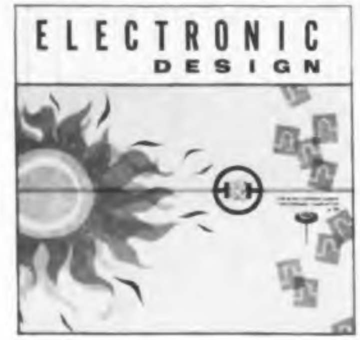
ELECT

D

RONIC
ESIGN

23-watt cesium-vapor thermionic converter p 50



COVER: Old Sol boils electrons off the cathode of an advanced thermionic converter. Dr. Fermi's energy-level diagrams remind us of the phenomena that produce the usable flow of electrical energy.

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ELECTRONIC DESIGN - ONE DAY SERVICE

USE BEFORE JULY 5th, 1961

A

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LIFT PAGE

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hp World's largest line of FULL

BASIC TEST EQUIPMENT

hp 382A/B/C Broadband Precision Waveguide Attenuators

Dielectric loading in new S832, X382 produces long electrical length for high accuracy with short physical dimension, provides hitherto unknown convenience. Calibrated range, 0 to 60 db. Degree-of-rotation scale allows accurate small changes at high attenuation and accurate resetting to high values of attenuation. hp 382B models calibrated to 0.1 degrees; 382C models to 0.01 degrees. hp 382A series rotary-vane attenuators, 3.95 to 40 GC, attenuation 0 to 50 db, $275.00 to $800.00; hp 382B/C models, $295.00 to $650.00.

hp 422
Crysta

High
flat fre
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—40 d
new hp
(pictur
to 40 GC. hp 422A, $
matched pairs for reflec
a pair. hp also offers h
covering a wide freque
GC, $75.00 to $130.00;
lines, 10 MC to 12.5 GC
as 420A in matched pai

hp 532/536A Frequency Meters

Comparable wide band, direct reading convenience are offered by hp 532 series, 3.95 to 40 GC, and hp 536A, 1 to 4 GC coaxial, Frequency Meters. Comprise high Q resonant cavity tuned by choke plunger; no sliding contacts. Transmit virtually full power at resonance. 532 series, $175.00 to $325.00; hp 536A, $500.

hp 914A/B, 906A Moving Loads

Full frequency coverage, 1 to 40 GC is available from hp waveguide or coaxial moving loads. Model 914 series, 2.6 to 40.0 GC, are waveguide sections containing sliding, tapered, low-reflection loads. Plunger controls load position, travels ½ wavelength at lowest frequency to
load reflectio
GC, coaxial
Type N ma
914A/B seri
906A, $250.0

POWER MEASURING EQUIPMENT

hp 434A Calorimetric Power Meter

Connect and read powers 10 mw to 10 watts, dc to 12.4 GC. No barretter, thermistor needed, no external terminations or plumbing. Measures CW or pulsed power. Two simple controls. DC input impedance 50 ohms approx.; input SWR less than 1.7 full range, less than 1.3 to 5 GC. Accuracy within 5% full scale. $1,600.00 (cabinet); $1,585.00 (rack mount).

hp 431A Microwave Power Meters. hp 478A/486A

Now end tedious zero se
Power Meter (pictured). N
full scale in 7 ranges, al
accuracy all ranges, drift
zero setting for all ranges, good for hours. Provides
10 db over previously available instruments. Opera
Thermistor Mounts. hp 431A, $345.00. *New hp 478A*
MC to 10 GC without tuning, is truly temperature c
thermistor pairs for use with dual bridge of 431A.
accuracy, drift-free operation. $145.00. *New hp X486*
temperature compensated, gives high accuracy, new
GC without tuning, SWR less than 1.5. $145.00.

IMPEDANCE MEASURING EQUIPME

hp 809B/814B Universal Probe Carriages

hp 809B, 810B

Easy waveguide interchange

hp 814B, 815B, 446B

Models 809B and 814B are precision built mechanical assemblies operating, respectively, with hp 810B and 815B series slotted sections.

Combination of the 809B carriage and 810 slotted sections covers 2.6 to 18.0 GC. Combination of 814B carriage and 815B series sections covers 18.0 to 40.0 GC.

On either carriage, waveguides can be interchanged in seconds. Only one probe (for each carriage) covers full frequency range. Manufacture is of highest quality, assures positive mechanical positioning of interchangeable waveguides and precise installation of mating hp probes. hp 809B has vernier scale reading to 0.1 mm, is equipped for dial gauge mounting. hp 814B has dial read directly to 0.01 mm. hp 809B, $175.00. hp 814B, $225.

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Range
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Carria
to 40.0
446B, $
el 440A
Type N

L-RANGE TESTED *waveguide and coaxial equipment*

422A, 421A, 420A/B
rystal Detectors

igh sensitivity (0.05 v/mw). t frequency response (±2 db) d accurate square-law characteristics (± 1 db from —3 to 40 dbm) are available with w 422A Crystal Detectors pictured), K and R bands, 18 A, $200.00 each, available in reflectometer systems, $420.00 ers high sensitivity detectors equency range: 421A, 7 to 18 0.00; 420A for Type N coax 5 GC, $50.00 each; 420B same d pairs, $150.00 pair.

752 Multi-Hole Coupler

Precision directional couplers provide coupling factors of 3, 10 or 20 db. Coupling accuracy ± 0.4 db or 0.7 db. Directivity better than 40 db full range, SWR less than 1:1 (752A), 1:05 (752C/D). Cover frequencies 2.6 to 40 GC. $100.00 to $375.00.

760D/761D
Dual Directional Couplers

Ideal for reflectometer systems, these coaxial couplers are flat to ± 0.5 db over 4-to-1 frequency range. Directivity is 35 db (760D) and 30 db (761D). Feature high power capacity, low insertion loss and SWR. 760D, 250 MC to 1 GC, $200.00; 761D, 1 to 4 GC, $185.00.

870A/872A Slide Screw Tuners

For waveguide, coaxial (872A shown) applications. Probe position, penetration sets up reflection cancelling existing reflection. Lead screw or micrometer varies probe insertion for 870A Tuners, 2.6 to 40 GC, $125.00 to $300.00. Micrometer drive varies insertion on 872A, 500 MC to 4 GC, $525.00.

cy to reverse phase of residual lection. Model 906A, 1 to 12.4 axial, includes adapters for male, female connectors. series, $50.00 to $250.00; 250.00.

372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models, 2.6 to 18.0 GC. $110.00 to $400.00.

375A
Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range: attenuation variable 0 to 20 db, dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 GC. $90.00 to $190.00.

362A Low Pass Filter

Compact models increase SWR measurement accuracy by suppressing harmonics; feature low insertion loss, broad stop band. 8.2 to 40.0 GC (includes N-band model). $325.00 to $385.00.

T

486A Thermistor Mounts

o setting with new 431A d). Measures 10 μw to 10 mw s, also reads in dbm. ± 3% drift less than 2 μw/°C! One ovides additional sensitivity of Operates with 478A, 486A *78A* (center, above) covers 10 ure compensated, contains two 31A. SWR less than 1.5, high *X486A Waveguide Mount*, also , new convenience. 8.2 to 12.4

430C Microwave Power Meter
476A/477B/485 Mounts

430C reads rf power direct in dbm or mw, requires no calculations. Covers 2.6 to 40.0 GC, operates with 476A, 477B, 485 bolometer, thermistor or detector mounts; also with 487 Broadband Waveguide Thermistor Mounts (see alongside). 430C, (cabinet), $250.00; 430CR, (rack mount), $255.00. *476A Universal Bolometer Mount*, 10 to 1,000 MC without tuning, $85.00. *477B Coaxial Thermistor Mount*, 10 MC to 10 GC without tuning, $75.00. *485 Detector Mounts* available in three basic series: S485A 2.60 to 3.95 GC, no tuning; 485B, 3.95 to 12.4 GC; 485D, 2.6 to 8.2 GC. 485 models, $75.00 to $185.00.

487 Waveguide Thermistor Mounts

Models covering 2.6 to 40.0 GC. Each covers full range of guide; no tuning. SWR 1.35 to 2.0. 10 mw max power. Uses permanently installed 100 ohm negative coefficient thermistor; 18.0 to 40 GC models use 200 ohm thermistor. $75.00 to $225.00.

MENT

444A/446B
Untuned Probes

444A (shown) is modified crystal (1N76 or 1N26) plus small antenna in convenient housing. Probe penetration easily variable; locks in position. No tun- g; sensitivity superior to elabo- te single, double tuned probes. ange 3.0 to 18.0 GC; fits ¾" ore. 446B for 814 Probe arriage, similar but covers 18.0 40.0 GC. 444A, $40.00. 46B, $145.00. also offers mod- 440A, for barretter or crystal, ype N coaxial, $85.00.

810/815B Slotted Sections

810B Slotted Sections. 810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. 3.95 to 18.0 GC. $90.00 to $125.00.

S810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 GC (S-band) size only. $450.00.

815B Slotted Sections. For mounting in 814B carriage. Available in two bands, 18.0 to 40.0 GC. Accurately machined; easy interchange, precise positioning. $265.00.

806B Coaxial Slotted Section. 3 - 12 GC, fits 809B, Type N connectors. $200.00.

805C/D Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 GC, reads in cm and mm to 0.1 mm. 805C, for 50 ohm Type N, 805B. for 46.3 ohm RG 44/U. 805C, $525.00; 805D, $600.00.

415B/C Standing Wave Indicators

415B operates with all waveguide and coaxial slotted sections, gives readings in SWR or db. Low noise level, 0.1 μv full scale sensitivity, 60 db calib. attenuator. $200.00 (cabinet), $205.00 (rack). *New 415C* (pictured) offers similar characteristics but is transistorized, incorporates revolutionary four-times expansion of readings at any point on any scale. Price on request.

416A
Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Especially useful for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. See offer for Application Note 42 elsewhere in this advertisement. $550.00 (cabinet), $535.00 (rack).

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Rue du Vieux Billard No. 1, Geneva, Switzerland
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CIRCLE 3 ON READER-SERVICE CARD

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Coming Next Issue: A Report On Today's Supersystems

The supersystems of today—ballistic defense systems, lunar probes, air traffic control, integrated data processing systems for industrial giants, and communications satellites to name a few—are making new demands on electronic engineers. The challenge is not one of 'how to design' but 'what to design' so that the system, as a whole, works. The problems are not technical but conceptual states one industry expert. System design is neither a cut-and-dry nor a cut-and-try process. What is demanded of the electronic engineer building today's and tomorrow's systems is the subject of a special report next issue June 7.

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Pneumatic and Hydraulic Logic Devices Pushed

Component Stage Passed in Drive to Develop Computer Systems For Special Applications. Some Units Have No Moving Parts

PRESSED by the need for computing systems able to operate in extreme environments and in industrial control applications with high efficiency, designers are pushing development of pneumatic and hydraulic logical devices. In many applications these would become subsystems of electronic systems, requiring interconnection.

Advantages claimed for pneumatic and hydraulic logic elements are their ability to pack a lot of computational capacity into a small volume, their resistance to extremes of temperature and radiation, and their low manufacturing cost.

Their disadvantages are the unfamiliarity of their technology to electronic designers who would have to work with or design them, and their relatively low speed. However clock rates of 10 to 100 kc appear to be feasible, depending on operating pressures needed. For many industrial control applications and some computing functions this speed is adequate.

So far, developments in this area have been announced by Diamond Ordnance Fuze Laboratories, Washington, D.C., Moore Products Co., Philadelphia, Minneapolis-Honeywell Regulator Co., Minneapolis, Kearfott Div., General Precision Inc., Little Falls, N.J., and International Business Machines Corp., Yorktown Heights, N.Y. In addition, researchers in the Soviet Union are known to be well along in development of both pneumatic and hydraulic logical circuitry.

In the systems under development, either a gas or fluid is made to flow through a network of channels and orifices in such a way that differences in pressure give solutions to logical problems. In some potential applications the gas or fluid pressure would do actual work, like moving parts.

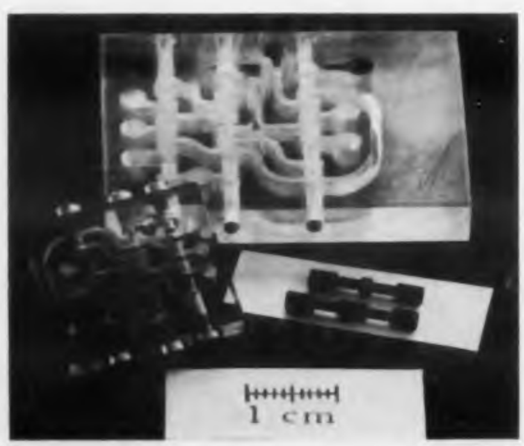
Two approaches are being pursued by researchers in this area. At DOFL, Moore Products, and Minneapolis-Honeywell, circuit elements with no moving parts are under development. Both companies are working under licenses from DOFL.

Kearfott is building pneumatic elements, and IBM is making hydraulic elements, in which moving parts aid circuit operation and simplify connection of the components to electrical systems. Both the moving-parts and no-moving-parts systems offer similar possibilities of realizing advantages inherent in the basic systems.

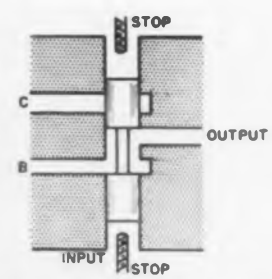
In 1959, DOFL scientists built analog fluid amplifiers that provided substantial gain. They have since built digital amplifiers and flip-flops, they have added feedback to their units, and

Pneumatic digital computing element in plastic lab model form is built to contain six flip-flops. Two chambers near right end of Kearfott-designed unit contain ball valves that move from one end of chamber to the other, cutting off flow of gas to one of two readout channels. Black box at right illustrates microminiaturization possible in 6-flip-flop unit.

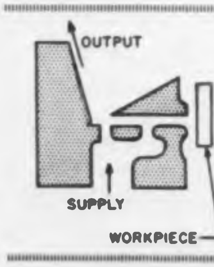
Structure of Kearfott pneumatic digital element shows how ball valves fit in chamber drilled in plastic plates sandwiched between end-plates. Horizontal grooves etched in plastic permit gas flow. Electrical pickoff would be made by coils or capacitor plates imbedded in the channel walls or ends.



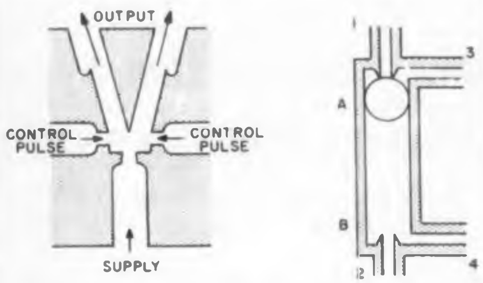
Scale-of-two counter built at IBM's Zurich laboratories has four stable states, operates hydraulically with moving sleeve valves. IBM has designed a series of logic components that operate hydraulically.



Hydraulic flip-flop built by IBM incorporates miniature sleeve valve to block orifices and vary fluid pressure thus indicating one of two stable states.



Dimensional gaging switch for commercial use built by Moore Products under DOFL license indicates passage of workpiece when it blocks orifice and changes gas pressure.



Pneumatic Logic—Two Approaches

A bistable element or flip-flop to implement digital logic can be made in two basically different ways—with and without a moving element. In drawing at left, supply of gas injected from bottom is deflected to either left or right fork by jets from sides to indicate either a "1" or "0" Geometry of chambers can be designed so that flow will remain diverted even though control pulse stops. No moving parts are needed, but boundry-layer phenomenon on which the approach is based is not completely understood.

In drawing at right, ball able to move freely is kept at *A* if gas is supplied through orifices *1* and *2*, which are connected to common supply, and connections *3* and *4* to atmosphere are open. If *3* is closed, forces acting on ball will send it rapidly to position *B*.

have built oscillators and counters. In all, about 60 different elements have been designed. A counter having substantial gain has been built. It is capable of 64 counts in 7 stages.

Moore products is developing a commercial high-speed dimensional gaging switch from one of the DOFL designs. The company has announced that five other "solid-state pneumatic elements" are under development.

Minneapolis-Honeywell has also taken out DOFL licenses to produce pneumatic logic elements with no moving parts. Both M-H and Moore Products have been producing pneumatic control equipment with moving parts.

The IBM and Kearfott systems are essentially valving systems. A moving sleeve valve is used in the IBM logic elements; a ball valve moves freely in the Kearfott components. An experimental half adder designed at Massachusetts Institute of Technology, incorporates a push-button valve.

An elaborate, full-scale hydraulic analog computer has been in operation at Southwest Research Institute for some time; it solves pipeline and chemical processing problems. ■ ■

CIRCLE 6 ON READER-SERVICE CARD ➤

NEWS

New PCM System Syncs Missile Telemetry Data

Matched-Filter Techniques Will Be Used With Pseudo-Random Code

A NEW type of synchronization for pulse-code-modulation telemetry has been developed for the Atlantic Missile Range telemetry system. Called Ultraloc by its designers at Texas Instruments, Dallas, the system is said to permit ground receiving equipment to lock onto incoming signals in minimum time and with high dependability. This is done through use of matched-filter techniques and a pseudo-random code.

In many telemetry systems frames of identifying, coded pulses are transmitted at the start of each message to allow ground receivers to synchronize with the transmission. The synchronization codes usually consist of alternating "0"s and "1"s. According to Texas Instrument engineers, this type of code does not provide minimum or even satisfactory frame acquisition time.

To reduce this confusion and to minimize frame acquisition time, the new design has a pseudo-random code of 31 bits that is processed by matched-filter type of logic circuitry. A pseudo-random code was chosen because it has a desirable correlation function, permitting a receiver threshold to be set high enough so that relatively many errors will be tolerated before synchronization is triggered, but still low enough so that the desired pulses will be recognized.

In operation, incoming signals are stored in a shift register large enough for the code to be detected. The system, to be delivered to the Atlantic Missile Range later this year, has a 64-bit register to accommodate codes of various types. The synchronization subsystem is part of a telemetering system designed by Texas Instruments to supplement or possibly replace the basic system now at the range, the company reports.

Each position of the shift register is connected to a two-position programing switch on a correlator—the positions signifying "0" and "1." The correlator output indicates when a synchronizing code is detected and registers the interval between synchronizing codes. If an incoming frame matches a programed frame, the correlator signals the beginning of synchronization, and a pulse is sent to peripheral circuitry checking.

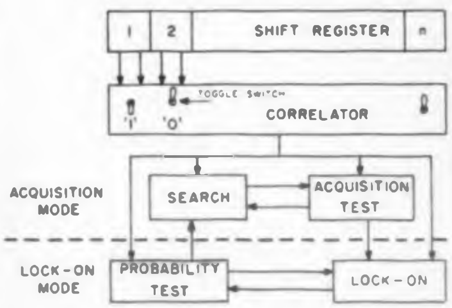
The peripheral equipment—flip-flop and gating logic circuitry—operates in two main modes: acquisition and lock-on. Definite lock-on is indicated only after two synchronized pulses out of

How Ultralock Works

A frame synchronization subsystem based on the Ultraloc technique has a shift register large enough to accommodate various codes. The register feeds pulses to a correlator that delivers a pulse signifying lock-on to logic circuitry. This circuitry establishes the certainty of lock-on.

In the acquisition mode, search circuitry detects the output of the correlator, which may be a pulse signifying that a desired frame of pulses has been received. Acquisition-test circuitry determines whether the desired pulses are present in two out of three consecutive periods. If this is so, lock-on is indicated and probability testing starts.

In this mode incoming signals are sampled regularly to maintain synchronization.



Sync subsystem comprises shift register, correlator and peripheral logic circuitry.

three in succession have been identified. The program of the peripheral logic keeps the circuitry checking after lock-on to detect frames missed because of atmospheric conditions or other disturbances that affect good reception.

Texas Instruments believes that the Ultraloc synchronization technique is applicable in radar and communication systems. Matched-filter radar systems based on "optimum" pseudo-random codes would be able to discriminate a main peak from clutter more easily than now possible with normally coded pulses, the company says.

Matched-filter communications systems for military uses are another application envisioned by the company. It says that receivers would lock onto signals in secure-communications-type networks faster and more reliably with an Ultraloc system. The company has proposed a tactical anti-jam communication system to the military. It calculates that use of the pseudo-random code would give its proposed receiver 30 db of extra gain, even though system design calls for bit redundancy of 1,000. ■ ■

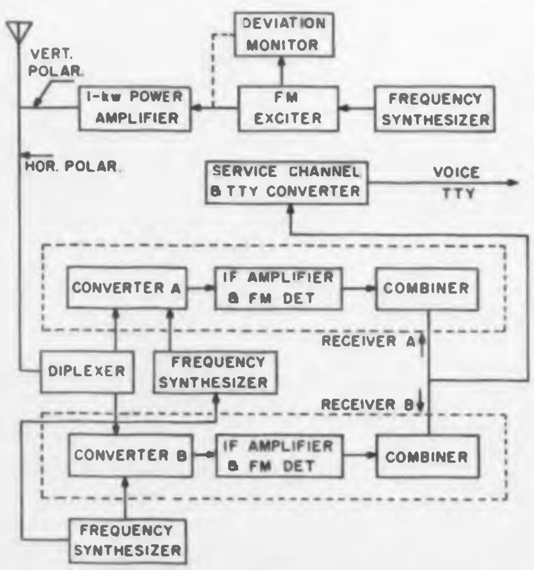
Air-Portable Tropo Unit To Aid Missile Control

1-Kw Communications Set To Be Used With Pershing

COMMAND and control of the Army's Pershing tactical missile will be aided by a 1-kw tropospheric-scatter communications terminal designed to go on the air 10 min after arriving at a site. Exactly how the air-transportable system will be used with Pershing is classified. Its range, however, is said to be up to 100 miles.

Pershing's range is given as 500 miles. Six of the terminals, designated AN/TRC-80, have been delivered to the Army for tests of the Pershing weapon system. They were designed and built by Collins Radio Co., Dallas.

The extremely compact terminal measures 100 x 80 x 65 in. and weighs 3,300 lb. Transmitter output is 1 kw; total power drain, 10 kw. The terminal uses a highly directional inflatable parabolic antenna of aluminum-coated plastic and operates in the 1,700-2,400-mc band. Collins reports that the system can be adapted to operate



Designed for rapid starting and operation by field troops, communications terminal has two receivers to assure reliable performance and to permit operation in diversity nets.

Microwave communications terminal for Pershing missile weapon system is air transportable and completely contained in 65-in. high shelter. Range is up to 100 miles via tropospheric scatter. Antenna is inflatable, aluminum-coated plastic.

at frequencies as high as those in the 4,400-5,000-mc band. The terminal is designed to operate in a diversity net. Each unit contains two frequency-modulated receivers, which can simultaneously receive signals separated by 18 mc or more. Post-detection combining is used.

An unusual feature of the AN/TRC-80 is said to be its high degree of self-testing. This capability was built in to provide fast start-up and reliable operation by field troops. Monitoring data are displayed in go/no-go form. Power sent to the antenna is displayed on one meter by a pointer, which crosses another that shows power reflected from the antenna. The vswr can be read where the pointers cross.

A signal generator is built into the receiving circuitry, so that a received signal is not needed for alignment. A button is pushed to generate the alignment frequency.

A special power tube is used in the power amplifier. It is a permanent printed-magnet focused klystron designed by Varian Associates, Palo Alto, Calif. The four-cavity tube weighs 350 lb and is said to provide a minimum power gain of 45 db when synchronously tuned and 35 db when tuned for maximum efficiency. Bandwidth in the synchronously tuned mode is about 3 mc. Solid-state rectifiers are used.

Collins says the transmitter carrier frequency is accurate to within ± 1 part in 10^6 for any of the 77 channels of the transmitter. ■ ■

Solid-State Electrometer

New Circuit Configuration Uses Vibrating-Capacitance Principle

A SOLID-STATE version of a mechanically vibrated capacitance electrometer was one of the few new devices discussed at the National Aerospace Electronics Conference in Dayton, Ohio.

The electrometer was described by its author as "uniting the two fastest-known semiconductor junctions into a high-input-impedance, low-output-impedance device which has the low intrinsic noise characteristics of a parametric amplifier." It illustrated how clever rearrangements of available components can produce radically new circuits. Low-input capacitance should result in high-frequency applications for the new configuration.

The basic circuit was developed by Charles F. Pulvair, Solid State Research, Electrical Engineering Dept., Catholic University of America, Washington, D. C.

As shown in Fig. 1, two back-to-back solid state voltage-variable junction capacitors are in series with the load and an ac driving generator. The input of the electrometer is the center point of the back-to-back junction capacitors, which are electrically "vibrated" by the generator.

If the generator is a tunnel diode, it, too, can

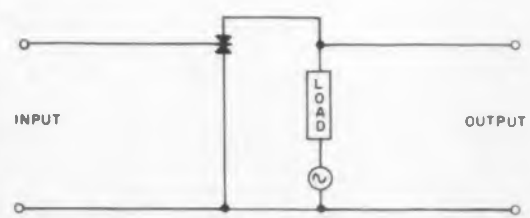


Fig. 1. Basic circuit of new solid-state mechanically vibrated capacitance electrometer.

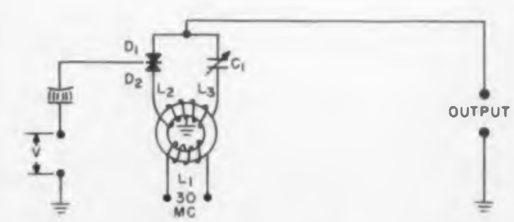


Fig. 2. Schematic of a device built with new solid-state electrometer circuit design. Frequency response approaches 10 mc.

Offers Design Versatility

be integrated with the capacitance junctions into one solid-state functional block, Mr. Pulvair pointed out.

Device Built With Circuit Has Frequency Response Approaching 10 mc

Fig. 2 shows the schematic of one of the devices actually built. It has a frequency response from 1/2 cps to almost 10 mc. The back-to-back junction capacitances are Pacific Semiconductor PC115 High Q Varicaps, and the transformer is a small Ferroxcube core. The centerpoint of the two junction capacitors is connected to the pickup electrode. To avoid a large drive voltage on the output, the drive voltage is balanced out by a simple bridge. The junction capacitors, the two halves of the driving coil L_2 and L_3, and the adjustable capacitor form the arms of the bridge.

When a 30-mc generator excites the bridge circuit, comprising the variable capacitance semiconductor capacitors, through a coupling coil, L_1, the sensing electrode acts as a vibrating capacitor probe. The capacitance of the center point of the two junction capacitors vibrates at twice the frequency of the driving oscillator—60 mc. When the sensing probe is brought into an electric field, the vibrating capacity at the center point of the junction capacitors is alternately charged through the field acting on the sensing probe, and an ac signal is generated in the bridge circuit.

Mr. Pulvair said a later model was built with a frequency response that extends out to 10^8 cps. In this case, Microwave Associates type MA4600 junction capacitors are used with a 400-mc drive.

These devices have input impedances in the kilohms and megohms, while their output impedances are less than 100 ohms. They have sizable current gains, but, like the cathode follower that they resemble, they have less than unity voltage gains.

Uses proposed by Mr. Pulvair for these devices included detection of electrostatic recordings, contactless Hall Effect measurements, mechanical motion transducers, sonar pickups, infrared detection and very high (megavolt) voltage measurements.

He also suggested they might perform novel functions in the functional blocks of molecular electronics. ■ ■

NEWS

Optical-Computer Design Under Study at Sylvania

Conference Hears System May Use Glass-Fiber Transmission Lines

OPTICAL computers, possibly using glass-fiber transmission lines and quantum-electronic storage elements, are now under consideration, according to L. C. Clapp of the Computer Development Laboratory, Sylvania Electric Products, Inc.

The Sylvania researcher discussed a number of approaches to optical computer design at the Western Joint Computer Conference in Los Angeles. Important new advances in memory design were reported by other speakers.

Mr. Clapp speculated that transmission lines in optical computers might be long glass fibers, which are extremely flexible and easy to use.

"The low cost of these fibers," he said, "compares favorably with the expensive wave guides needed for microwave computers."

The attenuation of light passing down such a fiber is due only to the absorption of the glass and is less than 1 per cent of energy per inch, Mr. Clapp said. Cross-talk between neighboring transmission lines would be eliminated by coating the optical fiber with a thin glass film of lower refractive index.

To store information, quantum-level memory devices might be used, Mr. Clapp said.

"Electrons can make transitions from one quantum level to another in very short times—on the order of 10^{-8} or 10^{-9} second at optical frequencies," he explained.

Three kinds of memories were discussed: gaseous, solid-state and maser. The difficulties with gaseous models include the fact that metastable states in gases are not permanent, and technological and production problems associated with making very small gaseous items are undesirable.

Masers, as they exist today, are large, bulky devices often requiring considerable external equipment, such as cooling systems and magnets.

Solid-state material, however, appears very promising for storage, he said.

