., Watertown 72, Mass.

CIRCLE 218 ON READER-SERVICE CARD



MODEL 803
\$845.00

NOW . . . make precise measurements of either DC or AC voltages with this all new jf instrument. Use the 803 as an AC Differential Voltmeter, DC Potentiometer or DC/AC VTVM. Actually 3 INSTRUMENTS IN ONE.

FEATURES

1. Standard Cell Reference
2. Direct in-line readout
3. Mirror Scale Meter
4. Eight Search and four Null ranges

DC

Accuracy: .05% from .1 volt to 500 volts

Input voltage ranges: 500-50-5-.5v

Null ranges: 10-1-.1-.01v

Input Resistance: Infinite at Null

Resolution: .005v at 500v to .00005v at .1v

AC

Accuracy: .2% from .5 volt to 500 volts from 30 CPS to 5 KC

Input voltage ranges: 500-50-5v

Null ranges: 10-1-.1-.01v

Input Impedance: 1 Meg. shunted by approx. 25 mmf

Resolution: .005v at 500v to .00005v at .1v

For complete details of the new jf Model 803 write direct or contact our engineering representative in your area.
Cabinet Size: 9 $\frac{3}{4}$ x 13 x 17 — Price: \$845.00 F.O.B. Seattle factory

JOHN FLUKE MANUFACTURING CO., INC.

1111 West Nickerson - Seattle 99, Washington

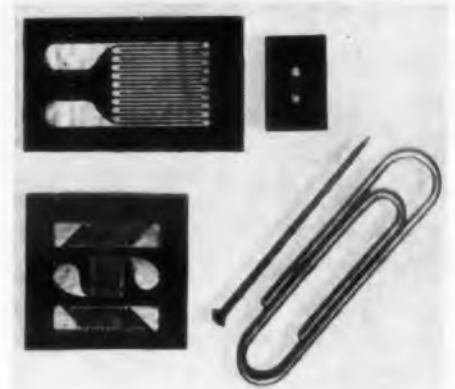


CIRCLE 219 ON READER-SERVICE CARD

NEW PRODUCTS

Strain Gages

Weigh 1.1 to 9.3 mg



These miniature MetalFilm strain gages are for use in rockets, space vehicles and supersonic aircraft. The model 121-R3A is a rosette gage that determines the magnitude and directions of principal strains; the 1X1-32A is a miniature gage for use in areas of very steep strain gradient; and the 341-500 is a high fatigue life unit for structures undergoing severe dynamic strains. The smallest gage is 1/32 in. wide, 5/32 in. long, and 1/1000 in. thick and the largest is 1/2 in. square and 1/1000 in. thick. The units weigh 1.1 to 9.3 mg.

Tatnall Measuring Systems Co., Dept. ED, Box 245, Phoenixville, Pa.

CIRCLE 221 ON READER-SERVICE CARD



Random Access Memory

Has 8 μ sec cycle time

The model TCM random access magnetic core memory is an all transistor, coincident current, ferrite core unit with an 8 μ sec cycle time. For use with the company's 3C T-Pac systems or any other type of digital system, the unit is modular and can be assembled to provide word capacities to 4096 and word lengths to 40 bits. Access time to any address is 4 μ sec.

Computer Control Co., Inc., Dept. ED, 92 Broad St., Wellesley, Mass.

CIRCLE 222 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1959

PLAIN FLANGE BRACKET STUD

POWER REQUIRED - MODEL 650
300 MW. FOR 5 MILLISECONDS
at 6, 12, 24 and 48 V. D.C.

CONTACT RATINGS -
2 A. at 28 V. D.C.
OR 115 V. A. C.

VIBRATION IMMUNITY -
30 G'S UP TO 2000 CPS

SHOCK - 100 G'S

MINIMUM LIFE - 100,000 OPERATIONS
AT 125° C

Micro-Miniature Latching Relays by Iron Fireman

5 MS PULSE AT 300 MW:

This very short burst of power and the shock and vibration immunities shown above are features of the newest addition to the Iron Fireman line of micro-miniature relays.

The model R650 relay was designed specifically to meet requirements when operating power is at a pre-

mium and ruggedness and dependability are essential.

Conforming to and exceeding the test specifications of MIL-R-5757C, the performance and reliability of the R650 relay is assured by the use of high temperature materials and a unique permanent magnetic structure.

Complete performance data available on request. Write to the address below.



IRON FIREMAN *Electronics* - DIVISION

2838 S. E. NINTH AVENUE, PORTLAND 2, OREGON

CIRCLE 220 ON READER-SERVICE CARD

AC Voltmeter Transistorized



Full scale readings of 1 mv to 300 v in 12 ranges with an essentially flat frequency response from 20 cps to 1.5 mc are possible with this transistorized battery operated ac voltmeter. The unit also has a db and a "battery OK" scale. Input impedance: 10 meg shunted by 15 μ f in the 1 to 300 v range; 1 meg shunted by 25 μ f in the 1 to 300 mv range.

Motorola Inc., Communications and Industrial Div., Dept. ED, 4501 West Augusta Blvd., Chicago 51, Ill.

CIRCLE 223 ON READER-SERVICE CARD

Portable Ohmmeters 0.5% accurate



Direct reading model 244 and 246 portable ohmmeters are calibrated in four ranges for measurements from 0.05 ohm to 50 K and 0.01 ohm to 100 K, respectively. They can be used for point-to-point circuit tests, resistance measurements on leads, grounds, and components, and a variety of other applications. Accuracy is held to 0.5% of mid-scale value. The units operate from self-contained batteries and compensate fully for resistance of leads and batteries. Housed in steel cases with removable lids, they measure 7-3/4 x 6-1/8 x 7-1/2 in. and weigh 12 lb.

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

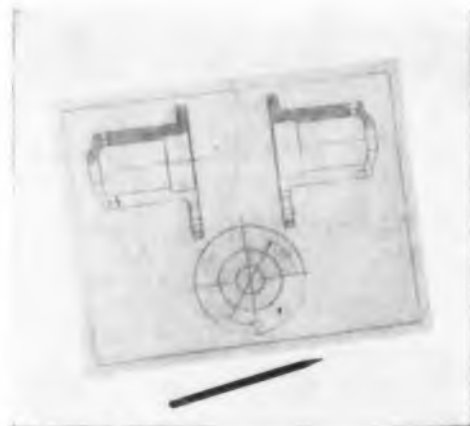
CIRCLE 224 ON READER-SERVICE CARD

Some Ideas

A year of relentless testing has produced a small library of interesting facts about HERCULENE (T.M.) Drafting Film. What follows is a consensus of drafting-room experience with HERCULENE—by K&E and its customers—with some up-to-date recommendations for using it. Take the matter of . . .

Shiny Back vs. Pencil Back

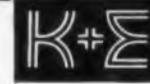
A basic question is: do you need a double-surfaced drafting film? We make HERCULENE Drafting Film both ways, of course—with a single surface (shiny back) and double surface (pencil back). It's our recommendation that you use pencil back HERCULENE only if it's your practice to make basic drawings on one side, changes on the other. For most other uses, shiny back is preferable. (At first, the double-surface film was chosen by many drafting rooms because it lay flatter on the board than shiny back. This is no longer true. K&E research labs have come up with a fully effective anti-curl treatment.) Especially in filing, shiny back HERCULENE presents fewer problems. The clean non-abrasive back won't smudge the face of the sheet underneath, even in a heavy stack of tracings. If you'd like to compare a few sheets, please let us know.



Note sharp clear lines made by Duralar pencil on HERCULENE Drafting Film.

Plastic Pencils and the HERCULENE Surface

Not just a handy catch-phrase, when K&E puts its exclusive "engineered surface" on a drafting material, the result is an exact, uniform tooth for sharp pencil drawing, inking and typing. With HERCULENE Drafting Film, however, an entirely new type of plastic (non-graphite) pencil yields especially good results. Quite a few of our customers have reported favorably on the well-known Staedtler "Duralar" brand. Duralar pencils come in five hardnesses, are non-smudging and have generally good covering power, sharpness and erasability. After about 20 prints, the Duralar lines show up consistently better than those made by a regular pencil, since graphite lines tend to lose density.



for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

Wet That Eraser!

The erasing qualities of HERCULENE Drafting Film are excellent, but (as with the pencils) we've discovered it's a new type of vinyl eraser that gives the best results. Examples of these non-rubber type erasers are the Richard Best "TAD" and the Eberhard Faber "RACE KLEEN"—both available from your K&E dealer. With vinyl erasers, pencil lines whisk off. Even stubborn ink and typing can be removed easily, with no damage to the surface. Here's a tip on how to do this:



Moisten the eraser slightly. It becomes no more abrasive, but a lot more "erasive." Moistening is a must when removing Duralar lines or typing after exposure to heat. (Incidentally, don't use electric erasing machines, steel erasers or typewriter erasers.) When erasing large areas, certain chemical eradicators work fine too. Our suggestion: use Vythene or a very light application of a denatured alcohol such as Solox, both of which can be applied with a cotton swab or clean cloth.

The Cleaner the Better

HERCULENE Drafting Film was designed for ink work, and its ink take is unexcelled. But like all films, its non-absorbency makes a few preparations advisable. The surface should be cleaned thoroughly before inking. Quickest and most effective way to do this is with the ABC Draftsman's Dry-Clean pad, which will remove finger marks and "traffic film" simply by rubbing the pad over the surface. Pouncing will also work well. A damp cloth is all right for general cleaning, but does not do the best job of preparing the surface for ink.

Inking over graphite pencil lines comes out best when done over light lines, drawn with a harder grade of pencil. A good way to remove excess graphite is to go over the drawing with an ABC pad. Inks vary in their usefulness on HERCULENE. We've tested several, and you're welcome to these results as well, on request.



After Typing, Please Pounce

Typed impressions on HERCULENE Drafting Film are crisp and sharp, but may take a while to dry because the film's surface doesn't "swallow" ink readily. A light pouncing right after typing will dry the ink and fix the lines—giving you uniform permanent contrast.

A new typewriter ribbon will produce the best impressions. At K&E we've tested a healthy variety of ribbons and we'd be pleased to send you the results on request.

Outstanding Advantages Proved in Tests

We're pleasantly amazed at the short time it took for HERCULENE Drafting Film to become an accepted "staple"—along with ALBANENE® Tracing Paper and PHOENIX® Tracing Cloth. Actually, it's a rare drafting room by now that has not tested HERCULENE during its first year on the market. The findings: All properties considered, HERCULENE stands up better than any other drafting film. It has great resistance to heat, aging and abuse. Its exclusive "engineered surface" plus its tough, durable Mylar® base provide superior pencil and ink take, fine erasability, remarkable dimensional stability...a combination we're proud to call unbeatable!

The K&E dealer near you has HERCULENE now. Stop in and see him.

KEUFFEL & ESSER CO., Dept. ED-6, Hoboken, N. J.

Please send further information about HERCULENE Drafting Film. I'd like samples too.

Name & Title _____

Company & Address _____

CIRCLE 225 ON READER-SERVICE CARD

Three voltage ranges: 0-200, 125-325, 325-525 VDC

1.5 AMPERE MODELS NEED ONLY 8 3/4" OF PANEL HEIGHT!

(metered)	(unmetered)
MODEL C-1580M: 0-200 VDC, 0-1500 MA. 580.00	MODEL C-1580: 0-200 VDC, 0-1500 MA. 550.00
MODEL C-1581M: 125-325 VDC, 0-1500 MA. 605.00	MODEL C-1581: 125-325 VDC, 0-1500 MA. 575.00
MODEL C-1582M: 325-525 VDC, 0-1500 MA. 680.00	MODEL C-1582: 325-525 VDC, 0-1500 MA. 650.00



800 MA MODELS NEED ONLY 7" OF PANEL HEIGHT!

(metered)	(unmetered)
MODEL C-880M: 0-200 VDC, 0-800 MA. 370.00	MODEL C-880: 0-200 VDC, 0-800 MA. 340.00
MODEL C-881M: 125-325 VDC, 0-800 MA. 345.00	MODEL C-881: 125-325 VDC, 0-800 MA. 315.00
MODEL C-882M: 325-525 VDC, 0-800 MA. 390.00	MODEL C-882: 325-525 VDC, 0-800 MA. 360.00



400 MA MODELS NEED ONLY 5 1/4" OF PANEL HEIGHT!

(metered)	(unmetered)
MODEL C-480M: 0-200 VDC, 0-400 MA. 289.50	MODEL C-480: 0-200 VDC, 0-400 MA. 259.50
MODEL C-481M: 125-325 VDC, 0-400 MA. 274.50	MODEL C-481: 125-325 VDC, 0-400 MA. 244.50
MODEL C-482M: 325-525 VDC, 0-400 MA. 289.50	MODEL C-482: 325-525 VDC, 0-400 MA. 259.50



200 MA MODELS NEED ONLY 5 1/4" OF PANEL HEIGHT!

(metered)	(unmetered)
MODEL C-280M: 0-200 VDC, 0-200 MA. 214.50	MODEL C-280: 0-200 VDC, 0-200 MA. 184.50
MODEL C-281M: 125-325 VDC, 0-200 MA. 189.50	MODEL C-281: 125-325 VDC, 0-200 MA. 159.50
MODEL C-282M: 325-525 VDC, 0-200 MA. 199.50	MODEL C-282: 325-525 VDC, 0-200 MA. 169.50



For all power supply needs through 1.5 amperes:

LAMBDA COM-PAK[®] POWER SUPPLIES

Less space! Improved performance!

Long, trouble-free service!

Transient free output!

Fills the need for compact, regulated DC power supplies. Economy of panel space, functional simplicity, new quick-service features.

Wiring, tubes and other components readily accessible. You can reach them easily, service them fast.

400 MA, 800 MA, and 1.5 ampere models include new, high-efficiency, long-life, hermetically-sealed semi-conductor rectifiers. All Com-Pak models are constructed with hermetically-sealed magnetic components and capacitors for long trouble-free service.

Condensed Data

LINE REGULATION Better than 0.15% or 0.3 Volt, whichever is greater.

LOAD REGULATION Better than 0.25% or 0.5 Volt, whichever is greater.

INTERNAL IMPEDANCE

C- 200 Series Less than 6 ohms.
C- 400 Series Less than 3 ohms.
C- 800 Series Less than 1.5 ohms.
C-1500 Series Less than 0.75 ohms.

RIPPLE AND NOISE Less than 3 millivolts rms.

POLARITY Either positive or negative may be grounded.

AMBIENT TEMPERATURE Continuous duty at full load up to 50°C (122°F) ambient.

AC OUTPUT
(unregulated) 6.5 VAC (at 115 VAC Input).

C- 200 Series 10 AMP
C- 400 Series 15 AMP
C- 800 Series 20 AMP
C-1500 Series 30 AMP

AC INPUT 105-125 VAC, 50-400 CPS

OVERLOAD PROTECTION AC and DC fuses; built-in blown-fuse indicators.

NEW PRODUCTS

Servo Amplifiers

Drive 3.5 w motors



Transistor-magnetic servo amplifier models 403-A and 403-B drive 3.5 w Mark XIV or equivalent size motors from low level ac signals. They require 115 v, 400 cps excitation. Respectively, they have input impedances of 30 and 500 K and gains of 2000 and 900 times.

ACF Industries, Inc., Avion Div., Dept. ED, 11 Park Place, Paramus, N.J.

CIRCLE 226 ON READER-SERVICE CARD

Power Transformer

For voltage doubler circuits



Power transformer R-93A permits the development of voltage doubler circuits with silicon rectifier power supplies. It provides taps on both primary and secondary windings and is rated at 110 or 120 v, 60 cps primary and 150, 160, or 170 v a 500 ma secondary. It also supplies 6.3 v, 6 amp filament power.

Triad Transformer Corp., Dept. ED, 4055 Redwood Ave., Venice, Calif.

CIRCLE 227 ON READER-SERVICE CARD

◀ CIRCLE 228 ON READER-SERVICE CARD

NEW 1959 CATALOG NOW AVAILABLE

New 36-page edition contains information and specifications on Lambda's full line of transistor-regulated and tube-regulated power supplies.

ALL LAMBDA POWER SUPPLIES ARE GUARANTEED FOR FIVE YEARS.

LAMBDA ELECTRONICS CORP.

11-11 131 Street, College Point 56, N. Y.

Lambda
Power
Supplies

Send
for
your
copy.



Impedance Meter

Direct reading



Meter model 310-B provides direct readings of impedance from 5 ohms to 100 K; phase angle in degrees; dissipation factor; and storage coefficient. Frequency range is 30 cps to 40 kc. Impedance and angle accuracy are $\pm 1\%$ and $\pm 2\%$, respectively, up to 20 kc.

Acton Labs, Inc., Dept. ED, 533 Main St., Acton, Mass.

CIRCLE 229 ON READER-SERVICE CARD

Germanium Transistors

For audio use

Type 2N1191 to 2N1193 transistors are low cost, germanium pnp alloy junction units for general audio use, including amplifier and switching service. They dissipate 175 mw and provide current gain ranges with 5 to 1 maximum spread.

Motorola Inc., Semiconductor Products Div., Dept. ED, 5005 E. McDowell Rd., Phoenix, Ariz.

CIRCLE 230 ON READER-SERVICE CARD

Metallized Paper Capacitors

For transistor applications

Tubular axial-lead capacitors, type MQZF, are hermetically sealed metallized paper units for low voltage transistorized applications. The subminiature capacitors have an operating temperature range of -55 to $+85$ C. Ratings are from 0.047 to 8.0 μ f. The smallest is 0.195 in. in diam and 11/16 in. long.

Astron Corporation, Dept. ED, 15 Grand Ave., East Newark, N.J.

CIRCLE 231 ON READER-SERVICE CARD

CIRCLE 232 ON READER-SERVICE CARD

**without E-W
cooling units,
electronic gear
in this hut
would
burn out
in minutes!**

The Ellis and Watts Model A-9 Unit that keeps this critical electronic gear cool has a cooling capacity of 9000 BTU's per hour. Without this vital cooling capacity the electronic equipment would burn itself out in a matter of minutes! Wherever electronic gear is used, it creates heat problems. And, in compact airborne huts these problems are especially serious.

Designing and building specialized units to keep electronic gear cool is our business at Ellis and Watts. Units of any capacity, configuration, control requirements or functions can be designed and built to any applicable military or commercial specifications. E-W Units will function perfectly in any climate conditions on earth.

For additional information on Ellis and Watts Model A-9 Unit for cooling electronic gear in airborne huts or similar installations, write for Bulletin #130-D.



ELLIS AND WATTS PRODUCTS, INC.
P. O. Box 33-D, Cincinnati 36, Ohio



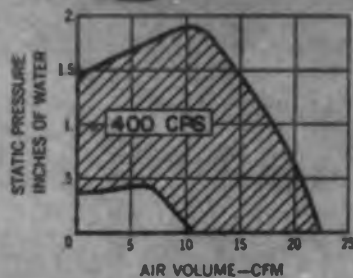
Compact, Model A-9 Unit, developed especially to provide cooling in airborne huts, measures only 27 1/4" x 26 1/8" x 16 1/4" high—leaves maximum space for vital electronic equipment.



Space At An
Absolute
Premium?

AXIMAX[®] 1

Ideal for flushing tightly packed "black boxes" aboard aircraft and missiles where size and weight must be held to a minimum, where reliability is critical and where high heat loads must be dissipated with cooling air. Dimensions 1½" x 1½", weight 4 ounces. The Aximax 1 will deliver 23 CFM free air or 19 CFM at 1" W.G. Choice of motors for 115 or 200 VAC, 400 CPS, 1 phase or 3 phase, for either pressurized or non-pressurized applications and for sine or square wave. Airflow instantly reversible by turning fan end-for-end. Meets military specifications.



Write for complete technical details...



ROTRON mfg. co., inc.
WOODSTOCK, NEW YORK ORIOLE 9-2401

CIRCLE 233 ON READER-SERVICE CARD

NEW PRODUCTS

MULTICONDUCTOR COAXIAL CABLES.—These cables consist of 95-ohm miniaturized coaxial conductors with Teflon dielectric and vinyl jacketing arranged in three layers around a center conductor. A cable may have up to 92 conductors.

Times Wire and Cable Co., Inc., Dept. ED, Wallingford, Conn.

CIRCLE 234 ON READER-SERVICE CARD

POLARITY-SENSITIVE DELAY LINES.—Provide output polarities identical or opposite to input polarities depending on connection method. Signal inversion needs no added parts.

Delttime, Inc., Dept. ED, 608 Fayette Ave., Maroneck, N.Y.

CIRCLE 235 ON READER-SERVICE CARD

RESISTANCE STANDARD BRIDGE.—With aged, encapsulated resistors, accuracy of the 1 K to 110 meg-meg model 801 has been increased to $\pm 0.01\%$ in the first two stages and $\pm 0.02\%$ in the other four.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

CIRCLE 236 ON READER-SERVICE CARD

RETRACTABLE CABLE.—"Spectra-Flex" has built-in spring steel coils that make it self-retracting.

Spectra-Strip Wire & Cable Corp., Dept. ED, P.O. Box 415, Garden Grove, Calif.

CIRCLE 237 ON READER-SERVICE CARD

MOUNTING ASSEMBLY.—Angle and clamp designed for quick mounting of switches and cable, filters, regulators and gages, valves, soldering apparatus, and lamps. Vibration proof.

Versa-Loc Corp., Dept. ED, Southern Blvd., Chatham, N.J.

CIRCLE 238 ON READER-SERVICE CARD

BUZZERS.—Series BD with standard voltages of 6, 12, and 24 v, others to 48 v dc. May be used for ac applications. Have dustproof cover and adjustable sound volume.

Line Electric Co., Dept. ED, 271 S. Sixth St., Newark 3, N.J.

CIRCLE 239 ON READER-SERVICE CARD

COIL AND WINDING IMPREGNANT.—One component, fast air-drying HumiSeal type 1B12 preserves original core and coil values, is solderable and humidity proof, withstands operating temperatures of -60 to $+130$ C.

Columbia Technical Corp., Dept. ED, 61-02 31st Ave., Woodside 77, N.Y.

CIRCLE 240 ON READER-SERVICE CARD

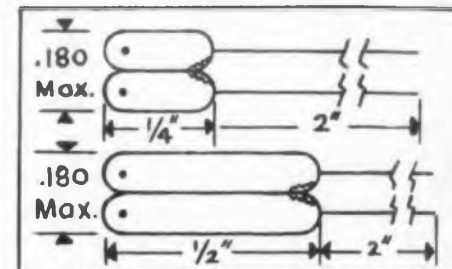
Using Thermistors

Edited by
FENWAL ELECTRONICS

—
**NEW "IDENTICAL"
THERMISTORS PERMIT
COMPLETE INTERCHANGEABILITY**

Now thermistor probes can be supplied with identical resistance temperature curves. These thermistors will meet a nominal curve tabulated in absolute resistance values at 1°F increments from 0°F to 350°F. All probes will be within $\pm 2\%$ of resistance at any temperature point on the curve.

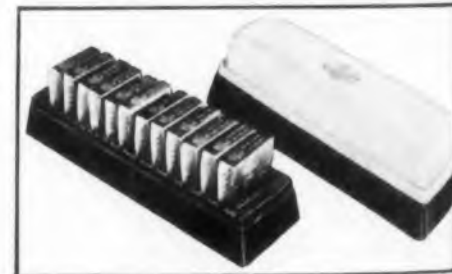
This now offers the user complete interchangeability and the opportunity to provide multi-point indication or control without having to individually calibrate



Shown twice actual size.

Patent Pending

each thermistor sensor. This, of course, is coupled with the advantage of tremendous sensitivity obtained from the inherent characteristic of a thermistor that gives in this case, a resistance change of from 26,520 ohms at 0°F to 70.4 ohms at 350°F. This curve can be obtained from Fenwal Electronics. Other details on these and other closer tolerance thermistors, ideal for telemetry and instrumentation, can be obtained from Fenwal Electronics, Inc., 35 Mellen Street, Framingham, Mass.



EXPERIMENTERS' KIT

The G200 Experimental Kit shown here simplifies selection of the "right" thermistor. Contains 12 different thermistors, each with complete operating characteristics. Available from distributors or the Framingham plant, \$19.95 net.



Making Precision Thermistors
to Make Your Design Ideas Come True

CIRCLE 241 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1964

Pulse Transformer

Operates at 135 C



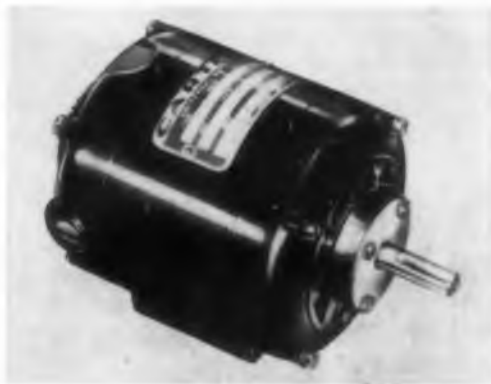
Designed for an ambient temperature of 85 C, this pulse transformer will withstand 135 C operating and 150 C nonoperating temperature. It is vacuum impregnated with silicone oil and has silicone rubber or Teflon gaskets and seals. Voltage output is 27 kv; step-up ratio, 1 to 5; primary impedance, 20 ohms; pulse duration, 0.9 μ sec; pulse repetition frequency, 1300 pps; and filament supply, 3.5 amp. The unit has a case diameter of 5-1/2 in. and a case height of 5-5/8 in. It weighs 14 lb.