Three New Computer Memories Stir Wide Attention at Parley

Announcement of three new computer memories at the conference captured the attention of visitors. Described were memory systems using tunnel diodes (Bendix), multiple-aperture reluctance switches (IBM) and quantum transition devices (Sylvania).

According to E. R. Beck, D. A. Savitt and A. E. Whiteside of Bendix Corp., tunnel diodes were favored as the basic elements in high-speed, random-access memories because of their fast switching speed and good environmental tolerance. The Bendix approach is based on destructive sensing of the current level in simple bistable elements, consisting of one tunnel diode and one resistor connected at the cross point of a rectangular matrix.

Coincident selection of a particular element is achieved by applying opposite-polarity pulses to the two appropriate coordinate lines. Any resulting permanent change in the current in a selected line is detected by means of a transformer and is used to indicate readout of a "1."

"We have proved the feasibility of the device with a trial system which simulated a memory of 64 words of 24 bits each," Mr. Beck said. Two words of active memory elements were used, he asserted, and the rest were simulated by resistors. Tests showed a 200-nsec cycle time.

"By replacing the transistor drivers with tunnel-diode circuits, drive pulses of the required amplitude can be obtained with a single diode switching between its low- and high-voltage states," Mr. Beck said. "It should be faster—and in particular should greatly decrease the delay in the rewrite loop. We could build a 64-word memory with a 100-nsec cycle time which would operate between −55 and +125 C."

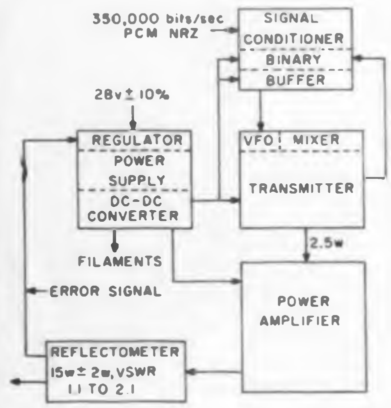
A transfluxor type of device called the multiple-aperture reluctance switch was said by A. W. Vidal of IBM Space Guidance Center to be a very substantial improvement of the state of the art.

"It is similar to the classic transfluxor in that it comprises square-loop magnetic material embodying two apertures," Mr. Vidal said, "but both apertures have the same inner diameter instead of one being much larger than the other." This permits the development of a practical three-dimensional coincident-current, non-destructive readout memory, he asserted.

Two tangible results of the study were mentioned: a Keyhole Mars component consisting of a bit of pressed ferrite with two holes in its thickness, and a three-dimensional, random-access memory configuration. The Keyhole Mars is designed for convenience in automatic production, testing, handling and array assembly. ■ ■

Minuteman Gets High-Data-Rate Telemetry

Standard 215-260-Mc Equipment of Pcm System Is Modified To Provide 350,000 Bits Per Sec With Bandwidth of 1.4 Mc



Airborne telemetry system for Minuteman missile is a redesign of basic telemetering hardware, yet has a data rate of 350,000 bit per sec with a 1.4-mc bandwidth. A reflectometer and signal processor had to be added.

Alan Corneretto
News Editor

STANDARD 215-260-mc telemetry equipment has been modified for the Minuteman ballistic missile program to provide a data rate of 350,000 bits per sec. The bandwidth of the pulse-code-modulation system is only 1.4 mc.

Minuteman is the nation's planned solid-fuel intercontinental ballistic missile. Some of its requirements met by the airborne portion of the control telemetering system are:

- Rf power output—15 w ±2 w under all environmental conditions.
- Bandwidth—1.4 mc for all signal content less than 60 db down.
- Modulation—True fm with less than 1.0 per cent linearity.
- Environment—Severe combined environment of 13 g, random vibration to 2 mc, 90,000 ft altitude, and 700-F radiant heating from chamber walls within 2.5 in. of the system.

These details were revealed by D. W. Lang of United ElectroDynamics, Pasadena, Calif., at the Seventh Aerospace Instrumentation Symposium, Dallas. This meeting was formerly called the National Flight Test Symposium.

System Modifications Include Adding Reflectometer and Signal Conditioner

One of the modifications necessary to achieve the high data rate, Mr. Lang reported, was insertion of a reflectometer between the power amplifier and antenna of the airborne transmitter. This was necessary to keep output power within tolerance, which was ±2 w at a vswr up to 2:1. Merely incorporating an input regulator was not enough to maintain output power at the level needed for the data rate.

The reflectometer is essentially a probe and a diode, Mr. Lang said. Potential across it is fed back as a voltage to a differential amplifier that controls the power supply's input regulator.

Another modification was the addition of a signal conditioner. In addition to providing dc and ground isolation, this specially designed unit assures that neither a pulse train of varying duty cycle nor one of varying symmetry has any effect on the transmitter center frequency.

The Minuteman telemetry system is one of the first designed according to the MIL-I-26600 standard, which contains stringent provisions to control radio-frequency interference. Mr. Lang said a heavy design effort would probably have to be made on all systems to make them conform to the new standard.

PCM Titan II Telemetry System Has Data Rate of 172,800 Bits Per Sec

Details of the Titan II telemetry system were also revealed at the meeting. J. P. Randolph of the Applied Physics Laboratory, Silver Spring, Md., reported that the liquid-fuel ICBM had 192 analog and 5 digital channels in its system. The bit rate, he said, is 172,800 per sec, and the word length, 8 bits. Titan II uses pulse code modulation.

The airborne portion of the system, designed by Epsco, Inc., Cambridge, Mass., weighs 35 lb and has a volume of 0.8 cu ft. Maximum cumulative error of the system is ± 0.4 per cent. (For more details, see story, p. 19.)

Mr. Randolph said he thought pcm was clearly superior to all other modulation systems. New techniques are making design of pcm systems more feasible than previously, he said, and new requirements are making the use of pcm mandatory for some missile and satellite applications.

He also said the transfer of some telemetry operations to the microwave portion of the spectrum had been slowed by lack of suitable components. He said component developments should be stepped up if reliable hardware for uhf telemetry is to be available by 1970.

Needed Soon Are 25-Cu-In. Transmitters And 2-Db Receivers for Telemetry

Mr. Randolph quoted some requirements for microwave telemetry equipment first listed by T. B. Jackson of the Naval Ordnance Laboratory, Corona, Calif. Needed are transmitters smaller than at present—ultimately 25 to 50 cu in. for a 2- to 3-w unit. They should be fm units, capable of modulation by pam, pcm, and pdm.

Receivers should have a noise figure of 2 db or less, a local oscillator stability of ± 0.005 per cent of received frequency, and a preamplifier gain of 25 db. They should be equipped for optional phase-lock operation and should have an if output after the limiters and ahead of the discriminator for predetection recording.

Receiving antennas should have high gain, narrow beam, circular polarization and full hemispherical coverage. They should provide automatic target acquisition and tracking with switchable beamwidths appropriate to each mode. Gains in the two modes should be 10 and 28 db at 1,485 mc, and 12 and 32 db at 2,250 mc. Reflector diameters should be limited to 12 ft for ground-based operation and 4 ft for shipboard operation.

New Oceanography Instrumentation For Measurements also sought

Other challenges to designers were laid down by Dr. D. W. Pritchard of Johns Hopkins University, Baltimore. In discussing instrumentation problems in oceanography, he said there were requirements for high-precision determination of salinity through measurement of conductivity. Involved in this may be temperature measurements accurate to ±0.002 C. Salinity measurements accurate to 0.002 per cent are required in water with salinities ranging from 33 to 39 per cent.

Wanted also are field instruments able to make direct measurements of water density to an accuracy of $\pm$ 1 x 10^{-5} gm/cm^3. Field measurement of pH with an accuracy of 0.01 pH units appears feasible now, Dr. Pritchard reported, but no single instrument for measuring current velocity has gained general acceptance among oceanographers.

A. T. Snyder of the Boeing Airplane Co., Seattle, sounded a call for a systems approach in instrumentation design. He said that too often designers were asked to develop an experimental test-data system for obtaining performance data on an experimental vehicle—they are asked to measure an unknown with an unknown.

If a systems approach were taken, Mr. Snyder said, adequate test-data systems could be developed before they were put into a test program. This could also be made easier, he stated, if more attention were paid to getting the "real answers" during testing, not merely the detailed data traditionally collected.

Instrument Classification Matrix Said to Reveal Missing Devices

What appear to be missing links in the spectrum of instruments that designers have made available to science and industry were reported by Dr. K. S. Lion of the Massachusetts Institute of Technology, Cambridge, Mass. He reported on a survey he made of the entire field of instrumentation and gave details of a systematic description of the instrumentation spectrum. All instruments, he said, can be described as either input transducers, output transducers, or modifiers. The modifiers were described as information processing systems, such as amplifiers or integrators.

Dr. Lion has constructed a seven-by-seven matrix of the types of instruments possible in terms of their input and output characteristics.

The chart indicates where design effort should be directed, he said.

The seven classes of transducers that make up the top- and side-column headings of the matrix are mechanical, thermal, magnetic, electric, optic, nuclear and molecular. Thermal input-electric output transducers exist, for example, and so do electric input-thermal output transducers. But in trying to find instruments to fit in the matrix, Dr. Lion was unable to discover any magnetic-thermal, mechanical-nuclear, magnetic-optic, magnetic-nuclear and nuclear-mechanical transducers. He said this might indicate that instruments should be designed. ■ ■

Satellite Microwave Transmitter To Be Solid State and Give 2.5 W

An all-solid-state transmitter designed for the Navy's Transit IV-A navigational satellite has an output in the 2- to 5-w range at a frequency higher than 350 mc.

Power gain is 26 db. Transistorized stages of the transmitter are operated in the grounded collector mode so that transistors may be set in a case, which acts as a heat sink.

The transmitter case is coated with a special white paint that resists changes caused by ultraviolet radiation. Because the transmitter is the greatest power user and heat generator in the satellite, it will be mounted externally above the main vehicle, where it will support a piggyback satellite.

The transmitter was designed by Texas Instruments, Dallas, Tex.

Telemetering transmitter for Navy's Transit satellite will be mounted externally. Stages, from left to right, are output filter, frequency quadrupler, power amplifier, matching network, preamplifier and frequency doubler, and first rf amplifier.

Land and Sea Tests for Latest Air Aids

Shipborne VORTAC, Flexible Radar and Digital Communications Designed to Help Federal Agency Control Civil Jet-Age Traffic

Shipborne VORTAC direction-finding and ranging system is being tested aboard Coast Guard cutter Androscoggin. Disk on forward mast is 15-ft diam counterpoise. Over it is a slotted cylinder VOR antenna. Rear mast holds a standard Navy Tacan antenna. VOR transmitter power is 200 w, and Tacan power, 7.5 kw. Tests so far indicate sea states have negligible effect on system efficiency.

Air-route surveillance radar system under test at Federal Aviation Agency's National Aviation Facilities Experimental Center near Atlantic City, N.J., is intended for both FAA and Air Force use. L-band AN/FPN-34 system built by Bendix Corp. has range of 0 to 120 nautical miles and can reach to 60,000 ft. Staggered pulse repetition frequency is 516 and 602 pps using pulses of 1,938 and 1,662 μsec. Peak power is 2 megawatts; average power, 2 kw. Radar has linear and circular polarization and four types of video: normal, integrated normal, logarithmic and moving-target indication. Elevation angle is from 0 to 30 deg. Transmitter uses QK470A magnetron, tunable from 1,280 to 1,350 mc.

Test facility for AGACS experimental ground-air-ground communication system at FAA proving grounds. When punched by operator, keyboard transmits preprogramed digital messages to aircraft. System, under development by Radio Corp. of America, is capable of handling 500 round-trip messages in 2 min at a data rate of 750 bits per sec. Console and cabinets contain message-display and insertion equipment, program and data-storage equipment, multiplexing equipment, landline coupling equipment and radio equipment. On aircraft, received messages are displayed by cockpit printer.

Transceiver under development permits air-traffic controller to move about freely in operations rooms and towers. Completely transistorized, it operates at 406 to 420 mc, providing 20 channels, so that 20 units can be used in same facility. Transceivers would work through signaling system linking controllers to all parts of traffic-control facility. Waveguide cavity type of filter rather than lumped-constant type is used in receiver circuit. ITT-Kellogg Div. designed the units, which are scheduled to be evaluated this summer.

Advertisement

Miniaturized Packaging Facilitated by Space-Saving Crimp-Type Modular Connector

A miniature modular terminal block, employing crimp type contacts with a variety of bussing arrangements, has been announced by Burndy Corporation as a new product development.

Occupying only 1/8 of the space required previously, the MINILOK, provides density of 100 connections in only 2 1/2 inches. Top and side feed nylon modules may be easily interlocked on a PVC rigid plastic track which may be cut to any desired length.

A variety of bussing configurations permit the electronic design engineer unusual flexibility as well as the advantage of truly miniaturized electronic packaging. Snap-in HYTIP contacts simplify wiring assembly and circuit changes. Sockets embody tip plated, heat treated, beryllium copper springs for contact retention.

Reliability is heightened by the use of basic parts that have already been proven by extensive field use. For economical production runs, with maximum reliability, contacts are installed by high-speed tooling of a type already in successful operation.

For further information contact Burndy Corp., Norwalk, Connect.

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NEWS

Battery Industry Reports Gains In Product Life and Reliability

Battery-industry improvements in watt-hour operation, shelf life and reliability were reported at the 15th Annual Power Sources Conference in Atlantic City, N.J. Delegates noted that advances were being made despite the attention being focused on such exotic energy-conversion schemes as thermionic converters and thermoelectric devices.

Steps to meet military battery requirements for missile applications were outlined by A. R. Riedel, quality control manager of the Power Sources Div. of Telecomputing Corp., Denver. Engineers developing missile batteries are particularly concerned with such factors as five to 10 years' shelf life and reliability exceeding 99 per cent. The requirements for the Air Force Minuteman program include 99.7 per cent reliability at a 90 per cent confidence level.

Reliability Program Is Set Up For Primary Zinc-Silver Batteries

Mr. Riedel said attempts were being made to achieve such reliability with primary zinc-silver batteries. Among the major steps in the program are:

- Designation of critical parameters.
- Determination of probability of occurrence of critical defects.
- Reliability allocation and prediction based on process steps.
- Process control.
- Preventive and corrective action.
- Process and design changes based on failure analysis.

Automatically activated silver-zinc oxide batteries, such as the BA-472/U, use an electrically-fired gas generator to supply the force needed to drive the electrolyte into the battery assembly. From studies of the thermal stability of such batteries in missiles, it has been concluded that the gas generator is the only potentially unstable component limiting the battery shelf life. Thus the minimum shelf life of the battery package is equal to the shelf life of the gas generator.

Satisfactory Operation Predicted After Five Years' Storage at 130 F

Commenting on the progress of reliability for the gas generator, N. T. Wilburn of the Army Signal R&D Laboratory, said that extrapolation of data indicated that the BA-472/U generator could be expected to operate reliably after five years of continuous storage at 130 F or below. Indications point to the possibility of a generator having a shelf life of at least 10 years, well beyond the normal obsolescence period of a missile.

Although fuel-cell research has been intensified in the last eight years, there is little optimism for the application of these devices for at least a year more, according to a spokesman for the Signal Corps Power Sources Div. Obstacles include the high cost of such fuels as hydrogen, oxygen and hydrogen peroxide plus the complexity and weight demands imposed by the fuel container and control equipment. At best, fuel cells appear to be reaching a stage where they can be examined for possible use in military equipment that now uses chemical batteries or power-driven mechanical generators.

Copies of the proceedings of the 15th conference are available from the TSC Publications Committee, P.O. Box 891, Red Bank, N.J. The cost is $10 for the first copy and $5 for each additional copy. Publication is scheduled for October.

Telemetry Micro-Multiplexer Eliminates Signal Conditioner

The airborne portion of the Titan II telemetry system will incorporate a micro-multiplexer that accepts low-level signals directly, eliminating the need for a signal conditioner.

The multiplexer, designed by Epsco, Inc., Cambridge, Mass., is all-solid-state, operates at 40 mv full scale, and is capable of 20,000 switch closures per sec. It consists basically of two sets of matched transistors.

By eliminating the signal conditioner and by using transistorized components, the company kept the volume and weight of the 200-channel airborne package to 0.8 cu ft and about 50 lb.

The system, scheduled for delivery to the prime contractor, Martin Co., in about one month, incorporates analog signal input filters to reduce on-line differential noise and to prevent high-frequency fold-over. For flexibility in handling different input signals, sampling rates of from 20 to 400 per second are available. A sophisticated five-pole, low-pass filter, designed for optimum transient response, is used in the ouput premodulation stage. The response is flat to 95 kc with 30 db/octave attenuation above 95 kc. This assures that square pulses going to the transmitter do not overmodulate it.

WASHINGTON REPORT

J. J. Christie
Washington Editor

THE SATELLITE COMMUNICATIONS ISSUES

Industry's eagerness to develop and operate a commercial satellite communications system has posed a string of knotty policy issues for the Federal Government.

Testimony before the House Committee on Space and Astronautics indicates that the most serious of these issues relate to technology and timing. There is strong industry pressure for prompt Government authorization of a private operational system, but countering this is a school of thought that favors making haste slowly to permit competing concepts to mature.

The matter of ownership and control, while still touchy, is now less acute as a result of unanimous acceptance of the joint-venture concept expressed in industry briefs filed with the Federal Communications Commission. The prime issue is whether a joint venture should consist exclusively of communications carriers or be open also to participation by aerospace and communications manufacturers.

Leading proponents of an all-carrier venture are AT&T, RCA, IT&T and General Telephone and Electronics. Pushing for mixed ventures are GE, Western Union and Lockheed Aircraft. The weak point in the all-carrier position is that companies backing it also have manufacturing divisions.

Differences Over Technology and Timing are brought into sharp focus by approaches recommended by GE and RCA. GE seeks immediate authorization for a joint-venture enterprise to develop and operate an intermediate-altitude active satellite system. RCA, champion of the high-altitude synchronous satellite, pleads instead for a joint industry-Government group to coordinate and guide current and planned R&D activities as an interim measure.

The GE system calls for putting 10 satellite units into equatorial orbit at an altitude of 6,000 feet and holding them in fixed relation to one another. The company argues that a demonstration satellite can be placed in orbit within 12 to 15 months after authorization is received. An initial operational system of 10 satellites and 20 ground stations is projected for mid-1965.

Symbolic of its eager-beaver approach, GE already has formed a unit known as Communication Satellite, Inc. (ComSat) as a nucleus for the proposed joint venture and has filed an application on ComSat's behalf with the FCC.

It is proposed that ComSat's basic ownership interest be in the satellite facilities and that ownership and operation of ground stations be included only "when a particular need arises." Carrier and manufacturer participants would be limited to 10 per cent equity. ComSat would market its services to the common carriers on a nondiscriminatory basis and would itself be subject to FCC regulations governing common carriers.

RCA's opposition to a satellite communications enterprise at this time is predicated on its belief that the high-altitude, synchronous, or 24-hour, satellite system stands a good chance of becoming the optimum one—but not until the late 60's. It is striving to persuade the Government not to authorize a venture that might freeze out consideration of its system of two or three very-high-capacity synchronous repeaters, positioned 22,300 miles above the equator.

Both economic and technical factors are cited in justification of this position. On the economic side, RCA contends that the projected volume of international communications traffic will not require the capacity to be gained by use of satellites until the late 60's.

From a technological standpoint, RCA argues that more time is needed for test and evaluation of many aspects of satellite communications problems. RCA would have its proposed industry-Government research coordinating group carry the ball at least until a U.S. position were drafted for the 1963 Conference of the International Telecommunications Union.

Projects ADVENT and RELAY of the Defense Dept. and the National Aeronautics and Space Administration, respectively, are acknowledged as possible influences on the timetable for establishing a commercial satellite communications system. ADVENT, an equatorial synchronous satellite, is scheduled to be launched later this year. RELAY, a low-altitude experimental system that will test the effects of the Van Allen radiation belt on solar cells and other components, is due for mid-1962 launching.

RCA notes that both projects should yield highly valuable data and experience that may well affect the course of current and planned industry-government R&D. Moreover GE concedes that its proposed undertaking could be advanced on the basis of the ADVENT program.

Under a Western Union proposal for an industry-carrier type of joint venture, similar to that recommended by GE, NASA would assume a commanding role. In fact, it would be "the final authority on the satellite technology adopted, such as the number and kind of satellites launched."

Interestingly enough, both RCA and Philco have raised the possibility of Defense Dept. or NASA developments providing a direct basis for a commercial system.

IN AID OF SMALL BUSINESS

A Defense Dept. commitment to increase contract awards to small firms by at least 10 per cent in the coming fiscal year is being pursued in much the same way as a sales or production drive in a private company.

The Secretary of Defense has assigned quotas to all major commands responsible for procurement, with a further breakdown by departments and installations. And he's requiring monthly progress reports.

One effort is directed toward increasing the "breakout" of components from large systems for competitive subcontracting. This can be achieved either by breaking out selected components from systems already under contract for direct Defense Dept. procurement or by forcing prime contractors to engage in maximum subcontracting before approving their make-or-buy plans during contract negotiations. The defense agency also has taken steps to provide advance notice on more of its hardware and R&D procurement through the medium of the Commerce Dept.'s daily publication, "Synopsis of U.S. Government Proposed Procurement, Sales and Contract Awards."

NASA likewise has taken steps to reorient procurement in the direction of small firms. One step has been to require prime contractors to submit make-or-buy plans for consideration in contract negotiations. The agency also will make use of the Commerce Dept.'s synopsis to tip off small companies to forthcoming R&D contracts of $100,000 or more. It will list firms that have been invited to submit proposals, so that subcontractors can scout business in advance of awards.

NEWS

Component Firms Warned Of 'Failures' in Assembly

Damaging Units in Subsystem Stage Said to Be Cause of Missile Losses

MISSILE failures often attributed to unreliable components may really be caused by poor handling of the components in the assembly stage, a Lockheed official has charged.

Addressing an Electronic Components Conference luncheon in San Francisco, Clare W. Harris, director of quality assurance and test services at Lockheed's Missiles and Space Div., advised the component makers to check on what happens to their products "after they leave the shipping dock."

"You component manufacturers must engage in some good old-fashioned applications engineering," he said. "Send engineers into the subsystem designer's plant and see how your component is being treated—out of self-defense, if for no other reason. If a missile failure is traced to a malfunctioning component, the component maker may be blamed."

Minimum Handling of Components By Systems Assemblers Urged

Mr. Harris urged that consideration be given to the problem of minimizing the handling of components once they left the plant.

"To help systems assemblers," he said, "component manufacturers should ship their products in packages designed not only to support the units during shipment but also to permit in-package testing on receipt, storage in stock rooms and finally transfer to the production lines."

Other aids to systems assemblers, the Lockheed official continued, might include "reliability specifications for processes," training of systems assemblers by components makers and a rejection evaluation system.

"Systems managers find," he said, "that when a failure occurs, it is always in a black box that has been giving the most trouble during production. The culprit is always the component that has caused the highest rejection rate."

The production line should be stopped right there, Mr. Harris said. "Components application engineers should investigate to see if the unit is being properly applied, and corrective action should be taken," he suggested. "This will be a lot cheaper than a missile failure."

Improper Soldering or Poor Potting May Be at Fault

The causes of failures, Mr. Harris said, include poor handling of components, poor soldering and welding, and the use of poor potting compounds.

"When a module is subjected to 10^{-6} mm of mercury pressure—equivalent to about 130 miles up—any bubble or gas void comes to the surface and outgasses. The potting compound deteriorates and in several cases has shrunk enough to separate terminals, causing a failure," he explained.

"But there was nothing wrong with the components themselves. The systems maker took your very excellent and reliable components and treated them carelessly."

Mr. Harris pointed out that the problem of circuit assembly was fast becoming one of the component manufacturers direct problems.

"You people will note that you're rapidly getting into the circuit business," he said. "With thin-film microcircuitry and chemtronic research coming along so fast, you're going to have to direct your attention to some of the problems that have been plaguing systems designers."

Quality-Control Suggestions Hailed by Component Makers

Reaction to Mr. Harris' address was highly favorable.

One component maker said, "It'll cost money, but we've got to send out field engineers."

Another complained that some projects were highly classified and that while subsystems manufacturers could discuss the application of their products in the entire system, the component maker sometimes ran into a problem demonstrating his "need to know."

The approach, Mr. Harris advised, is to confer with the buyer, but if that doesn't work, discuss the problem with quality assurance personnel.

"We are always very sympathetic to this particular problem," he said. ■ ■

New Mesa Transistor Line Introduced in West Germany

A new line of mesa transistors for use in vhf-fm equipment has been introduced in West Germany by Siemens & Halske A.G.

The frequency ceiling for the transistors is given as 250 to 300 mc, depending on type. The semiconductors have a maximum dissipation of 100 mw at 50 C and 300 mw with special cooling. The collector currents have a maximum of 12 ma.

Additional types now being developed by Siemens & Halske will have maximum collector currents of 50 ma.

The transistor case is 6.5 mm high and 9.4 mm in diameter.

Designers Depending More on High-Voltage Components

Conference Mirrors High-Power Trends in Radar, Dielectric And Induction Heating, Communications, Control Systems

Thomas E. Mount
West Coast Editor

INCREASING USE of high-power, high-voltage equipment was recognized at the Electronic Components Conference in San Francisco by the inclusion of a session on High Voltage Components for the first time.

According to General Chairman Hugh C. Ross, the trend toward high-power radar, dielectric and induction heating devices, power generators and high-power communication and control make high-voltage components more important to the designer than they have been in the past.

Several important developments in this rising field were described at the special session. Reports on solid-state klystron modulators, a nondestructive technique for measuring insulation breakdown, high-voltage dc fuses and special relays for the SAGE system highlighted the session.

Pnpn three- and four-electrode solid-state thyratrons to replace hydrogen thyratrons and thermionic devices like klystron modulators were described by Harry G. Heard of Radiation Inc., at Stanford, Palo Alto, Calif.

For use with line-type pulsers, cascade-pulse generators and klystron circuits, the solid-state modulators have significant advantages, Mr. Heard reported. These include size, weight, low stand-by power, no warm-up time, low forward voltage drop; very high peak-current, short-pulse capability, high reliability and high efficiency.

The most pertinent disadvantages of the devices include high cost, low forward blocking voltage and slow response, he said.

"The availability of solid-state thyratrons enables designers to make a complete system to convert ac power into triggered-pulse power at megawatt peak-pulse-power levels."

A simplified design of a typical 250-kw modulator is shown in an accompanying diagram. According to Mr. Heard, circuit efficiencies are typically 92 to 95 per cent, but "somewhat greater care must be exercised in the design of all-solid-state modulators than vacuum-tube devices, in that holding currents, triggering, signal shape and amplitude, diode junction thermal fatigue, fuse rating and device response time must be considered."

Special problems arise in the use of this modulator since direct output voltages of 350 or 400 cannot be obtained with single solid-state thyratrons, Mr. Heard said. Higher-than-normal turns-ratio pulse transformers are required if output voltages of 5 to 20 kv are needed.

Nondestructive Test Described For Forecasting of Insulation Breakdown

Borrowing from the power-engineering field, G. Leslie Hill of Hill Research Co., Oakland, Calif., told the conference of a technique he has perfected for forecasting the dielectric level of insulation without destroying it.

High-voltage, alternating-current acceptance tests and maintenance over-voltage tests, he said, can damage the insulation under test without the knowledge of the engineer.

"Puncture of the insulation may occur a few seconds prior to and/or at the termination of the 1-minute test period," Mr. Hill reported.

It is generally accepted, he added, that the ac high-pot test is a go or no-go test. "No method of predicting the dielectric strength of the insulation without puncturing it has heretofore been found," he went on.

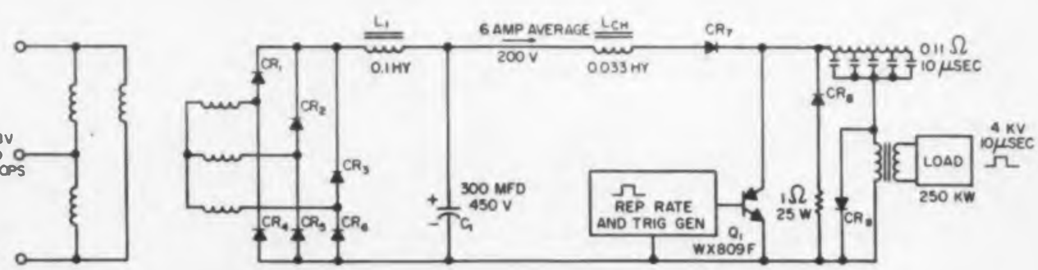
But for several years, Mr. Hill said, power engineers have known of a high-voltage dc insulation test that calls for rectifying increasing increments of ac to dc and applying the dc to the insulation under test.

"By means of a high-voltage voltmeter and a microammeter," he explained, "the voltage applied and the current passing through the insulation are indicated for each increasing increment of impressed voltage."