Stavid Engineering, Inc., Dept. ED, Plainfield, N.J.

CIRCLE 242 ON READER-SERVICE CARD

FHP Motors

1/35 to 1/10 hp



The Classic fhp motor line consists of eight standard models operating at 3600, 5000, 7500, or 10,000 rpm and rated 1/10, 1/12, 1/15, 1/18, 1/20, 1/25, and 1/35 hp. Available as universal, shunt, or series motors from 12 to 220 v input, they measure 4-1/2 x 3-5/16 x 3-3/8 in. and weigh 3-3/4 lb. The units have large brushes, precision ball bearings, and sealed in lifetime lubrication.

Carter Motor Co., Dept. ED, 2711 W. George St., Chicago 18, Ill.

CIRCLE 243 ON READER-SERVICE CARD

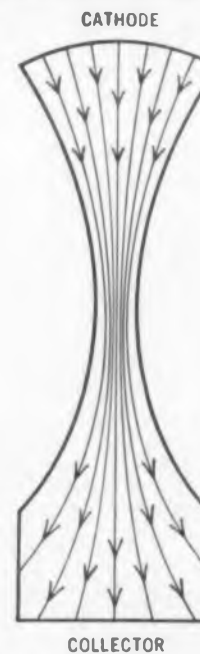
IMMEDIATE DELIVERY

15kw S-Band Amplifier Klystron has no heavy magnets

Exclusive Space-Charge Focus cuts weight to only 6½ lbs.

SAS-61 SPECIFICATIONS

Frequency Range 2700 to 2900 mc
Heating Time 90 sec.
Peak Power Output 15 kw
Maximum Drive Power 30w
Power Gain 30 db



New Space Charge Focus principle of beam control is shown in diagram. New Sperry tube design utilizing this principle reduces size, weight, power consumption and cooling needs.

AVAILABLE FOR IMMEDIATE DELIVERY. Sperry's new S-band transmitting tube is a 3-cavity pulse amplifier of high gain and extra-long service life.

EXCLUSIVE SPERRY SPACE-CHARGE FOCUSING design eliminates heavy, cumbersome magnetic structures — a feature of prime importance in equipment design. Although the SAS-61 weighs only 6½ lbs., its sturdy construction

withstands extreme vibration and environmental conditions.

MAIN APPLICATIONS for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal

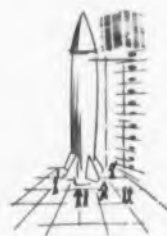
tunable cavities is a *complete* microwave unit. No external equipment is required.

SPERRY CAN DELIVER SAS-61 tubes in quantity at once. Write or phone your nearest Sperry district office.

SPERRY

ELECTRONIC TUBE DIVISION, SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION
Address all inquiries to Great Neck or Sperry offices in Brooklyn, Boston, Philadelphia, Los Angeles and Montreal. Export Dept., Great Neck, New York

CIRCLE 244 ON READER-SERVICE CARD



available astronauts

(30 g TO 5000 CYCLES—200 mw
—TO SCALE)

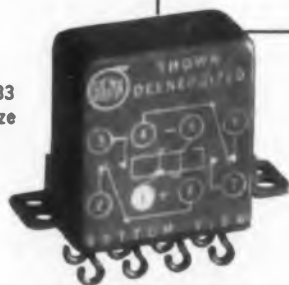
It's not easy these days to find a relay as ideally suited to fast, one-way, non-stop journeys as Morton P. Rodentia is. Morton's now-famous travels have proved conclusively that he can stand 30 g vibration to 5000 cycles while functioning, and shocks as high as 100 g do not even disturb his derby. The triumphant expression springs from his latest discovery—the Sigma Series 33 relay with vibration and shock ratings as good as his own, and a sensitivity of 200 mw to boot. As a matter of fact, this is the *only* switch with these specs Morton could find that also would fit into his 0.8" x 0.4" x 0.9" attache case. When last heard from, Dr. Rodentia (hon. Ph. D., Solid State U.) was dickering over delivery schedules with the supplier.

With its prime customer taken care of, Sigma is now ready to do business with anyone interested in these Series 33 relays. Similar in appearance to the perhaps better-known Series 32 magnetic latching relay, the "33" is a *non-latching* DPDT relay. Switching is accomplished by a signal of the correct polarity and magnitude (SigmaFormY). Specs of major interest are as follows and are further discussed in a preliminary bulletin available on request.

SERIES 33 RELAY

VIBRATION	30 g to 5000 cps with no contact opening (energized or de-energized)
SHOCK, CONSTANT ACCEL.	100 g does not cause damage or open contacts (energized or de-energized)
SENSITIVITY	Operate 200 mw, release 2 mw.
CONTACT RATING	2 amperes at 28 VDC/120VAC, resistive load, for 100,000 operations min. at 125°C max.
SPEED	Operate time 2 to 20 ms, depending on overdrive; Release time 2.5 ms, max.
OPERATING TEMP. RANGE	—65°C. to +125°C.
CONNECTIONS	Plug-in, hook terminals or 3" leads
MOUNTING	Flange or stud
ENCLOSURE	Hermetically sealed

Series 33
Actual Size



SIGMA

SIGMA INSTRUMENTS, INC.
91 Pearl St., So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO. (Since 1939)

CIRCLE 245 ON READER-SERVICE CARD

NEW PRODUCTS

SIGNALING CONTROLLER.—Can be used with any transducer generating a dc signal to provide automatic industrial process control. Reacts to 1 μ v changes. Calibration accuracy, $\pm 0.25\%$ of full scale; available ranges, 1 to 100 μ v.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N.J.

CIRCLE 246 ON READER-SERVICE CARD

LOW POWER CONTACTS.—For use with the company's type HR multipole relays, these interchangeable palladium alloy contacts are designed for electronic switching, grid, and instrument control circuits.

Ward Leonard Electric Co., Dept. ED, Mt. Vernon, N.Y.

CIRCLE 247 ON READER-SERVICE CARD

COAXIAL TERMINATIONS.—For —450 to +440 F use, units have dc to 3 kmc range, 50 to 70 ohm resistance, type N or C male or female connectors. Average power dissipation, 1 w; vswr, below 1.2 to 3 kmc.

Stoddart Aircraft Radio Co., Inc., Dept. ED, 6644 Santa Monica Blvd., Hollywood 38, Calif.

CIRCLE 248 ON READER-SERVICE CARD

DRAFTING MACHINE.—Portable Draftette Senior 12 folds like a jackknife, attaches to drawing board, desk or table. Has one-piece 6 x 9 in. interchangeable scale divided into 16ths or 10/50ths and 360 deg protractor. Available with or without 20 x 26 in. drawing board.

David Miller & Associates, Dept. ED, Box 572, Beverly Hills, Calif.

CIRCLE 249 ON READER-SERVICE CARD

VOLTAGE REFERENCE PACK.—For printed circuit board mounting. Output voltage, 8-4 v $\pm 5\%$ stability, ± 1 mv over $\pm 10\%$ line variation in 28 v supply; temperature coefficient, $\pm 0.001\%$ per deg C from —55 to +100 C. Encapsulated in epoxy housing 1 in. in diameter and 1-1/4 in. high.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

CIRCLE 250 ON READER-SERVICE CARD

MINIATURE STRAIN GAGE SIGNAL AMPLIFIER.—Model CA9 operates from 28 v dc, delivers 0 to 5 v dc, has self-contained balance and gain controls. Single package 3.87 x 1.87 x 1.16 in. combines power source for excitation and signal amplifier. Unit has 0 to 2 kc response, operates from —65 to +165 F, withstands 35 g vibration and 100 g shock.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 251 ON READER-SERVICE CARD

FOR...

Slip-On Insulation,
Instrument Tubing,
Bundle Sheathing,
Medical Tubing,
Pigtails...



USE

SPAGHETTI SLEEVING

MADE FROM

TEFLON*

PF Spaghetti sleeving has these important advantages:

1. Good dielectric strength (500 to 2000 volts/mil)
2. Excellent electrical properties at high temperatures (500°F) and a wide frequency range
3. Low coefficient of friction. It slips on easily in long lengths of wire up to 3 ft.
4. Eliminates the need for silver coated wire
5. Zero moisture absorption
6. Unaffected by any commercial chemical
7. Stress relieved for negligible shrinkage

25 sizes, 2 wall thicknesses, 10 colors in stock, 100% inspected and controlled dimensionally are available.

Write, wire or call for full details, competent engineering assistance and information on special sizes and walls. PF Teflon* flexible tubing, heavy-walled tubing and rod stock are also available.

PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Phila. 4, Pa. EVergreen 6-0603

*Teflon—DuPont trade name for Tetrafluoroethylene resin

CIRCLE 252 ON READER-SERVICE CARD

Power Amplifier

Provides 15 kw average output



The model QK622 Amplitron is an S band power amplifier stage rated at 3 megawatts peak and 15 kw average output. It supplies full power over an operating band of 2900 to 3100 mc at over 70% efficiency. It requires no heater power for starting or operation and lasts 1000 hr at rated power output. Pulse duration is 10 μ sec; duty cycle, 0.005; pulse voltage, 50 to 55 kv; peak anode current, 65 amp; rf input, 475 kw; and weight with permanent magnet, 125 lb. The unit can be operated at reduced peak power level to serve as a driver stage. High efficiency is retained at a peak power output of 600 kw and a gain of 10 db.

Raytheon Mfg. Co., Microwave and Power Tube Div., Dept. ED, Waltham 54, Mass.

CIRCLE 253 ON READER-SERVICE CARD

Timer Kits

For process control

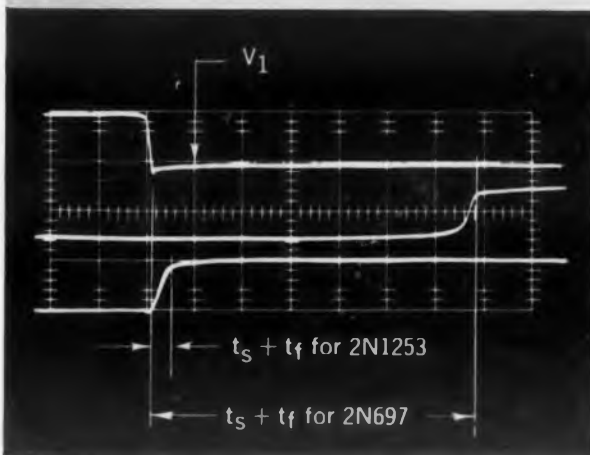


For use in process control, life testing, pulsing, and flashing, these timer kits are available in cycle lengths from 60 sec to 1 revolution per hr. They consist of a heavy duty, 115 v, 60 cps synchronous motor that drives an adjustable split cam assembly which actuates a totally enclosed, dustproof, snap action switch. Contacts are rated 15 amp at 120 v, 5 amp at 250 v ac, noninductive. Multi-cycling timers for repetitive cycle timings are also available.

Herbach & Rademan, Inc., Dept. ED, 1204 Arch St., Philadelphia 7, Pa.

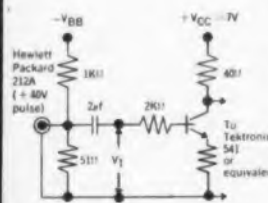
CIRCLE 254 ON READER-SERVICE CARD

New from Fairchild LOW STORAGE SILICON TRANSISTORS



Comparison of storage-and-fall-time performance between the new Fairchild 2N1253 and Fairchild's 2N697. The 2N1253 has performance otherwise equivalent to the 2N697 plus the additional advantage of low storage. An actual Polaroid photo is shown. Scale is 0.2 μ sec. per oscilloscope division. Scope was a Tektronix 543 with 53/54S plug-in giving a rise time of 15 nsec.

CIRCUIT USED IN COMPARING 2N697 AND 2N1253



NOTE:
V_{bb} is adjusted to make V₁ = 30V during turn-on and V₁ = -10V during turn-off.

TENTATIVE SPECIFICATIONS, 2N1252 AND 2N1253

ABSOLUTE MAXIMUM RATINGS (25°C)

V _{CE}	Collector to Emitter voltage (R _e = 10 Ω)	20 v
V _{CB}	Collector to Base Voltage	30 v
V _{EB}	Emitter to Base Voltage	5 v
Total Dissipation at Case Temperature 25°C		2 watts
at Case Temperature 100°C		1 watt
at 25°C Free-Air Ambient		0.6 watts

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	MIN.	TYPICAL	MAX.	TEST CONDITIONS
h _{FE}	D.C. pulse current gain	15	30	45	I _C = 150mA, V _C = 10V
V _{BE SAT.}	Base saturation voltage	1.0V	1.3	1.5V	I _C = 150mA, I _B = 15mA
V _{CE SAT.}	Collector saturation voltage	0.8V	1.5V	1.5V	I _C = 150mA, I _B = 15mA
h _{FE}	Small signal current gain at f = 20mc	2.5	5.8	5.8	I _C = 50mA, V _C = 10V
C _{ob}	Collector capacitance	30pF	45pF	45pF	I _C = 0mA, V _C = 10V
I _{CBO}	Collector cutoff current	0.1 μ A	10 μ A	10 μ A	V _C = 20V, T = 25°C
t _s + t _f	Turn-off time	75 μ sec	150 μ sec	150 μ sec	I _C = 150mA, I _{B1} = 15mA, I _{B2} = 5mA, R _L = 40 Ω , 10ms pulse

Fairchild's 2N1252 and 2N1253 provide the guaranteed shorter total switching time necessary for direct-coupled transistor logic circuits (DCTL) in combination with the inherent reliability and power dissipation that silicon mesa construction affords.

75 μ seconds is typical storage-plus-fall time at 150 ma collector current on these new devices; 150 μ s. is guaranteed. For low level operation, typical storage time is 35 μ s. for I_C = I_{B1} = I_{B2} = 10 ma. This performance makes them usable for saturating type logic circuits and high-current-level saturating switching circuits. A few of the many applications are magnetic core drivers, drum and tape write drivers, high-current pulse generators and clock amplifiers. They also provide extra safety factor in less critical applications.

To achieve high reliability, these transistors are preaged at 300° C, a temperature that would destroy most other types. This preaging time at 300° C accomplishes a stabilization of characteristics equivalent to thousands of hours of operation at junction temperatures as high as 175° C.

For full information, write Dept. B-6.



844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695

CIRCLE 255 ON READER-SERVICE CARD

This is
BJ ELECTRONICS

... bushes. 2. The
... In a busy manner. 1. Obs.
... [busy + -ness.] 1. Obs.
... work or personal concern; as, attend to busi-
... son for meddling or the like; as, he had no bu-
... ne's particular, esp. one's regular, work, occa-
... 4. Affair; matter; as, it was a strange busine-
... the details in acting or staging a play usually
... of actors or director. 6. Mercantile pursuit or
... le; commerce; as, he prefers business to law. 7.
... industrial enterprise; as, to sell one's busi-
... onage; as, to increase business by advertising.
See work
... as here co-
... m of activity that has for its end the supplying of c-
... ness, often an inclusive term, specifically names
... ties of those engaged in the purchase or sale of
... ed financial transactions; commerce and trade, c-
... xchange and transportation of commodities;
... commodities, especially by manufacturing
... scale that problems of labor and capita-
... ged in the operation of public car-
... etc.
Displaying the effi-

Business

The 8th definition of **business**, according to Webster, reads as extracted, "... to increase business by advertising." This advertisement has the sole purpose of offering the capabilities of BJ Electronics, Borg-Warner Corporation, to military suppliers for the manufacture of precision electronics. From your print specifications, this establishment will fulfill orders quickly and economically, utilizing 10 years of know-how and over 90,000 sq. ft. of new, completely equipped facilities. Consider your need, then ... consider this a direct solicitation of your sub-contract electronic business.

Write for facilities brochure. BJ Electronics, Borg-Warner Corporation, 3300 Newport Boulevard, Santa Ana, California.
National Direct Dial Number 714 KI 5-5581, TWX 5291.



NEW PRODUCTS

Inverter

High frequency

Model SV2C1200 Sineverter has an input of 22 to 29 v dc with transients per MIL-E-5894A and an output of 115 v $\pm 5\%$, 2 kc $\pm 1\%$, single phase, 0 to 50 va. It is shock and vibration resistant and measures 3 x 3 x 4 in.

Power Sources, Inc., Dept. ED, Burlington, Mass.

CIRCLE 256 ON READER-SERVICE CARD

Toggle Switches

Miniature



These miniature spst and spdt toggle switches are for aircraft, missile, and other use. The contacts are gold plated and the toggle is linked directly to the movable contact member. Switching is maintained or momentary.

Cutler-Hammer Inc., Dept. ED, 538 N. 12th St., Milwaukee, Wis.

CIRCLE 257 ON READER-SERVICE CARD

Preset Electronic Counter

Requires less than 1 w

A preset electronic counter model 37 can also serve as a variable delay unit or as a pulse rate divider and variable pulse-rate generator. It requires under 1 w total power. The standard unit provides a count range of 1 to 10,000 at rates to 110 kc and is housed in an ATT Type AIA case 4-7/8 x 7-5/8 x 9-9/16 in. Power requirements are +12 and -12 v.

C K Components, Inc., Dept. ED, 101 Morse St., Watertown, Mass.

CIRCLE 258 ON READER-SERVICE CARD

CIRCLE 259 ON READER-SERVICE CARD

Inertia Switch

Operates between 0.25 and 10 g



This hermetically sealed inertia switch is set to operate at an acceleration or deceleration between 0.25 and 10 g and at a time between 0.01 and 10 sec. Built to MIL-E-272A, it is rated 3 amp, resistive with 12 to 30 v dc operating voltage.

Walter Kidde & Co., Inc., Aviation Div., Dept. ED, Belleville, N.J.

CIRCLE 260 ON READER-SERVICE CARD

Variable Speed Drives

1/50 to 1/3 hp

Series SC-31 variable speed drives cover the 1/50 to 1/3 hp range and use no tubes. They have wide speed ranges with stepless adjustment from zero to full speed and use circuit breakers for armature protection.

Applied Technology Corp., Dept. ED, 475 Fifth Ave., New York 17, N.Y.

CIRCLE 261 ON READER-SERVICE CARD

Time Delay Relay

Delay of 0.05 to 60 sec

Model N17 is a subminiature time delay relay which uses all-silicon semiconductor devices for maximum reliability. The time delay is established by RC time constant circuitry, permitting an overall standard accuracy of $\pm 5\%$. Better accuracies are available. The unit's time delay ranges from 0.05 to 60 sec, preset at the factory. Ambient temperature (operating) ranges from -55 C to $+71\text{ C}$. Input voltage is 24 to 32 v dc, and current drain is 50 ma at 28 v.

Alto Scientific Co., Inc., Dept. ED, 55 Commercial St., Palo Alto, Calif.

CIRCLE 262 ON READER-SERVICE CARD

CIRCLE 263 ON READER-SERVICE CARD

Offering the Most
Complete Line
in the Industry!

HUDSON STANDARD CLOSURES



Hudson has the answer!

Hudson offers the widest selection of standard tooling, cover assemblies with innumerable modifications and special cases and covers for unusual applications. All finishes are available for components of mu metal, nickel-silver, aluminum, brass, copper, steel and stainless steel.

Hudson facilities range from batteries of standard and special presses to a fully equipped sheet metal department capable of handling your most rigid requirements.

If you need commercial or military closures, or help on a special design problem, call or write Hudson outlining your requirements.

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18-38 Malvern St., Newark 5, N. J.

TELEPHONE: MARKET 4-1802
TELETYPE: NK 1066



Precision Metal Components
for Electronics, Nucleonics,
Avionics and General
Industrial Applications





ELECTRONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

ELECTRONICS: In the half century since the invention of the original audion tube by De Forest, the art of electronics has expanded to a fourteen billion dollar industry that is contributing in hundreds of ways to our knowledge of the universe and our understanding of life itself. At Lockheed, for example, over half the technical staff is engaged in electronics research and development.

Significant contributions to the advancement of the state of the art in electronics have been made by Lockheed engineers and scientists in such areas as: computer development; telemetry; radar and data link; transducers and instrumentation; microwave devices; antennas and electromagnetic propagation and radiation; ferrite and MASER research; solid state electronics, including devices, electrochemistry, infrared and optics; and data reduction and analysis.

Over one-fifth of the nation's missile-borne telemetering equipment was produced by Lockheed last year. Its PAM/FM miniaturized system provides increased efficiency at one-fourth the weight of FM/FM missile-borne systems.

Advanced development work in high-energy batteries and fuel cells has resulted in a method for converting chemical energy directly into electrical power that promises a fuel utilization of almost 100% and an energy conversion efficiency of 70% or better.

Areas of special capability in computer development include the design of large scale data handling systems; development of special purpose digital computing and analog-digital conversion devices; development of high-speed input-output equipment; and advanced research in computer technology, pattern recognition, self-organizing machines, and information retrieval.

Other major developments are: a digital flight data recorder able to record each of 24 channels every few seconds; digital telemetry conversion equipment to reduce telemetered test data to plotted form rapidly and inexpensively; advancements in the theory of sequential machines; and a high-speed digital plotter that can handle some four thousand points per second with the finished plot programmed into the data tape as a continuous curve.

Lockheed Missiles and Space Division is engaged in all fields of the art — from concept to operation. Its programs reach far into the future and deal with unknown environments. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. F-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

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Lockheed

MISSILES AND SPACE DIVISION

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NOW! COMPLETE FACTS ABOUT EVERY CIRCUIT... RIGHT BEFORE YOUR EYES!

**DIT-MCO FAULT LOCATION CIRCUIT ANALYZER AUTOMATICALLY
PLOTS TEST SEQUENCE... PINPOINTS, IDENTIFIES
AND PATTERNS CIRCUIT ERRORS.**

DIT-MCO's exclusive cross-reference Matrix Chart automatically pinpoints each circuit flaw and puts clear, concise test information directly in front of the operator! Horizontal and vertical indicator lights cross-reference on the matrix square corresponding to the circuit under test. This square details type of flaw, circuit number and exact error location. Once an error is detected, the operator immediately marks it on the matrix square, resets the Universal Automatic Circuit Analyzer and continues the test.

All corrections are made direct from the Matrix Chart after the test sequence has been completed. This saves up to 90% correction time by eliminating time consuming searches through diagrams, manuals or interpretive readout devices. Because the DIT-MCO Matrix Chart is a simple, concise representation of all test circuits, specifications, instructions and modifications, *nothing* is left to chance or guesswork! The comprehensive nature of the Matrix Chart system provides important data for statistical analysis and permits effective checks and balances. from the drafting board to obsolescence!

DIT-MCO, Inc. employs an experienced staff of sales engineers in the field. Contact your field engineer or write for important facts about DIT-MCO Electrical Test Equipment.



**PLUGBOARD
PROGRAMMING
MEANS
EFFICIENT
TESTING!**

Jumper-wired plugboard programming utilizes simple, straight-forward adapter cables. Circuit modification problems vanish because all changes are easily made by re-jumpering the readily accessible plugboards.

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CIRCLE 264 ON READER-SERVICE CARD

NEW PRODUCTS

ACRYLIC CONTROL KNOB.—Has integrally molded pointer with color filled engraved hair line on under side. Fits 1/4 in. shaft and comes in variety of colors. Skirt diameter is 1 in.

Industrial Devices, Inc., Dept. ED, 982 River Rd., Edgewater, N.J.

CIRCLE 265 ON READER-SERVICE CARD

CONTROLLED ATMOSPHERE SYSTEMS.—Chambers provide under 1 ppm contamination without excess inert gas flushing, reach 5×10^{-4} ultimate vacuum in less than 20 min. Equipped with full-view Plexiglas domes.

Scientific Engineering Labs, Dept. ED, 1510 Sixth St., Berkeley 10, Calif.

CIRCLE 266 ON READER-SERVICE CARD

DELAY-LINE ASSOCIATED CIRCUITRY.—Complete custom delay packages to fit input, output, and packaging requirements, including amplifiers, flip-flops, and logic circuits.

Deltime, Inc., Dept. ED, 608 Fayette Ave., Mamaroneck, N.Y.

CIRCLE 267 ON READER-SERVICE CARD

MINIATURE TUBE AND TRANSISTOR SOCKETS.—Type SJ-424, for JETEC type sockets, has four contacts, Teflon body, is designed for compression mounting without additional hardware.

Fluorocarbon Products Inc., Dept. ED, Camden 1, N.J.

CIRCLE 268 ON READER-SERVICE CARD

MINIATURE RECTANGULAR CAPACITOR.—Type LK has four times the life required by MIL-C-25A, is 80% smaller than previous units. Operates to 125 C. Voltage ratings, 600 v to 50 kv.