Plotting the measured values of conduction current through the insulation or the calculated values of megohms resistance against the measured values of applied dc in a suitable system of coordinates permits the indication of dielectric strength of insulation before its puncture. The accompanying graph shows typical curves obtained in this way. Mr. Hill said the dc μa vs dc kv technique was more convenient than the megohms vs dc kv technique.

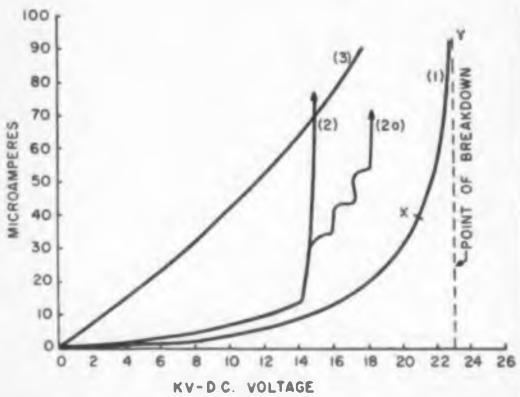
A New, Fast-Acting Fuse For High-Voltage DC Noted

Basic to the high-voltage field are fuses for short-circuit protection, and a new, fast-acting fuse for high-voltage dc was disclosed at the conference. LeRoy H. Franklin of Franklin Engineering Design Co., Palo Alto, Calif., described his company's line of fuses with current ratings from 1 to 32 amp and voltage ratings from 10 to 150 kv dc.



NOTE: CR_1 THROUGH CR_9 ARE IN1205

Simplified diagram of a 250-kw, 360-pps-10 μsec pulse width, all solid-state modulator shows principle of operation. Device can be used to modulc klystron.



Typical curves obtained when testing electrical insulation with high voltage dc show (1) solid homogeneous insulation in good dry condition, (2) faulty insulation, (2a) faulty insulation with a stepladder curve due to voids and (3) insulation in damp condition.

Mr. Franklin asserted that standard high-voltage fuses did not clear under dc conditions until the voltage or current approached zero externally. They cannot be used for such applications as capacitor bank protection, or to insert in the line between a bank of capacitors and a klystron, he said.

The Franklin line was said to offer fast clearing under short-circuit conditions, such as a flash-over, capacitor breakdown, insulation failure or cable failure, and to require only small amounts of energy to blow. Clearing time under high-overload conditions may be as short as 1 μsec, Mr. Franklin said.

SAGE Vacuum Coaxial Relays Described Publicly for First Time

Vacuum coaxial relays for the high-speed, high-power switching that make the SAGE aircraft-detection system possible were described publicly for the first time at the conference.

Ted N. Tilman and Wes N. Lindsay of Jennings Radio Manufacturing Corp., San Jose, Calif., said that vacuum relays for switching any one of 18 antennas in a SAGE system to either of two 20-kw, 400-mc transmitters literally make the SAGE system possible.

The vacuum relays offer several advantages over air switches, Mr. Lindsay told the conference. The high dielectric strength of the vacuum and consequent short gaps permissible between open switch contacts allow switching in 12 μsec at a repetition rate over 30 transfers per sec.

"Vacuum contacts are oxide-free and have very low resistance—between 250 and 500 microhms—and stable contact resistance for indefinitely long periods of time," Mr. Lindsay said. "The shelf life of vacuum contact devices is completely independent of environmental conditions, provided the vacuum envelope is not so seriously attacked as to be perforated."

The basic switch comprises a copper tee switch body with concentric center conductors sealed into the three legs of the tee by vacuum-tight ceramic disc insulators. The connection is made from the common center conductor to the two others by switch blades that move 0.125 in. toward or away from the center conductor.

Early actuators for the relay were simple electro-magnets. These, according to Mr. Tilman and Mr. Lindsay, worked fine at slow speeds, but when overpowered to increase the actuation speed to the 10 μsec leve', led to disaster in the form of bent contacts, bent switch blades and fractured bellows.

Required Input Power Reduced By Spring-Loading Approach

The present actuator is still operated by electro-magnets. The input power needed to obtain high-speed operation has been reduced markedly, however, by spring-mounting the moving parts so that the combination of springs and moving parts tends to oscillate of its own accord with a period corresponding to the desired time of transfer, Mr. Lindsay said. In effect, a large portion of the required actuation power is stored within the mechanism.

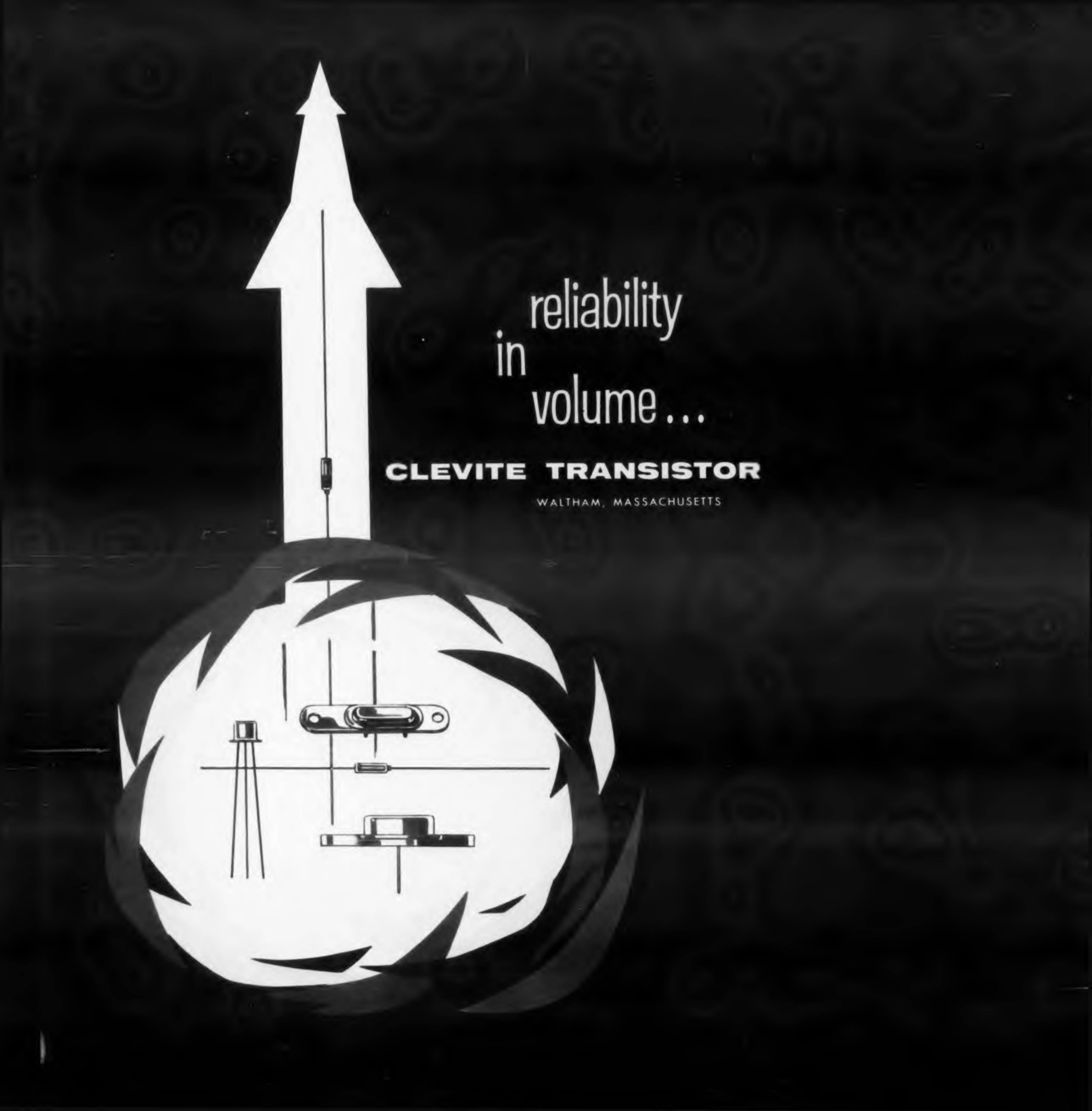
"In the case of a relay design where it is desired to move the contacts from open to closed position in, say, 8 μsec, the oscillation period will be twice the desired transfer time, namely 16 μsec," Mr. Lindsay said. "This corresponds to a frequency of about 63 cycles a sec. For this particular switch, we found by standard methods that a total spring constant of about 200 lb per in. is required to give this resonant frequency."

Owing to the vacuum construction, Mr. Lindsay said, the Jennings vacuum coaxial relay has been tested satisfactorily to 3-megawatts pulse power at an average power of 6 kw at 400 mc. It has also been tested to 20 kw cw at 600 mc at a 2:1 vswr load and at an ambient temperature of 52 C.

No forced-air cooling was used, Mr. Lindsay said. The housing reached a stabilization temperature of 67 C, and the common terminal inner conductor reached 90 C. No ill effects were said to be suffered by the relay.

Mr. Lindsay believes the relay to be unusual in its small size, speed of operation and good electrical characteristics. "Its development brings to the communications engineer a new component for high-speed antenna and transmitter switching in random, simultaneous or sequential systems," he said. ■ ■

CIRCLE 26 ON READER-SERVICE CARD ➤


reliability
in
volume...
CLEVITE TRANSISTOR
WALTHAM, MASSACHUSETTS

How to establish rating values for power transistors

by RICHARD F. MOREY, JR.

Manager, Applications Engineering, Clevite Transistor Division of Clevite Corporation

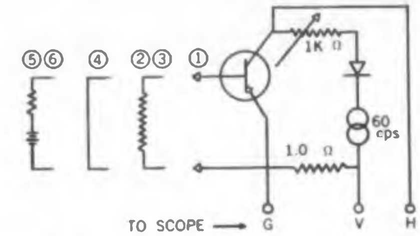
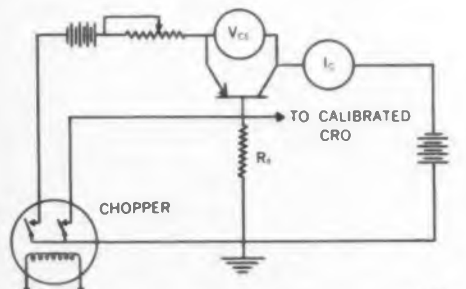


Fig. 2. Collector to emitter voltage test

Every manufacturer of power transistors provides information on the various circuit valves within which a given transistor will satisfactorily perform. These valves or "ratings" are established on the absolute maximum system and are defined so that "the rating values, if exceeded, will cause permanent impairment of the device." Since permanent damage can occur as a result of exceeding rating limits or as a result of an unqualified rating, Clevite Transistor exercises great care in the development of ratings and the proof of their validity.

Clevite places particular emphasis on ratings for junction temperature, power dissipation, collector current, and collector voltage. Each of these ratings is independent and it is not generally possible to approach more than one rating simultaneously. Therefore, specific tests are performed such as "thermal resistance" to establish maximum power dissipation and collector diode leakage current I_{CBO} at both room temperature and high operating temperature to establish maximum rated collector to base voltage. Figure 1 is a diagram of the Thermal resistance test, while Figure 2 indicates the testing configuration for establishing essential collector to emitter voltage ratings.

Other tests are performed to determine collector current and junction temperature. High-temperature-storage life tests to establish maximum junction temperature are further supplemented by Clevite's process of aging transistors at temperatures in excess of the eventual maximum rating.



COLLECTOR CUTOFF CURRENT READ BY CRO AS VOLTAGE DROP ACROSS R_s WHILE CHOPPER IS ON OPEN HALF CYCLE

Fig. 1. Thermal resistance test

Perhaps the most important tests are the collector to emitter breakdown tests ($V_{CES\,(max)}$ and $V_{CEO\,(max)}$) which are used to determine the maximum collector to emitter voltage. Figure 3 indicates a typical germanium power transistor operating in breakdown region. Observe that the bias applied between emitter and base differs for each of the seven curves. This bias differential causes the curves to differ significantly. Curve 1 breaks down sharply at 45 volts, while curve 6 breaks down initially at 118 volts, but upon transversing the curve, the voltage drops and another breakdown occurs at a point slightly greater than 60 volts. Curves 2, 3, 4, and 5 are somewhere between.

Curve 7 is simply the curve of the collector to base diode and is shown here for reference purposes.

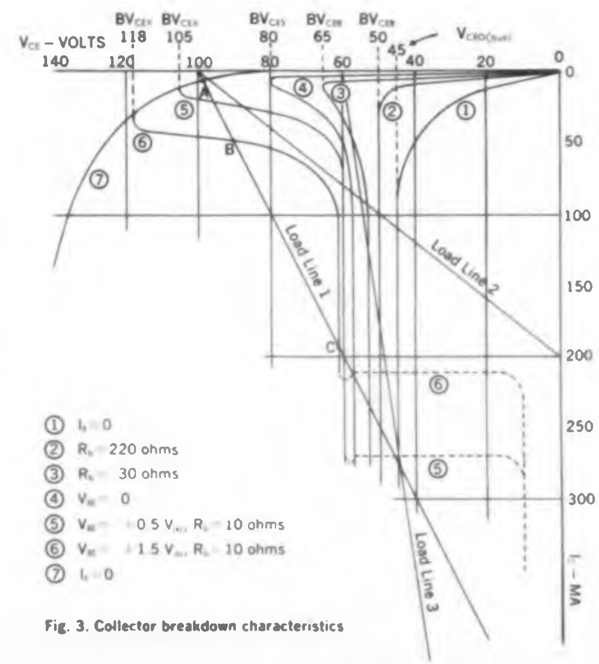


Fig. 3. Collector breakdown characteristics

It may be noted in a particular instance, such as curve 1, that at some voltage (in this case 45 volts) collector current increases without limit. This is the voltage at which collector multiplication causes the overall current gain (alpha) to equal unity.

The remaining curves serve to indicate the effect of a change in bias at different voltage and current conditions.

The tests and data shown here are only a segment of the total program undertaken by Clevite Transistor to assure a continuous high standard of product quality . . . "reliability in volume."

Detailed Technical Data Bulletins are available on all Clevite's Power Transistors and Diodes. To obtain technical information, please request Application Bulletins 1 & 2.

High-Altitude Electron Density To Be Studied at Penn State

A new method of measuring electron densities in the upper atmosphere will be investigated by the Ionosphere Research Laboratory of Pennsylvania State University.

The laboratory will study the feasibility of using a "mother-daughter" rocket system to measure electron densities at up to 1,500 miles into the ionosphere. The method, being tested under a grant from the National Aeronautics and Space Administration, is expected to be particularly valuable in determining the rate at which the local electron density decreases with altitude above the maximum F layer.

In the proposed mother-daughter system, a 15-lb capsule will be ejected from a rocket after burnout of the final stage at an altitude of about 250 miles. The capsule and the main rocket will follow similar trajectories with a maximum separation of about three miles.

Radio-wave velocity measurements will be used to gage the electron density. The ejected capsule will contain three phase-locked radio transmitters operating on 6, 12 and 72 mc, a matching system and an antenna. Signals from this capsule will be received at the main rocket, amplified and compared in phase. The phase differences and signal strengths will be telemetered to the ground from the main rocket. The velocity of the radio waves is dependent on the frequency, ambient electron density and the local values of the earth's magnetic field.

Supplementary instrumentation will provide exact data on the distance between the capsule and the rocket, as well as rotation data required to reduce the measurements to high-resolution information of the ambient electron density.

Breadboard model of 72-mc receiver in main rocket of proposed "mother-daughter" ionosphere rocket.

NEWS

Radio Astronomy Session Slated for August WESCON

A radio astronomy session will be held jointly with the International Astronomical Union at WESCON Aug. 22-25 in San Francisco.

This year's WESCON will also give special attention to the generation, detection and application of coherent infrared and optical electromagnetic radiation, using the latest quantum-electronic techniques.

Authors participating in any part of the technical program are asked to submit papers to WESCON headquarters in reproducible form by July 1.

Missile Checkout Techniques To Help Army Test Aircraft

Electronic checkout techniques similar to those used in missile launchings will be used by the Army to test its aircraft for safety.

Known as Project ALARM (Automatic Light Aircraft Readiness Monitor), the system is under development by Bendix Corp., York, Pa., under a contract with the Army Transportation Research Command, Fort Eustis, Va.

The concept envisions the use of strategically placed sensors to forecast electronically the conditions of critical structural components, thus saving valuable manhours in carrying out maintenance inspections.

Eta Kappa Nu To Honor Leading Young Engineer

The Eta Kappa Nu Association is again searching for an outstanding young electrical engineer to honor with its annual achievement award.

The qualities sought are achievement in the profession, leadership in church and civic affairs, evidences of cultural development and participation in professional activities. Recognition may be all or in part in any field, including industrial, educational, political, research, artistic, athletic, etc.

Eligible engineers must be under 35 by May 1 and must have been graduated not more than 10 years ago from an American college or university with a BS, EE or its equivalent.

Engineers, managers and teachers are being urged to help select candidates by May 31 from among their associates and acquaintances.

Further information may be obtained by writing to W. B. Groth, Chairman, 158 Oakland Ave., Eastchester, N.Y.

FAA to Test 'TV Marker' System That Pinpoints Aircraft in Traffic

A new system to facilitate identification of aircraft by different radar controllers is scheduled for delivery to the Federal Aviation Administration for evaluation this fall.

The system identifies aircraft as control of their movements in a traffic pattern is passed, or "handed off," from one radar operator to another.

Called TV Marker Hand-Off Equipment by its developer, Hazeltine Corp., Indianapolis, the system allows one radar controller to place an identifying number over a particular radar target. The coordinates of this target are translated to controllers of adjacent sectors in a manner that identifies the same target, but on a different radar indicator, or on a different radar system.

Two numerical characters are associated with each hand-off. These are written directly on the radar display and are intended to tell the radar operators which adjacent sector or neighboring facility is initiating the hand-off.

According to Hazeltine, the system should have application at every high-density traffic hub.

Gas Furnace Uses TE Power Source

Electric power from a built-in thermoelectric generator drives the blower in this new gas furnace under test at the C. A. Olsen Manufacturing Co., Elyria, Ohio. The 130-w generator, which converts heat directly into electricity without moving parts, is positioned around the combustion chamber of the furnace. The generator consists of four modules 8/14 in. high by 4-1/4 in. wide by 2-1/2 in. deep, one of which is being installed here. The blower and motor, powered by the generator, are at the base of the furnace.

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Zack Electronics	1	2	3		5	6	Palo Alto, Calif.
Elwyn W. Ley		2				6	Paramount, Calif.
Shanks & Wright				4			San Diego, Calif.
Peninsula Electronics					5		San Jose, Calif.
Denver Electronics	1					6	Denver, Colo.
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Capitol Radio	1					6	Washington, D.C.
Electronic Indus. Sales	1	2				6	Washington, D.C.
Electronic Equipment						6	Miami, Fla.
East Coast Radio	1		3	4		6	Orlando, Fla.
Thurow Distributors	1						Tampa, Fla.
Allied Radio	1	2				6	Chicago, Ill.
Chauncey's, Inc				4			Chicago, Ill.
Newark Electronics	1	2				6	Chicago, Ill.
Melvin Electronics						6	Oak Park, Ill.
Bruce Electronics			3				Springfield, Ill.
Graham Electronics	1	2	3	4	5	6	Indianapolis, Ind.
Radio Supply					5		Wichita, Kansas
P. I. Burks & Co.		2				6	Louisville, Ky.
D & H Distributing						6	Baltimore, Md.
Kann-Ellert Electron.		2					Baltimore, Md.
Radio Elec. Serv.	1				5		Baltimore, Md.
Cramer Electronics	1	2	3	4		6	Boston, Mass.
DeMambro Rad. Sup.	1	2			5	6	Boston, Mass.
Lafayette Radio	1	2	3			6	Boston, Mass.
Radio Shack		2					Boston, Mass.
Radio Specialties		2					Detroit, Mich.
Northwest Radio	1	2		4			Minneapolis, Minn.
Burstein-Applebee		2				6	Kansas City, Mo.
Walters Radio		2				6	Kansas City, Mo.
Interstate Indus. Elec.				4			St. Louis, Mo.
Olive Electronics	1				5		St. Louis, Mo.
General Radio		2				6	Camden, N. J.
Eastern Radio		2				6	Clifton, N. J.
Atlas Electronics	1	2				6	Perth Amboy, N. J.
Federated Purchaser	1	2				6	Mountainside, N. J.
Aaron Lippman & Co.		2					Newark, N. J.
Lafayette Radio	1					6	Newark, N. J.
State Electronics		2		4		6	Whippany, N. J.
Federal Electronics	1	2				6	Binghamton, N. Y.
Acme Electronics		2					Brooklyn, N. Y.
Radio Equipment		2					Buffalo, N. Y.
Wehle Electronics	1					6	Buffalo, N. Y.
Greylock Electronic		2					Kingston, N. Y.
Peerless Radio						6	Lynbrook, L.I., N.Y.
Bruno-New York		2				6	New York, N. Y.
Electronic Center		2				6	New York, N. Y.
Harrison Radio	1	2	3	4		6	New York, N. Y.
Harvey Radio	1	2				6	New York, N. Y.
Lafayette Radio	1	2	3			6	New York, N. Y.
Milo Electronics		2				6	New York, N. Y.
Terminal Hudson Elec.	1	2				6	New York, N. Y.
Higgins & Sheer Elec.		2					Poughkeepsie, N. Y.
Morris Electronics						6	Syracuse, N. Y.
Valley Indus. Elec.		2					Utica, N. Y.
Westchester Electron.	1	2		4			White Plains, N. Y.
Dalton-Hege Radio	1						Winston-Salem, N.C.
Akron Electronic Sup.		2					Akron, Ohio
United Radio	1		3	4			Cincinnati, Ohio
Pioneer Electronics	1					6	Cleveland, Ohio
Thompson Radio		2		4			Columbus, Ohio
Whitehead Radio			3				Columbus, Ohio
Allied Supply	1		3	4			Dayton, Ohio
Srepco, Inc.		2					Dayton, Ohio
Servex Electronics				4			Marion, Ohio
Engineering Supply	1						Tulsa, Okla.
Eoff Electric				4			Portland, Ore.
Television Parts			3	4			New Brighton, Pa.
Cameradio Co.					5		Pittsburgh, Pa.
Radio Parts	1	2				6	Pittsburgh, Pa.
Almo Radio		2				6	Philadelphia, Pa.
Herbach & Rademan	1						Philadelphia, Pa.
Phila. Electronics	1	2				6	Philadelphia, Pa.
Radio Elec. Serv.		2				6	Philadelphia, Pa.
Geo. D. Barbey Co.						6	Reading, Pa.
West Chester Elec.				4			West Chester, Pa.
Electra Distrib.	1	2					Nashville, Tenn.
Engineering Supply	1			4		6	Dallas, Texas
McNicol, Inc.				4			El Paso, Texas
Harrison Equip.	1					6	Houston, Texas
Lenert Co.	1					6	Houston, Texas
Rucker Electronic	1	2	3	4		6	Arlington, Va.
F. B. Connelly Co.	1	2	3	4	5		Seattle, Wash.
Radio Parts			3				Milwaukee, Wis.
Canadian Elec. Sup.	1						Montreal, Que.
Wackid Radio	1						Ottawa, Ont.
Alpha Aracon Radio	1						Toronto, Ont.
Electro Sonic Sup.	1						Toronto, Ont.
Wholesale Radio	1						Toronto, Ont.

CIRCLE 30 ON READER-SERVICE CARD

EDITORIAL

Recognize False Pride: Report Those Failures

Of the hundreds of thousands of different R&D projects currently funded in the United States, many are destined to produce negative results from a utilitarian standpoint. Will such failures be publicized for the benefit of future researchers or will everyone faced with similar questions have to find out for himself—and spend millions of dollars doing it?

Scientists and engineers pride themselves on their apparent open-minded attitude which permits them to abandon a hypothesis if tests prove the assumption wrong. There is also a sense of honor which compels a scientist to publish his findings —if they are successful. What is it, except false pride, that makes researchers, engineers and their organizations hide, or mask, misses and negative results.

Could it be that we are so inured with the philosophy of utilitarianism that we find it evil to discuss something that does not pass the test of utility. Is success equated only with producing something of utility or can it not also be measured in terms of thoroughness and objectivity? Let's have more forthright reporting which assumes that untrue assumptions proved untrue are as valuable and as good as proved true assumptions.

Wanted: A Gold-Plate Special Pot

A common sight in almost every lab is a set-up consisting of a motor-pot-counter-meter. The sound emanating from the set-up is also familiar—running dry gears and clicking counters. A typical conversation between a visitor and the lab engineer goes like this:

Visitor: "Life testing?"

Engineer: "Yes."

Visitor: "I thought it wasn't good design to use pots in equipment that has to have the reliability you are seeking."

Engineer: "That's right, but what can one do?"

Visitor: "Can you buy a good pot? I hear some systems producers are building their own."

Engineer: "I've been tempted to make my own. I can't buy a good enough one."

It seems to us it is high time for an all-out effort on the part of potentiometer manufacturers to make a truly superior, highly reliable unit.

To not rise to this challenge is to lose one's reputation by forfeit. Certainly such an ignoble demise should not occur in this era of scientific achievement.

James A. Lippke

Servos Can Be Designed Corner by Corner

An outgrowth of a lecture for fellow engineers, "Servo in a Nutshell," author Rudisill's advice is aimed at the designer who suddenly finds he must design an instrument servo and wants to know the basic design steps. He rapidly covers the practical "thinking" used by practicing servo designers in specifying components and testing out systems.

John A. Rudisill, Jr.
Bell Telephone Laboratories
Burlington, N.C.

IT IS possible to design and test all the elements of a servo system in terms of "corner frequency."

"Corner frequency" is of course that point (or points) on a db vs log frequency plot where the straight line approximations meet. (See Fig. 1 for definition.) The phase shifts associated with the "corners" are what cause servo stability problems.

The concepts described here can be used for practical servo design and laboratory breadboarding, even without a deeper understanding of the underlying mathematics. These principles are especially useful in complicated servos because they permit the designer to keep his head above the details. The graphical nature of the principles makes them a natural design tool.

Spot the Troublemakers Among the Component Corners

The components around a servo loop can be rated according to the flexibility of their corner frequencies. In Fig. 2, a typical position servo schematic, what are the critical components? The feedback transducer and the error generator can be eliminated because they are not frequency sensitive, at least in the servo's frequency spectrum. In addition, the tach loop will be overlooked for the time being. Of the remaining components, note that the equalizing network and the servo amplifiers are more flexible than the servo motor. It is easy, for example, to construct RC networks with corner frequencies placed over a range of frequencies extending far beyond the spectrum of any electromechanical system.

Amplifiers, though less flexible than networks, are still much more adaptable with respect to corner frequency location than the servo motor.

The servo motor is the least flexible of the components. Despite many fine designs now available, this "necesary evil" of an electromechanical system has definite bandwidth limitations. As a consequence, most of the servo designer's time is spent trying to compensate for the motor's inherently low corner frequency.

Servo components will be described in terms of their corners, starting with the servo motor.

Servo Motor Corner Pinpoints the Design Problem

Fig. 3 shows how the db ratio varies with frequency for the popular two-phase servo motor. The input is the voltage modulation of the motor's control phase and the output is the resulting mechanical oscillations of the shaft.

At low frequencies, the motor acts as a single integrator and the gain falls at 6 db per octave, with the accompanying −90-deg phase shift. But at *(1)* there is a corner determined by the amount of inertia, rotor resistance, friction, and the developed torque. After corner (*1*), the gain falls at 12 db per octave and the phase shift increases to −180 degrees.

As with feedback amplifiers, it is the −180-deg phase shift following the corner which creates the problem. In a closed-servo loop, the shift would cause instability.

The corner frequency of even the best servo motor, when delivering useful power, is unfortunately low. Values range from 0.01 to 50 cps for modern designs with the higher frequency units less capable of delivering torque. Therefore the designer's problem is to work around this corner on the system level. As will be shown, a tachometer loop around the motor is one way of doing this.

Fig. 4 shows the response for a typical servo amplifier. Servo amplifiers are available which produce pure gain with negligible phase shift over the complete servo operating range. To eliminate low frequency corners, direct-coupled amplifiers are used (or as is more common, ac amplifiers are used in conjunction with a carrier frequency).

All amplifiers do have upper corners (*2*) caused by capacitance effects, beyond which the gain drops at 6 db per octave. Since this corner can be designed to be a given amount beyond the motor's corner, it can sometimes be used to good advantage. If not used properly, this drooping characteristic can cause untold problems.

Equalizers, like the servo amplifier, are familiar to all electronic designers. A typical circuit along with its response plot has already been shown in Fig. 1. In a servo system, this type of equalizer would be used as a simple means of introducing corners (*3*) and (*4*) to offset the effects of other corners.

Combining the Elements To Form the System

Stepping from the component level to the system level of analysis is fairly simple with the corner frequency concept. It is merely a matter of adding (or properly combining) the individual responses, which are usually conveniently in series with each other, and then knowing how this will relate to the desired closed-loop response.