Plastic Capacitors, Inc., Dept. ED, 2620 N. Clybourn Ave., Chicago 14, Ill.

CIRCLE 269 ON READER-SERVICE CARD

CONNECTOR TOOLS.—Models 15500, 15510, and 15520 respectively crimp, insert, and remove the company's miniature DS connectors.

Deutsch Co., Dept. ED, 7000 Avalon Blvd., Los Angeles 3, Calif.

CIRCLE 270 ON READER-SERVICE CARD

HEAT DISSIPATING COIL.—Finned aluminum coil that clamps to rotary components, increasing their operating temperature limits. Made to fit size 8, 10, 11, 15, and 18 units.

Kearfott Co., Inc., Dept. ED, 1500 Main Ave., Clifton, N.J.

CIRCLE 271 ON READER-SERVICE CARD

for
ACCURACY
and
STABILITY

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PRECISION COAXIAL

S
T
E
P
ATTENUATORS



DC to 1 KMC

ACCURACY (at DC)

1 to 5 db: .02 db
6 to 10 db: .05 db
20 to 50 db: .10 db

RF CALIBRATION ACCURACY

1 to 30 db: .1 db
40 to 50 db: .2 db

We supply individual
calibrations at 400
and 1000 MC and, upon
request, at other frequencies.

ATTENUATION RANGE

MODEL 60

2 drums, 0-60 db in 1 db step

MODEL 64

3 drums, 0-64 db in .1 db step

MODEL 640

3 drums, 0-110 db in 1 db step

Impedance-50 ohms
Connectors-Female Type N

Long term repeatability and assured quality are a result of our experience in making coaxial attenuators with our own stable film resistors since 1947. Our facilities for attenuator calibration are the most accurate facilities available commercially.

Weinschel Fixed Coaxial Attenuators cover the frequency range of DC to 12 KMC.



Write for complete catalog specifying frequency range of interest.

Weinschel Engineering
KENSINGTON, MARYLAND

CIRCLE 272 ON READER-SERVICE CARD

Bulkhead Mounting Filters

Low pass



Series JX bulkhead mounting, low pass filters have a variety of ac and dc voltage ratings and current ratings from 5 ma to 50 amp. Depending on the model, they are rated for maximum ambient temperatures of 85 to 125 C.

Sprague Electric Co., Dept. ED, 347 Marshall St., North Adams, Mass.

CIRCLE 273 ON READER-SERVICE CARD

Toggle Switch

Four-way operation

The type 8SB2-1 toggle switch combines the advantages of multi-circuit control, single-hole panel-mounting, and a toggle actuator, with sub-miniature size. It comprises eight type USM5 switches, secured in a mounting bracket, with a four-way toggle mechanism. Mounting in panels up to 1/4 in. thick, the toggle is maintained in center position and is spring-returned from each of the four possible operate positions. Each operate position actuates two spdt switches and the eight basic switches meet MIL-S-6743. Ratings of each switch are: 2.5 amp 30 v dc inductive; 5 amp, 30 v dc, resistive; 5 amp, 125/250 v ac.

The W. L. Maxson Corp., Unimax Switch Div., Dept. ED, Ives Rd, Wallingford, Conn.

CIRCLE 274 ON READER-SERVICE CARD



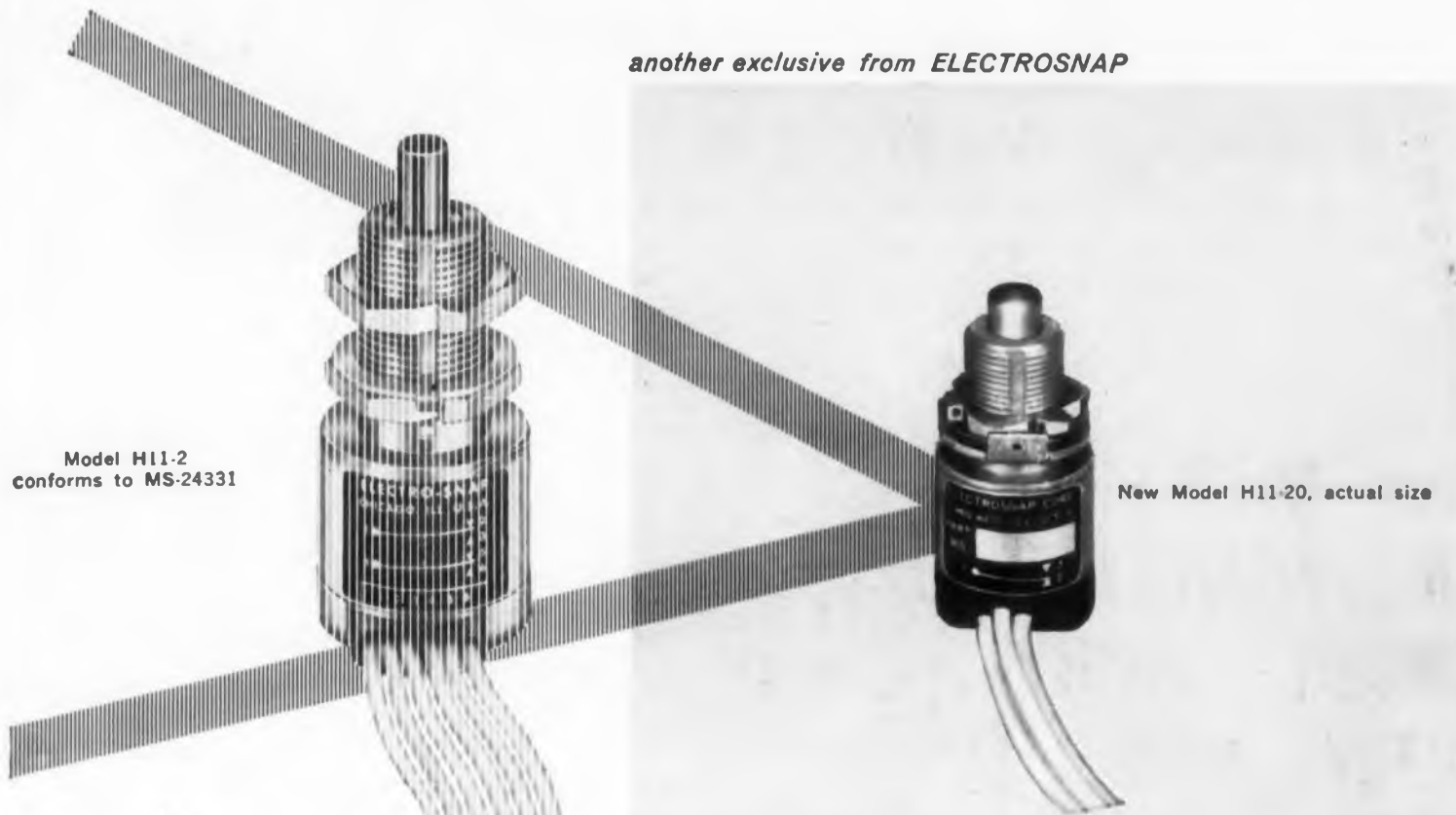
DC Relay

For printed circuitry

For use in printed circuitry, this miniature spdt relay has a standard operating voltage of 3 to 24 v dc; a dc resistance range to 8500 ohms, and a power requirement of 0.1 w. Contact rating is 1 amp, 50 v dc, resistive.

Price Electric Corp., Dept. ED, Frederick, Md.

CIRCLE 275 ON READER-SERVICE CARD



Model H11-2
conforms to MS-24331

New Model H11-20, actual size

another exclusive from ELECTROSNAP

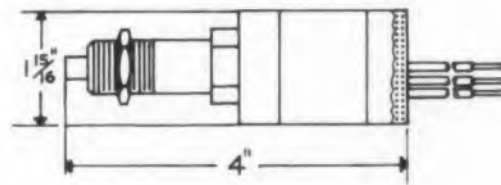
new miniaturized environment-free limit switch

It's 40% smaller than the MS standard... only $\frac{3}{4}$ " in diameter, $1\frac{1}{2}$ " high. Has these features of sealed switches which conform to MS-24331: single-hole mounting, "O" ring sealed plunger with built-in scraper to prevent jamming by ice or dirt, and epoxy sealed leads. This construction meets the requirements of immersion test, MIL-E-5272-I.

Switch has unusually high electrical capacity for its size: 6 amps @ 125/250VAC/30VDC resistive, 2.5 amps @ 30VDC inductive. Meets electrical capacity tests in 70,000-ft., -65° atmospheres. Circuit is S.P.D.T.

Unit is light-weight (only .1 lbs.), yet rugged enough to withstand 100 lbs. pressure in any direction. Case is silver-brazed for stronger, more positive seal. Corrosion-resistant materials used throughout; body, bushing and push-button plunger are stainless steel.

This switch is now used on commercial jet aircraft and is recommended for use in any environment on missiles, machine tools, military aircraft, etc.



Triple-Pole Environment-Free
Push-Button Switch

Model H11-24 simultaneously switches 3 circuits, has MS-type configuration. Electrical rating: 15 amps @ 125VAC/30VDC resistive, 10 amps @ 30VDC inductive. Weighs 9 oz. Meets requirements of MIL-E-5272, procedure 1 immersion test. Write for details.



ELECTROSNAP CORPORATION

SWITCH DIVISION
4216 W. Lake Street, Chicago 24, Illinois
Telephone: VAn Buren 6-3100 • TWX No. CG-1400

CIRCLE 276 ON READER-SERVICE CARD

Write for new technical
literature and specifications
on environment-free switches.

FORMICA® NEW EP-37

Laminated Plastic



Formica team:

(l to r) Eldon Fender, R&D; John Pitzer, Manager of Process Engineering; and Fenton Hamilton, Manager of Industrial Products—demonstrates flame retardant properties of new paper-epoxy grade.

Formica perfects new Flame Retardant grade

New EP-37 Properties . . .

- Flame retardant
- Self-extinguishing
- Dimensional stability under both solder dipping and humidity conditions
- Million megohms IR
- Cold punch 1/16"
- 10# avg. bond strength
- 500°F. solder heat resistance for 25 secs.

The team shown above demonstrates the flame retardant, self-extinguishing properties of the newest Formica® copper clad, EP-37. Because of these unusually effective properties, the new paper-epoxy is well suited for use in computers, radio, tv, telephone and aviation electrical devices. Increased dimensional stability—30% greater than existing grades under moisture conditions—offers many other application advantages.

This basic new material offers the additional properties shown at left—so essential for dependable printed circuit performance. For complete information, send for free test sample and data information. Formica Corporation, a subsidiary of American Cyanamid, 4512 Spring Grove Ave., Cincinnati 32, Ohio.



a product of 

FI-2158

CIRCLE 277 ON READER-SERVICE CARD

NEW PRODUCTS

Envelope Delay Equalizer

Provides 50 delay characteristics



Multistage delay equalizer model EN-766 offers 50 delay characteristics to complement or equalize envelope delay introduced by wire lines and other voice bandwidth circuits. The frequency of maximum delay is selectable in five steps from 1 to 10 kc, while the delay at each frequency is variable in 10 steps from 0.8 to 3.5 msec.

Rixon Electronics, Inc., Dept. ED, 2414 Reed Dr., Silver Spring, Md.

CIRCLE 278 ON READER-SERVICE CARD



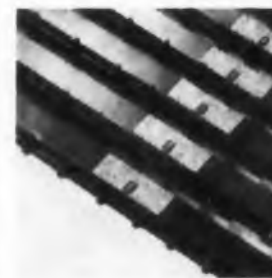
Microwave Signal Source

Has interchangeable tuning units

Microwave signal source model KSS has a 1 to 11 kmc range and four interchangeable plug-in tuning units. Outputs are 80 to 400 mw in the lowest range and 14 to 40 mw in the highest. The unit may be externally modulated and generate internal cw signals and variable 10 to 10,000 pps square wave signals. Frequency settings are accurate.

Polarad Electronics Corp., Dept. ED, 43-34th St., Long Island City 1, N.Y.

CIRCLE 279 ON READER-SERVICE CARD



Magnetostriction Delay Line

For delays to 100 μsec

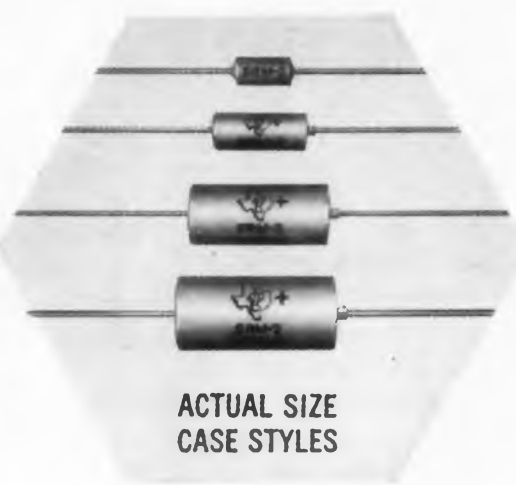
For delays to 100 μsec and digit rates to 1000 cps, the type 5810 magnetostriction delay line may have any number of continuously variable taps spaced at 2 μsec. Input and output impedances are made to requirements.

Ferranti Electric Inc., Electronics Div., Dept. ED, 95 Madison Ave., Hempstead, N.Y.

CIRCLE 280 ON READER-SERVICE CARD

CIRCLE 281 FOR ALLIED
CIRCLE 282 FOR TEXAS

NEW HIGH-RELIABILITY TANTALUM CAPACITOR SERIES



125°C operation • standard $\pm 10\%$ tolerance

Now, premium performance solid tantalum capacitors to fill your highest reliability requirements!

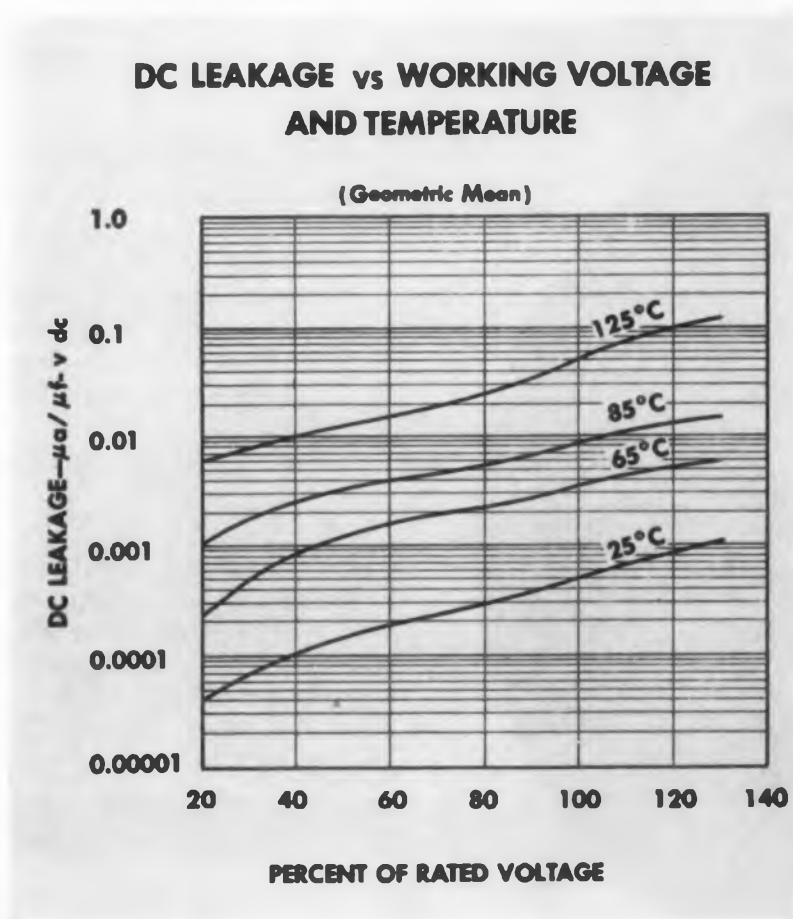
134 ratings from 1-330 μ f, 6-35 v

Exceeding all existing MIL specs over a full range of industry-standard ratings and case sizes, the subminiature SRM series features . . . new low dc leakage limits and long operating and storage life . . . standard $\pm 10\%$ tolerance . . . operation from -80°C to $+125^{\circ}\text{C}$. . . ruggedized construction . . . reverse voltage capability . . . nominal voltage derating required at 125°C . TI's advanced processing techniques and 100% testing of pre-aged units assure SRM capacitors to the most exacting reliability standards.

*Trademark of Texas Instruments Incorporated



Contact your nearest TI sales office today for delivery information and your copy of the 12-page bulletin listing specifications of all 134 ratings.



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**ELECTRONIC
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which gives complete specifications and prices on panel-mounting, relay-rack and plug-in models.



Build accuracy into all your equipment, test and production alike, with Metronix DC and AC Electronic Voltmeters.

These Metronix instruments are no larger than conventional voltmeters, cost little more. They offer higher accuracy because they don't load the circuit. In AC applica-

tions, they respond accurately over a frequency range of 20 CPS to 100 KC.

Selective, step-ranges run from 0-10MV, to 0-300V AC, and 0-1 to 0-1000V DC. Metronix Electronic Voltmeters can be furnished in MIL-spec, rack-mounting and plug-in models.

Metronix INC

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CIRCLE 283 ON READER-SERVICE CARD

api

S.A. 1875

Model
995A/4



\$1350

FOR NARROW-BAND F.M. ...

... Marconi designed this premium FM/AM generator with very high stability, calibrated Δf controls, 3 mod. frequencies and less than 25 cps spurious FM. Range is 1.5 to 220Mc without extra equipment.

FM: 0.5, 0-15kc; also high dev.
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Modulation: Calibrated, ± 1 to ± 40 kc.
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Write for 4 page brochure



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CIRCLE 284 ON READER-SERVICE CARD

NEW PRODUCTS

140 KW POWER-TEMPERATURE REGULATOR.—Model SPG5009 controls power input to an electrically heated process to maintain a precise temperature. Can be used in high temperature testing of materials and structures using radiant heating lamps. Available in 50 kva air cooled or 140 kva water cooled versions.

Research, Inc., Dept. ED, 115 N. Buchanan, Hopkins, Minn.

CIRCLE 285 ON READER-SERVICE CARD

CENTRIFUGE SPEED CONTROL.—For use with the company's model RCT 1 and RCT 2 centrifuge acceleration test machines, this unit provides electronic programming, sequencing, remote control, and infinitely variable g loadings.

Rucker Co., Dept. ED, 4710 San Pablo Ave., Oakland 8, Calif.

CIRCLE 286 ON READER-SERVICE CARD

PRINTED CIRCUIT LAMINATE.—Flame resistant Phenolite Grade EP-491 for use in computers. Has good cold punching quality, electrical properties, and dimensional stability. Available copper clad or unclad.

National Vulcanized Fibre Co., Dept. ED, 1059 Beech St., Wilmington 99, Del.

CIRCLE 287 ON READER-SERVICE CARD

VOLTAGE-TO-TIME CONVERTER.—Model 1230 connects directly to the company's model 1031 counter-timer to provide a 4-digit in-line readout of dc voltages. It accepts ± 1 mv to ± 100 v dc inputs and delivers two pulses directly proportional to input voltage. Conversion with automatic polarity is effected in 10 msec with 0.05% accuracy.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

CIRCLE 288 ON READER-SERVICE CARD

LOW-TORQUE DIAL COUNTER.—Designed as position indicator for servo systems with constant torque over the entire range. Has two concentric pointers, one connected directly, the other back geared to the input shaft. Directly readable to 0.00.

D. S. Plumb Co., Inc., Dept. ED, 77 Norfolk St., Newark 3, N.J.

CIRCLE 289 ON READER-SERVICE CARD

RATE GYRO TEST TURNTABLE.—Multiple fixed rate model T893 has provision for 14 slip ring connections and a 3/8 in. pipe pneumatic connection to the 12 in. table top.

Sterling Precision Corp., Dept. ED, 17 Matinecock Ave., Port Washington, N.Y.

CIRCLE 290 ON READER-SERVICE CARD

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 1/8" long x 3/8" wide x 1 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°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 1/2" long x 1 3/8" wide x 1 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.

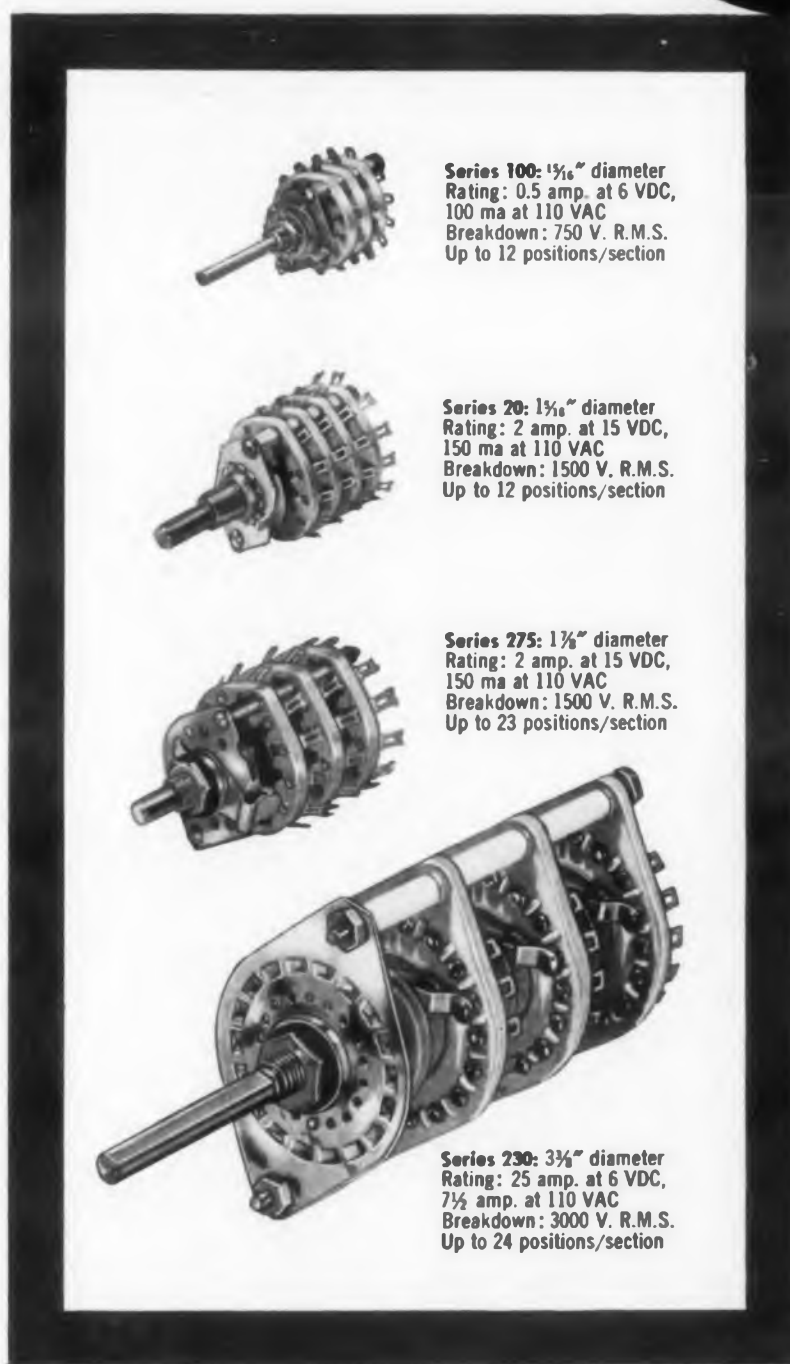


INCORPORATED

CIRCLE 291 ON READER-SERVICE CARD

Solving switch problems fast...

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



Series 100: 1/16" diameter
Rating: 0.5 amp. at 6 VDC,
100 ma at 110 VAC
Breakdown: 750 V. R.M.S.
Up to 12 positions/section

Series 20: 1/8" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 12 positions/section

Series 275: 1/8" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 23 positions/section

Series 230: 3/16" diameter
Rating: 25 amp. at 6 VDC,
7 1/2 amp. at 110 VAC
Breakdown: 3000 V. R.M.S.
Up to 24 positions/section

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

DESIGN AIDS FOR ENGINEERS

CENTRALAB's unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

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Centralab

P-5917

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS
CIRCLE 295 ON READER-SERVICE CARD



DC to DC Converter

Weights 3-1/2 lb

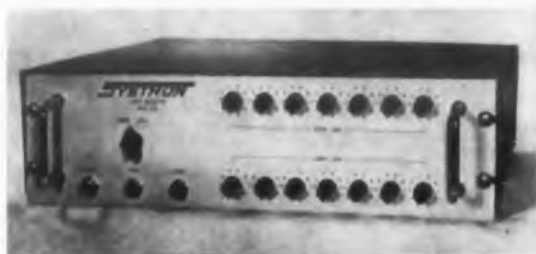
From a 12 to 14 dc source, the Cenco converter produces a 225 or 450 v output under nominal load. The portable, 3-1/2 lb unit is quiet, starts instantly, and creates no electrical interference.