Fig. 5 is a brief summary of the familiar feedback amplifier. To the basic amplifier with gain *A*, has been added a feedback circuit E_{fb}, which may be either a gain or loss according to its sign. Since the open-loop gain, *AB*, contains all the elements in the closed loop, but is relatively simple to measure, it is used as the basis of both feedback amplifier and servo design. The loop is broken at a convenient point, usually "*x*," and the test frequencies and voltages are fed into the "*forward*" side of the break and the *AB* response read from the other side.

(Note: It may be extremely difficult to calculate the open-loop gain, *AB*. In many high-performance servos it is even difficult to accurately measure the open-loop gain because of amplifier saturation from drift. Many new servo techniques center about the measurement of open-loop gain under closed-loop conditions.)

Fig. 2 has already shown a servo composed of all the components discussed so far plus a tachometer. The transducer would be a potentiometer (or one of a pair of synchros). The equations for the feedback amplifier will hold for this system. Further, neglecting the tach loop for the time being, the combined response plots of the elements around the loop can be obtained by direct graphical addition.

Fig. 6a (solid line) shows the combined open-loop response for the servo motor and amplifier. The limitation on system frequency response imposed by the motor corner (*1*) is obvious; with the amplifier gain shown, the system would be unstable if the loop were closed.

Tach Modifies Motor Corner to Extend Response

The value of putting a tachometer in an "inner" feedback loop around the motor is that it creates a new "black box" to replace the motor in the main servo loop (see Fig. 2.). This new "black box" has a higher frequency corner.

A tachometer (Fig. 7) has no corner frequency. From a position servo's standpoint, a tachometer is a differentiator (+6 db per octave) which, when in series or open-loop with the motor, reduces the motor's integrations by one level. That is (see dotted line in Fig. 6a), the tach's open-loop effect is to reduce the —6 db per octave slope to 0 db per octave and the —12 db per octave slope to —6 db per octave.

Closing the tach-loop to see what the "black box" means to the system cannot be done by simple graphical addition as for series components; it must be done according to the feedback equations of Fig. 5. Without going into the mathematics involved (since in many cases the closed tach loop response would be found by laboratory testing) the tach adds electrically simulated damping to the motor's own damping. Since the motor damping created the original corner (*1*), the tach's additional damping understandably moves the motor corner out to (*1a*).

Corner (*1a*) falls at the frequency at which the open tach loop (Fig. 6a) crossed unity gain. The

Fig. 1. RC network often used for servo equalizer indicates (in its response curve, below) the relationship between corners (3) and (4) and the phase shifts accompanying these corners. A virtue of this network (for example) is that while corner (3) causes a signal attenuation at higher frequencies, corner (4) brings the phase shift back to zero.

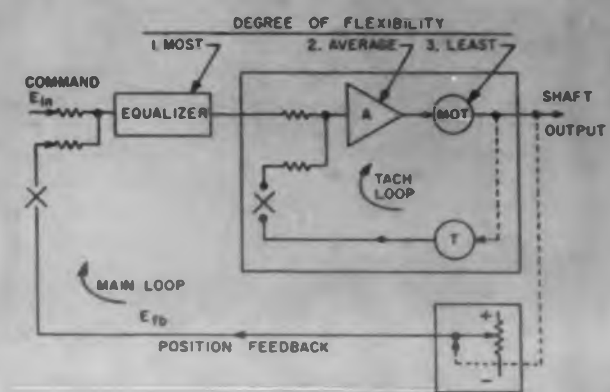


Fig. 2. Position servo's main (outer) loop is limited in bandwidth by the motor's corner until modified by the tach loop.

Fig. 3. Servomotor's corner (1) is important because it is usually the lowest frequency corner in the system and is followed (in a position servo) by a —180 deg phase shift.

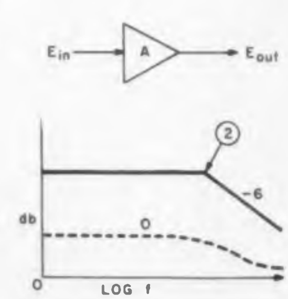


Fig. 4. Servo amplifier corner (4) is usually safely beyond the servo bandpass.

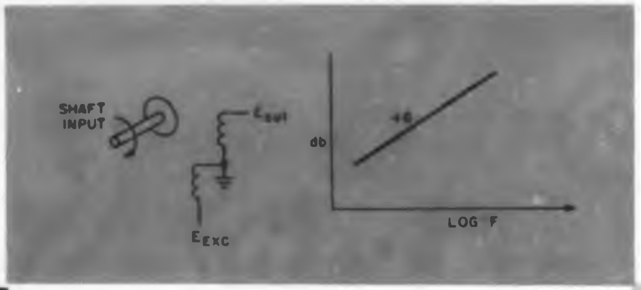


Fig. 7. Tach response is an electrical signal proportional to shaft velocity (which amounts to a +6 db per octave slope with respect to motor shaft position). It does not have a corner.

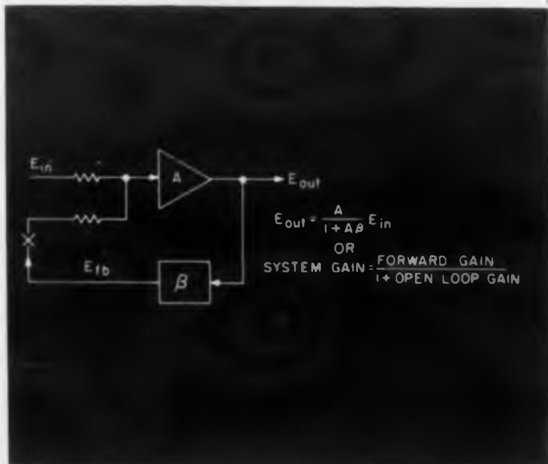


Fig. 5. Familiar feedback amplifier and its equations. The loop is usually broken at "x" for open-loop tests.

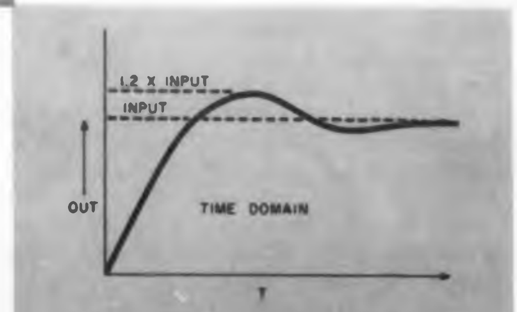


Fig. 8. Output of final should "closed" servo have this shape response for step input.

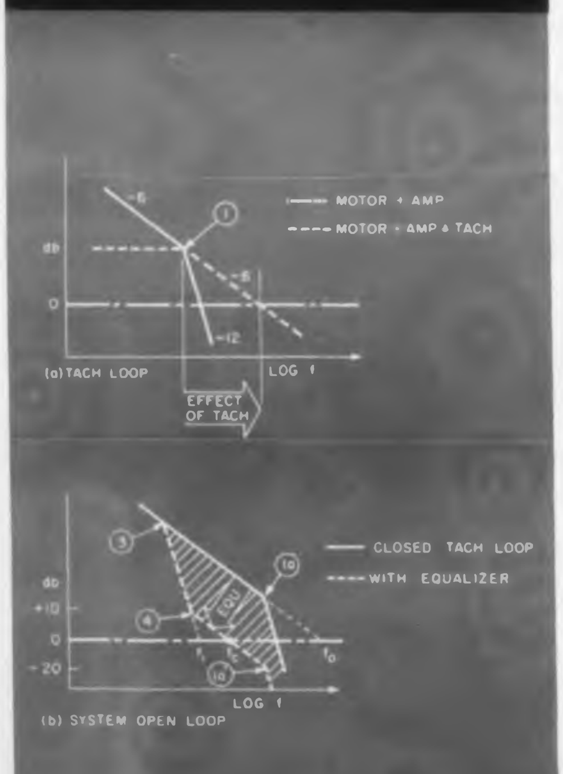


Fig. 6. Progressive juggling of corners (1), (1a), (1a'), (3) and (4) on graphs such as these helps the designer organize his approach to optimizing his system.

reason that the tach can only move the motor corner out to (*1a*) is that beyond this point the tach loop gain is less than 1 and the tach does not receive sufficient signal from the motor to be effective.

But, even though the system's lowest frequency corner has been brought out to (*1a*), the resulting system curve (solid line in Fig. 6b) is still unstable when the amplifier gain is turned up for good low-frequency response.

The addition of the equalizer network's corners, (*3*) and (*4*), solves this final problem. Corner (*3*) lowers the main loop gain (dotted line in Fig. 6b) as the frequency approaches corner (*1a*) while corner (*4*) keeps the gain up at unity gain frequencies so that the open-loop phase angle will not drop too soon to —180 deg.

Corners Can be Juggled to Optimize Final System

The beauty of the corner frequency approach is that the individual curves for the components are relatively easy to obtain, and once in hand, are easy to juggle for the best final system.

The corners for the networks can be obtained by calculations, those for amplifiers by input-output tests, and those for motors from manufacturer's data. The open- and closed-loop responses for the tach and main loops can be obtained by successive laboratory breadboard tests as the servo is built up. These corners should be combined on a single graph (Fig. 6a and 7b) and this graph used as a progressive guide for further system improvements.

Typical design improvements would be shifts of the network corners (*3*) and (*4*) to increase the reliability of the servo with variations in the components due to aging or temperature.

Three points may be picked off the final open-loop curve, Fig. 6b, which can be used by the servo designer as handy figures-of-merit for his system:

- ω_0 — If the initial portion of the open-loop curve is extended to zero db, f_o is obtained. Multiplied by 2π this becomes ω_0, a point which is easily measured and provides a direct indication of system gain. If the rate at which the servo is moving is divided by ω_0, the lag or tracking error is obtained.
- ω_1 — If the straight line between the equalizer's corners (*3*) and (*4*) is similarly extended to the zero db axis, point f_1 is obtained. This is approximately the natural frequency of the servo. Multiplied by 2π, it becomes ω_1, a direct measure of the speed of response of the servo. ($1/\omega_1$ is the minimum time for the servo to respond to an input).
- f_c — The point at which the main open-loop curve itself goes through the zero db axis is f_c, the system crossover frequency. It indicates the upper limit of servo response after the loop has been closed.

Rules-of-Thumb For Adjusting Corners

The following rules-of-thumb are the goals of the working servo designer:

1. ω_0 (or f_0) should be held high by the am-

plifier gain to keep the servo error small.

2. Corners *(3)* and *(4)* should be used to limit the gain at frequencies below f_0. The resulting f_c will be a compromise between maximum band pass and low noise.

3. Corners (3) and (4) along with f_c dictate f_1. f_1 must be kept as high as possible for rapid servo response.

4. The final tach loop corner *(1a)* should occur in the main loop between -10 and -20 db. This will allow for design variations and it will give a phase margin of 30-60 deg at f_c. (Phase margin is the "safety factor" between the system cross-over phase shift and the unstable -180 deg situation).

5. f_c should be 1/10th the tach loop corner frequency *(1a)* to ensure that the phase margin of step 4 is obtained.

It is assumed that the engineer will provide the isolation between the components needed to maintain the straight line relationships described in this analysis. Deviations from the ideal relationships may introduce distortion, jitter, oscillations, slow responses, large errors, and overshoots.

Closing the Loop Puts Analysis Back Into the Time Domain

When the break "x" in the main loop is finally connected, what happens when a step input is applied?

The result is shown in Fig. 8 which is a time domain plot. (The corner plots have been of course in the frequency domain.)

Fig. 8 is what the previous corner plots have been leading up to. Ideally, the output should overshoot the command by 1.2-1.5 times, undershoot, then settle down to the commanded value. Both the overshoot and the undershoot are inherent in a system "tuned" for fast response. (Yet engineers have been known to burn the midnight oil trying to eliminate the undershoot!)

Adjustments to the servo's final closed-loop response may be made through adjustments of the amplifier's gain, the tach loop gain or the equalizer.

An overdamped response (sluggish response) can be cured by increasing the gain or decreasing the frequency of the tach loop corner *(1a)*. An underdamped response (too large an overshoot with subsequent oscillations) can be cured by decreasing the gain or increasing the frequency of the tach loop corner.

Thus by following the concept of corner frequency from component level, through tach loop and equalizer adjustments, to total system, a simple, unified, "working" approach to the design of servo systems has been achieved. ■ ■

A Check List for Design Review

Part 1

Very few of us learn anything new from a check list. But a good check list can help prevent some awfully costly errors. This one was not really created by any one person. It was started in early 1957 by RCA's Airborne Systems Division. Since then it has been revised and refined through use.

The first part, covering Electrical Design, is presented here. The second and concluding part, covering Mechanical Design, Human Engineering, and Value Engineering, will appear in a subsequent issue of ELECTRONIC DESIGN.

Bruce D. Smith, Irving M. Aptaker
Radio Corp. of America
Aerospace Communications and Controls Div.
Burlington, Mass., and Camden, N.J.

A CHECK LIST alone cannot lead to better equipment. But it is a tool that can help designers meet the challenge of making better equipment. In a design review, no attempt should be made to redesign the equipment being reviewed; the primary objective should be to review the design. It should be emphasized, of course, that the design, not the designer, is under review.

For maximum benefits, design reviews should be conducted at the proper times in a design cycle. Reviews should minimize the possibility of repeating errors made in previous designs and, in general, should assure more reliable, reproducible, and maintainable products while minimizing cost of parts, materials, and processes. The following check list should help engineers evaluate and improve their designs.

Electrical Design

Parts Selection and Evaluation

1) Have appropriate standards been consulted for selection of standard electrical components?
2) Can a redesign omit a nonstandard part or replace it with a standard part?
3) What parts are nonstandard?
4) Have nonstandard parts been approved?
5) Have environmental tests been started on nonstandard parts?
6) Have potted circuits been subjected to environmental testing?
7) What are the parts having highest failure rates?

Parts Application

RESISTORS

1) What is operating ambient temperature?
2) What power dissipation is estimated?
3) Is the resistor properly derated?
4) What tolerance limit is required for satisfactory circuit operation?
5) What tolerance buildup (due to temperature, aging, electrical stress, etc.) can be allowed?
6) Has rated wattage been adjusted where short mounting leads are used?
7) Can any potentiometers be replaced by fixed resistors?
8) Has the voltage limit been exceeded on any fixed composition resistors?

CAPACITORS

1) What is operating ambient temperature?
2) What working voltage is expected?
3) Is the capacitor properly derated?
4) Is the capacitor subject to surge voltages that exceed the rated operating voltage?
5) What tolerance limit is required for satisfactory circuit operation?
6) What tolerance buildup can be allowed?
7) What derating factor was used for ac ripple or pulse voltages on MIL-E-25A paper capacitors?
8) Have capacitors with adequate temperature ratings been used whenever possible?
9) Have temperature-compensating or low-temperature-coefficient capacitors (mica or ceramic) been used wherever high stability is required?
10) Have high-dielectric ceramic capacitors been restricted to bypass usage?
11) Are tantalum capacitors bypassed for high frequencies (above 100 kc)?
12) Are all capacitors heavier than 0.5 oz securely mounted in accordance with specification MIL-E-5400, paragraph 3.1.3.5?

TUBES

1) Does the specification of the tube type define the required characteristics?
2) Does the operation of the tube approach any absolute rating under any usual variation of supply voltage or load?
3) What is the operating ambient temperature?
4) What electrode ratings are critical in this application?
5) Is the heater voltage within rating? What variations are expected?
6) Is the heater-to-cathode voltage within rating in this application?
7) Are the plate and screen grids properly derated?
8) What tolerance buildup can be allowed?
9) Has G_m variation been considered?
10) Were maximum grid-resistance ratings observed?
11) What variation in input and/or output capacity can be tolerated?
12) Does circuit operation depend on a tube parameter not controllable by the designer?
13) What is the maximum rated vs maximum expected bulb temperature?
14) Will the circuit perform satisfactorily with randomly selected tubes?—with tubes operating at their upper or lower MIL limits?
15) Have tube-approval data been taken?
16) If a printed-circuit board is used, have adequate cooling measures (convection to cooling air or conduction to a heat sink) been taken to prevent damage to the board or components mounted on it?
17) Have standard tube shields been used?

TRANSISTORS

1) Does the specification of the transistor type define the required characteristics?
2) Does the operation of the transistor approach any absolute rating under any usual variation of supply voltage or load?
3) What is the operating ambient temperature?
4) What is the maximum rated power dissipation? What is the maximum power dissipation expected in this application?
5) What is the maximum rated collector voltage? What is the maximum collector voltage in the present application?
6) What is the maximum rated collector current?
7) What deviation in beta is tolerable?
8) How much deviation in beta is expected due to tolerance buildups?
9) Will the circuit perform satisfactorily with ran-

domly selected transistors?—with transistors operating at their upper or lower MIL limits?
10) What deviation in power gain is tolerable?
11) What deviation in power gain is expected due to tolerance buildup?
12) Is the noise figure tolerable at the operating ambient temperature?
13) How much leakage current is expected at the operating ambient temperature?

SEMICONDUCTOR DIODES

1) Does the specification for the diode type define the required characteristics?
2) What is the operating ambient temperature for each diode?
3) What is the power dissipation within the diode? What is the maximum rated power dissipation?
4) How much reverse recovery time does the diode require?
5) What is the rated peak inverse voltage?
6) How much reverse current can be tolerated?
7) How much reverse current will flow at the operating ambient temperature?
8) Does the circuit perform satisfactorily with randomly selected diodes?—with diodes operating at their upper or lower MIL limits?
9) What Zener voltage reference is required? What Zener reference voltage is expected?

TRANSFORMERS, CHOKES, COILS

1) What is the operating ambient temperature?
2) What deviation in Q can be tolerated?
3) What deviation in Q is expected due to tolerance buildup and to temperature changes?
4) What is the maximum current-carrying capability of the choke or coil? What is the maximum current expected?
5) How close is the highest operating frequency to the resonant frequency of the choke or coil?
6) Has a requirement for shielding been established?
7) When a hum problem exists, has special consideration been given to core construction?
8) Do transformer specifications conform to MIL standards?

RELAYS AND SWITCHES

1) What "quality level" does each relay or switch represent?
2) How many actuations per hour are expected?
3) How many actuations per mission are expected?
4) What per cent of rated current does each contact carry?
5) Is relay closing time or opening time critical? If so, how much increase is tolerable?
6) What are the pull-in and drop-out voltages or currents?
7) What is the manufacturer's tolerance for initial coil resistance?
8) How much change in coil resistance is tolerable?
9) Has arc suppression been used?
10) Has the possibility of dry-circuit operation been considered?

ELECTROMECHANICAL DEVICES

1) Have the adverse effects on brushes at high altitudes been considered?
2) What consideration has been given to variations of dc motor speed-torque characteristics due to temperature and altitude?
3) How critical to proper operation is the speed-torque characteristic?
4) Can the associated circuitry tolerate increased loads caused by variation in motor characteristic?
5) Have appropriate specialists been consulted on the use of rotary solenoids and timing motors?
6) Has the designer depended solely on manufacturer's data for determining the force-movement characteristics of solenoids?
7) Are meter windows sealed to prevent moisture formation?
8) Has the possibility of charge formation on meter windows been investigated?
9) Are resolvers checked for accuracy and phase shift at elevated temperatures?

CONNECTORS AND PLUGS

1) Does the number of active pins per connector conform to the recommended limit?
2) Is a sufficient number of spare pins available on each connector? (At least four spares for connectors over 26 pins per MIL-E-5400C, paragraph 3.1.5.3.)

MISCELLANEOUS PARTS

1) Has the current rating of wire been reduced in cases where voltage drop is important?
2) Is wire color coding required, and, if so, is it in accordance with proper standards or specifications?
3) Has placement of components on printed-circuit boards been considered from the crosstalk point of view?
4) Does a heat-dissipation problem exist on printed-circuit boards?
5) Is a keying scheme employed to prevent interchanging printed-circuit boards?
6) Are transistors, diodes, and tantalum capacitors properly polarized on printed-circuit boards?
7) Are large potential gradients possible between adjacent pins of connectors on printed-circuit boards?
8) Do circuit breakers conform to MIL-C-5989B?

System and Circuit Considerations

1) What variations in input signal can be tolerated? What variations are expected?
2) What variations in impedance presented to the input terminals can be tolerated? What is expected?
3) How does the input circuitry contribute to input tolerances?
4) Is ac-power-supply distortion critical?
5) What percentage of distortion can be tolerated? What is expected? What tests have been performed to confirm the answers?
6) What variation in B+ voltage can be tolerated?
7) What variation in bias voltage can be tolerated?
8) What design features protect the circuit against excessive variations in line voltage?
9) What design features protect the circuit against loss of B+ or bias-voltage supplies?
10) How much change in the assumed cable length of inputs and outputs can be tolerated?
11) Is over-all protection provided against over-load, excessive heating, pressure changes, etc?
12) Do self-test features of a unit meet applicable requirements?
13) What problems were observed when the circuit was tested in conjunction with other units?
14) Has the unit been subjected to environmental testing? What problems were observed with respect to temperature, moisture, vibration, shock, altitude?
15) What alternate circuits or systems were considered?
16) Have "preferred circuits" been used wherever possible?
17) What factors influenced the choice of this particular circuit or system?
18) Are there firm specifications for this circuit, including test specifications?
19) Can any unreasonable or unusually difficult requirement be relaxed?
20) Can a simulation study be of assistance?
21) What marginal testing has been performed? Was marginal operation indicated in any case? What are the critical parameters affecting marginal operation?
22) Have heat runs been made on electrical components which are either thermal emitters or heat sensitive?
23) Have phase-margin checks been performed on all feedback loops?
24) What decoupling or neutralization schemes have been implemented to avoid regenerative feedback loops?
25) What analysis have been made to determine the existence of feedback loops and their effects on other circuits?
26) Is circuit operation contingent on the proper

positioning of more than one switch or control; i.e., are several adjustable components necessary in the circuit?
27) Can any circuits be simplified and still operate within requirements?
28) Can the unit operate satisfactorily after the minimum required warm-up time?
29) What system adjustments are required when a unit is replaced?
30) What means are used to decouple the power supply?
31) What design features have been incorporated to suppress parasitic oscillations?
32) What are the required tolerances on output signals? What are the expected variations?
33) How does the circuitry contribute to output tolerances?
34) Do weight-reduction considerations affect reliability?
35) Have static and dynamic power drains been determined?

Reliability Analysis

1) What is the estimated required mean life of this circuit?
2) What is the calculated mean life?
3) What is the mean life, based on bench or other tests?
4) Is there a history or record of bench failures?
5) Have random-failure rates and wearout rates been established for all parts?
6) What parts have an excessive failure rate?
7) What assumptions were made in calculations with respect to derating and temperature?
8) Are any parts operating near or above recommended ratings?
9) Has a statistical analysis been conducted to determine effects of drift in component parameters and of component-tolerance buildups?
10) Has a fail-safe design philosophy been used?
11) Is protection against secondary failures (resulting from primary failures) incorporated where possible?

Safety Factors

1) Is there adequate protection against dangerous voltages?
2) Are high-voltage warning plates necessary?
3) Have interlocks, safety switches, and grounding bars been considered?
4) Are all external metal parts at ground potential?
5) Are discharging rods necessary to discharge large capacitors?
6) Are bleeder and current-limiting resistors used in power supplies?
7) Are there burning hazards?
8) Are "hot" terminals exposed when plugs or connectors are not connected?
9) Are adjacent plugs or connectors keyed to prevent interchanging connections?
10) Can maintenance or adjustment be performed safely?

Maintenance

1) Are maintenance and test-equipment requirements compatible with the concept established for the system?
2) Does the unit require special handling?
3) Can the unit be readily installed and connected to the system?
4) Are factory adjustments such that they do not require readjustment when units are replaced in a system or when parts are replaced in the unit in the field?
5) What adjustments are necessary after a unit has been installed in the system?
6) Are adjustments capable of compensating for all possible tolerance buildups?
7) Is periodic alignment and/or adjustment recommended? How often?
8) Are all requirements for maintenance tests such that the specified time limitations can be met?
9) Has the number of factory and field adjustments been minimized?
10) Are interconnected circuits in the same package thus providing minimal inputs and outputs at each maintenance level?
11) Is the interaction between adjustments and other circuit parameters minimized?
12) Is the design such that damage to the circuit cannot result from careless use of an adjustment or combination of adjustments?
13) Are all adjustments and indicators of the "center zero" type where possible?
14) Is periodic testing necessary? How often?
15) Are the test points adequate? Are they accessible in the installed condition?
16) What overhaul testing is required?
17) What specific test equipment is necessary?
18) Have factory and maintenance test equipment requirements been minimized and coordinated with the requirements for other units?
19) What special techniques are required in the repair, replacement, or alignment of the unit?
20) Are parts, assemblies, and components placed so there is sufficient space to use test probes, soldering iron, and other tools without difficulty?
21) Are testing, alignment and repair procedures such that a minimum of knowledge is required on the part of maintenance personnel? Can trouble shooting of an assembly take place without removing it from a major component?
22) What special tools and/or test equipment are required?
23) Can every fault (degrading or catastrophic) which can possibly occur in the unit be detected by the use of the proposed test equipment and standard test procedures?
24) Have parts subject to early wearout been identified? Have suitable preventive maintenance schedules been established to control these parts?
25) Are the components having the highest failure rates readily accessible for replacement?
26) Are parts mounted directly on the mounting structure rather than stacked one on another?
27) Are units and assemblies mounted so that replacement of one does not require removal of others?
28) Are limiting resistors used in test-point circuitry; i.e., is any component likely to fail if a test point is grounded?
29) Can panel lights be easily replaced? (Panel lights should not be wired in series.)
30) Have voltage dividers been provided for test points for circuits carrying more than 300 v?
31) Will the circuit tolerate the use of a jumper cable during maintenance?
32) Are controls located where they can be seen and operated without disassembly or removal of any part of the installation?
33) Are related displays and controls on the same face of the equipment?
34) Are all units (and parts, if possible) labeled with full identifying data? Are parts stamped with relevant electrical characteristics information?
35) Are cables long enough to permit each functioning unit to be checked in a convenient place?
36) Are plugs and receptacles used for connecting cables to equipment units, rather than "pigtails" to terminal blocks?
37) Are field-replaceable modules, parts, and subassemblies plug in rather than soldered?
38) Are cable harnesses designed for fabrication as a unit in a shop?
39) Are cables routed to preclude pinching by doors, covers, etc.?
40) Is each pin on each plug identified?
41) Are plugs designed to preclude insertion in the wrong receptacle? Are plug-in boards keyed to prevent improper insertion?

Electrical Interference

1) Do all the provisions of MIL-I-26600 apply, or should some waivers be sought?
2) What tests have been performed for electrical noise?
3) Has the chassis or frame been grounded? Have

shock mounts been bypassed with ground straps? Has the insulated protective finish been removed where a metal-to-metal contact is required?

4) Are openings (such as those for access, ventilation, and case-mounted components) shielded to prevent case leakage? Are access doors of the metal-textile or finger-strip type?

5) Are heaters wired with twisted or isolated leads?

6) Are oscillators isolated from other stages and from antennas? Is oscillator power kept to a minimum? Is the oscillator heater decoupled from B-supply sources?

7) Do parasitic oscillations exist, and is suppression necessary?

8) Is undesired signal transfer reduced by interstage decoupling networks and link or parallel-tuned circuits?

9) Are pulse networks and transformers isolated? Are the leads associated with the pulse networks decoupled? Are these leads kept as short as possible?

10) Is pulse energy fed to succeeding stages in coaxial leads where possible? (Guard against waveform distortion caused by coaxial cable capacitance.)

11) Are sharp projections avoided in high-voltage circuits?

12) Are sharp bends avoided in high-voltage wiring?

13) Are the magnetic fields associated with indicators adequately isolated? Are indicator control and power leads decoupled by the use of feed-through bypass capacitors?

14) Are blower motors of the ac noncommutating type?

15) If it is necessary to use dc rotating equipment, is the design such as to minimize the effects of the commutation process? To this end, does the equipment employ such devices as interpoles, laminated brushes, as large a number of armature coils and commutator bars as possible, and good mechanical design and construction?

16) Is relay or switch operation likely to create power-supply transients in other units or circuits?

17) Has consideration been given to arc suppression during the making or breaking of switches or contacts?

18) Are gas-tube heater supplies and output leads well decoupled and isolated?

19) In power supplies using gas-tube rectifiers, is use made of line filters, electrostatically shielded transformers, and hash-suppression chokes in the plate and cathode leads?

20) Are electronically regulated power supplies provided with decoupling circuits to prevent oscillations in the regulator? Are long leads avoided in the plate and grid circuits? ■ ■

Fluorochemical Cooling for High Heat Dissipation

Fluorochemical cooling, especially when implemented with forced diffusion, can often save an apparently hopeless situation. Werner Drexel, an associate engineer at Sperry Gyroscope Company's Air Armament Div., has had lots of experience in cooling electronic equipment. In most cases, he has found that conventional cooling techniques are perfectly adequate. But there are often situations, especially with airborne equipment and electronic equipment for orbiting vehicles, where the usual techniques are far from adequate.