Central Scientific Co., Dept. ED, 1700 Irving Park Rd., Chicago, Ill.

CIRCLE 292 ON READER-SERVICE CARD

Digital Limit Detector

Has 1 to 10 digit limits



Digital limit detector model 1470 indicates low, go, and high to an exact number of counts with two banks of presettable switches. It can be integrated with any of the company's counters to provide alarm, digital control, or classification of basic measurements. The unit has solid state circuitry throughout and can be packaged with one to ten digit limits.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

CIRCLE 293 ON READER-SERVICE CARD



Wirewound Resistors

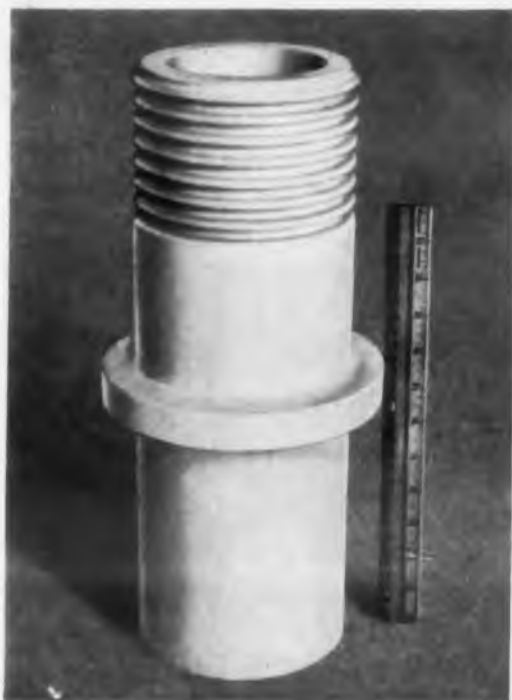
Have standard tolerances to 0.25%

Made in standard tolerances of 1, 0.5, and 0.25%, series E encapsulated, axial lead resistors can be provided with tolerances to 0.02%. Tolerances may be matched to 0.1% for analog computers and bridge networks. Rated loads are 1/8 to 1 w; resistances, 500 ohms to 1.85 meg; diameters, 1/4 to 3/8 in.; and lengths, 5/16 to 1 in.

Precision, Inc., Dept. ED, 4748 France Ave., N., Minneapolis, Minn.

CIRCLE 294 ON READER-SERVICE CARD

COORS PRODUCES CERAMIC TO MEET YOUR REQUIREMENTS!



Eighteen years ago, this insulator was the answer to a need for a new ceramic for use on an early atomic project—Coors first production run of large ceramic parts using the isostatic technique.

Coors precision finishing improves accuracy of electrical characteristics—this window for a traveling wave tube has thickness tolerances of $\pm .0005$ ", and a flatness of 2 to 3 light bands.

Brazing temperatures of 1083° C were used in making this hermetic ceramic-to-metal assembly, permitting high operating temperatures in the final use of this design.



New ceramic compositions, and new techniques have been introduced many times by Coors. Eighteen years ago Coors met the requirements of engineers in an early atomic project by supplying both a new ceramic composition and a new isostatic technique for forming ceramic components. The result—a new, mechanically strong, completely homogenous ceramic having excellent electrical properties.

Demands for better, stronger materials have been answered by Coors throughout the 47 years of their experience. Continuous re-

search assures future developments. For example, Coors AD-99 is only one of several ceramic materials recently developed to meet the new needs of the electronic industry.

Parallel with the development of new ceramic compositions is the research for new and better techniques. For example, a completely new department for metalizing and brazing was installed and recently enlarged. Ceramic-to-metal assemblies can be furnished where brazing temperatures go as high as 1083° C—bonds have tensile strengths as high as 9,000 to 12,000 psi.



Ceramic compositions or production techniques are of little value without precise control. You need close tolerances—you obtain them from Coors in production runs, or experimental prototypes. Customary, careful work by over 600 skilled workers permits holding tolerances of 30 millionths of an inch on production runs.

To meet increased demands, additional engineers are being assigned to the field—Coors engineers in your neighborhood give

you on-the-spot ceramic design service. They need only your invitation to help you with your ceramic problems.

For information concerning our facilities and for data about Coors high alumina ceramics, please write for bulletin 858.

Coors
**COORS PORCELAIN
COMPANY**

600 Ninth Street, Golden, Colorado

NEW PRODUCTS

5000 V Power Supply

Has dual range output

For gas proportional counters which use high voltage gases, the model HV-2C power supply has two output ranges from 1 to 2.5 and 1 to 5 kv. A 10-turn, 1000-division dial provides continuously variable output within the two ranges and also makes resetting of voltages accurate within ± 5 v in the high range and ± 3 v in the low. The unit will deliver 100 μ a at up to 3 kv and has ± 6 v high and ± 4 v low range stability. Voltage regulation is ± 2 v high range and ± 1 v low range for rated 105 to 125 v line variations.

Technical Measurement Corp., Dept. ED, 441 Washington Ave., North Haven, Conn.

CIRCLE 296 ON READER-SERVICE CARD

Reaction Vibration Machine

Handles loads to 10,000 lb

The type RVH-96-10,000 reaction vibration machine vibrates loads up to 10,000 lb in both vertical and horizontal directions. It requires no special foundation to absorb reactive forces and operates from 5 to 60 cps with adjustable displacement from 0 to 0.125 in. maximum. Changes in vibration direction and displacement settings can be made in minutes with the load in position. Maximum acceleration rating is 10 g, and table size is 8 x 8 ft. The system is designed to MIL-STD-167 requirements.

L.A.B. Corp., Dept. ED, 116 Onondaga St., Skaneateles, N.Y.

CIRCLE 297 ON READER-SERVICE CARD

Display Tube

For airborne use

Designed for airborne and monitor applications, the model 7AUP4 nine-pin display tube is 7 in. in diameter and has a 7/8 in. diameter neck for decreased deflection power. It

◀ CIRCLE 298 ON READER-SERVICE CARD

is 8 3/8 in. long and has electrostatic focus and magnetic deflection. Anode voltage is 8 kv; grid number 2 voltage, 300 v; focus voltage, 0 to +300 v; cutoff voltage, -25 to -75 v; highlight brightness, 75 ft-L min; and spot size, about 0.01 in. Deflection angle is 70 deg.

Westinghouse Electric Corp.,
Electronic Tube Div., Dept. ED,
P.O. Box 284, Elmira, N.Y.

CIRCLE 299 ON READER-SERVICE CARD

Heavy Duty Enclosures

Modular

Using a 22-1/16 in. wide frame, these modular, heavy duty enclosures provide for flush mounting 19 in. panels of any thickness. The panels may be recessed to any depth in the frame. Flush or bustle doors are available. The 1-1/2 in. wide, 14 gage steel, box channel construction with reinforced, built-in 12 gage castor mounts and lift eye receptacles provides rugged protection and mobility in modular or single unit applications.

Amco Engineering Co., Dept. ED,
7333 W. Ainslie St., Chicago 31, Ill.

CIRCLE 300 ON READER-SERVICE CARD

Thyratrons

For grid controlled rectifier service

Xenon thyratrons VTP 7386/561A/5685/5C21 and VTP 6278/5F14 are designed for grid controlled rectifier service. The first has plate current of 6.4 amp average and 100 amp peak and can be used to control current pulses to welding transformers, to control power to dc motors supplied from ac lines, or to convert ac power sources to dc supplies. The second can be used in inverters for the generation of medium or high frequency alternating currents from a low voltage dc source.

Hughes Aircraft Co., Hughes
Products, Dept. ED, International
Airport Sta., Los Angeles 45, Calif.

CIRCLE 301 ON READER-SERVICE CARD

CIRCLE 302 ON READER-SERVICE CARD



ESC delay lines

take off with America's talking satellite

On December 18, 1958, the world entered a new era of communications with the successful orbiting of an Atlas ICBM—the Talking Satellite that broadcast President Dwight D. Eisenhower's Christmas message to the world. Circling the earth at a speed of more than 17,000 mph, the Talking Satellite repeated the President's message, erased it, and received and rebroadcast new messages in both voice and code.

ESC Corporation is justifiably proud that its delay lines were selected to aid in this electrifying triumph for America and her electronics industry. Especially designed by ESC, these delay lines were used in the timing sequence for propulsion, the guidance system and the telemetering system.

As America's largest manufacturer of custom built and stock delay lines, ESC has continually met the responsibility of leadership by providing virtually every type of delay line needed by defense and industry. If you have a delay line problem, let ESC's design staff suggest a custom-built answer.



ESC

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CORPORATION 534 BERGEN BOULEVARD, PALISADES PARK, NEW JERSEY

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

*the highest,
the coldest,
the hottest*

... IN THE SMALLEST SPACE!

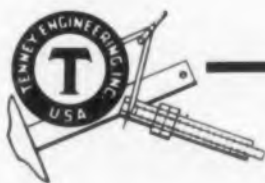


Tenney-mite STRAT environmental chamber

Altitudes to 200,000 ft., temperatures from -100° F to $+350^{\circ}$ F, in only 4 square feet of floor space. Now, any company can own a combined altitude and temperature test chamber . . . without sacrificing much valuable floor space. And the investment, too, is reasonable.

Only Tenney Engineering, world's largest and most experienced creator of environmental equipment, could produce the Tenney-mite Strat. Write for further information.

Write for a descriptive catalog and complete information on Tenney's research and development, engineering consultation, and design services.



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OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

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CIRCLE 303 ON READER-SERVICE CARD

NEW PRODUCTS



Transistorized Scaler

Has 2 mc maximum
counting rate

Transistorized scaler model 49-22 offers both preset time and preset count. It has a digital read-out system, a 0.5 μ sec resolving time, a maximum counting rate of 2 mc, a count capacity of 10 million, and a time capacity to 1000 min. Amplifier sensitivity is 0.5 mv and gain is 1000.

Radiation Instrument Development Lab, Inc., Dept. ED, 5737 S. Halsted St., Chicago 21, Ill.

CIRCLE 304 ON READER-SERVICE CARD

110 Degree Picture Tubes

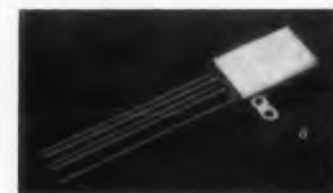
10-15/16 and 12-7/8 in. long



Model 17DKP4 and 21EQP4 110-deg picture tubes are 17 and 21 in. types with overall lengths of 10-15/16 and 12-7/8 in., respectively. Both have necks 3-9/16 in. long and incorporate a short electron gun that needs no ion-trap magnet and minimizes deflection distortion. They use magnetic deflection and low voltage electrostatic focus.

Radio Corporation of America, Electron Tube Div., Dept. ED, Harrison, N.J.

CIRCLE 305 ON READER-SERVICE CARD



Crystal Can Relay

Withstands 20 g, 2000
cps vibration

This crystal can relay operates from -65 to $+125$ C and under 100 g acceleration, 30 g shock, and 20 g, 2000 cps vibration. Ratings are 2, 5, and 10 amp and sensitivity is 50 mw.

Electronic Specialty Co., Dept. ED, 5121 Santa Fernando Rd., Los Angeles 39, Calif.

CIRCLE 306 ON READER-SERVICE CARD

CANNON PLUGS

Schweber

FOR
IMMEDIATE
LARGE
QUANTITY
DELIVERY
AT
FACTORY
PRICES

2500

Yes! You can now order up to 2500 each of such popular Cannon Connector types as Miniature D, KO, DPD, DPA, DPX, etc. Immediate shipment at factory prices.

 Schweber

ELECTRONICS

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PHONE 6-6520 TWX G-CY-NY-580

CIRCLE 307 ON READER-SERVICE CARD
ELECTRONIC DESIGN • June 24, 1959

RELIABLE MULTI- PURPOSE "K" SERIES

K STANDARD



FOR AIRCRAFT, ELECTRONIC, INSTRUMENT, MILITARY, MISSILE, INDUSTRIAL AND COMMERCIAL APPLICATIONS—Standard K and RK . in straight and angle 90° plugs with wall mounting receptacles. Conduit and clamp entry types. 1 to 110 contacts in 250 different insert arrangements. 10, 15, 30, 40, 60, 80, 115 and 200 amp. silver plated brass on copper contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 110 to 5000V, 60 cps ac rms.

KH-RKH



FOR USE UNDER CRITICAL PRESSURE AND LEAKAGE CONDITIONS—Hermetically sealed plugs with steel shells, steel contacts, and Canseal glass insulators for true hermetic sealing. Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

RK



FOR FLUSH OR SEMI-FLUSH MOUNTING—Cannon RK Plug assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K Series. Note: RK will mate only with RK's.

TBF-K



FOR CARRYING CIRCUITS THROUGH BULKHEADS

Cannon TBF-K Bulkhead Plugs feature a double-faced construction allowing mating at both ends. Pin inserts. Single piece shell.

RLKL-LKL



FOR TV AND OTHER PANEL SWITCHING OPERATIONS—Quick connect and disconnect RLKL Plugs are designed for one-hand fast disconnect use on TV station program switching panels and similar type operations. Feature a quick coupling means. Latch-lock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

FW-K FWR-K



FOR OPEN FLAME PROTECTION AGAINST HIGH TEMPERATURES—Cannon K Firewall Plugs are available in straight and angle 90° shell types. Wall mounting receptacles also available. Phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon originated the firewall connector and continues to be the leader in this important field.

SK-M7-21C



FOR USE IN TELEPHONE "BEEPER" AND SIMILAR APPLICATIONS

—Widely used on telephone recording units known as "beepers." Adaptable for other similar applications.

K ACCESSORIES—Cannon K Series Accessories include Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, and Dummy Receptacles to hold and protect plugs when not in use.

Cannon has available a wide variety of other Plug designs FOR EVERY CONCEIVABLE APPLICATION...including aircraft and electronic Plugs conforming to Specification MIL-C-5015D; Unit-Plug-In Rack/Panel and Modular; Audio and Low-Level Circuit Plugs; Miniature and Sub-Miniatures; Coaxial RF Series Plugs, Printed Circuit Plugs; GM Plugs and Cannon Plug/Harness Systems: "Kwik-Term" Terminals and DC Solenoids.

FOR ADDITIONAL INFORMATION on the typical designs illustrated...other configurations for your specific applications...or the design, engineering and manufacture to your special needs...write to **Cannon Electric Company**—3208 Humboldt Street, Los Angeles 31, California. Please refer to Dept. 841.

LARGEST FACILITY IN THE WORLD FOR PLUG RESEARCH-DEVELOPMENT-MANUFACTURE

**CANNON
PLUGS**

Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne, and Tokyo. Distributors and Representatives in the Principal Cities of the World.

CIRCLE 308 ON READER-SERVICE CARD

THE BIG LOOK



2½-inch size

ACTUAL SIZE—Although they look bigger, these a-c and d-c units are actually 2½- and 3½-inch sizes. Mounting is interchangeable with JAN, MIL and ASA (round) specifications. Widest range of scales and face-plate colors are available.



3½-inch size

General Electric small panel meters

BIG LOOK styling of General Electric's new small panel meters adds *functional beauty* to your products and equipment. Distinctive design creates the illusion of bigness, yet these new meters fit into the same panel space as old style meters. You get big border-to-border scale . . . *modern, clean-line design* . . . *your choice of seven attractive colors* . . . and widest selection of scales.

Up to 28% longer scales allow accurate readings. Tough neoprene gaskets provide *complete protection* of internal parts and movements from dirt, dust or water. Best of all, General Electric BIG LOOK meters are *competitively priced*. And you can plan on *fast delivery*, too, from a national network of authorized stocking distributors and G-E Apparatus Sales Offices.

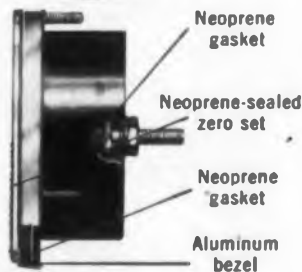
Let G.E.'s BIG LOOK in panel meters help you improve the appearance and reliability of your equipment at low cost. Get the full story. Just contact your G-E Apparatus Sales Engineer, or write for bulletin GEA-6678, Sect. 593-303, General Electric Co., Schenectady, N. Y.



SELF-SHIELDED CORE-MAGNET, used in d-c milliammeters below 5 MA and all microammeters, permits mounting of meters on magnetic or non-magnetic panels without special calibration.



ALL A-C METERS utilize moving-iron mechanisms—plus magnetic damping to settle the pointer quickly and accurately.



COMPLETELY SEALED CASES protect internal parts of instrument from harmful contaminants. Even zero-set is sealed with a neoprene O-ring.

Progress Is Our Most Important Product

GENERAL ELECTRIC

NEW PRODUCTS

Space Environment Chamber

Simulates 100 mile altitude.

This chamber simulates environmental conditions at altitudes to 100 miles. It is 8 ft in diameter and 15 ft long, permitting the testing of large components, assemblies, and subassemblies. Pumping equipment capacity is sufficient to handle considerable quantities of gas such as might be experienced in combustion and ion propulsion studies. The system is track mounted, and the chamber can be opened either by rolling the removable end from the cylinder or by moving the cylinder from the fixed end.

Scientific Engineering Labs, Dept. ED, 1510 Sixth St., Berkeley 10 Calif.

CIRCLE 309 ON READER-SERVICE CARD

DC Power Supplies

High voltage

These tube type and semiconductor high voltage dc power supplies are designed for such applications as hard tube radar modulators, tube and high frequency structural testing installations, wind tunnel charging supplies, and linear accelerators for atomic research. One console houses all controls, meters, and protective devices for each supply unit. Ratings are 10 to 1000 kv dc and milliamperes to 250 amp.

General Electric Co., High Voltage Specialty Transformer Section, Dept. ED, Holyoke, Mass.

CIRCLE 310 ON READER-SERVICE CARD

Etched Precision Resistors

In values to 200 ohms per sq in.

For use as meter shunts and attenuator pads, these etched precision resistors have resistive elements of cupro-nickel alloy and can be bonded to phenolic impregnated

CIRCLE 311 ON READER-SERVICE CARD

paper laminate, epoxy glass laminate, metal, or silicone glass laminate. Power dissipation averages are 2, 5, 15, and 30 w per sq. in., respectively. Obtainable tolerances are 1% from 0 to 1 ohm, 0.5% from 1 to 10 ohms, and 0.1% above 10 ohms. The units have resistances ranging from fractional values to 100 ohms per sq. in. and will withstand 100% overload for short periods.

Photocircuits Corp., Dept. ED, 31 Sea Cliff Ave., Glen Cove, N.Y.

CIRCLE 312 ON READER-SERVICE CARD

Subminiature Tube Shield

Removes up to 90% of heat

This heat-dissipating resilient thermal conductive elastomer called Elastaclamp is designed to provide complete contact between heat transfer medium and glass envelope while protecting tubes from severe shock and vibration. Use of the material does away with dangerous hot spots and reduces bulb temperature in many cases up to 90%. Tube shield also permits continuous operation in ambient temperatures to 200 C. Elastaclamp is available for T3 flat press and T3 subminiature tube outline.

Augat Bros. Inc., Dept. ED, 33 Perry Ave., Attleboro, Mass.

CIRCLE 313 ON READER-SERVICE CARD

Pulse Delay Network

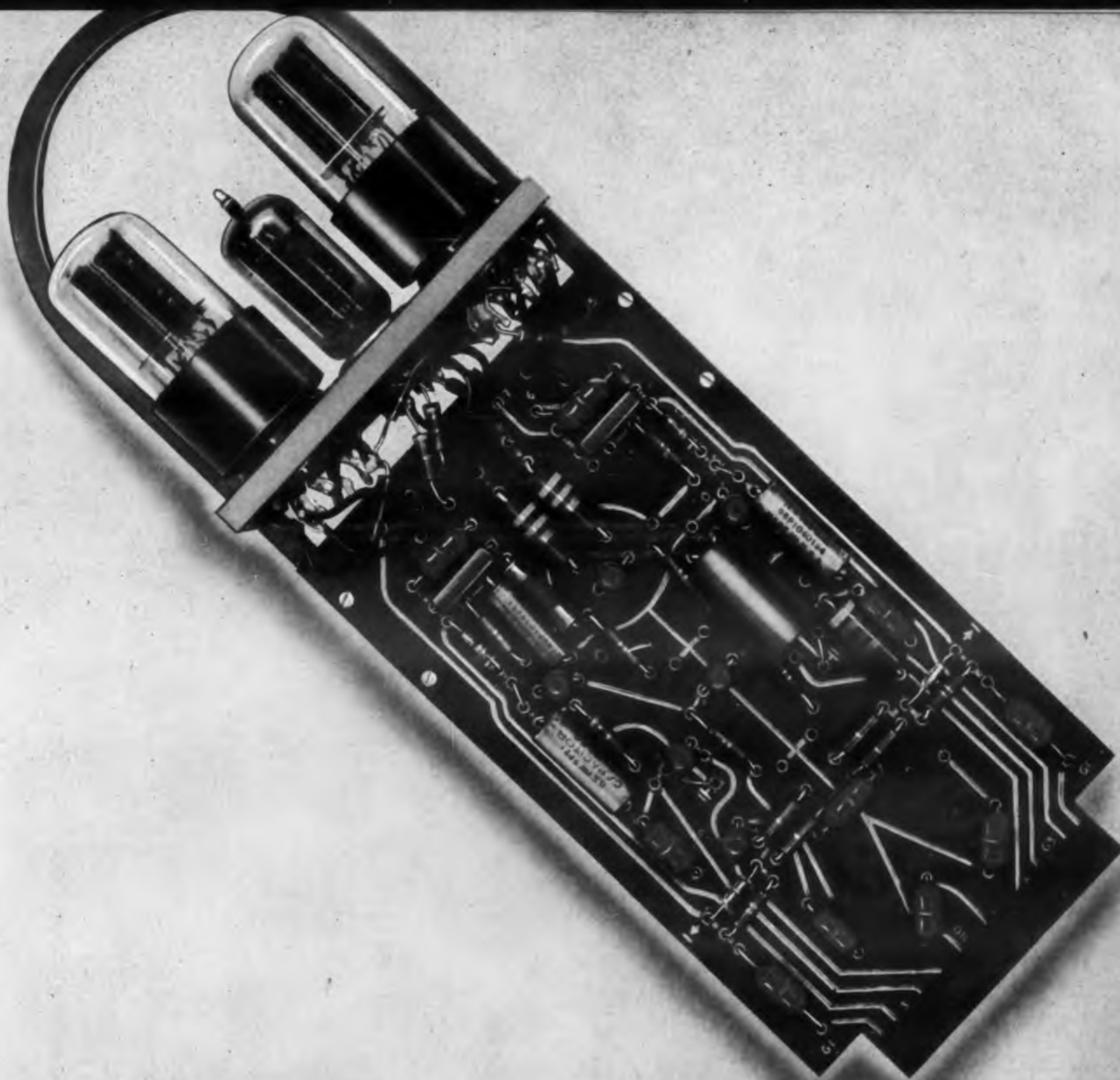
Has 3.5 db maximum attenuation

Pulse delay network LD 228 meets MIL-E-5272 and MIL-STD-202A and has a delay of 75 ± 5 nsec with taps at 38 ± 3 and 47 ± 3 nsec. Impedance is 330 ohms; attenuation, 3.5 db; input and output rise times, 1 and 4 msec, respectively.

Ratigan Electronics Inc., Dept. ED, 425 W. Cypress St., Glendale, Calif.

CIRCLE 314 ON READER-SERVICE CARD

CIRCLE 315 ON READER-SERVICE CARD



Top reliability in miniature size...

Daven wire wound resistors

For printed circuit boards, miniature plug-in packages... any tight place in which you must have a really small wire wound resistor, check Daven for the Super Davohm Miniatures that can solve your problem. For example...



These resistors meet and exceed all requirements, except physical size, of MIL-R-93-B, and MIL-R-9444.

The overall stability of Daven Miniature Resistors is possible because of an entirely new approach to subminiature production techniques. A unique spool design permits low-stress winding of fine resistance wire... obtaining 2 to 3 times the resistance value previously supplied on a miniature bobbin. This is done under the most stringent quality control and inspection.

The industry's widest range of sizes, temperature coefficients, and tolerances is available for your requirements. Write today for further information and a complete resistor catalog.

THE DAVEN CO.



LIVINGSTON, NEW JERSEY

TODAY MORE THAN EVER THE DAVEN © STANDS FOR DEPENDABILITY

U. S. Hits Venus By Radar Beam; 56 Million Miles

1st Planet Contact

WESTFORD (Mass.), March 19 — (UPI) — Man has made his first contact with another planet. Scientists reported tonight they bounced a radar signal off Venus for a space round trip of 56,000,000 miles.

It was the first two way contact with any celestial body beyond the moon.

President Eisenhower sent a special message congratulating scientists and engineers of the Lincoln Laboratory of the Massachusetts Institute of Technology for the achievement, one of the major breakthroughs of the space age.

"Congratulations to all involved for this notable achievement in our peaceful ventures into outer space," the President said.

Made Smaller

The universe as man knows it has been made smaller—the unprecedented contact between Earth and Venus, Lincoln Lab's official announcement said "preliminary calculations indicate the dimensions of the



Eimac Klystron final amplifier at Millstone Hill Radar site.

EIMAC KLYSTRON POWERS VENUS CONTACT— 100 TIMES FARTHER THAN PREVIOUS RECORD!

On February 10 and 12, 1958, a high-power radar of M.I.T.'s Lincoln Laboratory transmitted and received radar signals between Earth and Venus. A round-trip of 56,000,000 miles! This historic event was man's first radio contact with another planet. It was by far the longest man-made radio transmission on record.

The final amplifier tube of this giant radar is a super-power Eimac Klystron, the same used in missile and satellite detection and tracking. Eimac's long

experience and leadership in the development and manufacture of ceramic-metal power klystrons enabled the firm to design a super klystron capable of producing tremendous amounts of RF energy at the desired frequency.

In this application, as in troposcatter installations throughout the world, Eimac Klystrons have won a reputation for exceptional reliability and long life. Today Eimac manufactures power amplifier klystrons for ultra high and super high frequencies.

CIRCLE 319 ON READER-SERVICE CARD

The transmitter for Lincoln Laboratory's giant radar was built by Continental Electronics Manufacturing Company. The radar was sponsored and is supported by the Air Research and Development Command of the United States Air Force.

EITEL-McCULLOUGH, INC.



San Carlos • California

NEW PRODUCTS

Receiving Tubes

Have 100 mil heaters

Directly interchangeable with 150 mil prototypes, these radio receiving tubes employ 100 mil heaters. Type 18FW6 is a semiremote cutoff pentode for i-f application; type 18FX6, a dual control miniature pentagrid converter amplifier for converter application; type 18FY6, a high mu triode double triode for detector audio application; type 36AM3, a half-wave rectifier; and type 32ET5, a beam power pentode.

Sylvania Electric Products Inc., Sylvania Electronic Tubes, Dept. ED, Emporium, Pa.

CIRCLE 316 ON READER-SERVICE CARD

Missile Programmer

Has 13 channels

Designed to MIL-E-5272, the missile programmer has 13 isolated channels with an operation time of 35 min and a time accuracy characteristic of ± 20 msec. Contact rating is 0.5 amp, 115 v, inductive and size is 2-3/8 x 3 x 6 in.

Ratigan Electronics Inc., Dept. ED, 425 W. Cypress St., Glendale 4, Calif.

CIRCLE 317 ON READER-SERVICE CARD

Ceramic Ladder Filters

Occupy less than 1 cu in.

For use in i-f sections of superheterodyne communication systems, these ceramic ladder filters occupy less than 1 cu in. and directly replace conventional filters with up to 30 elements. Units with a 455 kc center frequency and 6 db bandwidth from 4 to 50 kc have very low insertion loss.

Clevite Electronic Components Div. of Clevite Corp., Dept. ED, 3311 Perkins Ave., Cleveland 10, Ohio.

CIRCLE 318 ON READER-SERVICE CARD

Total Temperature Probe

Measures while deicing heater goes

For use at flight speeds to Mach 2 and higher, the model 102-D probe provides precise total temperature measurements while deicing heat is continuously applied. It will deice within one minute when subjected to the icing conditions defined in Section 3.5, Paragraph g of MIL-P-25632A. By continuously removing boundary layer air from the internal flow through the probe, the temperature of the central core of the flow, and hence the indicated total temperature, is almost completely independent of the temperature of the probe housing.

Rosemount Engineering Co.,
Dept. ED, 4900 W. 78th St., Min-
neapolis 24, Minn.

CIRCLE 320 ON READER-SERVICE CARD

Electroluminescent Lamps

Last over 12 years

Glo-Escent lamps are electro-luminescent panels that consume 0.1 ma per sq in., operate on 110 v ac, 60 or 400 cps, and produce a brightness of 0.1 to 1 ft-L. Pale green, they range to 7 x 14 in. in size and last 50,000 hr.

Miller Dial & Name Plate Co.,
Dept. ED, 4400 N. Temple City
Blvd., El Monte, Calif.

CIRCLE 321 ON READER-SERVICE CARD

Cathode Ray Tubes

11-1/4 and 13-3/16. in long

For portable and shallow TV sets, 17 in. type 17DHP4 and 21 in. type 21EMP4 cathode ray tubes are 11-1/4 and 13-3/16 in. long, respectively. Operated at 6.3 v, the 17DHP4 heater uses 0.45 amp and the 21EMP4 0.6 amp.

Westinghouse Electric Corp.,
Electronic Tube Div., Dept. ED,
P.O. Box 284, Elmira, N.Y.

CIRCLE 322 ON READER-SERVICE CARD

CIRCLE 323 ON READER-SERVICE CARD

Now, from the Laboratories of CLARE,

THE MOST EXCITING RELAY DESIGN OF THE YEAR

NEW SIX-IN-LINE HG6F RELAY BRINGS BIG SAVINGS IN SPACE, POWER, AND COST

Latest in the Clare line of Mercury-wetted Contact Relays, world famous for their billions of operations*, is Type HG6F, a six-in-line flat-pack relay. This striking new design provides the most reliable, durable, maintenance-free relays ever made anywhere, plus these savings.



Compact CLARE
TYPE HG6F Relay ready
for mounting. Overall
dimensions: 3.640" x 3.125" x 1.046"

MECHANICAL FEATURES

Flat, rectangular package makes most efficient use of chassis space. Printed circuit mounting eliminates customary internal wiring except for coil leads.

Units can be stacked in line without interaction.

No shelf deterioration; requires no maintenance.

Contacts cannot wear, get dirty, stick by locking or welding, nor chatter.

Tamper proof.

Completely protected against dust and dirt, corrosive fumes, and explosive atmospheres.

No mechanical damage when subjected to usual military shock and vibration tests.

ELECTRICAL FEATURES

Life expectancy measured in billions of operations.

No contact chatter or bounce.

Low and consistent contact resistance.

Full line of coil resistances.

Contacts rated at 5 amperes, 500 volts (d-c or rms)

Product of voltage prior to closing and current prior to opening, 250 volt-amperes maximum.

Nominal operating time: 1 watt input, 11 milliseconds; 2 watts input, 7 milliseconds; 4 watts input, 5 milliseconds.

Release time: 4 milliseconds or less. Maximum continuous dissipation: 5 watts at 100° F.

SAVES SPACE—

Unique packaging affords up to 50% savings in space over cylindrical multi-element mercury-wetted contact relays.

SAVES POWER—

Six switches per coil saves operating power.

SAVES COST—

Switch cost as much as 26% below cost of same number of switches in cylindrical packages.

*Mercury-wetted contact relays on test have completed over 8 billion operations with a contact-load of 250 volt-amperes, and are still going strong.



Arrangement of six-in-line mercury-wetted contact switches on printed circuit panel.



Four CLARE Type HG6F relays mount in a space 50% less than cylindrical multi-element assemblies.

SEND FOR BROCHURE CPC-2

For complete information, contact C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY

CLARE RELAYS

FIRST in the industrial field



Cutler-Hammer's new sensitive, heavy-duty transistorized relay. The Tung-Sol germanium transistor, power type 2N379, is at the center of the plug-in module, electronic heart of the relay.

New versatile relay relies on Tung-Sol semiconductor



Tung-Sol semiconductors furnish the combination of sensitivity and ruggedness needed for Cutler-Hammer's new transistorized relays. The Tung-Sol units react quickly and display unfaltering electrical stability. They resist shock and vibration, and stand up under the most severe industrial service.

The cold weld seal found in all Tung-Sol power and high power transistors—an exclusive development of Tung-Sol research—contributes heavily to the long-life reliability Cutler-Hammer values. Cold welding gives a true hermetic, copper-to-copper seal and eliminates heat damage, "splash" and heat-caused

moisture. The special seal stays vacuum-tight, moisture-proof even through "breathing".

If you need the power-saving, space-saving features of semiconductors . . . if your circuit calls for tubes—you can be assured of premium performance when you specify Tung-Sol. Tung-Sol makes both to a single high quality standard. Our applications engineers, expert in both vacuum tube and semiconductor problems, can give you an impartial recommendation for the circuit complement that most efficiently answers your design needs. Tung-Sol Electric Inc., Newark 4, New Jersey.

 TUNG-SOL®

NEW PRODUCTS

Harness and Cable Assemblies

For extreme environments



These molded harnesses and special electric cable assemblies are produced from a variety of materials for maximum protection against specific environmental hazards. Harnesses can be made for -120 to $+500$ F continuous use and $+600$ F intermittent use. Any type and quantity of conductors, connectors and junctions can be provided.

Revere Corporation of America
Dept. ED, Wallingford, Conn.

CIRCLE 324 ON READER-SERVICE CARD

20 Amp Switch

Rain tight

Rain tight and explosion proof the 2CX3 switch is UL listed and suitable for use in Class I vapor-air mixtures, Groups C and D and in Class II dust-air mixtures, Groups E, F, and G. UL rating is 20 amp, 125, 250, or 460 v ac.

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

CIRCLE 325 ON READER-SERVICE CARD

FM Systems

For multichannel telemetry data

These fm systems multiplex various IRIG bands on a single tape recording head. They permit the recording of over 100 telemetry information channels on one multitrack tape recorder for playback in automatic data reduction equipment.

Wiancko Engineering Co., Dept. ED, 255 N. Halstead, Pasadena, Calif.

CIRCLE 326 ON READER-SERVICE CARD

CIRCLE 327 ON READER-SERVICE CARD

Precision Wirewound Resistors

Have specified temperature coefficients



In values of 10 ohms to 3 meg, these precision wirewound resistors are made with any specified temperature coefficient from -25 to $+6000$ ppm per deg C. They are available with solder lugs and axial, radial, or special leads.

Ultronix, Inc., Dept. ED, 111 E. 20th Ave., San Mateo, Calif.

CIRCLE 327 ON READER-SERVICE CARD

DC Power Supplies

Have 0.25% regulation

Built to MIL-T-945A requirements, these power supplies have ± 150 or 300 v dc output and current ranges of 200, 400, and 1000 ma. Input is 115 v $\pm 10\%$ at 60 cps; regulation, 0.25% for line or load; ripple, 5 mv; and output impedance, 0.5 ohms. Output voltage is adjustable $\pm 10\%$.

Lawn Electronics Co., Inc., Dept. ED, Woodward Rd., Englishtown, N.J.

CIRCLE 328 ON READER-SERVICE CARD

Preset Controllers

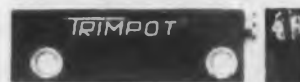
Have range of 0 to 180,000 counts per min

Operating from all types of sensing devices, these transistorized industrial preset controllers have instantaneous reset and glow counter tube or Nixie in-line readout. Preset range is 0 to 180,000 counts per min or 75,000 counts per sec. Two to six digit single or dual units are available with three or more preset numbers on any model.

Dynapar Corp., Dept. ED, 5150 Church St., Skokie, Ill.

CIRCLE 329 ON READER-SERVICE CARD

CIRCLE 330 ON READER-SERVICE CARD



Subminiature ...
Proven Reliability

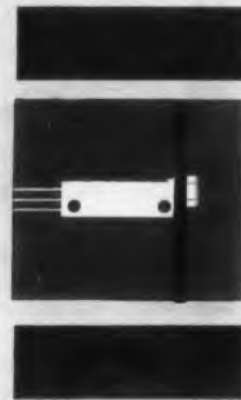
ACTUAL SIZE

TRIMPOT® MODEL 220

As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than $3/16" \times 5/16" \times 1"$. Power rating is 1 watt and maximum operating temperature is 175°C . This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld® fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. Write for complete technical data and list of stocking distributors. AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications. *Trademark

Exclusive manufacturers of Trimpot®, Trimit®. Pioneers in potentiometer transducers for position, pressure and acceleration.



**BOURNS
Inc.**

P.O. Box 2112C, Riverside, California
Plants: Riverside, California
and Ames, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

**DESIGNERS
SPECIFY P&B's
MR RELAY
WITH
CONFIDENCE**



for a host of control applications

RELIABILITY coupled with low cost are two factors which place the MR series relays high on P&B's best seller list. They are being used in a multiplicity of designs... transmitters, street lighting equipment and small motor starters, to name but a few.

Both AC and DC models are available, with AC coils ranging up to 440 volts. All are adaptable for printed circuit mounting. The wide variety of contact arrangements include:

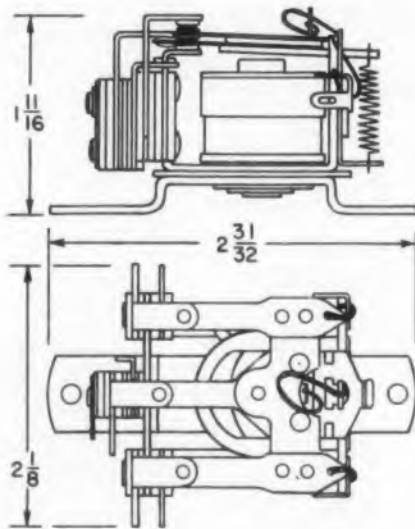
SPST-NO	SPST-NC-DB	DPST-NC	3PST-NC
SPST-NC	SPDT	DPDT	3PDT
SPST-NO-DB	DPST-NO	3PST-NO	

For more information about this medium duty, compact relay, call or write today—or get in touch with the P&B sales engineer nearest you. See our complete catalog in Sweet's Product Design File.



LM SERIES: Plate circuit relays similar to the MR. All sp and dp contact arrangements shown above are available. Coils are wound to specified resistances up to 58,000 ohms max. Sensitivity ranges from 15 mw min. (single pole) to 70 mw min. (double pole).

MR SERIES



GENERAL SPECIFICATIONS:

Breakdown: 1500 volts, 60 cycle rms between all elements.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

Temperature Range:

DC —55°C. to +85°C.
AC —55°C. to +75°C.

Pull-in: Approx. 75% of nominal dc voltage; 78% of nominal ac voltage.

Weight: 4 ozs.

Dimensions: 2 1/2" long x 2 3/8" wide x 2" high.

Mounting: Two 3/16" dia. holes. Can be adapted for printed circuits.

CONTACTS:

Arrangements: Up to 3pdt.

Material: 3/32" dia. silver. (Others available).

Load: 8 amps @ 115 volts, 60 cycle, resistive.

COIL:

Max. Resistance: 34,500 ohms.

Power: 1.5 watts dc; 3.25 volt-amps ac. Will withstand up to 6 watts at 25°C.

Voltages: Up to 110 volts dc; up to 440 volts 60 cycle ac.

NEW PRODUCTS

Vibration Exciter

5 to 2500 cps range



Vibration exciter model C125 can be used for sine wave testing or for random or complex motion testing. It has a five ton vector force output and a 5 to 2500 cps frequency range. Weight of the moving element is 100 lb.

MB Mfg. Co., Dept. ED, P.O. Box 1825, New Haven 8, Conn.

CIRCLE 331 ON READER-SERVICE CARD

Double Pulse Generator

High speed

Available in seven ranges from 1 cps to 10 mc, the model B-5-2 pulse generator produces two identical pulse trains. Output pulse widths are adjustable from 20 msec to 12.5 msec with rise and fall times of 8 msec. Both pulses may be delayed individually up to 500 msec.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

CIRCLE 332 ON READER-SERVICE CARD

Servo Mounting Potentiometer

Stands 500 cps, 24 g vibration

Available for standard bushing servo mounting, model 55 wire wound precision potentiometer withstands vibration of 24 g at 500 cps or 10 g at 1000 cps. Maximum resistance is 100 K ±5% on standard units of ±1% on special type. Rated 2 w at 65 C, the unit operates from —55 to +105 C and survives 5 million revolutions.

New England Instrument Co. Div., Dept. ED, 320 Main St., Woonsocket, R.I.

CIRCLE 333 ON READER-SERVICE CARD

CIRCLE 334 ON READER-SERVICE CARD



POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

IN CANADA: POTTER & BRUMFIELD CANADA, LTD., GUELPH, ONTARIO

Gear Motors

Provide up to 175 in.-lb at 10 rpm

Heavy duty model HD1, HD2, and HD4 gear motors operate on 115 v ac, 60 cps and may have any single speed from 0.5 to 1000 rpm. Respectively, they are rated at 1/65, 1/30, and 1/20 hp and provide torques of 40, 80, and 175 in.-lb at 10 rpm.

New England Gear Works, Dept. ED, Meriden Ave. and South End Rd., Southington, Conn.

CIRCLE 335 ON READER-SERVICE CARD

High Speed Relay

For telegraphic use

For telegraphic use, this solid state, spst relay has up to 200 baud keying speed and accepts polar or neutral inputs. It has an operating current of 20 to 60 ma with a 130 ohm input resistance. The contacts handle 200 ma with a 160 v open circuit voltage.

Rixon Electronics, Inc., Dept. ED, 2414 Reedie Dr., Silver Spring, Md.

CIRCLE 336 ON READER-SERVICE CARD

Molded Magnetic Amplifiers

Operate with overloads of 1000%

Besides a life of at least 10 years, Ferrac 400 cps molded magnetic amplifiers feature strong resistance to shock and vibration and the ability to operate with overloads of 1000% and into dead shorts. Four types are available. The M-5501 is a general purpose unit with a variety of circuit applications. Type M-5502 has a sensitive 100 K winding and a 5 K feedback winding. With positive feedback to increase the B winding gain to infinity, it can provide circuits with high input or output impedance. Type M-5503 is designed for use as a thermocouple amplifier, and type M-5504 is a general purpose unit with a small bandwidth and high gain.

Airpax Electronics Inc., Seminole Div., Dept. ED, Fort Lauderdale, Fla.

CIRCLE 337 ON READER-SERVICE CARD

CIRCLE 338 ON READER-SERVICE CARD ➤



Avco / Crosley

Crosley

And

Fire Control Systems for the B-52

New and greater responsibilities have been given Avco's Crosley Division by the U. S. Air Force. Long a producer of fire control systems for bombers, including the B-47 and B-66, Crosley recently was named prime contractor for the ASG-15 fire control system on B-52 bombers ordered for the Strategic Air Command.

Crosley now has complete responsibility for engineering, production and performance. Two of Crosley's large plants manufacture, assemble and test complete turrets, computers and radar units for the ASG-15 system that both "searches" and "tracks" to aim the guns that defend the B-52.

In the months and years immediately ahead, many new and ingenious improvements will be made in bomber defense. Crosley already is at work on several, and has achieved remarkable results that will be reflected in the bomber defense systems of the future.

Crosley's extensive experience and technical capability have made it the first name in fire control systems.

For further information, write to:
Vice-President, Marketing-Defense Products,
Crosley Division, Avco Corporation,
1329 Arlington Street, Cincinnati 25, Ohio.

OPPORTUNITIES FOR ENGINEERS

Crosley offers excellent opportunities to mechanical engineers with experience in airborne gunnery, and electronic engineers with experience in fire control, radar and servos. Write to: Director, Scientific and Technical Personnel, Dept. L-69E, Avco/Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.



are **YOU** designing
one of **OUR**
de **POWER SUPPLIES?**

68 standard units — hundreds of
modified standards — **YOUR** special
requirements may well be one
of our standards!

OUTPUT—0.5 to 36VDC
0 to 2 amps

REGULATION—Line—18MV (105-125VAC)
NL-FL—18MV

OUTPUT—0.5 to 36VDC
0 to 15 amps

REGULATION—Line—18MV (105-125VAC)
NL-FL—18MV

OUTPUT—5 to 7VDC and ranges includ-
ing 27 to 32VDC
0 to 3 amps and ranges includ-
ing 0 to 1 amp

RIPPLE—less than 2MV RMS

REGULATION—Line change 105 to 125V :
25MV (max change in out-
put V); NL-FL—15MV

OUTPUT—28VDC Fixed
0 to 5 amps

REGULATION—line— $\pm 0.25V$
NL-FL—0.5V

MAX RIPPLE RMS
without filter—3.5V
with filter—15MV

OUTPUT—28VDC (nominal) with taps
0 to 10 amps

MAX RIPPLE—without filter—2V
with filter—35MV

MAX RIPPLE—35MV RMS

APPLICATION—28V high current DC power
supplies

OUTPUT—105; 150; 105 or 212VDC (nom-
inal)

DC VOLTAGE REGULATION—
Line—0.5% (1.0% for 212V)
NL-FL—2%

MAX RIPPLE—5MV RMS

OUTPUT—150; 300; 300VDC (6 amps @
6.3VAC) (adjustable ranges)

DC VOLTAGE REGULATION—
Line—0.2; 0.15; 0.05%
NL-FL—0.25; 0.1; 0.05%

MAX RIPPLE—3; 4; 3MV RMS

OUTPUT—450VDC (6 amps @ 6.3VAC)

ADJUSTABLE RANGE—250 to 500VDC

DC VOLTAGE REGULATION—
Line—0.05%
NL-FL—0.05%

MAX RIPPLE—2MV RMS

OUTPUT—Twin 0-60VDC

DC VOLTAGE REGULATION—
Load—20MV (full output)
Line—0.35% (105-125VAC, 60cps)

MAX RIPPLE—1.5MV RMS

OUTPUT—0-300; 0-300VDC (10 amps @
6.3VAC)

DC VOLTAGE REGULATION—
Load—60MV (full output)
Line—0.15% (105-125VAC, 60-400cps)

MAX RIPPLE—2MV RMS

OUTPUT—3-1000VDC (10 amps @ 6.3VAC)

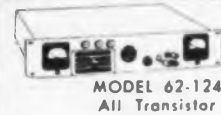
DC VOLTAGE REGULATION—
Load—450MV (full output)
Line—0.045% (105-125VAC, 60cps)

MAX RIPPLE—8MV RMS

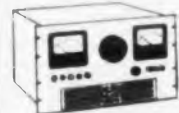
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number
see
below



MODEL 62-124
All Transistor



MODEL 62-121
All Transistor



MODELS 22-111
to 22-117
All Transistor



MODEL 22-101
Magnetic Amplifier
Regulated



MODEL 21-103
UNREGULATED



MODEL 21-105
FILTER



15 MA PLUG-IN
REGULATED



150 MA MODULAR
REGULATED



300 MA MODULAR
REGULATED



MODEL 62-102
(300 MA SERIES)



MODEL 62-125
DUAL UNIT
300 MA/150 MA



MODEL 62-126
500 MA SERIES

NEW PRODUCTS



Coaxial Switch

Has under 0.4 db
insertion loss

For use with RG 117/U and similar cables, the type YL coaxial switch can be supplied with a wide range of rf connectors, including LT, LN, 7/8 in., and TRU. At 4 kmc, vswr is under 1.4, insertion loss is under 0.4 db, and crosstalk is over 30 db. Characteristics improve at higher frequencies. The unit is 9 in. wide, weighs 3 lb, and covers frequencies to 11 kmc.

Transco Products, Inc., Dept. ED, 12210 Ne-
braska Ave., Los Angeles 25, Calif.

CIRCLE 340 ON READER-SERVICE CARD



Recording Oscillo- graph

Handles up to
50 channels

The model 603 oscillograph records up to 50 channels of test data on paper 12 in. wide. It provides variable record speeds between 0.05 and 170 ips and presents data ready for study in seconds. The record drive is both forward and reverse, and response is flat to 6000 cps.

Midwestern Instruments, Dept. ED, P.O. Box
7186, Tulsa, Okla.

CIRCLE 341 ON READER-SERVICE CARD



Variable Attenuator

Microwave

The VAMP variable attenuator covers its full 0 to 30 db attenuation range with less than 180 deg of drive shaft revolution. It has a capacity of 10 w average power and is available in ranges of 2 to 4, 4 to 7, and 7 to 11 kmc. It weighs about 2-1/2 lb.

Antenna & Radome Research Associates, Dept.
ED, 1 Bond St., Westbury, N.Y.

CIRCLE 342 ON READER-SERVICE CARD



Silicon Rectifier

Pill size

Designed to replace bulky selenium rectifiers in TV sets, radios, tape recorders and electronic instruments, the 40E5 silicon rectifier is slightly larger than an aspirin. It has a 400 piv rating and handles 750 ma with a resistive load, 500 ma with a capacitive load. It is rugged and withstands high temperatures.

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

CIRCLE 343 ON READER-SERVICE CARD



Metered Autotrans- formers

Measure voltage,
current, or
power directly

Equipped with meters in the output or load circuit, Variac autotransformer models W5MT3A and W5MT3W provide direct volt and ampere readings and direct volt and watt readings, respectively. They have dual scales from 1 to 5 amp or 150 to 750 w and afford 3% full scale accuracy. The portable units are 9-15/16 x 6-3/4 x 6-3/8 in.

General Radio Co., Dept. ED, West Concord,
Mass.