Werner H. Drexel
Sperry Gyroscope Co.
Div. of Sperry Rand Corp.
Great Neck, L.I., N.Y.

WHERE electronic equipment requires tight packaging and high heat dissipation per unit volume, fluorochemical cooling represents an important step forward. It often allows for space and weight savings that would be impossible with the use of conventional cooling methods and materials. Its advantages are particularly marked in cooling airborne electronic equipment.

How to cool with fluorochemical evaporation and condensation using forced diffusion can best be shown with an example of a typical design. We can take, as an example, a cooling problem with a regulated, high-voltage power supply.

Assuming densely packed equipment for airborne application, one must then cope with intense power dissipation as well as high voltage. It then becomes necessary to use boiling heat transfer and voltage protection with a coolant that offers high dielectric strength.

Such an approach requires a pressure vessel, partially filled to allow room for expansion and condensation. The space above the liquid should be filled with an inert gas to eliminate the vacuum that would result at very low temperatures (−65 F). At such low temperatures liquids have very low vapor pressures.

The coolant selected for such an application should have some of the following fluid properties:

1. Boiling point of about 200 F to permit ram-air cooling.
2. Freezing point below −65 F to permit very-low-temperature operation.
3. Low viscosity, high density, and high volumetric expansion rate to provide good fluid convection.
4. Low surface tension so vapor bubbles boil off the hot surface readily, producing smaller bubbles and promoting nucleate boiling.
5. High thermal conductivity and high specific heat for good heat absorption.
6. Self-healing properties, so liquid and gas will leave no decomposition products as a result of an electric arc.
7. Noncorrosive, nontoxic, and nonflammable properties for the liquid and gas within the temperature range of the equipment.

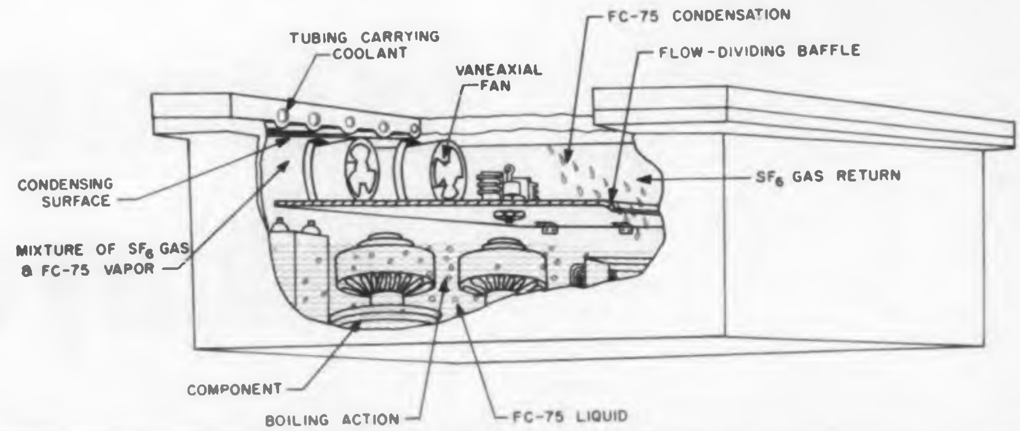


Fig. 1. Typical arrangement for fluorochemical cooling of high-heat-dissipating power supply.

Table 1 compares several fluorochemicals with Coolanol, a widely used transformer oil, and lists some of their important applicable properties. Only the FC-75 liquid meets all the requirements specified for the high-voltage power supply. The SF_6 gas is suitable for filling the space above the liquid in the equipment container. The SF_6 gas may become toxic at temperatures beyond 300 F, but since the electronic equipment cannot tolerate ambient of 300 F, the toxicity is of no particular concern.

Where toxicity does present a problem, Perfluoroethane should be chosen if price and availability can be tolerated. The gas selected to fill the space above the liquid should remain a perfect gas over the entire temperature range of the equipment.

High-Heat Components Below Liquid Level

The power supply to be cooled should be packaged in a pressure vessel. About 40 per cent of the volume of the vessel should be filled with the fluorochemical liquid. The remaining space should be filled with SF_6 gas as shown in Fig. 1. The SF_6 provides the dielectric medium at low temperatures. All the high-heat-dissipating components should be placed below the liquid level.

The heat transfer takes place as follows:

- The FC-75 evaporates due to local boiling at the heat-dissipating components.
- The generated FC-75 vapor is forced to diffuse through the SF_6 gas atmosphere and the SF_6 gas film on the condensing surface.
- The FC-75 vapor on the cover cold plate condenses.
- The heat of condensation is conducted through the cover material into the primary coolant circulating through tubes in the cover.

Low-dissipation components are located above the liquid level. They transfer their heat to the gas-vapor mixture according to convection laws. As a result, the vapor passing such components receives a slight amount of additional heat.

Boiling Mode of Heat Transfer Occurs in One of Two Forms

Boiling is a mode of heat transfer which can transfer millions of BTU per hour per square foot. Two general forms of boiling exist—nucleate boiling and film boiling.

In nucleate boiling, the liquid is in direct contact with the hot surface. The liquid at the surface becomes superheated and remains in this unstable condition till something triggers a phase change. Formation of vapor bubbles is evidence of such a phase change.

The bubbles are born at distinct locations on the hot surface. These locations are called nucleation sites. They consist of microscopic surface imperfections some of which hold entrapped gases. It is believed that one or more molecules of such an entrapped gas starts the formation of bubbles. The entrapped gas usually lasts for many days of continuous boiling, after which the site is dead. Gas may come in contact with the pit again, or new sites may appear, and nucleation may begin again.

Film Boiling Involves Large Temperature Differences

No bubble formation appears in film boiling. Instead, a blanket of vapor covers the entire hot surface. Large temperature differences are associated with film boiling since the vapor film acts as an insulating medium.

The transition region between nucleate boiling is not clearly understood, largely because a steady-state condition cannot be achieved. A decrease in heat flux with an increase in temperature difference is experienced during this transition period. Fig. 2, which plots heat flux vs temperature difference, shows the regions of nucleate and film boiling as well as the transition.

Nucleate Boiling Cools Hot Components

In the cooling system under discussion the components located in the FC-75 liquid dissipate their heat by means of nucleate boiling. The general equation for this heat-transfer mode is:

$$Q = K\,S\,(\Delta T)^n \qquad (1)$$

A component dissipates an amount of heat Q (BTU/hr), and has a surface area S. The terms K and n are constants for a given liquid under a given condition. They are functions of the properties of the liquid and its pressure, and are somewhat dependent on the geometry and surface character of the component.

The term ΔT is the difference in temperature between the component surface and the vapor or liquid. For a typical component immersed in FC-75 liquid, representative values of K and n are as follows: at a system pressure of 26 psig, $K = 18$ and $n = 1.3$; at a system pressure of 8.5 psig, $K = 11$ and $n = 1.4$.

Boiled-Off Vapor Diffuses Through Gas

The boiling action around the components generates FC-75 vapor which escapes the liquid and enters the SF_6 gas region above the liquid. The FC-75 vapor diffuses into the SF_6 gas and is in part carried by the convective flow of the gas. A mixture of condensable vapor and noncondensable gas results. To complete the heat-transfer cycle the generated vapor must condense on the cover surface and return to the liquid. However, in a mixture of vapor and gas, the noncondensable gas hinders the movement of the vapor and impairs condensation. First the vapor must diffuse through the SF_6 gas and then through the SF_6 gas film located on the condensing surface.

As the vapor particles reach the condensing surface, condensation occurs and a condensing film is established. The heat liberated by condensation must be transferred across the condensing film into the cover heat exchanger. Heat is transferred across the condensing film as a function of the heat transfer coefficient, as expressed by:

$$h_c = 0.725\left(\frac{k^3\,\lambda\,\rho^2\,g}{d\,\mu\,\Delta t}\right)^{\frac{1}{4}} \qquad (2)$$

where k = conductivity of condensate, λ = latent heat of condensation, ρ = density of condensate, g = acceleration due to gravity, d = diameter of tubes, μ = viscosity of liquid or condensate, and Δt = temperature difference across the condensing film.

Vapor Diffusion Rate Controls Condensation Rate

After some of the vapor has been removed in the form of condensate, the mixture of the vapor and noncondensable gas near the condensing surface will have a lower concentration of vapor than the main body of the mixture. As the rising vapor diffuses through this vapor-lean layer it is condensed on the cold cover surface.

The rate of condensation is therefore controlled by the rate of vapor diffusion. For steady-state condition the rate of evaporation must equal the rate of condensation. The rate of evaporation sets the pace. The rate of diffusion is forced to adjust itself to the rate of evaporation, a condition that may result in high pressure and temperature.

Free diffusion includes molecular diffusion and thermodiffusion. Molecular diffusion of vapor particles into gas molecules results from the energy level of the vapor. Thermodiffusion results from gas convection.

The basic action of molecular diffusion is described by Fick's Law:

$$W = -D\,\frac{dc_v}{dx} \qquad (3)$$

where W = weight flow of vapor in pounds per unit time per unit cross section, D = the diffusion coefficient in unit area per unit time, c_v =

Table 1. Important Properties of Popular Coolants

Name	Boiling Pt. (F) at 1 Atmosphere	Freezing Pt. (F)	Dielectric Strength at 70 F Relative to Air
Perfluoroethane	—115	*	1.5
Sulphur Hexafluoride (SF_6)	—85	*	2
Freon 115	—39	*	2.8
Freon 11	75	—168	3.1
Freon 113	117	—31	2.6
Freon 112	199	79	—
FC-75	213	—171	7.5
FC-43	350	—87	8.0
Coolanol 45	$>$ 600	$<$ —85	5.4

* Extremely Low.

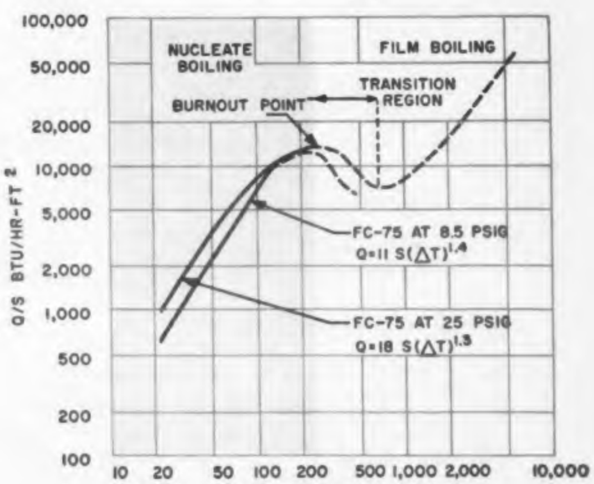
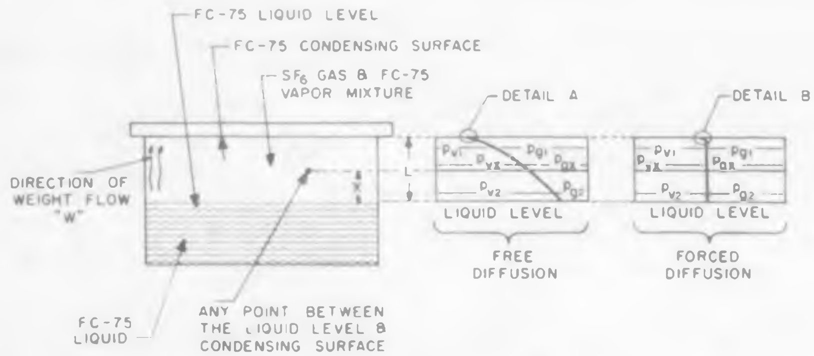


Fig. 2. Heat flux vs temperature difference for nucleate boiling, for film boiling, and for the transistion region.



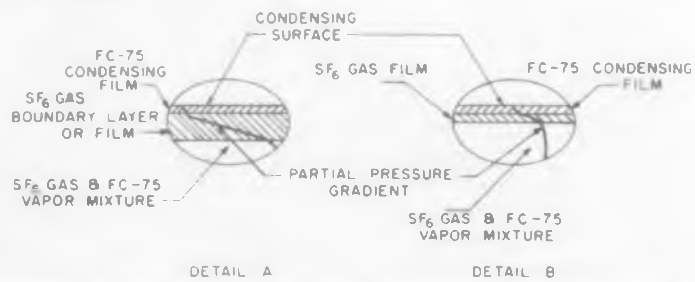


Fig. 3. Partial-pressure relationships in the cooling vessel. The symbols p_{g1}, p_{g2}, and p_{gx} represent the partial pressures of the SF_6 gas at the condensing surface, at the liquid level, and at any point between them, respectively. The symbols p_{v1}, and p_{v2}, and p_{vx} represent the partial pressures of the FC-75 vapor at the corresponding positions.

vapor concentration in lb/ft³, x = a length coordinate.

From the universal gas law, vapor concentration is:

$$c_v = \frac{W_v}{V} = \frac{p_v}{R_v T} \tag{4}$$

so that Fick's Law becomes:

$$W = \frac{-D}{R_v T}\frac{dp_v}{dx} \tag{5}$$

where W_v in Eq. 4 is the mass of vapor in pounds. The molecular diffusion as expressed by Eq. 5 indicates an upward movement of vapor caused by a high partial vapor pressure near the liquid and a low partial vapor pressure near the condensing surface. The partial pressure relationship of the mixture of FC-75 vapor with SF_6 gas is shown in Fig. 3.

Free Thermodiffusion Helps Vapor Rise

The second part of free diffusion, thermodiffusion, occurs with a large temperature difference between the fluid and the condensing surface. This causes a difference in partial pressure which, in turn, causes a mass flow of SF_6 gas in the downward direction since the partial pressure of the gas is higher near the cover (Fig. 4).

Since no gas can leave the container, an equal and opposite upward flow of SF_6 must exist. It is the flow that carries part of the FC-75 vapor. If this upward gas flow is designated v, then the quantity of vapor transported by this upward gas flow will be vc_v in pounds per unit time per unit cross section. The total diffusion will then be the sum of the molecular diffusion and the thermodiffusion as represented by

$$W = \frac{-D}{R_v T}\frac{dp_v}{dx} + v\,\frac{p_v}{R_v T} \tag{6}$$

The basic diffusion expression leads to Stefan's Law, expressed as:

$$W = \frac{-D}{R_v T}\,\frac{P}{P - p_v}\,\frac{dp_v}{dx} \tag{7}$$

For a container with constant cross section, integration of Eq. 7 between $x = 0$ and $x = L$ gives:

$$W = \frac{DP}{R_v T}\,\frac{P - p_{v1}}{P - p_{v2}} \tag{8}$$

where V = volume (in Eq. 4), v = velocity of SF_6 gas carrying FC-75 vapor (in Eq. 6), D = diffusion coefficient, x = distance from fluid to condensing surface in feet, P = total internal pressure of system, R_v = gas constant of FC-75 vapor, T = average absolute vapor temperature, p_{v1} = partial pressure of FC-75 vapor at the condensing surface, p_{v2} = partial pressure of FC-75 vapor at the liquid level, p_v = partial pressure of FC-75 vapor.

Diffusion Rate is Function Of Partial-Pressure Ratio

Eq. 8 shows that the rate of diffusion is a function of the partial pressure ratio. The partial pressure of the FC-75 vapor at the condensing surface is controlled by the temperature of the condensing surface.

However, the partial pressure of the vapor at

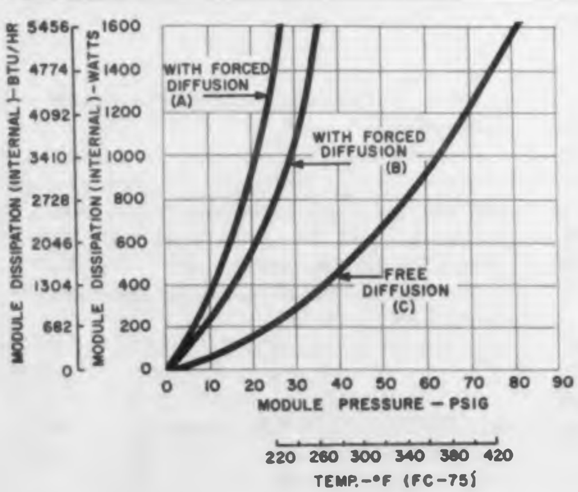


Fig. 4. (Left) Heat-transfer rate as a function of vapor-diffusion rate with FC-75 coolant and SF_6 gas. Curve A is for a polished cover and two vaneaxial fans. Curve B is for a polished cover and one vaneaxial fan delivering 10.5 cfm at 1.5 lb per cu ft at 25 psig. Curve C is for a rough cast over cover with no fans.

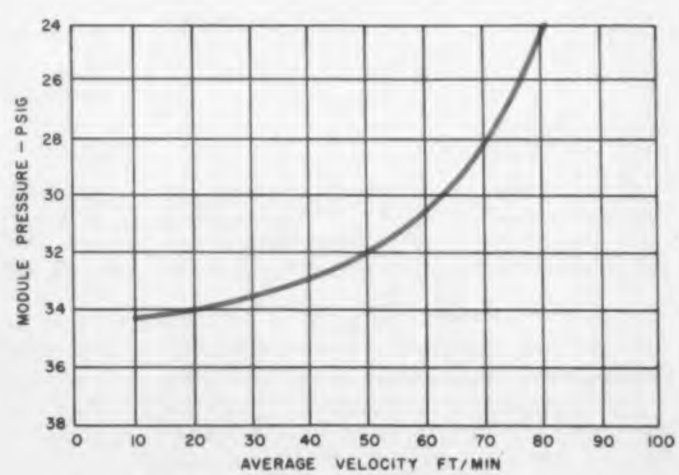


Fig. 5. (Right) Module pressure as a function of vapor-diffusion rate (which is proportional to fan speed).

the liquid level will build up to such a magnitude that it satisfies the partial pressure relationship of Eq. 8. Total pressures can go as high as 85 psi with liquid temperatures up to 440 F. A temperature gradient of 230 F exists from liquid level to condensing surface.

This large temperature gradient causes the initially unsaturated vapor to be cooled as it rises to the condensing surface. The mixture will reach its dew point and the vapor will condense without being in contact with any surface. This phenomenon, "fogging," is undesirable because the heat of condensation must now be absorbed by the SF_6 gas and in turn transferred to the cover by free convection.

Forced Diffusion Necessary For High Dissipation

Since free diffusion is inadequate for high dissipation, it is necessary to force the diffusion. The complete vapor diffusion expression in Eq. 6 consists of the molecular diffusion term

$$\frac{-D}{R_v T}\,(dp_v/dx)$$

and the thermodiffusion term

$$\nu\,(p_v/R_v T)$$

The thermodiffusion term can be manipulated by increasing the gas velocity v by some external means. By doing so, the previous free diffusion becomes forced diffusion with the relationship:

$$W = \nu\,\frac{p_{v1} - p_{v2}e^{\nu L/D}}{R_v T\,(1 - e^{\nu L/D})} \qquad (9)$$

Vane-axial fans with propellers specially designed to handle the high-density gas-vapor mixture can be used to pick up the saturated vapor as it leaves the liquid and to drive it against the condensing surface, forcing the vapor through the SF_6 gas film.

The partial-pressure relationship shown in Fig. 3 indicates that the partial pressure gradient along the distance L (from liquid level to cover) is practically eliminated. Fig. 3 also shows how the thickness of the gas film is reduced.

This reduction decreases partial pressure drop as well as temperature difference. All this results in a lower component temperature.

For example when two vane-axial fans are used, each having a vapor-gas delivery of 11/cfm, the heat transfer can be increased from 17 BTU per hr-F-ft^2 for free diffusion, to 140 BTU per hr-F-ft^2 for forced diffusion. This eightfold increase in heat transfer decreases pressure from 85 to 27 psig with a corresponding temperature reduction from 440 F to 230 F as shown in Fig. 4. A plot of module pressure vs gas-vapor-mixture velocity is shown in Fig. 5 ■ ■

High-Density Electronic Packaging—Resistance Welding

Resistance spot welding, used throughout the High-Density Electronic Packaging (HDEP) program, requires close control of process parameters and special lead materials. The techniques developed for reliable welds are outlined. (The basic philosophy of HDEP was outlined in the April 12 issue and layout procedures described in the May 10 issue).

P. J. Gray, R. Steigerwald, P. N. James
The Sippican Corp.
Marion, Mass.

WELDING is gaining acceptance throughout the electronics industry as a fundamentally sound connection technique that will meet the increasingly stringent demands for ultra-reliable systems equipment. Some of the country's largest electronics interests (Convair, Lockheed, Sylvania, Hughes, General Electric) have established welding programs for use in packaging projects, including High-Density applications. Welding is also readily adaptable to component manufacture and various microminiaturization concepts.

Experimental and production work has demonstrated two outstanding features of the welding process:

- Welding produces a sound electrical joint. A fusion of conductive materials is inherently a better conductor than a bond between conductive interfaces.

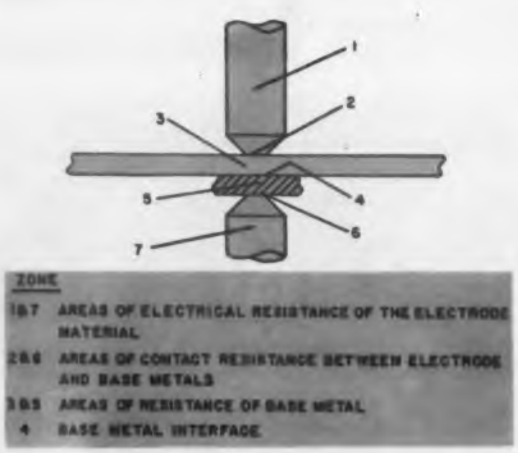


Fig. 1. Seven separate resistance zones encountered in the resistance weld process.

- Welding produces a rugged mechanical joint. Greater unit strength is achieved by a fusion of metals than by a bonding of metallic interfaces.

Problem Areas Particular to Resistance Welding

The main problem in establishing welding as a production technique for electronics is the control of weld variables. Until recently, it has been difficult to define what is acceptable as an electrically and mechanically sound weld, as well as to properly accommodate, via suitable equipment, all of the variables in the welding process. Advances in weld equipment design have resolved the latter phase of the problem, while materials research and establishment of weld margins have evolved a clearer concept of what constitutes a good weld.

Ideally, a welded electrical connection exhibits fusion of the joined materials. The sound fusion process must produce a good diffusion, with no voids, gas pockets, porosity or material expulsion. Fusion can only take place where appropriate materials, proper electrodes, and correct weld heat and pressure values are employed. These factors must be correlated with the melting temperatures and alloying properties of the materials involved.

Joints where the weld is forged or mechanically bonded can, for some types of materials and applications, be classed as acceptable. The use of such "forge welds" is not recommended as a normal procedure because the hot working temperature of metals is relatively hard to define and is a narrow region as compared to the range of melting temperatures. Consistently obtaining the temperatures required for forged welds in the time allotted by a 1- to 2-msec welding pulse is a less tolerant process than obtaining a true coalescence of metals. The further fact that electronic conductor materials force the process to be heterogeneous metallurgically, as well as involving many surface chemistry problems (e. g. oxides), demands that the joint not rely on surface phenomena but penetrate to the region of a true diffusion.

When welding similar materials, i.e., materials with like chemical composition, the weld is performed simply by melting the metals at the interface and allowing the melts to run together and recrystallize. When welding dissimilar metals, the problem becomes more complex. Some metals, such as copper and nickel, alloy in any proportion; other metals, such as lead and aluminum, do not alloy at all, while still other metals alloy only in fixed proportions.

Concerning the best case, that in which metals alloy in all proportions, two major factors must be considered: First, there is usually a relatively great difference in the melting points of the constituents. Copper and nickel have a difference in melting temperature of nearly 700 F; consequently it is somewhat difficult to get them to simultaneously reach their melting temperature when they are in contact. Second, because copper is a much better thermal conductor, it tends to conduct heat away from the nickel, the latter metal having the higher melting point. Therefore, proper heat balance must be insured when attempting this weld.

Welding those materials which do not alloy at all is difficult. A mechanical mixture of metals may be created, but this is usually a poor bond of low mechanical strength and poor electrical conductivity. Therefore, the metallurgy of a weld should be carefully analyzed before proceeding with a metallographic investigation.

In the case of metals which alloy in fixed percentages, it is possible to weld them by maintaining very close tolerances on the weld variables. Again, however, there is the possibility that an alloy has been formed or even precipitated, which can be detrimental to the joint.

The use of cladding in highly conductive materials enables heat to be concentrated in an extremely small area and reduces the heat-affected zone without lessening the strength of the weld. By varying such factors as the electrode material, tip design, heat and pressure, good welds are obtained which demonstrate the characteristics of both high tensile and high peel strength.

While nickel-clad copper has produced a reliable weld with good margins to such materials as heavily tinned copper leads, it still does not answer the ultimate requirement of a single material to bridge between the two basic families of component leads. Therefore, there is still a requirement to use intermediate welds which would not be required if a complete system of compatible leads were available. Investigations are being continued in an attempt to develop new welding materials.

Mechanics of Resistance Welding and Control Procedures

In a resistance spot weld, coalescence is prouced by the heat obtained from the resistance to flow of electric current through the workparts which are held together under pressure by electrodes. In making a resistance weld, current is passed from one electrode through the base material to the other electrode. During this passage, it encounters seven separate resistance zones, as shown in Fig. 1. Zones (*1*) and (*7*) are areas of electrical resistance of the electrode material; (*2*) and (*6*) represent the contact resistance between the electrode and the base metals. This is a point of high heat generation, but due to the high thermal conductivity of the electrode material, the surface of the base metals does not reach fusion temperature. Zones (*3*) and (*5*) are areas of resistance of the base metal itself. Zone (*4*), the base metal interface, is where the weld formation starts. It is the point of highest resistance and, therefore, the point of greatest heat generation. Since the hot spots at (*2*) and (*6*) lie between (*4*) and the electrodes, the heat generated at this interface is not readily lost to the colder electrodes.

Power Supplies: There are two basic types of power supplies, the stored energy type and the ac welders. This latter type welds with ac line current, modulated by the power supply into various pulse configurations. This machine was designed with vacuum tube welding principally in mind, and for High-Density Packaging has a serious drawback due to its long pulse width which allows excessive heat to be transferred to the components. However, it can provide an upslope or preheat cycle which can be used to burn off dirt or oxides.

Stored energy welders of the capacitive discharge type are also employed. In these machines, a charge is maintained on a bank of

Fig. 2. Various sizes and shapes of electrodes are needed for the close work involved with HDEP.

Table 1 • Typical Weld Data

Lead Dimension (in.) & Mat.	Electrode (Lead)	Conductor Dimen. & Mater.	Electrode (Conductor)	Press* (lb)	Heat* (W/Sec)	Pull Test (lb)
	Pincer-type		Pincer-type			
0.018 Kovar (gold flashed)	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	3	6	18.5
O.025 Kovar (gold flashed)	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	3	9	17.5
0.025 Brass (tinned)	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	4	13	15.2
0.021 Ni. (electrotin plated)	RWMA Grp. A, Class 2	0.010 x 0.031 Ni. Rib.	RWMA Grp. A, Class 2	4	22	18.5
0.020 Ni Fe Alloy #42 (gold flashed)	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	3	7	16.9
0.033 Ni Fe Alloy #42	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	4	20	35.0**
0.019 Cu Weld	RWMA Group B	0.020 Ni. Wire	RWMA Grp. A, Class 2	3	11	22.4
0.020 Dumet (tinned)	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	3	10	17.6
0.020 Dumet (gold flashed)	RWMA Grp. A, Class 2	0.016 x0.016 Ni. Clad Cu Ribbon	RWMA Grp. A, Class 2	3	10	9.0
0.016 Cu (tinned)	RWMA Grp. A, Class 2	0.016 x0.016 Ni. Clad Cu Ribbon	RWMA Group B	2	26	9.5
0.025 Cu (tinned)	RWMA Group B	0.016 x0.016 Ni. Clad Cu Ribbon	RWMA Grp. A, Class 2	4	45	10.5
	Vertical-type		Vertical-type			
0.015 Ni.	RWMA Grp. A, Class 2	0.015 Ni. Wire	RWMA Grp. A, Class 2	4	4	9.2
0.015 Ni.	RWMA Grp. A, Class 2	0.020 Ni. Wire	RWMA Grp. A, Class 2	4	5	9.6
0.016 x 0.016 Ni. Clad Cu	RWMA Group B	0.020 Ni. Wire	RWMA Grp. A, Class 2	4	14	10.5

**Limit of test machine.

*These settings apply to specific machines at The Sippican Corp. and may require modification, even for machines of the same model.

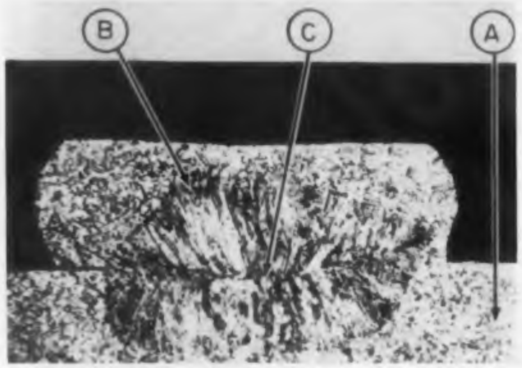


Fig. 3. Photomicrograph showing the areas which should be present in a good weld.