CIRCLE 344 ON READER-SERVICE CARD



Servo Analyzers

Have 0.0008 or
0.25 to 100 cps
range

Model 100-A and 100-B servo analyzers have 1% stability and respective ranges of 0.25 to 100 cps and 0.0008 to 100 cps. They generate 20 v peak-to-peak sine and square waves, 30 v modulated sine waves and 5 v trigger pulses for external sweep. The units have a 100 to 1 attenuator, accept 50 to 5000 cps carrier frequencies, and measure phase from 0 to ± 180 deg.

Aetna Electronics Corp., Dept. ED, Readington
Rd., North Branch, N.J.

CIRCLE 345 ON READER-SERVICE CARD

CIRCLE 339 ON READER-SERVICE CARD

Falcon missiles travel "first class" in containers secured by LINK-LOCK



Register Tube Cold cathode

The Digitron GR 10 G cold cathode register tube may be used to display the count of either hard tube counting circuits or cold cathode load tube decades. It has a 160 deg viewing angle and 1-1/2 in. numerals that are easily read from 50 ft. Maximum cathode current is 9 ma and operating voltage is 180 v.

Baird-Atomic, Inc., Dept. ED, 33 University Rd., Cambridge 38, Mass.

CIRCLE 346 ON READER-SERVICE CARD



Brake Motors High torque to size ratio

Type FC brake motors, for start-stop operations in drives and positioning systems, are hysteresis-synchronous or induction units wound for 115 or 200 v ac, 60 or 400 cps. Intermittent torques to 12 oz-in. are attainable, and the brake coil can be wound for any voltage to 100 v dc. Brake holding force is 10 oz-in.; engagement time, 40 to 50 msec; diameter, 1.675 in.; length, 3.75 in.; weight, 17 oz.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

CIRCLE 347 ON READER-SERVICE CARD



Static Inverter Three-phase

This three-phase dc to ac static inverter has output ranges to 3 kva and load unbalance of 100%. Frequency stability is 0.5 to 0.002%; output voltage regulation, $\pm 3\%$; harmonic content, under 5%. The unit operates with 22 to 30 v input variation and withstands 300% overloads. It may be hermetically sealed and can be used at temperatures to 250 F. Of modular design, it incorporates control oscillator, logic system, power section, and voltage regulator.

Borg-Warner Corp., Pesco Products Div., Dept. ED, 1310 Vanowen St., Burbank, Calif.

CIRCLE 348 ON READER-SERVICE CARD



Fourteen No. 2 LINK-LOCK fasteners → maintain a pressure-tight seal around cover of Falcon cases.



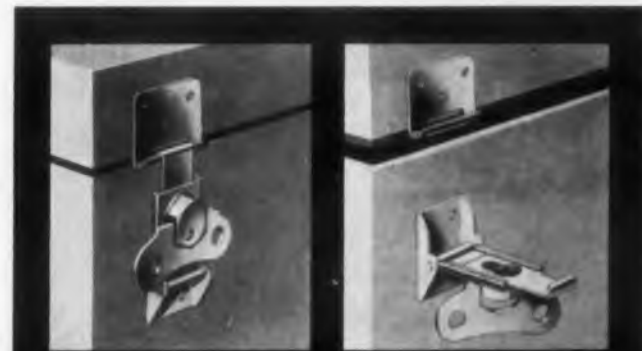
Before they take to the skies, Falcon air-to-air guided missiles are shipped or stored in containers sealed pressure-tight by Simmons LINK-LOCK fasteners.

These precisely engineered fabricated aluminum cases are produced to Hughes Aircraft Company specifications by the following companies: Vendorlor Manufacturing Co., Fresno, California; Allison Steel Manufacturing Co., Phoenix, Arizona; Avco Corporation, Crosley Division, Richmond, Indiana.

Features like these make the LINK-LOCK ideal for use on military cases made to rigid specifications as well as on inexpensive commercial containers:

- Impact and drop resistant.
- Positive-locking without springs.
- High preloading and high load carrying capacity.
- Compact design—lies flat open or secured.
- 3 sizes, for heavy, medium, light duty.
- Flexible engagement latch design...can be varied to suit different applications.

Write for Catalog #1257. Contains complete details of LINK-LOCK and other Simmons Fasteners with unlimited money-saving applications. Samples and engineering service available on request.



Half-turn applies high closing pressure, counter-turn disengages for opening. LINK-LOCK lies flat open or closed.

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FASTENER CORPORATION

North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK
DUAL-LOCK • HINGE-LOCK

See our 8-page catalog in Sweet's Product Design File

CIRCLE 349 ON READER-SERVICE CARD

a NEW Fuse Wire

**Bimetallic wire
that disintegrates
with explosive
violence at 600° C
without support
of oxygen!**

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CIRCLE 350 ON READER-SERVICE CARD

deep drawn aluminum boxes and covers

**11,600
Standard
Sizes
and
Shapes**
WITH NO TOOLING COST!



Choose from more than 11,600 sizes, shapes and heights of square, round, rectangular boxes and covers — pay no tooling charge! All can be trimmed and modified to your specification . . . brackets and fasteners can be installed, holes and louvers punched, etc. Complete facilities for welding and painting too! Send print or contact your Zero Representative for quote on custom deep drawn parts using the exclusive Zero-Method tooling.



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NEW ZERO STOCK
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CIRCLE 351 ON READER-SERVICE CARD

NEW PRODUCTS



**Explosive Circuit
Tester**
Miniature

About the size of a pack of cigarettes, this tester provides a safe means of testing bridge-wire fuses and explosive circuits without actuating or firing the explosives. It can be used to check ejector circuits, guided missile circuit continuity, bomb fuses, and remote control detonators. The unit, which needs no battery and derives its power from light, can be powered by a match.

McLean Development Labs, Inc., Dept. ED, 230 Park Ave., New York, N.Y.

CIRCLE 352 ON READER-SERVICE CARD



**Carrier
Modulation
Analyzer**
Phase sensitive

This visual phase sensitive detector is designed to evaluate the performance of ac servo systems and similar devices using carrier modulation. Used with any oscilloscope, it provides a visual demodulation of the carrier with no phase shift or time delay. Phase and amplitude distortion are zero regardless of carrier frequency. Quadrature and harmonic rejection are 100 to 1.

Boonshaft and Fuchs, Inc., Dept. ED, Hunting-
ton Valley, Pa.

CIRCLE 353 ON READER-SERVICE CARD



**Semiconduc-
tor Power
Supply**
Continuously
variable

Incorporating a magnetic line voltage regulator and a transistorized regulator circuit, the model ME36-5EM semiconductor power supply provides a continuously variable, 0 to 36 v dc output with vernier control at 0 to 5 amp. Recovery time is under 50 μ sec and overshoot is less than 1% of the voltage setting. Ripple is under 1 mv rms; line regulation is 0.05% for 105 to 125 v ac changes; and load regulation is 0.1% from no to full load. The unit is 7 in. high and fits standard 19 in. racks.

Mid-Eastern Electronics, Inc., Dept. ED, 32
Commerce St., Springfield, N.J.

CIRCLE 354 ON READER-SERVICE CARD



LOUD, CLEAR SIGNAL FROM 1760 MILES...

in the 215 mc to 260 mc telemetering band

**THE MODEL REL-10 R-F POWER
AMPLIFIER**, with outputs from 10 to
100 watts, dramatically increases the
range of missile and aircraft tele-
metering systems . . . teams up with
presently available FM transmitters...
withstands adverse space environ-
ments as demonstrated during the
full range of the 1760-mile Thor shot;
as part of the 75,000-mile Lunar
Probe; and on the Atlas Project Score
satellite. For full specs, write for Data
File ED-725-2



size: 5.31" L x 3.56" W
x 3.00" H



RHEEM MANUFACTURING COMPANY
DEFENSE AND TECHNICAL PRODUCTS DIVISION
11711 WOODRUFF AVENUE, DOWNEY, CALIFORNIA
CIRCLE 355 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1955

Miniature Relays

20 to 100 mw sensitivities



Type TQA miniature relays are designed for dc operation at sensitivities from 20 to 100 mw. Contact rating at 28 v dc, resistive is 3 amp for silver and 0.5 amp for palladium or gold alloy. The units withstand 100,000 operations; -55 to +100 C; 50 g shock; and 10 g, 10 to 500 cps vibration. Type TQAH is a hermetically sealed version.

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

CIRCLE 356 ON READER-SERVICE CARD

Precision Gaussmeter

Measures 300 to 20,000 gauss

Model G-501 is a precision nuclear magnetic resonance gaussmeter for determining magnetic field strength and homogeneity of stable or slowly changing magnetic fields. It permits measurements from 300 to 20,000 gauss with standard probes.

Harvey-Wells Electronics, Inc., Research and Development Div., Dept. ED, 5168 Washington St., West Roxbury 32, Mass.

CIRCLE 357 ON READER-SERVICE CARD

Preventive Maintenance Check Panels

For computers

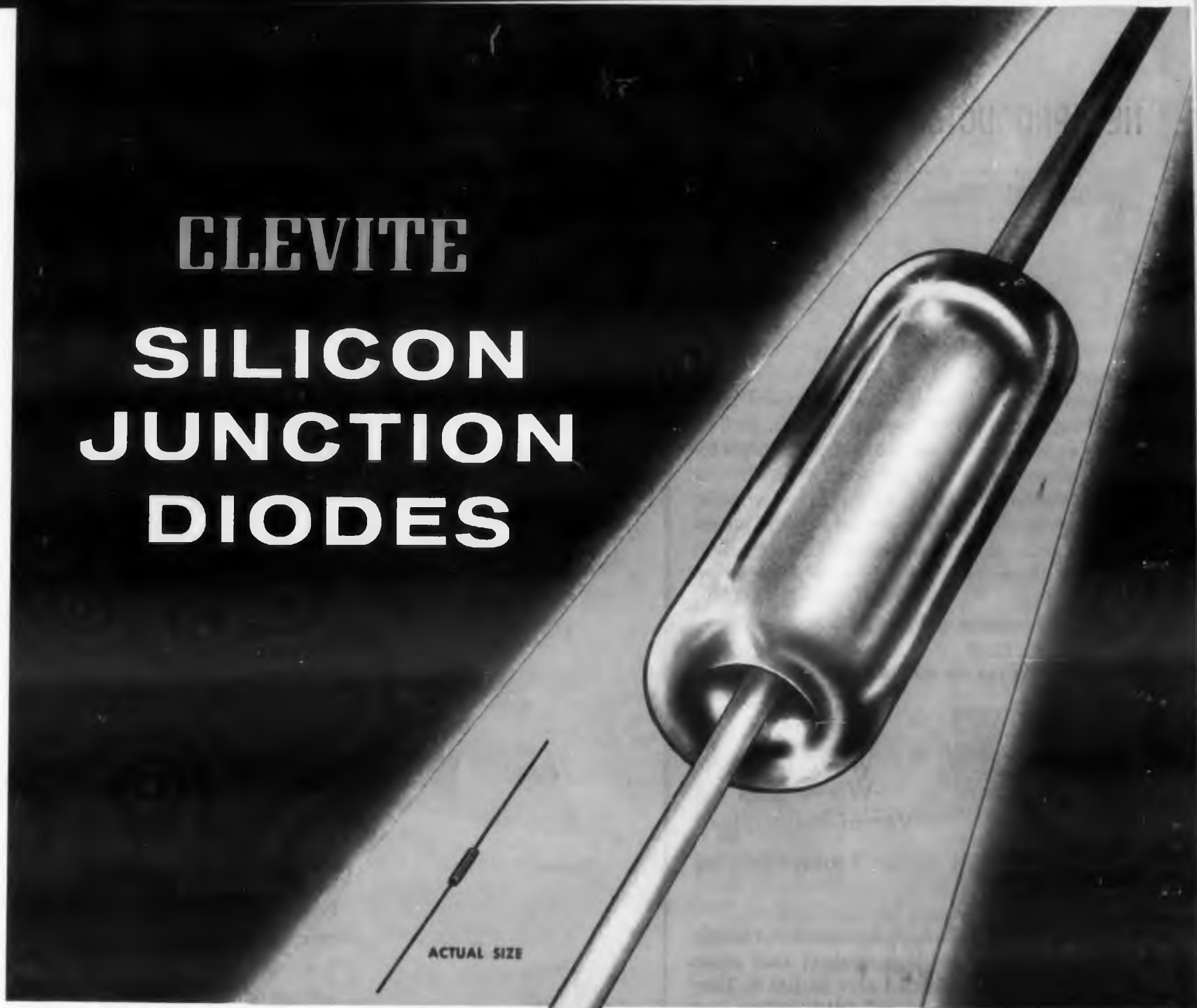
Preventive maintenance check panels 20.174 and 20.175 quickly verify the accuracy of fully expanded 16-31R and 16-131R PACE systems as well as smaller and non-standard systems. They do not require any computer setup modification except the throwing of the function switches.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.

CIRCLE 358 ON READER-SERVICE CARD

CIRCLE 359 ON READER-SERVICE CARD

CLEVITE SILICON JUNCTION DIODES



*250 MW Package . . .
Fast Switching and General Purpose Types
Featuring . . .*

- **MECHANICAL RELIABILITY** — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.
- **ELECTRICAL SUPERIORITY** — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.
- **PRODUCT UNIFORMITY** — Tight manufacturing controls.

For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current		
			@ 25°C	@ 150°C	Test Volts
1N457	60 V	20 ma @ 1.0 V	0.025 μ a	5.0 μ a	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μ a	5.0 μ a	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μ a	5.0 μ a	175 V
1N662	90 V	10 ma @ 1.0 V	20 μ a	100 μ a (@ 100°C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μ a	50 μ a (@ 100°C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μ a	30 μ a (@ 125°C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μ a	30 μ a (@ 125°C)	175 V

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A DIVISION OF
CLEVITE



NEW PRODUCTS



HV Power Supply
For specialized tubes

A dc power source for photomultipliers, klystrons, ionization counters, traveling wave tubes, and backward wave oscillators, the model 222A power supply has a 500 to 5000 v range. Its 0 to 10 ma rating permits operation of several photomultipliers at once. The unit features positive or negative polarity, continuously metered current, and 10 mv peak-to-peak maximum ripple. Two selector switches and a linear vernier control permit accurate adjustments. Voltage may be reset to within 0.05%.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

CIRCLE 360 ON READER-SERVICE CARD

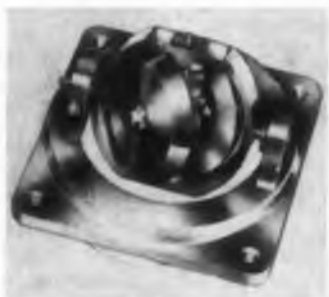


Miniature Wirewound Variable Resistors
5 w capacity

Series WW and WN Radiohms are 5 w, variable wirewound resistors in long or short shaft styles and resistance values from 1 ohm to 100 K. They are 1-3/32 in. in diameter and 9/16 in. deep and have a minimum life of 10,000 cycles.

Centralab, Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 361 ON READER-SERVICE CARD

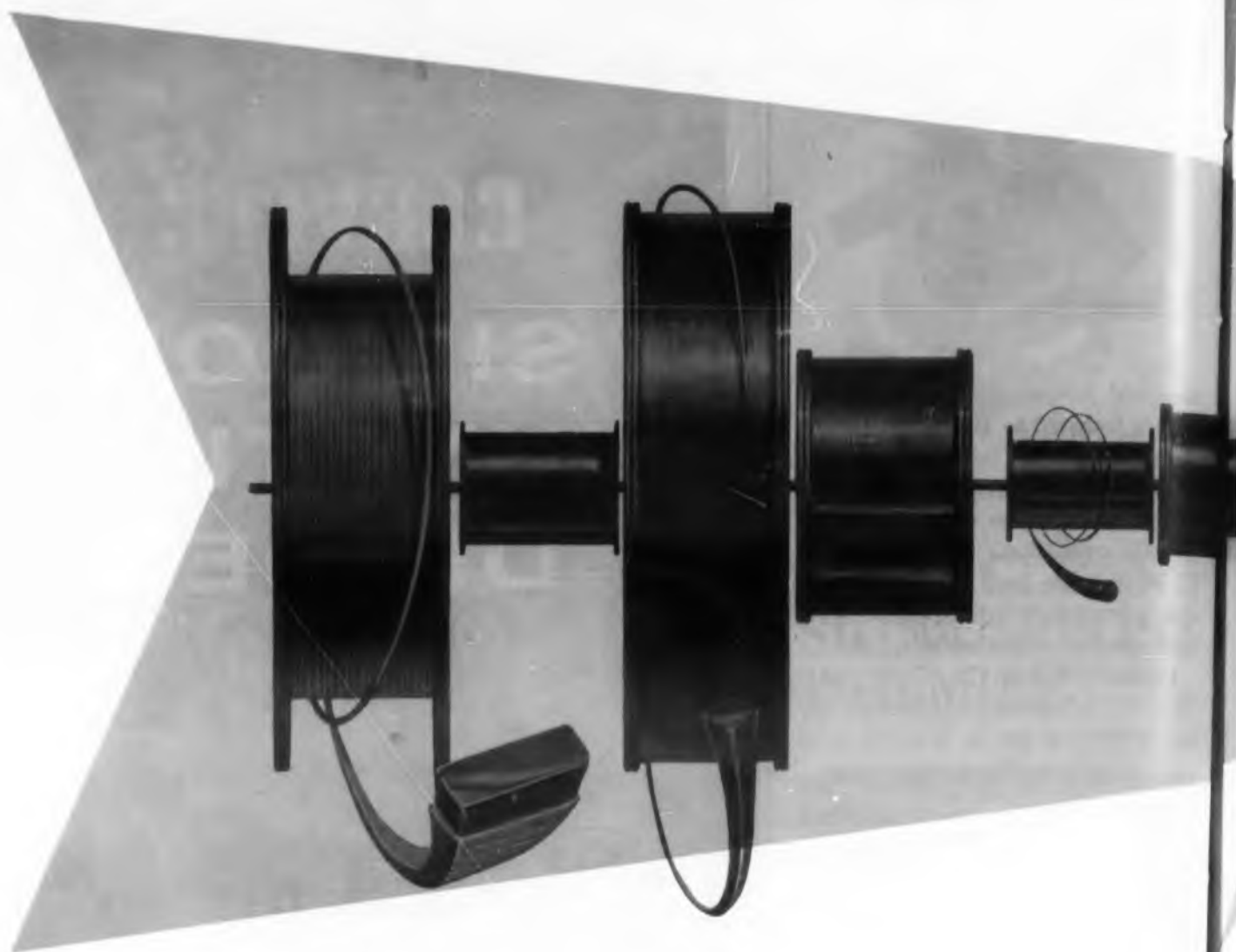


Gyro
Has inner gimbal

This split rotor, solid bar inner gyro is designed for small, short range missiles and drones. The spring wound, two-axis unit resists shock to 100 g, acceleration to 30 g, and vibration to 10 g while maintaining 0.1 deg per sec drift accuracy. Maximum time to speed and uncage is 0.1 sec and running time is 4 min with 8 min rundown time.

Clary Corp., Clary Dynamics Div., Dept. ED, 408 Junipero St., San Gabriel, Calif.

CIRCLE 362 ON READER-SERVICE CARD



Phelps Dodge Applied Research has developed many outstanding magnet wires that anticipate the requirements for advanced insulation system designs. This widely diversified group of Phelps Dodge "firsts" includes:

CLASS A (105°

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, surest and

*Magnet Wires that
pace the Industry
come from
Phelps Dodge!*

BONDEZE® (solderable); **FORMVAR** (square and rectangular)

(105°) BONDEZE® (self-bonding); **S-Y BONDEZE**® (solderable self-bonding)

PIP-EZE® (solderable self-gripping)

CLASS B (130°C)

NYLEZE® (solderable); **THERMALEZE**® B (round film)

CLASS F (155°C)

THERMALEZE® F (round, square, rectangular film)

DAGLAS® (flexible glass)

CLASS H

DAGLAS® H (flexible glass)

**FIRST FOR
BEST QUALITY
-FROM MINE
TO MARKET!**

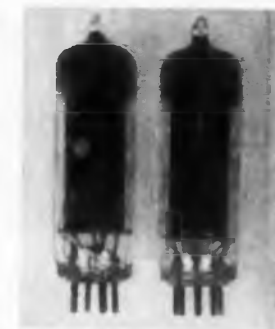


**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

CIRCLE 363 ON READER-SERVICE CARD



Thermal Analog Tube

For system evaluation

The Thermion thermal analog tube is a tool for reliability design before prototype stages. It is physically and thermally identical to any vacuum tube of the same size class, an accurate thermal analog of an electron tube under study. The unit permits optimum thermal component layout in system breadboarding and evaluation stages and also the selection of thermally efficient hardware, mountings, and enclosures.

Research Council, Inc., Dept. ED, 1062 Main St., Waltham 54, Mass.

CIRCLE 364 ON READER-SERVICE CARD



Slip Ring and Brush Assemblies

For thermocouple and strain
gage circuits

These slip ring and brush assemblies are designed for transmitting signals from rotating strain gages and thermocouples to fixed recorders or control stations. In sealed housings, they have individually adjustable brushes. Contacts and rings are of compatible material to avoid spurious emf effects.

Rotary Devices Corp., Dept. ED, 30 Jay St., Englewood, N.J.

CIRCLE 365 ON READER-SERVICE CARD



Relays

Withstand 30 g vibration

Made to MS-24250 requirements, type B relay is a crystal case unit rated 2 amp, 28 v dc or 115 v ac for a life of 100,000 cycles. It is also available as type BR with internally mounted silicon rectifiers for use at 400 cps or higher. Both units withstand 30 g, 50 to 2000 cps vibration.

Hi-G, Inc., Dept. ED, Bradley Field, Windsor Locks, Conn.

CIRCLE 366 ON READER-SERVICE CARD

GR Automatic VOLTAGE REGULATOR

for Constant A-C Line Voltage



- Handles Any Load Up to 6 KVA
- Accuracy Is $\pm 0.25\%$, Independent of Load
- Speed Of Correction 10 Volts Per Second
- Output Voltage Adjustable $\pm 10\%$
- Input Voltage Range $\pm 10\%$
- High Efficiency
- No Power-Factor Restrictions
- Costs and Weighs Less Than Any Other Type Per KVA
- Eight Different Models for Table, Relay Rack or Wall Use and for 115- or 230-Volt Lines, 50 or 60 Cycles
- Prices from \$490.00
- Four Militarized Models Available

Write for AUTOMATIC VOLTAGE REGULATOR BULLETIN

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

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

CIRCLE 367 ON READER-SERVICE CARD

SEND FOR THESE DETAILED DATA SHEETS

ON MINIATURE LAMPHOLDERS
AND INDICATOR LIGHTS

- No. X3245 — Electronic Triggerswitch
- No. R115 — "Mineon" Indicator Light Assembly
- No. 101N-022 — Neon Glow Indicator Light Assembly
- No. H2005-IL — "Mini-space" 2-Pin Lampholder
- Series 1900 — 2-Pin Lampholders with Mounting Brackets
- "Tynylite" Midget Screw Lampholders
- No. 121 — "Tynylite" Midget Indicator Light Assemblies

and also the Quick-Reference Catalog of the big DRAKE line.



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MANUFACTURING COMPANY

4624 N. OLCOTT AVENUE • CHICAGO 31, ILLINOIS

MINIATURE LIGHTING SPECIALISTS

CIRCLE 368 ON READER-SERVICE CARD

NEW PRODUCTS



Half-Wave Magnetic Triggers

For silicon controlled
rectifiers

Series 408 half-wave magnetic triggers are designed for use with C35 or equivalent silicon controlled rectifiers. Their operating range extends from 50 to 400 cps, and their output presents a steep wave front to the gate circuit of the rectifier, allowing precise determination of firing angle. The units are insensitive to line transients, commutator noise, and capacitance to ground. In combination with silicon controlled rectifiers, they provide high power amplification. They are 11.6 cu in. and weigh 15 oz.

ACF Industries, Inc., Avion Div., Dept. ED, 11 Park Place, Paramus, N.J.

CIRCLE 369 ON READER-SERVICE CARD



Metallized Paper Capacitors

Operate from -55
to $+125$ C

Series M-150 and W-150 metallized paper capacitors come in round, rectangular, and wafer types and may be hermetically sealed. They operate from -55 to $+125$ C, and have voltages of 100, 200, 300, 400, and 600 v. Values start at 0.001 μ f.

Electron Products Co., Dept. ED, 430 N. Halstead Ave., Pasadena, Calif.

CIRCLE 370 ON READER-SERVICE CARD



Servo Motor

Size 8

Built to BuOrd Mark 23, Mod 1, the type 5002-04 size 8 servo motor has a 0.35 oz-in. stall torque and a 24,700 rad/sec² torque to inertia ratio. No load speed is 6200 rpm and rotor moment of inertia is 10 g cm².

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

CIRCLE 371 ON READER-SERVICE CARD



Self-Balancing Potentiometers

For flight testing

Series EMP-NS2 Autopots are self-balancing potentiometers that accept outputs from thermocouples or other transducers in flight test programs. The direct reading, plug-in units include pyrometers in 25 ranges and millivoltmeters in 14. Power requirement is 0.15 amp, 115 v, 400 cps; resolution 0.25% of full scale; minimum readable input charge, 30 μ v.