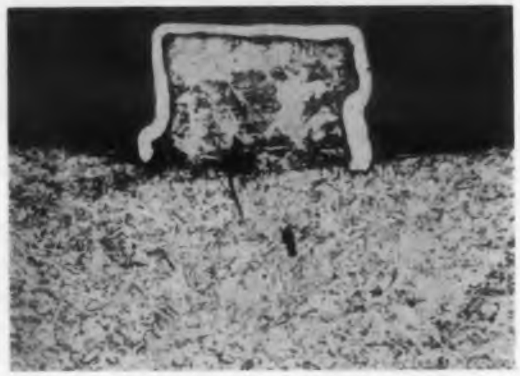


Fig. 4. Photomicrograph showing the effect of insufficient weld pressure.

Fig. 5. Photomicrograph showing the effects of improper heat balance.

capacitors which is discharged through a pulse transformer to create the welding current. Pulse widths of the order of 1 msec can be achieved with these machines, thus avoiding thermal damage to components. These supplies are presently available with capacities from 3.6 up to 500 w sec. Power supply size selection is made in accordance with the weld settings to be used.

Weld Heads: Although manufacturers of power supplies produce small welding heads, most heads are not designed with the requirements of high density packaging in mind. Therefore, several electronic packaging groups have designed special equipment characterized by low inertia, exactly reproducible pressure settings (as measured by an accurate external gage), high electrode-arm stiffness, and a mode of operation which allows the operator to handle the work easily in the normal horizontal reference planes.

Cabling: Since welding pulses are on the order of thousands of amperes, inductive losses in the cabling between the power supply and the head are quite significant. While the exact amount of loss in a particular set-up is not serious, the variations in losses due to difference of cable length and arrangement between stations can seriously affect reliable welding. Cables may be used, if necessary, if they are of specified length and are bound together to minimize these variations; however, rigid bus bars provide the best solution, when accompanied by proper head and power supply design.

Electrodes: There are three basic configurations of electrodes; vertically opposed, pincer, and the vertical and spade type. They are listed in order of desirability from a weld technology point of view; Fig. 2 shows an array of electrodes developed by Sippican.

These configurations utilize several different kinds of electrode tips, including tapered, cylindrical neck, beveled, spade bottom and blunt shapes. Electrodes are generally about two inches long by 1/8 in. in diameter.

Various materials can be used in the composition of electrodes to achieve operating factors such as limited wear, ease of sticking action and low or high conductivity.

Variables in Welding: Aside from operator error, most of the variables encountered in welding are controllable. Such items as heat and pressure are capable of being closely regulated within the limits determined by the design of the welding head and power supply; the degree of regulation can be determined by metallography.

A major factor in the control of variables is the mechanical means by which heat and pressure are applied to the joint. This mechanical arrangement or configuration may be the difference in whether or not a reliable weld can be made.

Vertically opposed electrodes provide the ideal combination from the standpoint of flexing and follow-up and this configuration is used whenever possible. It is used, for instance, in welding of matrices of the large wiring module and the smaller circuit module type. The vertical and spade configuration is often employed where welds are made at the edge of a package.

The pincer electrode configuration was developed: (a) to provide a way to make the welds which must be made from one side, as opposed to being welded through as in a matrix; (b) to allow wiring in more than one direction, and (c) to facilitate operator handling.

Welds of this nature had been done with the vertical and spade configuration, but two major drawbacks were apparent in that the work had to be held in the vertical plane and the operator could not properly view the welds as they were being made. Also, because the electrode and the work piece were in the same plane and necessarily close to one another, it was difficult to get the electrode through the leads which are in the horizontal plane and to add more than one level of wiring at a time.

With the pincer configuration, the work piece is held in the horizontal plane and is viewable. Wiring may be led anywhere without fear of interfering with access to another joint. In addition, this configuration allows welds to be made closer to the surface of the matrix film.

Choosing a Setting: To determine a weld setting for unknown materials, a series of steps is performed:

(a) Thermal conductivity of the materials to be welded is considered first. If the material conductivities are vastly different, then electrodes of equally different conductivities must be employed. If there is a great difference in size between the two constituents, this must also be considered.

(b) The mechanical arrangement is reviewed to insure that the electrodes chosen for the work can be fitted into the configuration desired.

(c) Using this configuration, a series of welds is performed on sample pieces. Heat and weld force are varied in steps of 10 w-sec and 1 lb, and sample welds are made. A "schmoo diagram" is drawn which plots pressure on the ordinate and weld heat on the abscissa.

(d) The upper and lower limits, as derived from the diagram, are metallographically examined to insure a good metallurgical bond. If they prove to be sound, then physical tests are made to obtain a comparison figure for future quality control work. If not sound, a different sample is analyzed. Typical weld data is contained in Table 1.

Analytic Techniques To Analyze Welds

Metallography: The use of metallography as an analytic technique depends largely on experience and interpretation. Even a skilled metallographer can be led astray by having improperly etched or polished a specimen, thereby creating pseudo-defects such as inclusions. Therefore, caution must be exercised in inter-

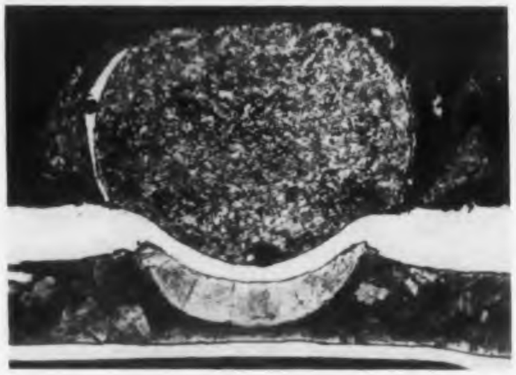


Fig. 6. Photomicrograph showing a nugget contained within a clad section, a result of improper heat balance.

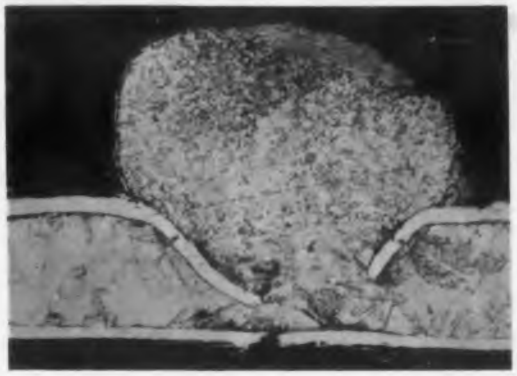


Fig. 7. Weld showing where clad is broken through at interface.

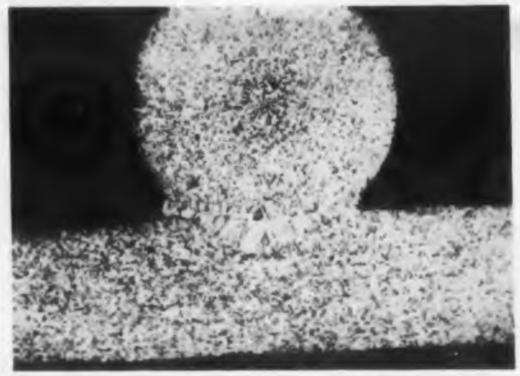


Fig. 8. Photomicrograph showing proper nugget formation between nickel wire and nickel ribbon.

preting metallographic samples.

Typical of the information sought in viewing a specimen are the direct effects of poor control of the welding variables. For example, when welding pressures are insufficient to hold the mating surfaces or the welding interface together, examination will often show that the point of contact between the electrode and the parent metal is a heat-affected zone or even a recrystallized area. On the other hand, too much pressure may be evidenced by expulsion of the weld metal or excessive deformation in the cross-section.

Insufficient heat is apparent from the lack of a fusion zone. Too much heat may cause defects such as gas pockets, porosity or too large a nugget, or possibly a molten zone across the entire width of the two metals to be joined. It must be kept in mind that lowering the pressure effectively raises the heat generated at the interface. Consequently, many of the defects described above are very much dependent on both heat and pressure.

The areas which should be shown in a good weld are outlined in Fig. 3. The area market "*A*" is of parent metal, as it is shown cold worked from the drawing or forming process. Examinaing in toward the weld, the area at "*B*" shows some evidence of being heat affected. The cast structure, area "*C*" is the result of the metal having melted and recrystallized. The dendriticlike appearance is because the metal, in cooling from the outside toward the inside, grows long crystals at an equal rate from both sides, thereby causing a "cast" structure.

The size of the nugget in itself is not a valid criterion for evaluating a weld. A small nugget may often be more desirable than a nugget which encompasses too great a percentage of the area of the weld. This is because the nugget inherently lacks ductility, and the area immediately surrounding it (the heat-affected zone) is likewise relatively brittle. Although the nugget depicted in Fig. 3 appears to encompass about 80 per cent of the cross-sectional area, it is shown in only two dimensions. If viewed from the top, it would be seen that this nugget is also football-shaped in the third dimension, leaving a large portion of ductile parent metal around the weld area. It is, nevertheless, larger than optimum and is used here only to illustrate the appearance of the metal in the areas referred to.

Note that in this weld there is no evidence of expulsion, no gas pockets or inclusions are seen and no defects exist at the grain boundaries in the area surrounding the weld. In physical tests, this weld showed excellent properties.

When metals are heated to melting temperature, they tend to expand. Because the welding pulse is so short, pressure must be maintained when applying force at the melting temperature, or the metal will shrink as it solidifies and create a shrinkage cavity (Fig. 4). This is usually a problem of too little pressure, but when trying to compensate for it by increasing the pressure at the weld, it may be found that as soon as the shrinkage cavity disappears, the situation wherein the metal deforms and expulsion occurs may be encountered. If this happens, a condition is sought where inertia of the welding configuration is reduced.

There are often cases which indicate improper heat balance, i.e., heat sinking through the electrodes (Fig. 5). Proper selection of electrode materials overcomes this condition. Fig. 6 shows a nugget contained entirely in a clad section. Fig. 7 shows the same materials where the clad has broken through the nugget at the interface, indicating proper heat balance. These welds were made with virtually the same energy settings and the same pressure; however, the weld shown in Fig. 7 was made with a large unbalance in conductivity of electrodes.

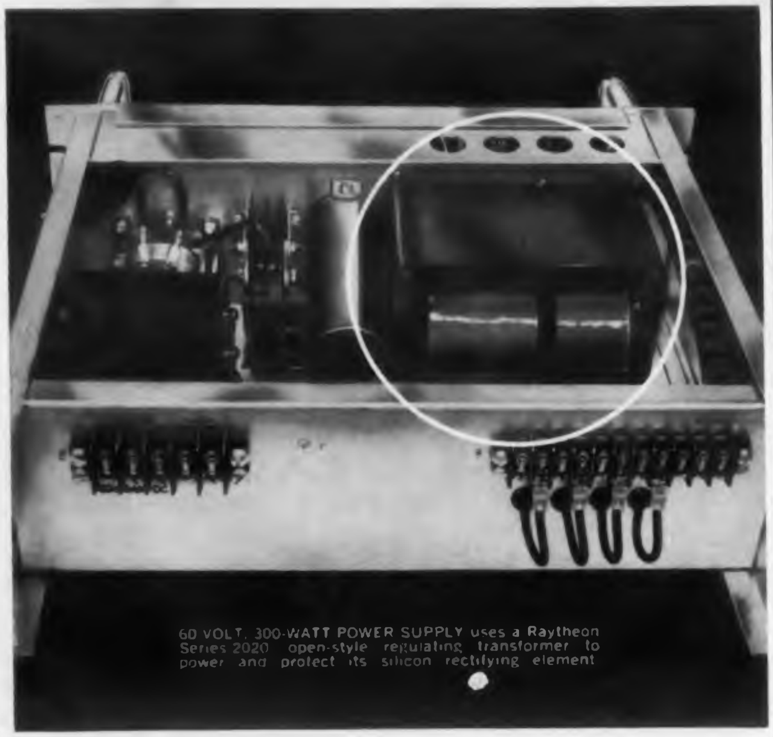
Physical Testing: The physical testing employed in evaluating a weld is used primarily as a quick check and quality control tool. When a sound metallurgical bond is achieved, as evidenced by the metallographic investigation, predetermined sample sizes are used to obtain physical strength data.

To determine physical strength, a "pull test" is employed. In reality, it is a combination tension and shear test. The test is applied in tensile fashion, but due to the mechanical holding problems, a shear stress is imparted to the joint. Because this is probably akin to the stress which may be induced in a weld due to severe mechanical vibration or, especially, to temperature cycling, the test has some validity.

The criterion for accepting results of physical tests, pertinent to weldable base metals, is that the weld must have a tensile strength equal to or greater than the tensile strength of the lesser of the two materials. This is not unreasonable, even in high-tensile materials, because in forming a weld there is a certain amount of cold-working in the parent metal. Cold-working a material does of course, increase its tensile strength while decreasing its ductility; therefore, the unaffected, more ductile parent metal "necks down" under tensile load, and failure occurs at the lesser cross-section.

As stated previously, physical tests are not used as an analytical tool. It is impractical to attempt to qualitatively analyze the alloy or phase metal which is likely to have formed in the weld nugget or at the weld interface. Consequently, there is no means for accurately evaluating what the tensile strength should be. This is the reason why welds are evaluated metallographically, and then sample lots physically tested for average comparison figures.

Environmental Factors: The welding process requires materials which are free of oil, dust and other impurities. All components are ultrasonically cleaned prior to incorporating them in an assembly. Certain materials—brass, for example—must be treated with care to prevent formation of oxide films. ■ ■



Ultra-Fast Switching-Time Meter Reads Six Parameters Simultaneously

A NEW, completely transistorized instrument can measure six transistor switching times and provide simultaneous readout of all six channels of information. The instrument reads delay, rise, fall, turn-on, turn-off, and storage times to an accuracy within 2 per cent ±0.1 nsec.

Manufactured by E-H Research Laboratories, Inc., 163 Adeline St., Oakland, Calif., the instrument can be used to test diodes in most accepted test circuits including the JAN 256 and the IBM "Y." For diodes, it can measure delay time, storage time, stored charge, and turn-on time, as well as forward and reverse recovery.

The switching-time meter, model 140A, can resolve time differences down to 50 psec and can provide all readout information in less than 50 msec. Its front-panel meter can be switched to any of the information channels or individual outputs for each channel, available at the rear of the instrument, can be monitored by separate meters, relays, or other analog devices. Each channel provides 0 to 1 v full scale for each range.

The 140A includes the power supplies and drive circuits needed for any device under test. These include a collector supply, which can deliver up to 20 v and up to 200 ma, and a base-drive pulse generator. The latter is available in two forms to suit various test conditions. It is available as a fast-rise, voltage-pulse generator or as a pure current generator with a rise time of 5 ma per nsec for use in base-charge tests. The width of pulses available from the generator can be reduced from 10 μsec to as low as 0.2 μsec by changing a single timing capacitor.

The component-test socket for the instrument is mounted on a printed-circuit card which is inserted into the front of the instrument. This allows one to change components on a card or to keep several cards on file for different test-circuit types.

Using tunnel-diode discriminators to detect a point of interest on a transient waveform, the 140A measures time differences directly. The instrument starts a gating pulse at the instant that the base pulse arrives at the transistor under test. The amplified output of a tunnel-diode discriminator turns off the gate pulse when the collector goes through a 10 per cent point. The width of the constant-amplitude gate is proportional to the time difference being measured. The measurement is repeated over a few cycles (at a 10-kc repetition rate), integrated, and amplified to yield an analog voltage calibrated directly in units of time.

The 10 per cent discrimination point is established either as an absolute voltage or current level or as a percentage of the collector swing. In the latter mode it is particularly useful in testing transistors not operating to saturation or transistors whose saturation voltage varies over a wide range.

The 140A costs $3,750. It is available on 30-day delivery.

For more information on this fast switching-time meter, turn to the Reader-Service Card and circle 252.

Thermionic Converter Develops 23 W

A VAPOR thermionic converter, operating with 15 to 17 per cent efficiency, provides a power output of 23 w at 1,530 C. Useful life of 10,000 hr steady operation is predicted for the device in applications where seal temperatures can be kept below 500 C.

Pilot production studies by the manufacturer, the Power Tube Dept. of General Electric Co., Schenectady, N. Y., indicate that the device is suitable for production in quantity. The converter was developed to operate in a cathode temperature range of 1,200 to 1,500 C for applications in space vehicles. Power output is 12 w at 1,330 C.

Cesium contained in a reservoir is used to adjust the work functions of the anode and cathode surfaces as well as to create a plasma or interaction space between the anode and cathode. The reservoir is a long, narrow tube, sealed at the tip, extending from the anode side. The tube serves to maintain optimum temperature differential between anode and reservoir; tip temperature is about 300 C, while anode temperature is in the area of 600 C.

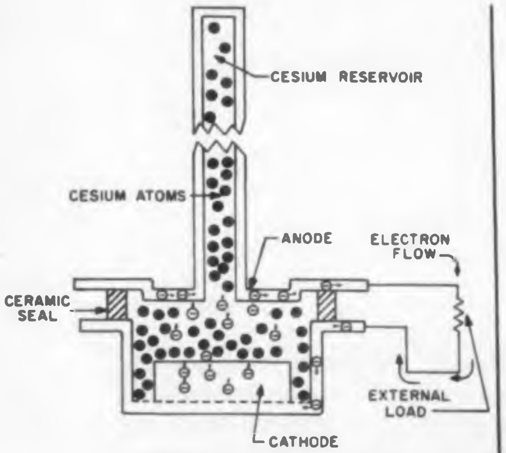


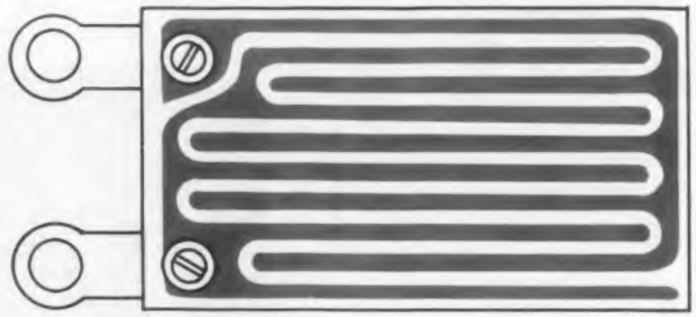
Diagram shows cesium atom and electron flow in vapor thermionic converter. Long reservoir tube serves to drop cesium temperature from about 600 C at anode to 300 C. Cesium vapor collects at far end of reservoir tube.

In operation, a rather small space-charge limited current is drawn between cathode and anode until the voltage applied across the internal cathode-to-anode region is sufficient to cause breakdown or initiation of a hot cathode arc. Breakdown is followed by an increase in current at practically constant voltage up to the point where saturation emission is drawn from the cathode. Depending on cathode-anode spacing and the vapor pressure conditions, there exist a number of electron mean free paths between the cathode and the anode. In this condition a low-voltage arc is formed in the space between the cathode and anode if their contact potential difference is great enough to initiate and maintain a discharge.

Power density of the thermionic converter is 4.6 w per sq cm, or twice that of the best previous vapor converter, and far greater than the 1/2 w per sq cm performance limit of vacuum converters.

The major factor in development of the high-temperature converter is the achievement of a metal-ceramic seal, compatible with cesium vapor for extended periods of time, operating at temperatures up to 700 C. A seal capable of withstanding up to 1,000 C is under development.

For more information on this arc-mode vapor thermionic converter, turn to the Reader-Service Card and circle **251**.



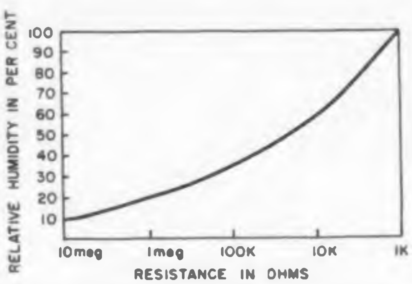
Relative Humidity Sensor Measures Full Range

RAPID and accurate sensing of changes in relative humidity is provided by a single hygrometric circuit element. Surface resistivity of a conducting layer varies precisely over the entire range from 0 to 100 per cent relative humidity.

Under development for some time by Phys-Chemical Research Corp., 40 E. 12th St., New York 3, N. Y., the device is now made available in large quantities. It is useful wherever a readout of relative humidity is necessary, and in the control of humidification and dehumidification equipment.

Substrate material is a chemically treated styrene copolymer, rugged and heat-resistant. A conducting surface layer, integral with the nonconducting substrate, is affected by moisture to a depth of only a few microns. Ohmic resistance of the sensing element varies from 40 megs at 0 per cent to 1,000 ohms at 100 per cent relative humidity. Operating by adsorption rather than absorption, the device has a response time of 30 sec for a 63 per cent change in relative humidity under conditions of no ventilation. Response time is shorter for increasing than for decreasing relative humidity excursions, as water is adsorbed rapidly but released rather slowly; ventilation will improve the response speed.

The sensor is used in a low-level ac circuit, typically in conjunction with a temperature transducer for complete atmospheric control. Supply frequency of more than 20 cps is required for calibration stability. Maximum current is 200 μa; power dissipation is approximately 0.05 w. For elements calibrated at 77 F, temperature coefficient is about 0.2 per cent per degree, linear over a wide range of temperature and relative humidity. Manual or automatic compensation of



Standard characteristic curve shows sensing element resistance change in relation to per cent relative humidity. Curve extends to 40 meg at 0%.

the read-out or control device is necessary only if large temperature variations are encountered.

Standard accuracies of the elements ranges from within ±3 per cent on model PCRC-11 to within ±7 per cent on model PCRC-19. Hysteresis effect amounts to 2-1/2 per cent at the widest deviation point, 50 per cent relative humidity, and can be ignored except in the most critical applications. Circuit compensation for the effects of hysteresis, temperature change, impedance, and response time will provide measurement accurate to within ±1 per cent relative humidity.

The sensor is unaffected by environmental conditions that are not detrimental to polystyrene, allowing operation in most gases and with liquids that are nonionic. Dust settling on the sensor surface will not affect performance beyond a possible slight decrease in speed of response. The absence of surface coatings or emulsions enables the element to operate unaffected by condensation or water immersion.

A military adaptation of the device, model PCRC-M, is manufactured to meet MIL-H-14410 Sig C. It will be used for humidity sensing of the atmosphere in sealed packages.

Dimensions on all models are 7/8 x 1-5/8 x 1/16 in. excluding terminals. Gold-plated solder lug terminals are standard, with other terminal types made to customer specification. Useful life of the device will exceed 10 years with proper usage.

Unit price in quantities of 1 to 5 is $12.50, model PCRC-11, $10.00 for model PCRC-15, and $8.00 for model PCRC-19.

For more information on this relative humidity sensor, turn to the Reader-Service Card and circle 253.

NEW PRODUCTS

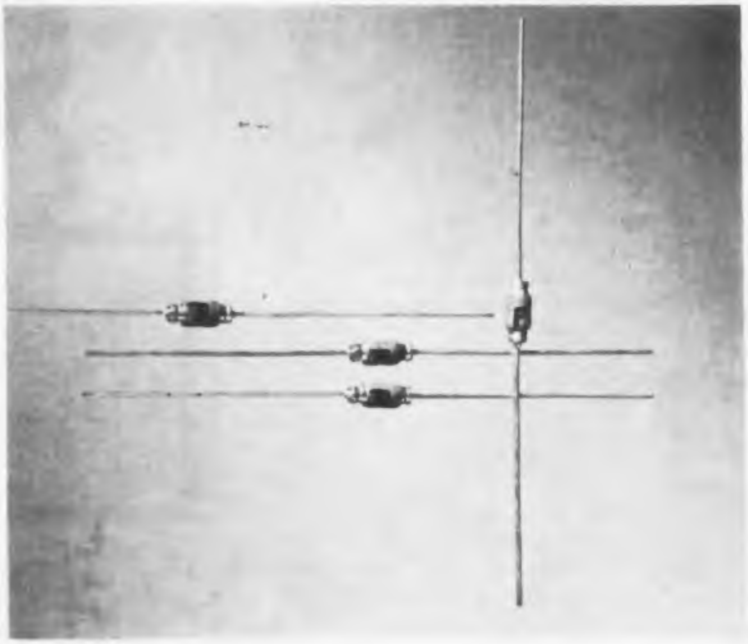
Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Direct-Writing Recorder Accurate to 1/2% 254

Recorder Mark 200 has accuracy of 1/2%; the system offers error-free rectilinear presentation, complete absence of overshoots, and a trace width of 0.010 at all velocities. The eight-channel system has sensitivity of 50 mv per chart line. Push-buttons control eight-step attenuation per channel and the 12 chart speeds from 0.05 mm to 200 mm per sec.

Brush Instruments Div. of Clevite Corp., Dept. ED, 37th and Perkins, Cleveland 14, Ohio.

***P&A:** $8,500; 90 days.*



Silicon Diode Has Improved Characteristics 256

Laminar diode type PS9013 has faster reverse recovery and higher forward conductance characteristics than types 1N690, 1N691 and 1N920, 1N921 which it replaces. Capacitance is 7 pf at 9 v reverse. Forward current at 0.9 v is greater than 500 ma; saturation voltage is greater than 80 v at 25 C. Reverse recovery time is less than 0.2 μsec.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

***P&A:** $4 ea, 100 to 999; immediate.*

Multi-Range DC Voltmeter Offers High Input Impedance 257

Servo-driven dc voltmeter model HV-160 has 100 meg impedance on ranges from 3 mv to 1 v, 10 meg on ranges from 3 to 300 v. Accuracy is 0.15% on 11 selectable scales. Double-regulated Zener reference is used, eliminating reference cells. Indication is provided by knife-edge pointer on a 14-in. mirror scale. Servo gain is automatically adjusted for each scale by the range switch. The instrument may be mounted in case or rack.

Houston Instrument Corp., Dept. ED, P. O. Box 22234, Houston 27, Tex.

***P&A:** $545 to $575; stock after June 1.*

Semiconductor Heat Sink For Bread-Board Use 258

Water-cooled heat sink accommodates most power transistors and rectifiers including those in the diamond-shaped TO-3 case, TO-36 case, and types having 8-32, 10-32, or 1/4-28 mounting studs on nonterminal faces. Semiconductor is clamped to a silver-plated copper sheet. Water flow of 1 pint per min at room temperature will result in typical stud temperature rise of 0.5 C per w. Test leads and clips are furnished.

Owen Laboratories, Inc., Dept. ED, 55 Beacon Place, Pasadena, Calif.
P&A: $35 ea; 14 days.

Magnetic Digital Assemblies Implement Subsystem Construction 255

Magnetic digital circuit assembly series SRA-10 can be used for store, delay, count, time, control, program, and convert functions. There are 18 types, operating over 6 frequency ranges from 0 to 10 through 0 to 750 kc. The 10-bit basic format may be extended. Elements have low power drain. Maximum operating temperature is 70 C for germanium units, 125 C for silicon.

Di/An Controls, Inc., Dept. ED, 944 Dorchester Ave., Boston 25, Mass.
P&A: $163 to $322 ea; stock to 2 weeks.

NEW PRODUCTS

Power Transistors 586

Dissipate 40 w at 25 C. Diffused silicon mesa transistors types 2N2018 and 2N2020 operate at 150 v collector-to-base, 6 v emitter-to-base. Types 2N2019 and 2N2021 operate at 200 v collector-to-base and 6 v emitter-to-base. Operating current range is 50 ma to 2 amp.

Transitron Electronic Corp., Dept. ED, 168 Albion St., Wakefield, Mass.

P&A: $52.00 to $66.00, 1-99; $34.00 to $44.25, 100-999; 3 weeks.

Timing Terminal 584

For tracking systems. The all-transistor model 90,000 receives remotely generated timing signal inputs and provides local outputs for telemetry recorders and associated equipment. It generates 60 v pulses at 200 ma with less than a 5-μsec rise time into 0.1 μf, driving up to 20 lines in various combinations of requirements. Unit operates at ambient temperatures to 65 C.

Vitro Laboratories, Dept. ED, 200 Pleasant Valley Way, West Orange, N.J.

Silicon Rectifiers 587

Piv is 5 to 1,200 v. Double-diffused, axial silicon rectifier handles up to 6 amp. It has a hermetically sealed, insulated body and can be supplied with lugs on both ends or with stud base. Size is 0.425 in. long x 3/8 in. diam. All requirements of MIL-STD-E/1084 are met.

Solitron Devices, Inc., Dept. ED, 500 Livingston St., Norwood, N.J.

P&A: $0.40 to $8.00 ea; immediately.

Power Supply 572

Provides constant current. Solid-state power supply PS-120 has a programed current range of 1 μa to 1 amp. Regulation is 0.2% in the lowest range to 0.1% or better in all other ranges, no load to full load. Line regulation is 0.1% from 105 to 125 v. Ripple is 0.1% or less.

Casa Electronics Co., Dept. ED, 2333 Barry Ave., Los Angeles 64, Calif.

P&A: $1,975; 4 to 6 weeks.

IF Transformers 593

For transistor sets. A complete line of if transformers and oscillator coils offers 4 models in 1/4 x 1/4-in. size and 4 models in 3/8 x 3/8-in. size comprising the input, interstage, output and oscillator transformers. All models are completely shielded and are iron core tuned.

Vidaire Electronics Manufacturing Corp., Dept. ED, 365 Babylon Turnpike, Roosevelt, N.Y.

Gyro 592

For aircraft and missiles. Model 584 has a high gradient, linear inductive pickoff. Output axis bearings are unloaded; damper design obtains a null repeat ability of 0.04% of full scale. Gyros are available with self-checking features and in all-attitude, 3-gyro assemblies. Power is 400 cps.

Summers Gyroscope Co., Dept. ED, 2500 Broadway, Santa Monica, Calif.

Ultrasonic Cleaner 569

For general cleaning. Model SG-3 can be used with tanks up to 8 gallons capacity. It develops a power of 400 w and will operate effectively in fluids up to 400 F. It can also be used as an aid in blending or homogenizing solutions, accelerating organic reactions, removing oxide deposits, and similar processing.

Will Corp., Dept. ED, Box 1051, Rochester 3, N.Y.

Circuit Breaker 571

Rated at 15 to 100 amp. Maximum voltages are 500 ac and 250 dc, with interrupting ratings of 15,000 amp ac and 10,000 amp dc. Three-pole breaker AQB-A101 is a plug-in type for use with single or double mounting blocks, front or rear connected. It is furnished as a thermal-magnetic and magnetic only device. It weighs 6 lb; size is 3-7/8 x 4-1/8 x 6-1/2 in. deep.

Westinghouse Electric Corp., Standard Control Div., Dept. ED, Beaver, Pa.

Silicon Rectifiers 588

Piv is 200 to 600 v. Types 1N1612 through 1N1616 have rectified forward currents of 15 amp at 25 C and 5 amp at 50 C; recurrent peak forward currents of 50 amp at 25 C, and 15 amp at 50 C. Units are temperature cycled 5 times over an 8-hr period from −60 C to 150 C and meet MIL-S-19500/104 (Navy). Units are supplied in welded case with glass-to-metal hermetic seal between case and anode lead. Weight is 4.36 g.

Texas Instruments Incorporated, Semiconductor-Components Div., P.O. Box 5012, Dallas 22, Tex.

Wave-Pulse Generator 583

For digital testing. Model 5SP supplies 2 square wave outputs, 180 deg out of phase from each other and 2 pulse outputs, one positive and one negative. Square wave spacing is adjustable from 2 μsec to 2.5 sec. Pulse width is adjustable from 0.5 to 500,000 μsec, while pulse amplitude can be varied from 0 to 11 v ±1 v. Output can be continuous, or pulsed manually at random. It may be triggered from an external source.

Wang Laboratories, Inc., Dept. ED, Natick, Mass.

P&A: $149.50; from stock.

Delay Lines 545

For coding use. A series of delay lines, made for use in transponders, meets all applicable military specifications. Model D170 has these characteristics: time delay 20.3 μsec, tapped at 1.45-μsec intervals; rise time 0.50 μsec, delay tolerance ±0.05 μsec. Temperature stability is less than 40 ppm per deg C; attenuation is 3 db. Potted in epoxy foam and hermetically sealed, size is 4 x 2 x 1 in.

Computer Devices Corp., Dept. ED, 6 W. 18th St., Huntington Station, N. Y.

Availability: 2 to 3 weeks.

Ultrasonic Cleaner 591

For general cleaning. The system thirty develops a power of 30 w avg and a peak power output of 120 w. It is fused for 2 amp and requires 117 v ac, 50/60 cps. It has a 1-pint capacity, with a working compartment measuring 3-5/8 x 3-5/8 x 3 in. deep. A 220-v, 50/60-cps model is also available.

Ultrasonic Industries, Inc. Dept. ED, Ames Court, Engineers Hill, Plainview, L. I., N.Y.

Price: $69.95

Induction Motor 554

For hydraulic pump. Made for military and commercial applications, induction motor EF-30-1 operates continuously at 5,500 rpm. Power required is 208 v, 400 cps, 3 phase; output is 1 hp, torque 15.3 oz-ft. Motor conforms to military specifications. Weight is 17 lb 15 oz.

General Precision, Inc., Kearfott Div., Dept. ED, Little Falls, N. J.

Snap-Action Switch 547

Rated at 10 amp. Series E33-00A uses a simplified coil spring construction for long life. Overtravel is 0.050 in. min. Rating is 10 amp, 1/2 hp, 125/250 v ac. Case is 1-3/32 x 5/8 x 13/32 in. Switches can be ganged for multiple cam operation. Screw, quick-connect, and solder lug terminals are available.

Cherry Electrical Products Corp., Dept. ED, 1650 W. Deerfield Road, Highland Park, Ill.

High-Temperature Resin 594

Stable from −60 to +280 C. Isochemrez 460 is used for potting, casting, dipping and coating. It is used with the firm's No. 16 harderner and is available in a variety of colors.

Isochem Resins Co., Dept. ED, 221 Oak St., Providence 9, R. I.

Price: *$7.50 for sample kit.*

Power Supply 585

Electronically regulated. Type 132 powers an internal amplifier and one Tektronix letter-series plug-in. The internal amplifier has a frequency response of dc to 22 mc, rise time of 15 nsec, noise level less than 0.5 mv peak-to-peak. Front-panel terminals permit push-pull or single-ended, positive or negative input.

Tektronix, Inc., Dept. ED, P.O. Box 500, Beaverton, Ore.

Price: *$390.00.*

Telemetry Receiver 590

For predetection recording. Type 1450 receiver operates in the 215- to 260-mc band and is fitted with connectors for recorder output and playback input. Function switching is accomplished from the front panel. Frequency is determined by plug-in crystal units or plug-in variable frequency oscillator. Noise figure is less than 8 db. Outputs are provided for signal strength recorder, spectrum display, frequency monitor and video. Power requirement is 117 v ac, 60 cps.

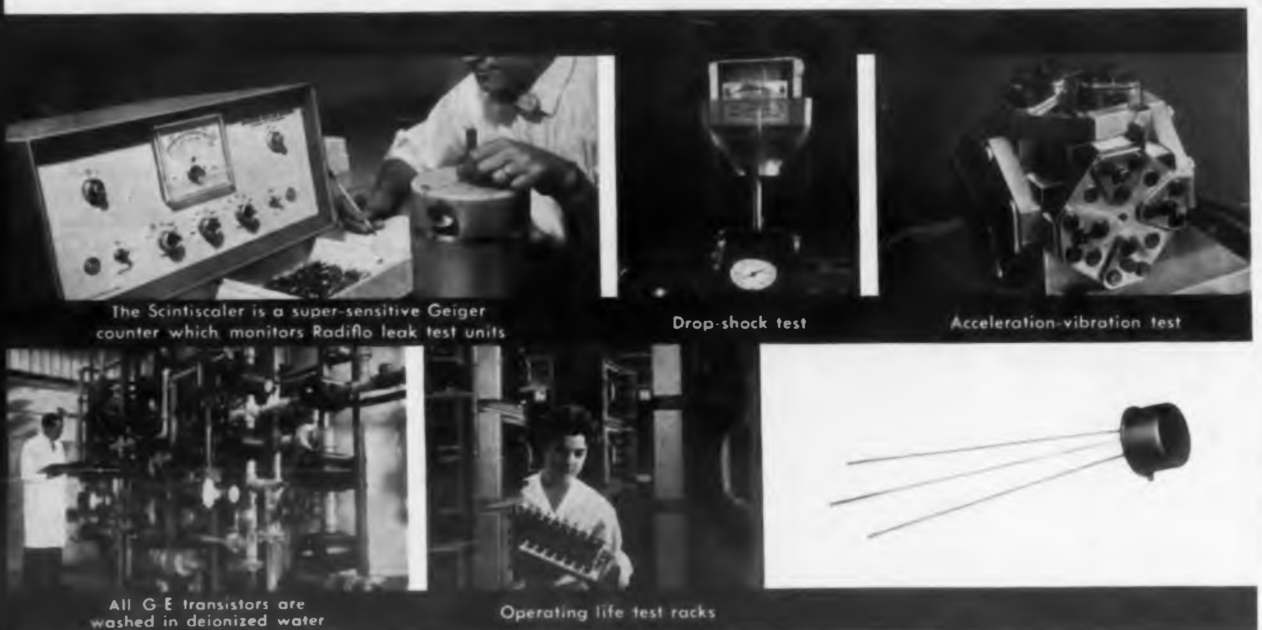
Vitro Electronics, Dept. ED, 919 Jesup-Blair Drive, Silver Spring, Md.

Silicon Rectifiers 589

Piv is 200 to 600. Types 1N2069, 1N2070, and 1N2071 have 750 ma avg rectified forward current at 25 C, and rms voltages of 140 to 420 v. Average rectified current at 100 C is 500 ma, and recurrent peak current at 25 C is 6 amp. Rectifiers weigh 0.5 g and are supplied with standard epoxy encapsulated bodies with silver leads. Ambient operating temperature is −65 to 100 C.

Texas Instruments Incorporated, Semiconductor-Components Div., Dept. ED, P.O. Box 5012, Dallas 22, Tex.

come from General Electric



The Scintiscaler is a super-sensitive Geiger counter which monitors Radiflo leak test units

Drop-shock test

Acceleration-vibration test

All G-E transistors are washed in deionized water

Operating life test racks

G-E spec sheets give you the *complete* story of built-in performance. 2N404, for example, provides the most thorough characterization ever published. And *restrictive life testing* is your assurance of reliability and electrical stability. In addition to dozens of electrical and mechanical tests during production, every General Electric PNP high frequency transistor lot is subjected to a *minimum* of three separate *life* tests before warehouse acceptance, and then sampled again before shipment to you: operating at maximum rated dissipation, storage at maximum rated storage temperature, and room temperature storage. *All* operating life tests are performed under *maximum rated power conditions* with a duty cycle of 50 minutes "on" and 10 minutes "off."

For complete technical information and more of the impressive life test data on the 2N404, 2N396A, 2N428, or *any* of the types listed, call your G-E Semiconductor Products District Sales Manager, or write to Semiconductor Products Department, Section 23E97, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N. Y. 17, N. Y.

FOR FAST DELIVERY OF G-E PNP HIGH FREQUENCY TRANSISTORS AT FACTORY-LOW PRICES, CALL YOUR G-E SEMICONDUCTOR DISTRIBUTOR

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 43 ON READER-SERVICE CARD

Differential Amplifier 487

For low-level signals. Unusually stable gain characteristics are featured in a dc differential amplifier designed for airborne instrumentation. Measuring 1 x 3-1/2 x 5 in., the unit operates from −50 to +70 C with ±1% gain change, or ∓0.2% from 25 to 31 v dc supply.

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

Phase Meter 488

Suitable for field use. Model 1010 phase meter features 0.1 deg absolute accuracy over the entire 0 to 360 deg phase range without ambiguity. Direct reading of phase difference is provided over a frequency range of 30 to 20,000 cps. The rugged unit is useful in test and inspection of polyphase systems, feedback amplifiers, etc.

Maxson Electronics Corp., Dept. ED, 475 10th Ave., New York 18, N. Y.

P&A: $3,990; 30 days.

Constant-Voltage Batteries 489

Complete series is offered. From 17 basic types of mercury cells a wide variety of multiple-cell batteries can be designed to meet various specifications for space, weight, voltage or battery life.

Burgess Battery Co., Div. of Servel, Inc., Dept. ED, Freeport, Ill.

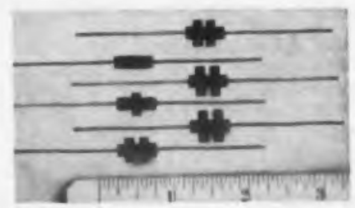
NEW PRODUCTS

Commercial Thermostat 577

Operate to 176 F. Type GP thermostats are enclosed in a polypropylene boot filled with epoxy resin. Bimetal disk thermal element provides rapid, positive action. The UL-listed device is rated for 100,000 cps and will handle 15 amp resistive at 120 v ac.

Stevens Manufacturing Co., Inc., Dept. ED, P. O. Box 1007, Mansfield, Ohio.

Coil-Wound Chokes 573



For military and commercial use. Fixed inductances of six chokes in series 2952 range from 1 to 1,000 mh. Units have good self-resonant frequency and current-carrying capacity. They are useful where environmental stresses are moderate.

Cambridge Thermionic Corp., Dept. ED, 45 Concord Ave., Cambridge 38, Mass.

P&A: $0.34 to $0.53 ea, 100 to 249; stock.

Curve Tracer 574

For diode characteristics. Recording curve tracer model 558 plots forward and reverse characteristics of all diodes, including Zeners, automatically or manually with better than ±1% accuracy. Forward voltage is 1.0 v full

◄ CIRCLE 44 ON READER-SERVICE CARD

scale, with 5 forward current ranges from 0.5 ma to 50.0 ma per in. There are 7 reverse voltage ranges from 1.0 to 100.0 v per in. and 3 reverse current ranges of 1.0, 10.0 and 100 μa per in. Diodes are protected from high reverse currents. Panel height is 21 in.

Aerotronic Associates, Inc., Dept. ED, Contoocock, N. H.

Transducer 581

For angular position. The model GM 9060 includes transformer and rotary-to-linear converter in the same housing. It has a temperature range of −65 F to +300 F. Linearity is ±0.5%; sensitivity 5 v full scale; input 26 v at 400 cps; phase shift 3 deg max with an external capacitor. Transducers in this series are available with full scale displacements from ±40 deg to ±10 revolutions or more.

Vinson Manufacturing Co., Dept. ED, 8044 Woodley Ave., Van Nuys, Calif.

Power Supply 575

Eliminates storage batteries. Models BE-6 and BE-12 are designed for use with electromedical instruments. The BE-6 supplies a 6-v dc output at 1 amp max. Line regulation is 0.05% for 100 to 125 v ac input and ripple content is less than 1 mv rms. The BE-12 supplies a 12-v dc output at 1 amp max, with a line regulation of 0.02% and ripple voltage less than 2 mv rms. Both models feature automatic recovery from short circuits and overloads.

The Waters Corp., Dept. ED, P.O. Box 288, Rochester, Minn.

Price: $135.00

CIRCLE 45 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Cable Tester 544

With digital readout. Cable tester model 50 measures resistance to 0.1 ohm for continuity and up to 100 meg for leakage. Sequencing is manual or automatic, 1 circuit per sec. Tester handles 50 or more conductors. The accepted or rejected wire is identified through a clear digital readout.

Automation Dynamics Corp., Dept. ED, 255 County Road, Tenafly, N. J.

Body for Vacuum Tubes 595

Uses high alumina. Designated Body 207, the material is suitable for use in high-power, high-frequency vacuum tubes. It has a high mechanical strength and a high dielectric constant.

Centralab, Electronics Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Tape Reader 596

Capacity is 500,000 bits. Model 90 photo-electric tape reader is suitable for on-line use in computer, communication and control applications. It accommodates 5, 6, 7 and 8-level codes punched 10 holes per in. Tape speeds up to 80 ips can be furnished.

Cook Electric Co., Data Stor Div., Dept. ED, 2700 Southport Ave., Chicago 14, Ill.

Variable Resistors 597

Power rating is 3/4 w. Series 300 resistors now have a resistance range of 250 ohms through 2.5 meg. They surpass MIL-R-94B style RV 6 in moisture resistance and thermal cycling. A metal-ceramic heat sink provides full power rating at 70 C with derating to zero at 150 C.

CTS Corp., Dept. ED, Elkhart, Ind.

Multi-Range Recorder 598

Chart speed is to 8 ips. The recorder has four groups of four points with any group on these ranges: 1, 2, 5, 10, 20 or 50 mv dc. Each group has a separate zero suppression circuit with a range of ±50 mv in steps of 1 mv. All equipment is contained in a portable cabinet.

The Indikon Co., Dept. ED, 76 Coolidge Hill Road, Watertown 72, Mass.

Computer 546

Lists 91 instructions. Packaged in an office desk, computer 160-A is useful for general data processing. It has a magnetic core memory of 8,192 twelve-bit words, buffered input and output, and program interrupt. Memory can be expanded in modules up to 32,768 words. A variety of peripheral equipment can be added.

Control Data Corp., Dept. ED, 501 Park Ave., Minneapolis 15, Minn.

***Price:** $90,000; lease, $2,250 per month.*

Telemetering Preamplifier 599

Range is 225 to 260 mc. For the transmission of meter or gage readings to remote locations, model 3010 has a noise figure of 4.5 db avg and a gain of 20 db min. It is available in an rf chassis without power supply, in rack and panel design with power supply, or in a weatherproof case.

Community Engineering Corp., Dept. ED, 234 E. College Ave., State College, Pa.

Cabinet Fastener 600

Single-hole mounting. The grip is in increments of 0.06 in. Having push-button operation, the device provides rapid access to panel assemblies, cabinets and components.

Camloc Fastener Corp., Dept. ED, 61 Spring Valley Road, Paramus, N. J.

Electrolytic Copper Foil 601

Standard thicknesses offered. It is produced in a continuous strip 78 in. wide on hard surface drums. It has maximum bond strength when cured to plastic boards and is compatible with all commercially used adhesive systems.

Clevite Corp., Dept. ED, 540 E. 105th St., Cleveland 8, Ohio.

Time-Delay Relays 602

Accuracy is ±3%. The T series relays have preset delays of 0.1 to 300 sec and fast recovery. Having no moving parts, they stand 20 g vibration at 2,000 cps and 50 g shock. Input is 22 to 32 v dc. They meet military specifications.

Curtiss-Wright Corp., Electronics Div., Dept. ED, 35 Market St., East Paterson, N. J.

CIRCLE 861 THRU 869 ON READER-SERVICE CARD ➤

New miniature ceramic trimmer—the smallest ceramic disc trimmer on the market • Style 538—3/8" diameter

Ideal for missile and other high temperature applications, this 3/8-inch diameter trimmer operates through a temperature range of −55°C to +125°C.

ERIE's new Style 538 is designed for printed circuitry as well as conventional circuitry.

CAPACITANCE: NPO; 2pf-8pf and 5.5pf-18pf   N500; 3pf-10pf and 8pf-25pf
N300; 2.5pf-11pf and 7pf-25pf   N650; 3pf-10pf and 9pf-35pf

WORKING VOLTAGE: 200 VDCW

ALSO AVAILABLE: ceramic trimmers with capacities ranging from 1.5 to 50 pf; custom designed assemblies containing up to 25 or more trimmers (for printed or conventional circuitry); and self-locking ERIE tubular trimmers in ceramic and high temperature polystyrene dielectrics.

Circle 861 on Reader Service Card.

NEW additions to the line of ERIE ELECTRONIC COMPONENTS

New Erie Gold Seal Button® mica capacitors the world's finest UHF capacitor

At 200°C, this exciting new capacitor far exceeds requirements of MIL-C-10950. Finest in design and quality to assure maximum freedom from internal contamination. Welded full-hermetic seal plus gold-plating assure maximum conductivity and resistance to leakage even under the most severe environmental operating conditions. Operates perfectly at temperatures from −55°C to +200°C at 500 VDCW. Capacities: 15pf to 2500pf.

Also standard ERIE BUTTON MICA CAPACITORS in capacities from 5pf to 8200pf. Wide range of stand-off and feed-through types, mountings, and styles. Exceed MIL-C-10950 specs.

Circle 862 on Reader Service Card.

New miniature radial-lead tubular Ceramicons®

Two recent additions to the wide variety of ERIE's radial-lead capacitors are Style 374 and 375.

Style 374 is an enamel coated capacitor only .320" long and .125" diameter.

Style 375 is a dipped phenolic coated capacitor only .330" long and .140" diameter.

Both styles are available in the full range of Temperature-Compensating and Hi-K dielectrics.

Capacitance: 2pf—5600pf

Working Voltage: 200 VDCW

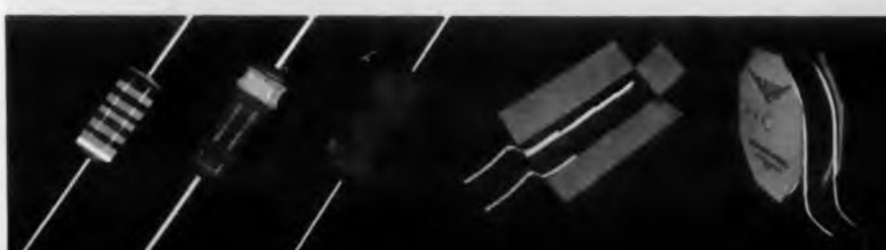
Circle 863 on Reader Service Card.

Erie Axial-Lead Tubular Ceramicons®

Seven types available: 309, 310 (lacquer-coated), 312 313, 314, 315, and 316 (molded). Full range of Temperature-Compensating and General Purpose dielectrics, with capacitance range from 0.5pf to 0.01mf. Operate in −55°C to +150°C ambient range.

FOR AUTOMATED ASSEMBLY methods, all axial-lead CERAMICONS can be supplied in reel or ribbon pack, as well as in bulk pack. Exceed MIL-C-20 and MIL-C-11015 specs., EIA RS-198, RS-165, SMC-1 and ERIE high-reliability spec. 900 where applicable.

Circle 864 on Reader Service Card.



Temperature-Controlled Ovens 849

Have stability to ±0.003 C. A complete line of 87 different design temperature-controlled ovens to hold crystals, diodes, transistors and other electronic components has stabilities to 0.003 C. They meet MIL specifications. Special ovens with or without modifications are available.

Monitor Products Co., Dept. ED, 815 Fremont Ave., South Pasadena, Calif.

Tape Reader 543

Rate is 1,000 characters per sec for scanning. Model 322 handles 5, 6 or 7-level formats. A parity check assures accuracy. The unit is especially designed to detect genuine perforations, distinguishing them from oil spots.

Radio Corp. of America, Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

Nonlinear Potentiometer 848

With six taps and 10-deg separation between each, the 200-M46 is available in these values: 100, 200, 500 ohms; 1, 2, 5, 10, 20, 50 and 100 K. Standard tolerance is ±5%. Case is 1 in. long and 2 in. in diameter.

Maurey Instrument Corp., Dept. ED, 7917 S. Exchange Ave., Chicago 17, Ill.

Brushless Alternator 850

For airborne applications. Electromagnetically excited brushless alternator has a 1-piece rotor design, eliminating rotating windings, rectifiers, and slip-rings, limiting cooling requirements to the stator. Gas or liquid may be used for cooling. With a weight of about 2 lb per kva, harmonic distortion is 3-1/2% max.

Thompson Ramo Wooldridge Inc., Tapco Group, Dept. ED, 1845 E. 30th St., Cleveland 14, Ohio.

CIRCLE 47 ON READER-SERVICE CARD ▶

◀ CIRCLE 861 THRU 869 ON READER-SERVICE CARD

NEW PRODUCTS

Static Frequency Changer 558

Output is 48 to 90 cps, fixed or variable power for loads of 0 to 4 kva. Input is 115 v at 400 cps, three phase. Model SV-1 complies with MIL-E-5400 and uses silicon semiconductors throughout. Frequency stability is ± 1 cps.

Kidde Electronic Laboratories, Walter Kidde & Co., Inc., Dept. ED, 9 Brighton Road, Clifton, N. J.

Nuvistor Tubes 580

For critical applications, type 7587 ceramic-and-metal tube is 1/3 the size of a conventional tetrode. Able to resist shock and vibration, it is suitable for airborne uses. Over-all length is 1.05 in. Maximum diameter is 0.44 in.

Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N. J.

Glass-Seal Subassemblies 553

For use in the manufacture of diodes, these beaded leads and subassemblies are produced to fit individual specifications. Both moly and dumet studs with hard glass packages can be supplied.

Alloys, Unlimited, Inc., Dept. ED, 21-01 43rd Ave., Long Island City 1, N. Y.

P&A: 2 to 3 weeks.

Temperature Probe 400

Is noise-free. Passive probe model 300 is designed to provide noise-free remote location of electronic monitoring equipment without signal loss while monitoring extreme environment tests. Temperature range is -200 to $+500$ F; the device comes in any length with about 2% signal loss per 100 ft.

United Aerotronics Corp., Dept. ED, Box 239, Burlington, N. J.

Dual Receiver 568

Range is 10 kc to 54 mc in this combination of types SP-600-VLF and SP-600JX. Sensitivity is uniform over the entire range. The units are suited for laboratory use in seeking, measuring or receiving information.

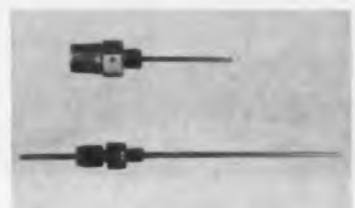
Hammarlund Manufacturing Co., Inc., Dept. ED, 460 W. 34th St., New York 1, N. Y.

Telemetering System 472

Is all-electronic. Telemetering system uses few moving parts, requires no synchronization. Transmitter uses a photo-diode detector for noncontact input. Receivers are panel-mounted recorders with plug-in components. Link may be telephone or two-wire line, high-tension power lines, audio frequency or microwave channels.

The Foxboro Co., Dept. ED, Foxboro, Mass.

Temperature Transducer 469



Resists radiation. Designed for nuclear energy applications, temperature transducers have a range of −325 to +500 F with an accuracy of ±1/2 F. Repeatability is within ±0.05%; resistances up to 1 K at 32 F are available. Time response is about 0.4 sec for 63%.

Winsco Instruments & Controls, Dept. ED, 11789 W. Pico Blvd., Los Angeles 64, Calif.

High-Temperature Dielectric 401

Temperature limit is 400 F. Loss tangent is less than 0.001 from 20 mc to 10 kmc. The material has an adjusted dielectric constant of 3 to 10 in steps of 1 and a volume resistivity of 10^{13} ohm-cm. Designated type CMD-3048, uses include waveguide ferrite supports.

Custom Components, Inc., Dept. ED, P. O. Box 248, Caldwell, N. J.

Availability: from stock.

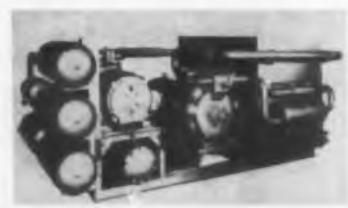
NEW PRODUCTS

Tantalum Capacitors 476

Three-terminal device. Type 180D is a tantalum, three-terminal capacitor. The line current is carried directly through the tantalum pellet from terminal to terminal of the capacitor while the case is the ground terminal. Units are hermetically sealed and available in ratings from 60 μf at 6 v to 6.8 μf at 35 v dc. Max current is 5 amp dc at 25 C and 2 amp dc at 125 C.

Sprague Electric Co., Dept. ED, North Adams, Mass.

Liquid Cooler 470



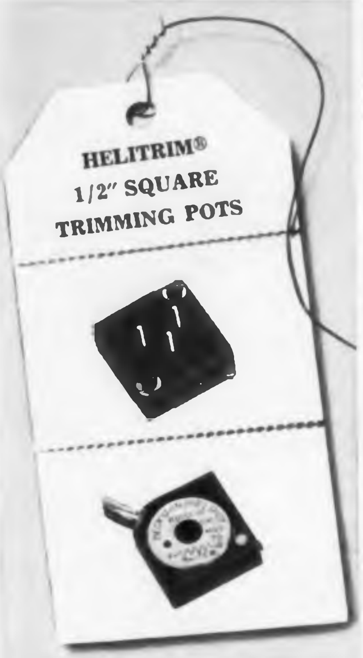
Drops to −120 F. Model W-120 liquid cooler may be used with low-temperature convection fluids such as trichloroethylene, acetone, and methylene chloride. Refrigeration capacity is 120,000 BTU per hour at −100 F. Accuracy is said to be ±0.2 F.

Webber Manufacturing Co., Inc., Dept. ED, P.O. Box 217, Indianapolis 6, Ind.

PNPN Diode 468

In glass package. Type E silicon pnpn diode is capable of handling 10-amp pulses or 150 ma of continuous current. Weight is 2 g, length 0.280 in. Typical turn-on time is less than 0.1 μsec. Package improves environmental stress resistance. Diodes are made in commercial and military types with switching voltages ranging from 20 to 200 v.

Shockley Transistor Unit of Clevite Transistor, Dept. ED, Stanford Industrial Park, Palo Alto, Calif.



Now available from Helipot at the lowest price in history!

Model 70 with Teflon leads, $5.35 and down; Model 71 with pins, $5.95 and down.

Take your pick: Model 70 with leads... Model 71 with pins. They'll solve your trimming and space problems and see you through adverse environmental conditions, too!

They're the best pair of square trimming pots on today's market ... at this or any price!

The reasons?