Daystrom Pacific, Dept. ED, 9320 Lincoln Blvd., Los Angeles 45, Calif.

CIRCLE 372 ON READER-SERVICE CARD



Transistor Oscillators

400 cps to 500 kc range

Series LTO transistor oscillators have a 400 cps to 500 kc range, up to 1 ppm frequency stability, $\pm 0.002\%$ calibration accuracy, and 15 min warmup time.

Monitor Products Co., Dept. ED, 815 Fremont Ave. S., South Pasadena, Calif.

CIRCLE 373 ON READER-SERVICE CARD



Film Resistors

7 to 150 w sizes

Type RD high power, high frequency resistor exceed MIL-R-11804C requirements and can be cycled from near absolute zero to almost red heat without electrical property loss. They can be supplied in values from 10 ohms to 3 K and in standard sizes from 7 to 150 w. Standard tolerances are ± 2 and $\pm 5\%$ and standard temperature coefficient is under 0.035% per deg C. Spiralled resistors in the same sizes can be furnished with resistances to several megohms. All units derate to zero at 235 C.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.

CIRCLE 374 ON READER-SERVICE CARD

NEW FROM TI

1N2175 SILICON

PHOTO-DEVICE

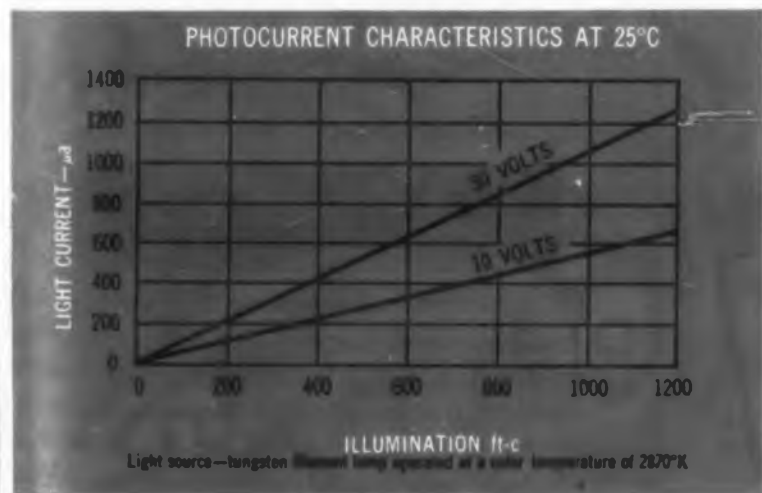
SWITCHES FROM

DARK TO LIGHT CURRENT

IN 2 MICROSECONDS



TI 1N2175 subminiature unit is ideal for punch-card or tape data processing, and many other control systems



Now you can get quadrupled sensitivity and unprecedented design flexibility with the new subminiature TI 1N2175 Photo-Device.

Easily activated, the 1N2175 switches from a low dark current of only $0.5 \mu\text{a}$ to a high light current of $1200 \mu\text{a}$ at 1200 ft-candles — within 2 μsecs . Rated at 250 mw at 25°C, the 1N2175 operates over a range of 1-50 volts, and derates linearly to 125°C. Minimum operating temperature is -55°C.

Specify the TI 1N2175 today and get immediate off-the-shelf delivery in 1-999 quantities from all authorized TI distributors and production quantities through TI sales offices.



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SEMICONDUCTOR-COMPONENTS DIVISION
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TI semiconductors are USE-PROVED by thousands of customers and GUARANTEED for one full year! Now available at Factory Prices in 1-999 quantities:

Silicon transistors, germanium transistors, silicon diodes and rectifiers and carbon film resistors.
sensistor silicon resistors: 1-499
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Newark Electric's all-new, 1959 INDUSTRIAL ELECTRONICS CATALOG #69

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Chicago 5, Illinois

CIRCLE 376 ON READER-SERVICE CARD

147

The TELEDYNE



TELEDYNE®

World's most rugged
pressure transducer

BONDED STRAIN GAGE construction makes the TELEDYNE practically insensitive to vibration or shock . . . keeps it on the job long after other transducers have failed. The resolution of the Teledyne is INFINITE for the precise measurement of gaseous or liquid pressures. Handles extremely corrosive alkalis and acids including fuming NITRIC ACID. Pressure Cavity can easily be cleaned-out. Repeatability 0.1%, Linearity 0.25%, Hysteresis 0.5%, Ambient Temperature -65° F. to +250° F. (18° C. to 121° C.), 1 Millisecond Response. Eleven Pressure Ranges 0-100 up to 0-10,000 PSIG.

Wheelco 8000
Recorder-Controller

TABER TELEDYNE can be used with the Taber Pressure Indicator shown or other standard recorders and controllers of strip or round chart type, such as the Wheelco 8000 shown at right.



Write for Literature and Prices

TABER INSTRUMENT CORPORATION

Section 161 107 Goundry St.
North Tonawanda, N. Y.
Phone: LUDlow 8900 • TWX - TON 277

CIRCLE 377 ON READER-SERVICE CARD

TADANAC BRAND HIGH PURITY METALS

for SEMICONDUCTOR and other uses

ANTIMONY suitable for intermetallic compounds — with zinc and tellurium each less than 0.01 ppm.
BISMUTH total impurity content of less than 1 ppm.
CADMIUM total impurity content of less than 1 ppm.
INDIUM no single impurity in excess of 0.1 ppm also other grades with a wide range of preform shapes and sizes.

LEAD total impurity content of less than 1 ppm.
SILVER total impurity content of less than 1 ppm.
TIN no single impurity in excess of 1 ppm.
ZINC total impurity content of less than 2 ppm.
INDIUM ANTIMONIDE highest commercial purity



Write for our new brochure on TADANAC Brand High Purity Metals.

INQUIRIES ARE INVITED regarding preforming these metals to your specification.

COMINCO

THE CONSOLIDATED MINING AND SMELTING COMPANY OF CANADA LIMITED

Metal Sales Division: 215 St. James Street W., Montreal 1, Quebec, Canada — Phone AVenue 8-3103

9143

CIRCLE 378 ON READER-SERVICE CARD

148

NEW PRODUCTS



Sweeping Oscillator

Covers 200 cps to 11 mc

The Ligna-Sweep model SKV sweeping oscillator covers 200 cps to 11 mc and provides sweep widths from 20 kc to 10 mc on its variable bands and 2 to 20 kc on its fixed bands. Sweep rates are 0.3 to 30 cps in three ranges, 30 cps, and line lock.

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

CIRCLE 379 ON READER-SERVICE CARD



Digital Interval Timer

Measures to the nearest 0.1 msec

Portable model 2202TL digital interval timer meets MIL-T-945A and MIL-E-4970 and measures intervals to the nearest 0.1 msec for a total indicated time of 9.9 or 99.9 msec. Longer intervals can be provided. The unit has indicator lights that show the sequence of two events.

Erie-Pacific, Div. of Erie Resistor Corp., Dept. ED, 12932 S. Weber Way, Hawthorne, Calif.

CIRCLE 380 ON READER-SERVICE CARD

Ferrite Components

Need no external magnet



Using a compact magnetic field unit in place of heavy external magnets to control transmission characteristics, these ferrite components are 1/10 the weight and volume of older components. The magnetic field unit is small enough to fit inside the coaxial envelope of ferrite isolators. For the 400 to 11,000 mc frequency bands, the component can be used in radars, countermeasures, communications, missiles, and special test equipment.

Sperry Microwave Electronics Co., Div. of Sperry Rand Corp., Dept. ED, Clearwater, Fla.

CIRCLE 381 ON READER-SERVICE CARD

ELECTRONIC DESIGN • June 24, 1955



Guided Missile Beacon Decoder type

Guided missile beacon model SRTS-2003CH is designed for radars using coders such as the KY-94-/GPA. It has a 2700 to 2900 mc receiver and transmitter frequency, 50 db minimum image rejection, -65 dbm minimum triggering sensitivity, and two- or three-pulse code selection.

Telerad Mfg. Corp., Dept. ED, Flemington, N.J.

CIRCLE 382 ON READER-SERVICE CARD



Silicon NPN Switch Inratings to 400 piv

The Trinistor triode is a three-terminal, multi-junction silicon npnp switch that can replace thyatrons and be used as a converter, inverter, frequency changer, variable frequency generator, motor controller, and voltage regulator. Its break-over voltage can be controlled by the base current. The device will block the rated voltage in the reverse direction and also in the forward direction when there is no input signal to the base terminal. When a base signal of 2 to 5 v is applied, the unit will switch from a blocking to a conducting condition. The base signal draws 25 to 150 ma. In ratings to 400 piv, the Trinistor is designed for circuits with voltage to 400 v and currents to 50 amp.

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

CIRCLE 383 ON READER-SERVICE CARD



Pushbutton Switch Rated 10 amp, 125 v ac

This small, open blade pushbutton switch is a dpdt unit with gold flashed contacts rated at 10 amp, 125 v ac. It is also available with palladium contacts.

Robershaw-Fulton Controls Co., Dept. ED, P.O. Box 449, Columbus 16, Ohio.

CIRCLE 384 ON READER-SERVICE CARD

BENDIX SR RACK AND PANEL CONNECTOR

with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of -67°F to +257°F.

Here, indeed, is another outstanding Bendix product that should be your first choice in rack and panel connectors.



FEATURES:

Resilient Insert • Solid Shell Construction • Low Engagement Forces • Closed Entry Sockets • Positive Contact Alignment Contacts—heavily gold plated Cadmium Plate—clear irridite finish • Easily Pressurized to latest MIL Specifications.

SCINTILLA DIVISION
SIDNEY, NEW YORK



Export Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

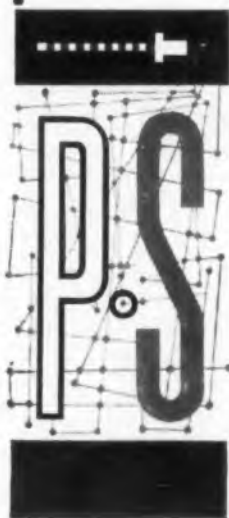
Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Illinois; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

CIRCLE 385 ON READER-SERVICE CARD

**Reliable!
Dependable!
Available!**

For high-performance
slip rings,
brushes, commutators
and switches

the name
to remember
is



**POLY-
SCIENTIFIC
CORPORATION**

BLACKSBURG, VIRGINIA

CIRCLE 386 ON READER-SERVICE CARD



MEDALIST* meters

Combine increased readability with attractive color styling. ASA/MIL 1 1/2", 2 1/2" and 3 1/2" mounting. Up to 50% longer scale in same space as conventional types. Standard and special colors. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Company, Manchester, N. H., U. S. A.

*T.M. Reg. U.S. Pat. Off. U.S. & Foreign Patents
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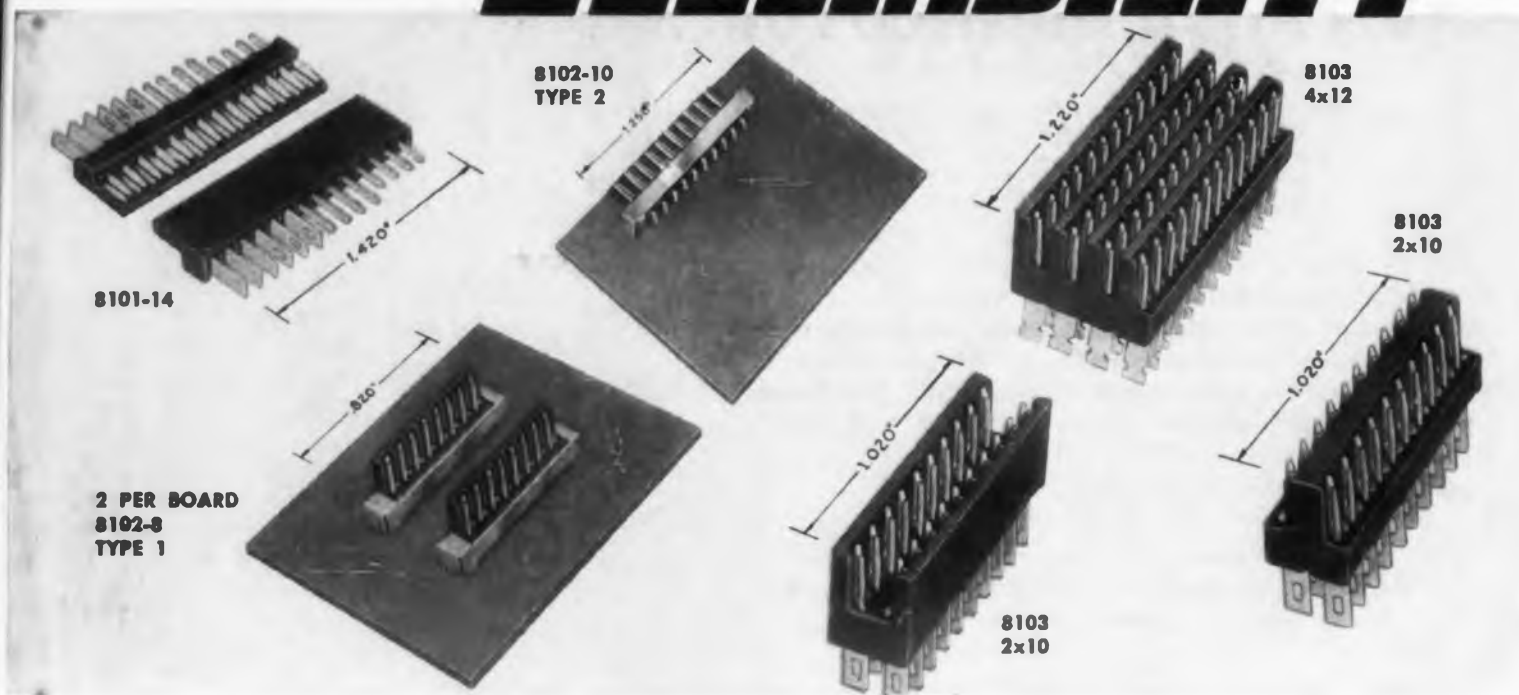
**marion
meters**



CIRCLE 387 ON READER-SERVICE CARD

you specify

RELIABILITY



when you specify . . . ELCO'S new Series 8100 MICRO-MINIATURE VARICON CONNECTORS

Elco's 8100 Series Micro Miniature Varicon Connectors are designed for applications where highest contact density and reliability are a necessity. Contacts are of the forklake mating Varicon principle, thereby assuring lowest contact resistance at all typical environmental conditions during the entire life of the equipment.

The connector can be supplied in three different variations:

8101 Series — Up to 14 contacts in one row at .100" spacing.

8102 Series — The same connector with brackets for p.c. mounting applications with up to 12 contacts in one row at .100" spacing. (Type 1 and 2.) Brackets for chassis mounting on request.

8103 Series — The same connector with 2, 3 or 4 tiers of up to 14 contacts at .100" spacing per row, bonded together at various patterns.

The width of one tier is .140", the height 3/8" without contact tail. The height of a mated pair is 17/32".

The pictures shown above depict only a few of the possible variations of this connector. Limitless other combinations are possible. For further information and full specifications, please write for Bulletin 114 on your company letterhead.

GENERAL SPECIFICATIONS FOR 8100 SERIES

CURRENT RATING: 3 AMPERES
 WITHSTANDING VOLTAGE AT SEA LEVEL: 1000 VOLTS, AC, RMS
 WITHSTANDING VOLTAGE AT 3.4" Hg.: 500 VOLTS, AC, RMS
 CONTACT RESISTANCE: 0.005 MAXIMUM

INSULATION RESISTANCE: 1000 MEGOHMS, MINIMUM
 INSULATOR MATERIAL: DIALLYL PHTHALATE—Glass-filled
 CONTACT MATERIAL: Standard—Phosphor Bronze
 0.0002 Nickel Plate plus 10 to 15 millionths gold.

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



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

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

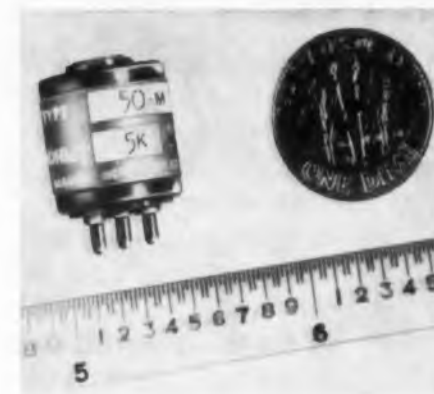
CIRCLE 388 ON READER-SERVICE CARD

See the Complete
 Elco Line at
BOOTHS 520-522
 Wescon, San Francisco,
 August 18-21

NEW PRODUCTS

Trimmer Potentiometer

Has 1/2 in. diameter



Printed circuit trimmer potentiometer model 50-M7 is 1/2 in. in diameter and available with resistances from 25 ohms to 10 K. It is light and sealed and built for rugged environments. No shaft locking device is necessary. The unit is designed to MIL-R-19A, MIL-E-5272A, MIL-R-19518, MIL-R-12934B, and NAS 710. One terminal is polarized for quick assembly.

Maurey Instrument Corp., Dept. ED, 7924 S. Exchange Ave., Chicago 17, Ill.

CIRCLE 389 ON READER-SERVICE CARD



Pilot Light

Mounts in seconds

Supplied with a nut that permits it to be mounted in seconds through any 1/2 in. hole and any panel thickness, the Jiffi-Lite pilot light has a built-in NE-51 neon lamp and wired resistor. Voltage range is 80 to 160 v.

Fedtro Inc., Federal Electronic Sales Div., Dept. ED, Federal Electronics Bldg., Rockville Centre, N.Y.

CIRCLE 390 ON READER-SERVICE CARD



DC Power Supply

400 cps

A high efficiency laboratory power supply, the model M-1201 has $\pm 10\%$ regulation no load to full load and recovers to 1% of the output voltage setting in under 0.1 sec. Input is 115 or 200 to 120 or 220 v ac; output, 24.32 v dc at 25 amp; ripple, 0.05 v rms.

Perkin Engineering Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

CIRCLE 391 ON READER-SERVICE CARD



Multicylinder Tuner

10 to 200 μf range

This tuner consists of five high dielectric glass cylinders coaxially tuned by invar pistons attached to a common adjustment plate. It has a 10 to 200 μf range, low loss, low inductance, good vibration resistance, and no derating to 125 C. A staggered piston tuning arrangement bends the tuning curve to an arbitrary function. Curves for linear or logarithmic frequency tuning may also be obtained.

JFD Electronics Corp., Dept. ED, 6101 16th Ave., Brooklyn 4, N.Y.

CIRCLE 392 ON READER-SERVICE CARD



Telemetry Multicoders

Low level and mixed

Designed for missile environments, these low level multicoders are available in any standard IRIG switching configuration for pam and pdm systems. A mixed high and low level system is available for 90 channels. Power requirements are 26 to 30 v dc, 2.5 w for the low level and 4 w for the mixed system. Maximum sensitivity is 10 mv for full scale output and common mode signal rejection is ± 50 v dc to ± 10 v at 1 kc for 1% of full scale error.

Applied Electronics Corp., Dept. ED, P.O. Box 43, Metuchen, N.J.

CIRCLE 393 ON READER-SERVICE CARD



Silicon Rectifier

High power

The type 300 high power silicon rectifier is available with 50 to 500 piv ratings. The hermetically sealed cells weigh under 3 oz, provide up to 70 amp forward direct current, and operate at up to 190 C junction. Maximum reverse current is 20 ma at rated piv.

Westinghouse Electric Corp., Dept. ED, P.O. Box 5088, Pittsburgh 30, Pa.

CIRCLE 394 ON READER-SERVICE CARD

FIRST IN CLASS



FALCON MISSILE

Playing follow-the-leader at 50 millisecond intervals, three *Super Falcon* missiles rocket ahead of their diamond-shaped supersonic shock waves. Homing in on radar, these deadly air-to-air missiles locate, track, and destroy their prey, with the same killer instinct of the birds they're named after.

Hughes Aircraft, the developer and manufacturer of these missiles and the Armament Control System that triggers them, specified Hitemp magnet and Teflon* wire for their missile, and Teflon wire for its control system.

Hitemp Wires, Inc., the leading specialist in high temperature insulated wires and cables, proudly answers roll call with those developers and manufacturers enlisted in defending our American birthright—*Freedom*.

HITEMP WIRES, INC.

1200 SHAMES DRIVE, WESTBURY, NEW YORK

*Registered trademark for Du Pont fluorocarbon resins.

CIRCLE 395 ON READER-SERVICE CARD



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NEW PRODUCTS



**Stabilization
Cavity**
For 8500 to 9600 mc
frequencies

Stabilization cavity model VA-1299 can be tuned at any fixed frequency from 8500 to 9600 mc with ± 15 mc trim. Stabilization factor is 20; insertion loss, 10 db; unloaded Q, 20,000; and temperature coefficient, less than 5 kc per deg C. The unit is hermetically sealed and weights 1 lb.

Varian Associates, Dept. ED, 611 Hansen Way, Palo Alto, Calif.

CIRCLE 396 ON READER-SERVICE CARD



Logic Module Tester
Automatic

This automatic tester evaluates logic circuitry printed on computer cards on a go no-go basis. Speed and degree of response as well as continuity of the circuitry are measured. The unit has its own power supplies, pulse generators, and voltage sources and can perform up to nine tests or test programs on each circuit.

Atronic Products, Inc., Dept. ED, 1 Bala Ave., Bala-Cynwyd, Pa.

CIRCLE 397 ON READER-SERVICE CARD



**DC Servo
Amplifier**
Modular

Industrial dc servo amplifier model SA-2002-P is designed for electrohydraulic control systems and features modular construction. It has adjustments for gain, zero, balance, dither, and feedback potentiometer excitation. Inertial gain is over 60 ma per v; quiescent current for the differential output is 15 ma for loads to 3 K; and dither output is 350 cps.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Rd., Nashville, Tenn.

CIRCLE 398 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 260C
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.

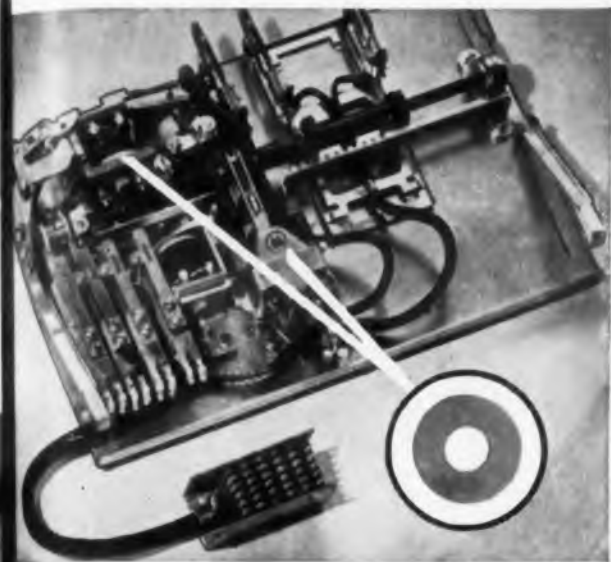
*T.M. REG. U.S. PAT. OFF.

CIRCLE 600 ON READER-SERVICE CARD



Dow Corning CORPORATION
MIDLAND, MICHIGAN

How 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.

CIRCLE 601 ON READER-SERVICE CARD

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.

CIRCLE 602 ON READER-SERVICE CARD

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.

CIRCLE 603 ON READER-SERVICE CARD



AN Connector Terminals, Navy Helicopter

For further information on these products write Dept. 1618

Miniature Choppers

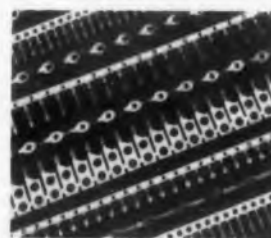
60 or 400 cps



These general purpose miniature choppers are spdt or dpdt, 60 or 400 cps units in both make-before-break and break-before-make designs. They are hermetically sealed and dry gas filled for operation in any climate. Maximum noise is $450 \mu\text{v}$ across 1 meg at 400 cps.

Collins Electronics Mfg. Corp., Dept. ED, Stevensville, Md.

CIRCLE 399 ON READER-SERVICE CARD



Terminals, Receptacles, Connectors

In chains

For use with automatic insertion machines, these miniature tubular terminals, Wrap-A-Wire terminals, receptacles, and connectors are supplied in chain form. They are designed for printed circuits and many other electronic uses.

Malco Mfg. Co., Dept. ED, 4025 W. Lake St., Chicago 24, Ill.

CIRCLE 400 ON READER-SERVICE CARD



Portable Tube Tester

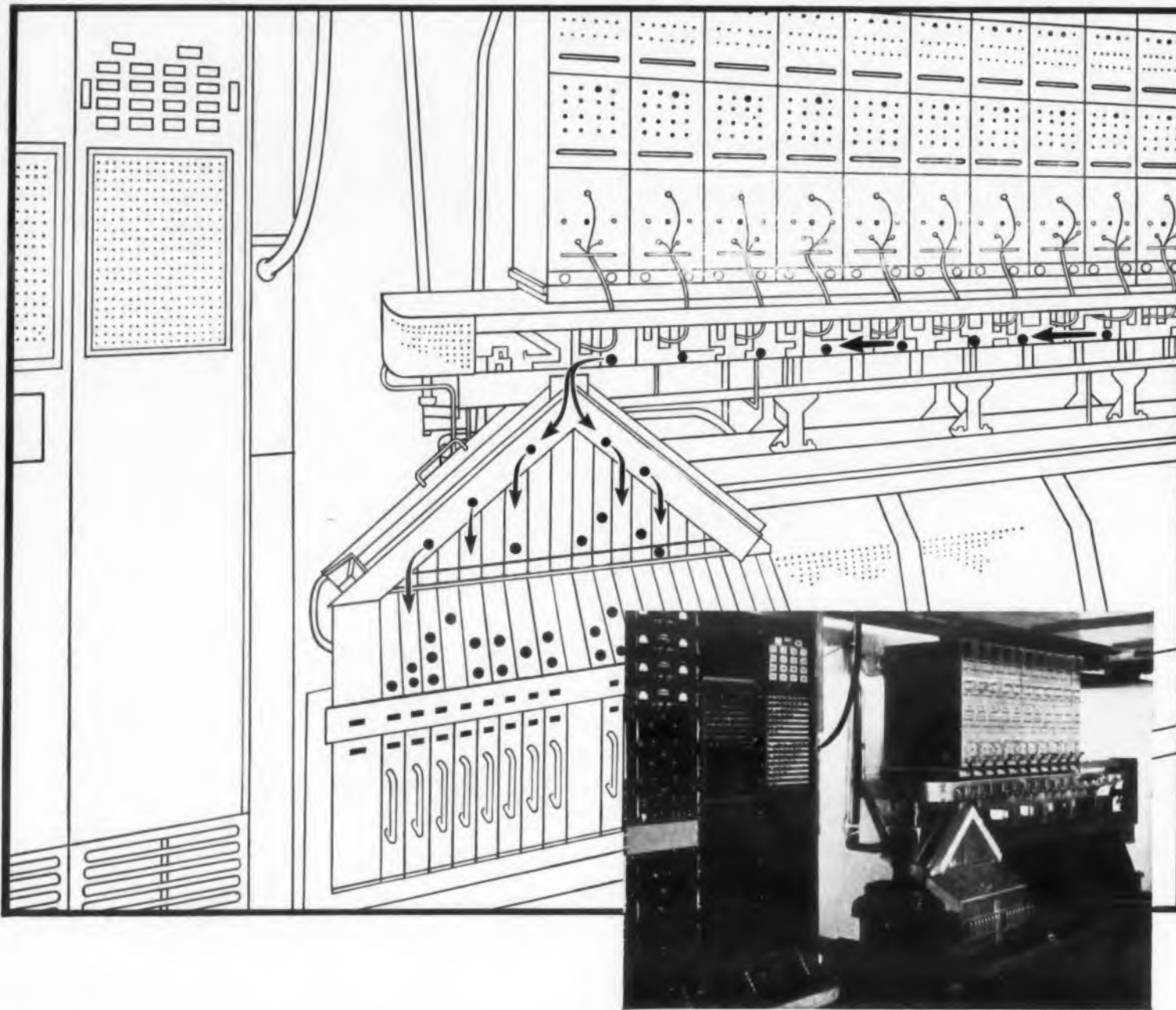
Checks transistors and diodes

Portable model 800 dynamic mutual conductance tube tester is a low cost unit that incorporates a transistor and diode check. It checks leakage between tube elements up to 10 meg and tests special tubes such as 117N7 types. The meter directly indicates 0 to 3000, 6000, and 15,000 μmhos . The unit has sockets for 4, 5, 6, and 7 pin; octal; loctal; noval; and 7 pin miniature types.

Hickok Electrical Instrument Co., Dept. ED, 10525 Dupont Ave., Cleveland 8, Ohio.

CIRCLE 401 ON READER-SERVICE CARD

TECHNOLOGICAL LEADERSHIP IN SEMICONDUCTORS



How Sylvania rates semiconductors

Now in operation at Sylvania's Semiconductor Division is a new Digital Automatic Tester and Classifier. Designed and developed by engineers of the Division, it automatically subjects semiconductors to 16 separate tests and classifies them into as many as 256 different categories at a speed of 1500 per hour.

The new computer rates each semiconductor on each test. It compares the final test results with predetermined standards and then places each unit in its proper category. Replaceable plug-in test modules enable the device to test for an almost infinite variety of electrical and mechanical characteristics and parameters.

For the circuit designer... the new classifier means new uniformity and higher quality in semiconductors. It eliminates damage due to excessive handling and reduces human error to a minimum, assuring duplicate performance from unit to unit. Continuous operation has proved test accuracy within a tight 0.5 percent limit for all parameters. The end result is a new standard of excellence in semiconductor devices.

At Sylvania, technological achievements like the Digital Automatic Tester and Classifier are in progress every day. Always, the objective is to produce the best possible semiconductor at the lowest possible cost.

 **SYLVANIA**
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS



SYLVANIA ELECTRIC PRODUCTS INC.
Semiconductor Division
100 Sylvan Rd., Woburn, Mass.

CIRCLE 402 ON READER-SERVICE CARD

Adapters Increase Meter's Versatility

YOU CAN now convert Simpson multimeters, models 260 and 270, into many different test instruments by plugging any one of seven compact adapters (described below) into either of the meters. Called Add-A-Testers, the recently developed adapters are self-contained and self-powered, like the meters.

The seven adapters—made by Simpson Electric Co., 5207 W. Kinzie St., Chicago 44, Ill.—are about half the size of meters, as shown in the photograph. Designations, model numbers, and specifications of the adapters are:

Transistor Tester, model 650. The full scale beta ranges of this adapter are from 0 to 10, 50 and 250; beta accuracy is a nominal $\pm 5\%$. The I_{co} range is from 0 to 100 μa with an accuracy of $\pm 1\%$, full scale.

DC VTVM, model 651. Voltage ranges that can be measured are from 0 to 0.5, 1, 2.5, 5, 10, 25, 50, 100, 250, and 500 v. Accuracy is $\pm 1\%$, full scale, and the input impedance is greater than 10 meg on all ranges.

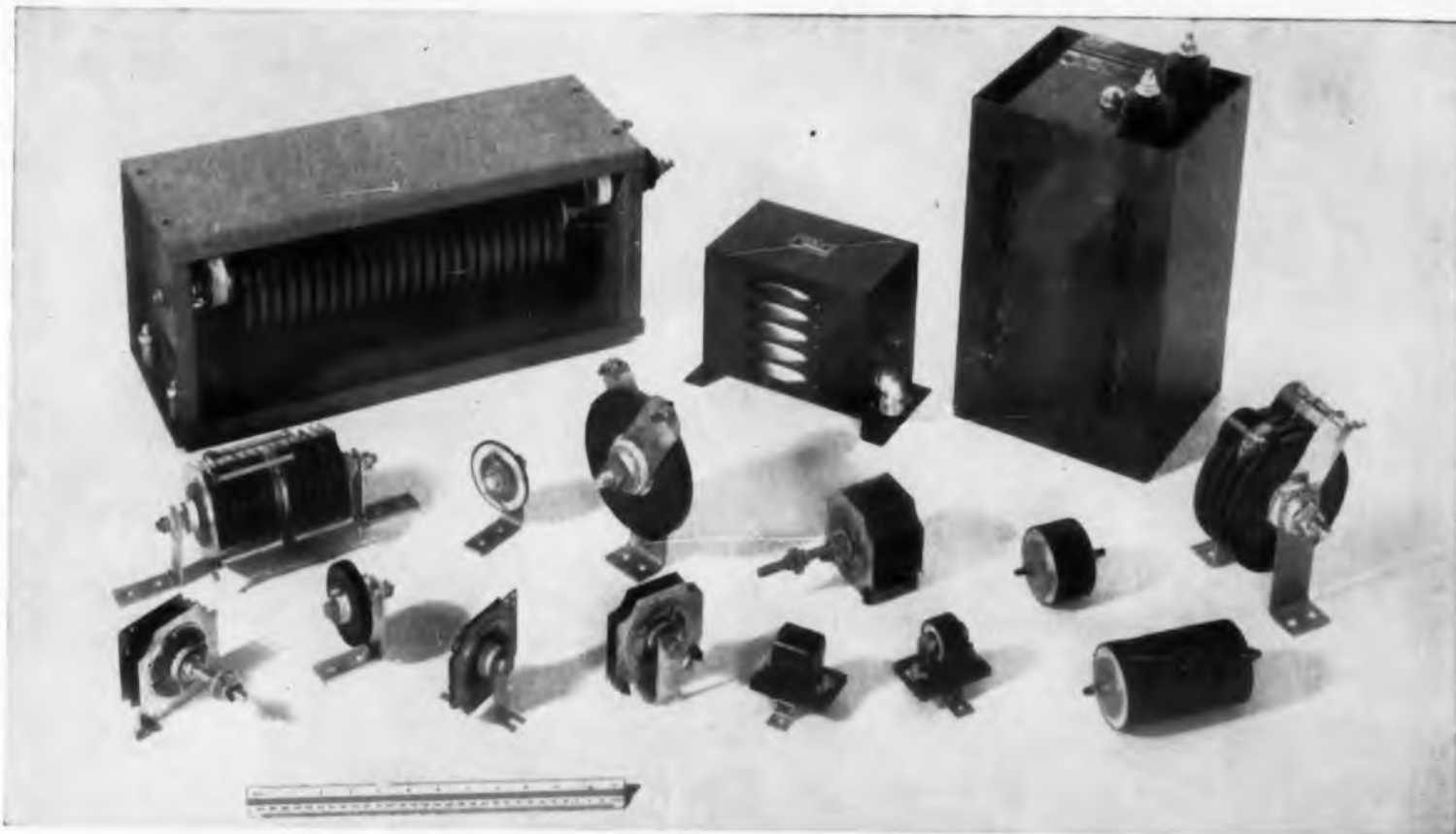
Temperature Tester, model 652. Temperature ranges for this unit are from -50 to $+100$ F, and $+100$ to $+250$ F. Three lead positions are provided and the sensing element used is a thermistor.

Ac Ammeter, model 653. Ranges that can be covered with this adapter are from 0 to 0.25, 1, 2.5, 12.5, and 25 amp; accuracy is $\pm 1\%$. Frequency range handled is from 50 to 3000 cps.

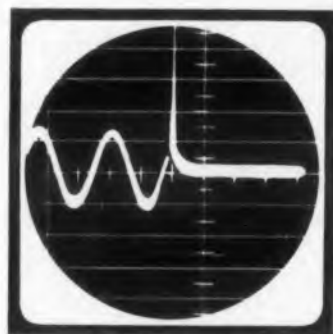
Audio Wattmeter, model 654. Load ranges for this adapter are 4, 8, 16, and 600 ohms. The unit can be used to continuously indicate up to 25 w (8, 600 ohms), and 50 w (4, 16 ohms). Or, on an intermittent basis, it can register up to 50 w (8, 600 ohms), and 100 w (4, 16 ohms). Accuracy is



Metallurgical Memo from General Electric



The G-E Thyrite varistor assemblies illustrated are rated from 6 to 10,000 volts. In addition to protecting highly inductive coils, Thyrite is used with rectifiers, diodes, and equipment operated in conjunction with high-speed switches.



Prevent this inductive surge voltage with a Thyrite® Varistor Assembly

When an inductive circuit is suddenly opened, this is what happens: a heavy overvoltage is induced, and if no protection is provided, the insulation of the equipment is in danger of breaking down.

This equipment can be protected in several ways. Linear resistors could be used, but they consume excessive power. Or a discharge resistor might be used intermittently when interruptions occur, but this requires additional expensive circuitry. *A more effective method of protection is to use General Electric Thyrite varistors.*

Protection with General Electric Thyrite Varistors. Thyrite is a unique *non-linear* resistance material that reduces surge voltages and arcing to safe limits by offering low resistance at peak current. As current decays, Thyrite immediately offers higher resistance, reducing current drain to a minimal amount.

General Electric Thyrite varistors are particularly suited to protect highly inductive coils such as chokes, reactors, D-C motor fields and transformers.



New Medium Voltage Units. New 3-inch diameter medium voltage assemblies, two of which are shown above, are engineered for 1 kv to 10 kv systems. They are part of a complete line of Thyrite rods, discs and assemblies available for components rated from 6 to 10,000 volts.

For more technical information on Thyrite varistors and assemblies — or for the assistance of a G-E engineer — call or write: *Magnetic Materials Section, General Electric Company, 7820 N. Neff Ave., Edmore, Mich.*

MAGNETIC MATERIALS SECTION

GENERAL  ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS
CIRCLE 403 ON READER-SERVICE CARD

Any one of seven adapters may be plugged into the meter to increase its usefulness. The adapters are self-contained and self-powered.

±5%. The adapter has a direct reading scale that extends from 17 μ w to 100 w.

Microvolt Attenuator, model 655. Range for this adapter is from 2.5 to 250,000 μ v; it is continuously variable in decade steps. Frequency is from dc to 20 kc and accuracy is ± 1 db.

Battery Tester, model 656. This unit checks all radio and hearing aid batteries up to 90 v at the manufacturers' recommended load, or any external load.

Multimeter Modifications

In some cases, depending on the particular adapter used, it is necessary to modify the multimeter. The multimeter modification has to be made but once. Afterwards the meter can be used directly with any adapter.

For more information on these adapters, turn to the Reader-Service card and circle number 104.



Want a billion-position switch?

Magnetic amplifier manufacturers turn to Orthonol® tape cores for precise proportioning control or switching action

Orthonol is a switching material that can be turned all the way on—or part way on—with vast precision.

The rectangular B-H loop of the 50% nickel, grain-oriented alloy provides an amplifier output which is linear and directly proportional to control (reset) current. This response is so linear that the amplifier acts as a valve with an infinite (at least a billion) number of steps from full off to full on.

Full off and full on can be achieved with snap action, because the horizontal saturation characteristic of the B-H curve means a very low saturated impedance. Thus, when the amplifier is on, it is *on*; when it is off, it is *off*. On-to-off impedance ratios of at least 1000 to 1 provide complete assurance of this absolute characteristic.

Should your manufacturing facilities prevent the use of

Orthonol in tape wound core form, you can still take advantage of this excellent material in laminations. An Orthonol laminated core has characteristics almost identical to those in toroidal form.

Like all Magnetics, Inc. products, Orthonol tape wound cores and laminations are Performance-Guaranteed. Full details await your inquiry. *Magnetics, Inc., Dept. ED-60, Butler, Pennsylvania.*

MAGNETICS inc.

CIRCLE 404 ON READER-SERVICE CARD

Internal bracing

is secret of . . .

High-Value Ceramic Capacitors

HIGH-VALUE ceramic capacitors are now possible because of a unique method of construction. Using a triangular type of internal bracing, these capacitors can be made with very thin walls, necessary to get low capacitance. In announcing their patent application on this form of construction, Packard Bell Electronics Corp., 12333 W. Olympia Blvd., Los Angeles 64, Calif., points out that the units are expected to replace paper capacitors in the 0.01 to 0.25 μf range. They also are expected to replace mica units in no-drift capacities of 300 μf to 0.01 μf .

Some of their advantages include long life, operation at high temperatures, lack of pinholing and eliminating of lead inductance. Less mounting area is required permitting greater ease of mounting at less cost.

Two forms of ceramic capacitors will be made—extruded and molded. The extruded type is relatively easy to manufacture. But it has to be solder-dipped at the two ends after metal clips have been added.

Molded capacitors are to be produced and installed in equipment with no hand labor. Internal plate connections are made by the configuration of the capacitor itself. Installation of the unit in a printed circuit board would require only that a machine drop it into a clip—the outer plate making contact with the circuit—and the electrode attached to the inside plate dip-soldered. For high-temperature uses, no solder is needed. A clip or



Triangular bracing of thin walls of ceramic capacitors makes possible rugged high-value units.



screw-in arrangement for the inner electrode should be adequate.

Molded units are made by firing and plating the hardened ceramic with copper, then tin plating over the copper for ease of soldering. Ceramics used for the capacitors range from NPO (zero drift) to N7000 dielectric. Paper capacitor dielectric constants run on the order of 6 to 10.

When the molded capacitor is installed in a metal chassis with one plate of the capacitor going to the chassis, the outer plate serves as a shield for eliminating radiation which appears on the inner plate. The arrangement reduces undesirable coupling problems from one portion of the circuit to another.

Uses anticipated by the designer, Harold F. Rieth, Packard Bell Senior Staff Engineer, include military applications where life, reliability and high temperature capability are at a premium and commercial equipment where cost savings, size and safety are important.

Ac-dc radios are often grounded to the chassis through a paper capacitor. If it ruptures, there is considerable danger from shock. Rieth conceives the ceramic capacitor to be a good solution to this problem. He hopes, too, to see an automobile ignition system capacitor that will never have to be replaced.

For further information on these ceramic replacements for paper capacitors, turn to the Reader-Service Card and circle 105.



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... All motors are available in two phase and synchronous models

SPECIFICATIONS (applicable to all motors described above)

Two Phase Induction Motor

Nominal No Load R.P.M.*	Gear Ratio	Intermittent Rated Load (oz.-in.)	Maximum Starting Torque (oz.-in.)	Power (Watts) Loaded	Current (amp.) †Loaded	Temp. Rise °F
330	44:1	4	10	11.5	0.11	70
144	10:1	5	20	11.5	0.11	70
48	30:1	15	60	11.5	0.11	70
23	60:1	30	110	11.5	0.11	70

Synchronous

R.P.M.*	Gear Ratio	Pull-In Torque Minimum (oz.-in.)	Continuous Torque (oz.-in.)	Power (Watts) Loaded	Current (amps.) Loaded	Temp. Rise °F
180	10:1	12	12	24.0	0.21	100
180	10:1	2	2	11.5	0.11	65
90	20:1	14	12	11.5	0.11	65
60	30:1	21	18	11.5	0.11	65
30	60:1	42	36	11.5	0.11	65

*1/6 less at 50 cycles

†Field winding 11.0 watts, balance in amplifier winding

Note: Some speeds available at 25 cycles

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

Honeywell



First in Control

CIRCLE 406 ON READER-SERVICE CARD

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MINIATURIZED · WITHSTAND HIGH SHOCK · LIGHTWEIGHT

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Tube	Ef Volts	If Amps	Peak Anode Voltage	Peak Anode Current Amps	Peak Power Watts	Frequency Mcs	Output Mates To	Weight	Band
BL-212	5.0	0.5	1200 V	0.8	100	5400-5900	50 Ω SM Jack	8 oz.	C
BL-223	5.0	0.7	1900 V	1.1	400	5400-5900	50 Ω TNC Plug	10 oz.	C
BL-226	5.0	0.5	1300 V	0.9	100	9100-9500	50 Ω TNC Plug	8 oz.	X
BL-227	5.0	0.5	1300 V	0.9	100	8700-9100	50 Ω TNC Plug	8 oz.	X
BL-228	5.0	0.5	1300 V	0.9	100	8300-8700	50 Ω TNC Plug	8 oz.	X
BL-230	5.0	0.7	2800 V	1.9	1000	5400-5900	50 Ω TNC Plug	10 oz.	C
BL-231	5.0	0.5	1450 V	1.0	200	5400-5900	50 Ω SM Jack	8 oz.	C
BL-233	5.0	0.7	2800 V	1.5	1000	9375	UG 40/U	11 oz.	X
BL-242	5.0	0.7	1900 V	1.1	400	5400-5900	TNC or 50 Ω N Plug	10 oz.	C
BL-243	5.0	0.5	1450 V	1.0	200	5400-5900	50 Ω SM Jack	8 oz.	C
BL-245	5.0	0.7	2800 V	1.9	900	5400-5900	50 Ω TNC Plug	10 oz.	C
BL-247	5.0	0.5	1200 V	0.8	100	9100-9500	50 Ω TNC Plug	8 oz.	X
BL-250	5.0	0.5	1350 V	1.0	150	5400-5900	50 Ω TNC Plug	8 oz.	C
BL-M003	5.0	0.5	1300 V	0.9	100	9100-9500	50 Ω TNC Plug	7 oz.	X
BL-M004	5.0	0.5	1200 V	0.9	150	8900-9100	50 Ω TNC Plug	8 oz.	X
BL-M007	5.0	0.5	1300 V	0.9	100	9100-9500	50 Ω TNC Plug	8 oz.	X
BL-M008	5.0	0.7	2200 V	1.1	400	5400-5900	50 Ω TNC Plug	10 oz.	C

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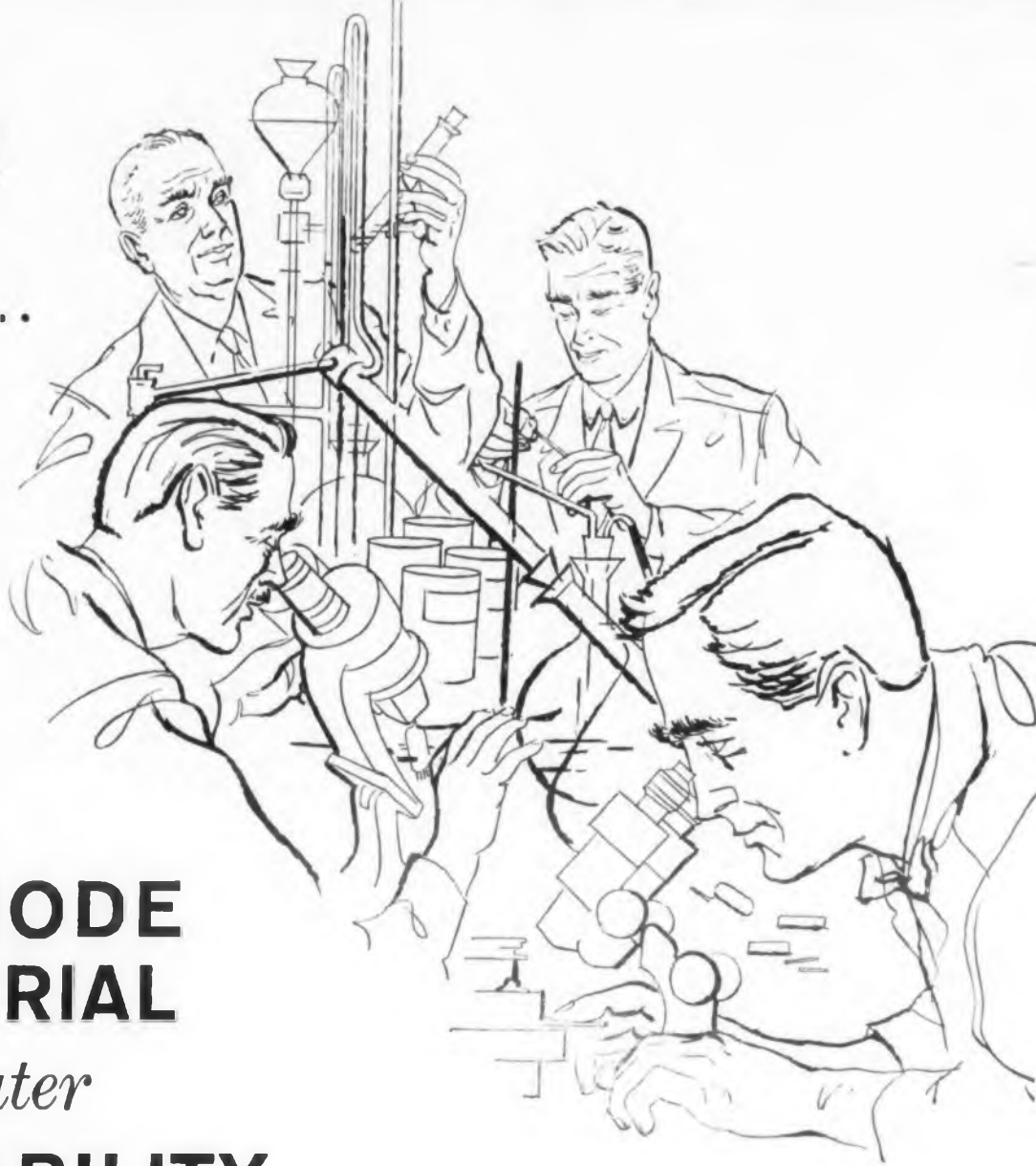
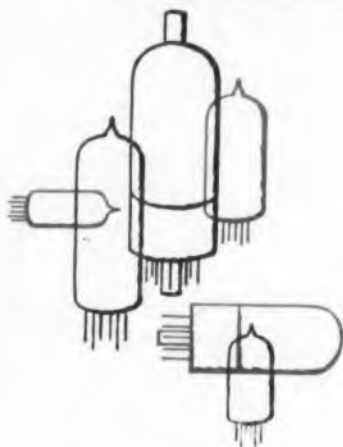
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