Elementary... they offer special features (such as Teflon leads on the 70) as standard! And both standard models incorporate a unique slip clutch stop that positively prevents the wiper from going off the end of the coil and into dead space. (Continuous units are available as special.)

The specs tell the story! Standard resistance ranges of 10 to 50,000 ohms... resolution from 1.01% at 10 ohms to 0.083% at 50K ohms... 1 watt power input at 50°C derating to zero at 150°C!

And all this performance is packed into a 1/2" square all-metal housing that's sealed against humidity.

Your local Helipot representative carries these pots in stock for immediate delivery. Call him.

Beckman® / Helipot®

POTS : MOTORS : METERS

Helipot Division of Beckman Instruments, Inc. Fullerton, California

CIRCLE 856 ON READER-SERVICE CARD

Size 5 Servomotor 857

For minimum size and weight applications

Model 9005-1502-0 Servomotor is designed for applications calling for minimum size and weight. The Size 5 weighs 0.6 ounces, is 0.865" in length. Powered by 26-volt, 400-cycle reference voltage, the servomotor has a no-load-speed of 10,000 rpm. Torque-at-stall registers 0.1 oz.in., while rotor inertia is 0.18 gm.cm.^{2}, providing an acceleration-at-stall of 39,000 rad/sec^2. Stainless steel bearings, shaft and housing, and Teflon for insulation permits operation over an ambient temperature range of −55°C to +130°C. Maximum unit operating temperature is +200°C.

Beckman Instruments, Inc., Helipot Division Technical Information Service, 2500 Harbor Blvd., Fullerton, Calif.

Single-Turn A-C Potentiometer 858

Reduces quadrature and loading effects

Model 5803, a 3" diameter single-turn A-C potentiometer, has high input impedance and low output impedance to substantially reduce quadrature and loading effects. New design minimizes the chance of catastrophic failure and provides stable linearity throughout the life of unit. Impedance range is 1,000 to 75,000 ohms, with frequency range of 400 to 1,000 cps. This is the first of a series of precision potentiometers for A-C excited circuits. Beckman Instruments, Inc., Helipot Division Technical Information Service, 2500 Harbor Blvd., Fullerton, Calif.

All-Metal Panel Meter Line 859

Gasket sealing keeps movement trouble-free

These all-metal panel meters are gasket sealed to keep out dust, moisture and foreign particles. Steel movement enclosures protect against the effects of magnetic panel materials or stray RF. Pictured is 4" x 6" meter, with scale length of 4.7" for maximum visibility and reading ease. The 4" x 6" meter mounting configuration matches other meters of similar size. Standard meter finish is flat black with bezel available in any color.

Availability: 30 days.

Beckman Instruments, Inc., Helipot Division Technical Information Service, 2500 Harbor Blvd., Fullerton, Calif.

HERE'S WHY VELOCITY DAMPING IMPROVES SERVOSYSTEM RELIABILITY... The velocity-damp servomotor is a replacement for complicated rate-feedback loops—it achieves stability by simple and self-contained electromagnetic means.

For example, the BECKMAN® Size 8 Velocity-Damp Servomotor offers up to 25 dyne-cm.-sec./rad. additional damping, and can replace damping generators in 80% of present applications. In addition to elimination of phase shift and null voltage problems inherent in rate feedback systems, the velocity-damp unit is shorter, lighter, and consumes less power.

In BECKMAN Velocity-Damp Servomotors, damping is a direct function of velocity. A low-inertia drag cup, integral with the motor shaft rotates in a magnetic field generated by a pair of permanent magnets. Polarity of one magnet is variable with respect to the other, so that total force due to induced currents may be externally adjusted during operation.

In addition to Size 8 Velocity-Damp Servomotors, BECKMAN offers similar units in their Size 11, 15 and 18 lines.

For a complete delineation of servomotor damping theory... including transfer functions to help you determine damping needs... write for our Servo Brief entitled, "Electromagnetic Damping."

Beckman® / Helipot®

POTS : MOTORS : METERS

Helipot Division of
Beckman Instruments, Inc.
Fullerton, California

CIRCLE 860 ON READER-SERVICE CARD

NEW PRODUCTS

Variable Delay Line 351

Has no tap interference. Sliding taps in model VLR 15 variable lumped constant delay line are designed so that they may pass one another, permitting independent settings. Each of the 3 taps has a resolution of 0.025 μsec. Delay is variable from 0 to 1.5 μsec, with 0.072 μsec rise time max.

Allen Avionics, Inc., Dept. ED, 255 E. Second St., Mineola, L.I., N. Y.

Tape Reader 842

Meets military requirements. Punched tape reader model 84 is made for on-line service in computer, communication and control applications. It photoelectrically reads data at a preset speed up to 60 in. per sec. The self-contained unit uses no gas or vacuum tubes. Tape capacity is 500 ft.

Cook Electric Co., Public Relations Dept., Dept. ED, 2700 Southport Ave., Chicago 14, Ill.

Silicon Transistors 847

For industrial use. Diffused mesa silicon transistor line, made especially for industrial users, contains 5 types ranging from audio amplifier to high-speed switching. A Nixie driver is also included. Lots up to 50,000 units may be ordered.

Rheem Semiconductor Corp., Dept. ED, 350 Ellis St., Mountain View, Calif.

Price: $1.60 to $3.85 ea, 1,000 units.

Light Source 843

For optical maser studies, model 511 provides close optical coupling between the flash tube and the crystal. Xeon-filled, U-shaped tubes are used, providing greater efficiency than spiral flash types. The power needed is 110 or 220 v, 60 cps, 2 kw.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston 15, Mass.

SEALED MICRO MINIATURE
RELAYS

FOR IMMEDIATE LARGE QUANTITY DELIVERY AT FACTORY PRICES

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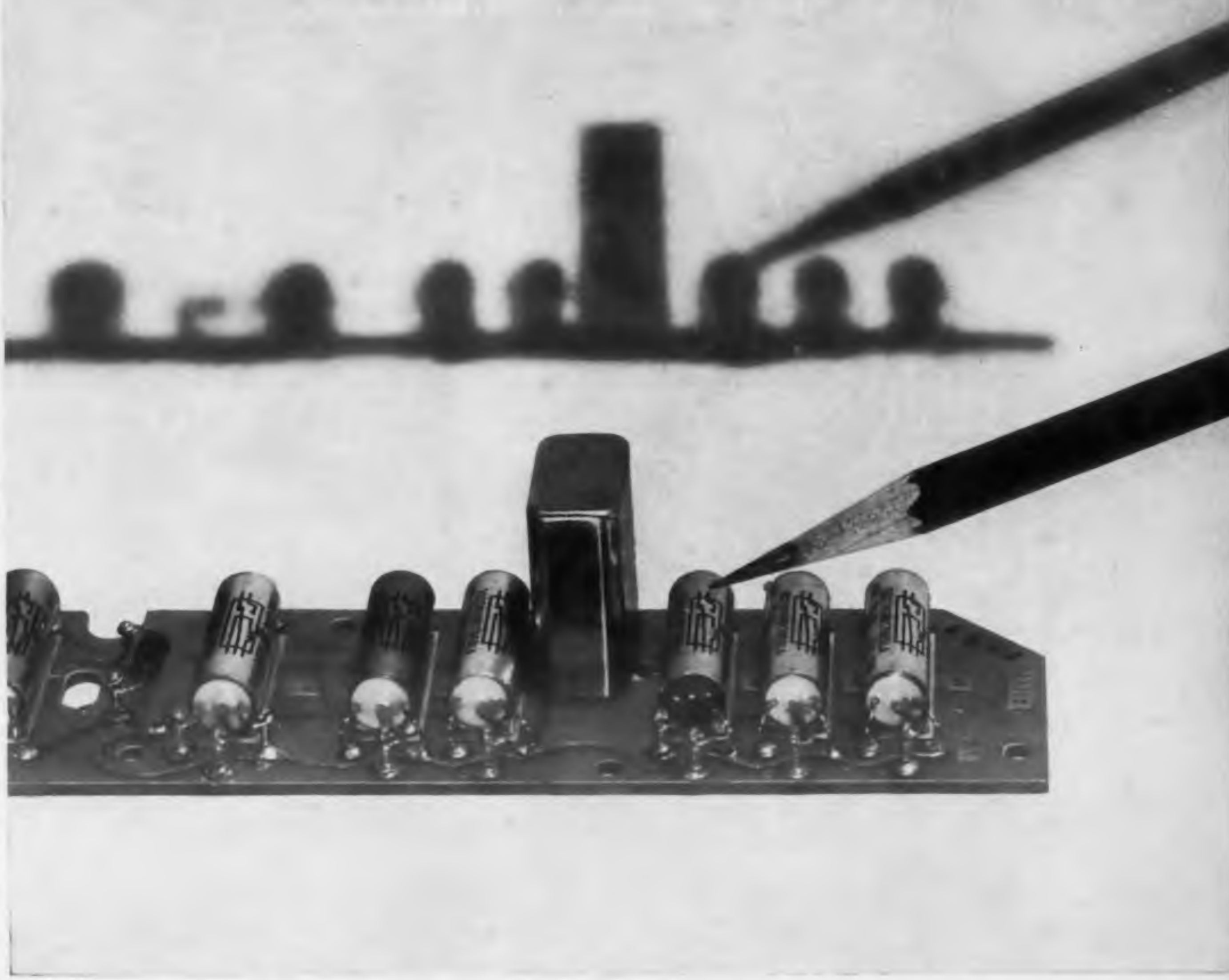
ELECTRONICS

CIRCLE 51 on READER-SERVICE CARD

CIRCLE 52 ON READER-SERVICE CARD ➤

GENERAL ELECTRIC SEALED RELAYS—UNMATCHED FOR RELIABILITY



New Unimite relays are only 1/3rd the height of crystal cans, make boards "wafer" thin

With new General Electric Unimite relays, you can lay out a switching circuit .374″ thin, including mounting! Mount Unimites on their .900″ side, and they stand only .320″ off the board—1/3rd the height of "stand-up" crystal-can types.

And there's no performance compromise! Rated one amp, 28vdc, spdt, Unimites switch in a fast 1.5 milliseconds. They weigh only .105 ounce.

In addition, Unimites offer characteristic G-E high reliability. General Electric's exclusive all-welded construction eliminates solder- and flux-caused malfunctions. Internal contamination is eliminated by isolating the contact chamber, and by using chemically inert materials.

Best of all, Unimites are available now! Call your G-E Sales Engineer. Or, write for Bulletin GEA-6822, to General Electric Co., Schenectady, New York. *Specialty Control Department, Waynesboro, Va.* 792-20

Progress Is Our Most Important Product

GENERAL ELECTRIC

Adjustable Resistor 356

With screw adjust. Power resistor model OX eliminates heat or shock hazard during adjustment. Power rating is 10 w in still air at 25 C. Temperature coefficient is low; resistance range is 25 to 100,000 ohms. Adjustment range is 95% of total resistance with 36 turns. Resolution is 0.7% to 0.07%. Size is 2.30 x 0.77 x 0.36 in.

Invar Electronics Corp., Dept. ED, 1723 Cloverfield Blvd., Santa Monica, Calif.

Two-Part Epoxy Adhesive 363

Setting is in 45 sec. Type X-305 is recommended for repairing printed circuits, sealing electronic components, replacing soldering as well as laminating purposes. Tensile shear strength is over 2,000 psi.

Mereco Products Div., Metachem Resins Corp., Dept. ED, 530 Wellington Ave., Cranston, R. I.

P&A: $10 up for 3 oz; from stock.

Acoustic Noise Generators 853

Range is 50 to 10,000 cps in the Acousti-Dyne units. Model 825 has a sound pressure level of 164 db; model 830, 168 db; model 835, 174 db. The units have adjustable operating characteristics to produce a single-frequency tone or an am tone.

American Measurement & Control, Inc., Dept. ED, 240 Calvary St., Waltham 54, Mass.

Variable Capacitors 854

High-vacuum types, these units have capacitances of 5 to 30, 8 to 50, 16 to 80 and 5.5 to 206 pf. Peak voltage is 15 kv for the first three units. Units in the last range can have 8 or 10 kv. Dimensions of the largest unit in the series are 9.5 x 3.5 in.

English Electric Valve Co., Ltd., Dept. ED, Chelmsford, England.

◄ CIRCLE 53 ON READER-SERVICE CARD

"Leadership in semiconductors"

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CHICAGO, Illinois
6641 W. North Ave.
Oak Park, Ill.....................VIllage 8-5556

CLEVELAND, Ohio
14625 Detroit Ave.
Lakewood, Ohio................ACademy 1-9191

DALLAS, Texas
511 Braniff Airways Bldg.
Dallas 35, Texas..............FLeetwood 7-9448

DAYTON, Ohio
379 W. First St..................BAldwin 4-9651

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First National Bank Bldg.
621 Seventeenth St...............AComa 2-1686

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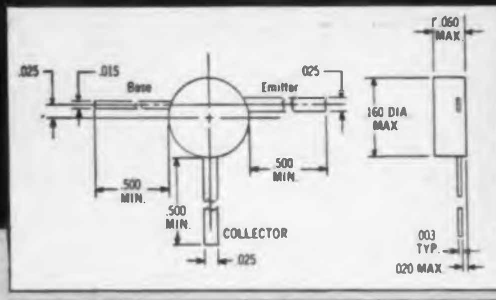
CIRCLE 54 ON READER-SERVICE CARD

CIRCLE 55 ON READER-SERVICE CARD ➤

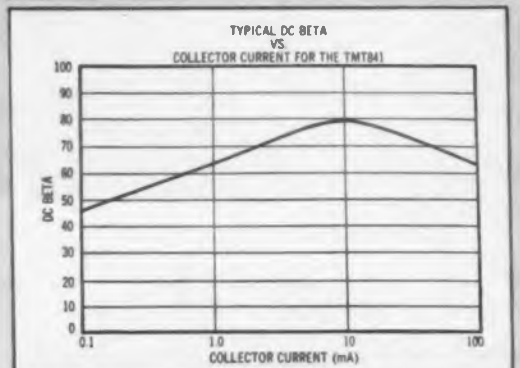
NEW FROM

Transitron micro-T

(A MESA MICRO-TRANSISTOR)



- SILICON DIFFUSED
- HERMETICALLY-SEALED
- ALL-GLASS PACKAGE



AMPLIFIER TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum AC Beta (h_{fe})	Typical Gain-Bandwidth Product (Mc)	Maximum Collector Leakage Current at 25°C (µA)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 830	45	20	45	1	150
TMT 840	45	40	45	1	150
TMT 841	45	80	65	1	150

SWITCHING TYPES					
Type	Maximum Collector Voltage (Volts)	Minimum DC Beta (h_{FE})	Typical Gain-Bandwidth Product (Mc)	Maximum Saturation Resistance (Ohms)	Maximum Power Dissipation at 25°C Ambient (mW)
TMT 842	45	20	45	120	150
TMT 843	45	45	65	120	150

INTRODUCING THE FIRST SERIES IN A COMPLETE LINE OF MICRO-TRANSISTORS

Development of the **MICRO-T** — first silicon diffused mesa micro-transistor in an hermetically sealed all-glass package — represents a major step forward in microminiaturization. As compared with conventional "metal can" configurations, the **MICRO-T's** hard glass packaging embodies a significant improvement in the hermetic seal between leads and package. Reliability is substantially increased; possibility of leakage is sharply reduced.

This new series of 45-volt micro-transistors is the first designed for small-signal low-level applications, with current operating range from 50 microamps to 20 milliamps. Other electrical characteristics include an R_{CS} of 100 to 200 ohms; minimum Betas from 20 to 80; cut-off frequencies of over 50 megacycles. Perfectly compatible with present circuitry, **MICRO-T's** will facilitate microminiaturizing in such critical areas as airborne, space vehicle and missile application. They are 1/20th the size of the TO-5, and 1/5th that of the TO-18.

The first five types of **MICRO-T's** are available now. For full information, write for Bulletins No. PB-78, (Amplifier types) and PB-79, (Switching types).

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electronic corporation
wakefield, melrose, boston, mass.
SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

NEW PRODUCTS

Pressure Switch 556

Life is 100,000 cycles. Different models have pressure settings of 1,500 to 3,550 psi. Typical data for an spdt unit: cut-out pressure, 3,000 psi; cut-in pressure, 2,600 psi; proof pressure, 4,500 psi; burst pressure, 7,500 psi. Testing is per MIL-E-5272A.

Walter Kidde & Co., Inc., Dept. ED, 675 Main St., Belleville 9, N. J.

Color Display Tube 579

Resolution is 1,000 lines in type C-74329. It is suitable for critical industrial and military systems. Measuring 25 in. long, the tube is similar to type 21FBP22, but provides higher brightness through the use of sulfide phosphors.

Radio Corp. of America, Electron Tube Div., Dept. ED, Lancaster, Pa.

Power Supply 365

Output is 50,000 v. Model 6VT6B has 0.005% regulation. Carrier ripple is negligible, 60-cps ripple is under 0.005%. Resettability is 0.1% with output current drains to 500 μa. Output is variable from 1.5 v. The unit is for laboratory applications.

California Magnetic Control Corp., Calmag Div., Dept. ED, 11922 Valerio St., North Hollywood, Calif.

Radar Control Unit 409

Range is 1 to 49 mc. This switching device is for use with the firm's ionospheric sounders and radars and may be adapted for other equipment. It provides rapid scanning through the necessary frequency bands in increments of 100 kc.

Philips Electronics Industries Ltd., Industrial and Medical Div., Dept. ED, 116 Vanderhoof Ave., Toronto 17, Ont.

Time-Code Generator 399

Unit has seven time-code outputs. Model 275, for WWV synchronizing, has six outputs for high- and low-speed analog magnetic tape recorders or oscillographs. The seventh is a 42-bit parallel output for digital acquisition systems or line-computers.

Hermes Electronics Co., Div. of Itek Corp., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

Terminals and Connectors 379

Series offers large sizes. Elongated ring terminals as well as regular ring terminals, butt and parallel connectors are offered. Made from annealed pure electrolytic copper and electro-plated with pure tin, they come in wire sizes 8, 6, 4 and 2.

ETC, Inc., Dept. ED, 990 E. 67th St., Cleveland 3, Ohio.

Slide Switches 366

Design is compact. For instrument use, units are single pole, two-hole mounting, ac. The 1940 and 1942 units are rated at 10 amp for 250 v, 15 amp for 125 v and 1/2 hp for 120 to 240 v. The 1960 and 1962 units are rated at 3 amp for 25 v, 6 amp for 125 v and 1/4 hp for 120 to 240 v.

Circle F Manufacturing Co., Dept. ED, Trenton 4, N. J.

Wire Strippers 405

Pincer type, single loop types are offered. The Thermo-Strip device can be used for all thermoplastic insulations and is suitable for use with missile and computer equipment. It operates continuously; no foot switch is needed.

Ideal Industries Inc., Dept. ED, Sycamore, Ill.

NEW PRODUCTS

Heat Dissipator 353

With side connections. The Uni-Mount is a heat dissipator for 7- to 10-w power transistors. Made for TO-3 and TO-6 units, mount configuration keeps electrode connections and transistor on same side of mounting wall.

Accel Electronic Products, Dept. ED, P. O. Box 467, Monterey Park, Calif.

P&A: Less than $1 ea; 30 days.

Antenna Mount 855

Supports 1,100 lb. Model 10 antenna mount is a servo-controlled pedestal, for shipboard and ground applications, with an assembly weight of less than 600 lb. Mount will support 1,100 lb of antennas of parabolic, end-fire array or horn type. All servo components are within the pedestal. Maximum speed is 5 rpm.

Temec, Inc., Dept. ED, 7833 Haskell Ave., Van Nuys, Calif.

Germanium Transistors 846

Have high beta. Greatest current gain for TO-36 device is claimed for the 2N1980 series of germanium high-beta transistors. Types 2N1980, 2N-1981 and 2N1982, operating at 50, 70 and 90 v, have collector current of 15 amp. Major uses for the high-beta units include voltage regulators, high-current switching, oscillators, and amplifiers.

Texas Instruments, Incorporated, Dept. ED, P. O. Box 5012, Dallas 22, Tex.

Electrolytic Capacitors 845

For communications applications, the BMT and BMTU units have axial leads and miniature design. The BMTU has an upright mounting. They are offered in a wide range of capacities and voltages, have low leakage and can have an operating temperature to 105 C.

Illinois Condenser Co., Dept. ED, 1616 N. Troop St., Chicago 22, Ill.

◄ CIRCLE 58 ON READER-SERVICE CARD

Double Stand-Off Terminal 423

Design is miniature. Type DST-900 is for wiring both above and below a chassis with complete electrical isolation by means of a single-terminal installation. The two lugs are separated by solid Teflon.

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

Electronic Counter 418

Rates are up to 1 mc. Units are offered in 3, 4, 5 and 6-place models. Preset count detection capability is up to 250 kc. The units can be used for time-interval generating and frequency dividing as well as control and test applications.

Schlumberger Corp., Ridgefield Instrument Group, Dept. ED, Ridgefield, Conn.

Price: $740 to $1,200.

Printed-Circuit Cleaner 416

Operation can be automatic. Using Freon cleaning agents and ultrasonic energy, the system removes activated and nonactivated fluxes and other contamination. It can be used on metals, plastics and insulation materials.

National Ultrasonic Corp., Dept. ED, 95 Park Ave., Nutley, N. J.

CIRCLE 59 ON READER-SERVICE CARD ➤

New ruggedized CBS Ceramic mike offers higher output, choice of narrowband or improved wideband response

New button design and novel element suspension of ruggedized CBS Ceramic deliver nearly twice the output of conventional ceramic microphones . . . provide more than many crystal microphones, while eliminating their heat and humidity problems. Specially vented acoustic cell also provides flatter response with improved lower frequencies and minimized peaks. And the CBS Ceramic offers these advantages at low cost.

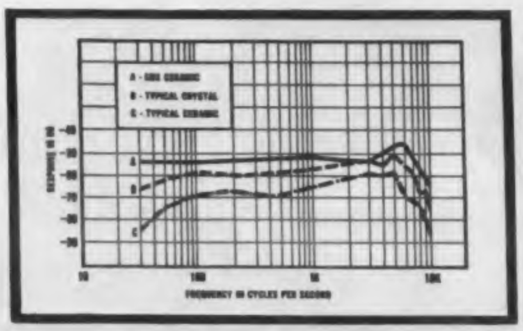
Frequency response of the CBS Ceramic can be supplied to match: 1. Narrowband requirements of mobile and fixed communications, 2. Wideband needs of entertainment equipment. For communications, the microphone is designed to attenuate sharply frequencies below 200 cycles.

Note the comparative frequency-response curves and the variety of models. For complete details on standard or special models, call your local CBS Electronics sales office.

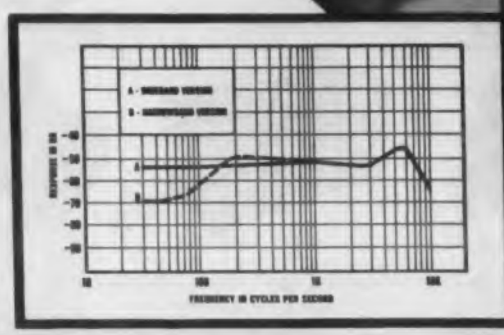
FOUR STANDARD MODELS

Mark III . . . lightweight metal case, chrome finish. Mark III-L . . . adds gooseneck for language labs, paging, bank drive-ins, etc.

Mark VI-A . . . lightweight, plastic case, built-in stand. Mark VI-B . . . adds push-to-talk, coiled cord.



CBS Ceramic microphone compared with crystal and conventional ceramic microphones.



Frequency response of CBS Ceramic designed for high-fidelity (A), and for communications (B) use.

CBS ELECTRONICS

Danvers, Massachusetts — A Division of Columbia Broadcasting System, Inc.

AUDIO COMPONENTS • TUBES • SEMICONDUCTORS • MICROELECTRONICS

Sales Offices: Danvers, Mass., 100 Endicott St., SP 4-2360 • Newark, N. J., 231 Johnson Ave., TA 4-2450 Melrose Park, Ill., 1990 N. Mannheim Rd., ES 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RA 3-9081 Minneapolis, Minn., The Heimann Co., 1711 Hawthorne Ave., FE 2-5457.

NEW PRODUCTS

Static Inverter — 559

Able to power a synchronous motor for use in magnetic-tape recorders, model S13 converts 22 to 28 v dc to 220 v ac at 60 cps. Transistor power-switching devices are used. External synchronization is permitted from 55 to 65 cps.

Kidde Electronic Laboratories, Walter Kidde & Co., Inc., Dept. ED, 9 Brighton Road, Clifton, N. J.

Copper-Clad Micarta — 473

Is fire-retardant. Two cold punch, paper-base phenolics of XXXPC grade are made for printed circuitry. Grade 65MO5, with high bond strength and solder resistance, is recommended for small circuits. Grade 65MO6 is warp-free and has high impact strength. Blister time at 500 F is 25 sec.

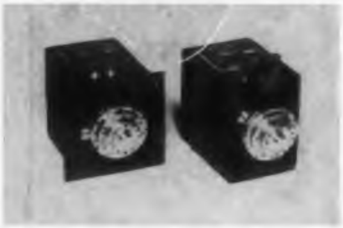
Micarta Div., Westinghouse Electric Corp., Dept. ED, Hampton, S. C.

Miniature Accelerometer — 474

With low cross-sensitivity. Accelerometer model 106, weighing 0.3 oz, is capable of measuring 10^4 g with a linearity of 2% from 1 to 15 kc. Sensitivity is 15 mv per g, with cross-sensitivity of 3% Temperature range is −65 to +360 F. Standard model has insulated mounting, hermetic connector and stainless steel case.

United Aerotronics Corp., Dept. ED, Box 239, Burlington, N. J.

Triple Decade Capacitors 475



With direct in-line readout. Triple decade capacitors types 283W and 284W have direct in-line readout. Two basic ranges are available in each type; 0.0001 to 0.1099 μf and 0.001 to 1.099 μf. Type 283W is a standard bench decade while 284W is for panel mounting. Applications are for wave filter design as well as in timing and integrating circuit work.

Sprague Electric Co., Dept. ED, North Adams, Mass.

400-Cps AC Motor 412

Rating is 1.8 hp at 3,750 rpm. Model 1300 continuous-duty unit has a brush holder that permits constant brush pressure, low noise interference. Winding insulation is rated for temperatures to 260 F. Units can be furnished for use up to 150,000 ft.

Hoover Electric Co., Hanger 2, Dept. ED, Port Columbus, Columbus 19, Ohio.

Solid-State Relay 369

Pickup time is 10 μsec. Dropout time is 100 μsec. For missile and aircraft use, model SSR-4-2.00 switches a 4-v dc source. It carries 2-amp load current continuously. It may be used as a timing or time-delay relay with the addition of external circuitry.

Curtiss-Wright Corp., Inter-Mountain Branch, Dept. ED, P. O. Box 8324, Albuquerque, N. Mex.

Printed-Circuit Kit 406

All necessary equipment is included. The Scribe 'N' Peel kit permits the coated Stabilene film to be marked with a sharp steel instrument and to be photographically processed onto a "peelable" film. The finished work can be transferred to copper laminate.

Keuffel & Esser Co., Dept. ED, Third and Adams Sts., Hoboken, N. J.

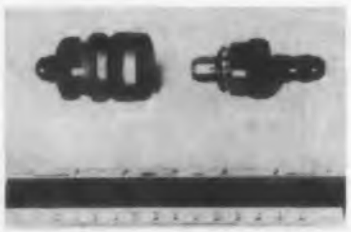
Power Supplies 477

For plug-in use. The Trypack series of modular, transistorized power supplies has units with outputs of 0 to 20 v at 0 to 2 amp, and 0 to 50 v at 0 to 750 ma. Output voltage is regulated to better than 0.05% with less than 0.5 mv ripple. Voltage and current are adjustable.

Trygon Electronics, Inc., Dept. ED, 111 Pleasant Ave., Roosevelt, L. I., N. Y.

***P&A:** $184; stock to 3 weeks.*

Push-Pull Connector 471



Operates to 3,000 psi. The Inst-O-Matic series of couplers sustain operating pressures up to 3,000 psi. Coupling connects at 50 psi and disconnects at 3,000 psi; an entry seal prevents leakage and spillage. Sizes range from 1/4 to 2 in. inside diameter.

Wiggins Connectors, Dept. ED, 3424 E. Olympic Blvd., Los Angeles 23, Calif.

Telegraph-Message Generator 570

Transistorized and self-contained, types DT-101A and DT-101B are for shortstop systems. Three types of messages are supplied: an 80-character fixed message, two alternating repeated characters and reversals. The A unit generates signals at 4.5, 50, 56.9 and 74.2 baud.

Digitech, Inc., Dept. ED, 382 Danbury Road, Wilton, Conn.

***Availability:** 12 weeks.*

Digital Readout 370

Unit is self-decoding. It mounts in a panel space 1 x 3.1 in. and extends 2.5 in. behind the panel. Alphanumerical characters are displayed at rates to 50 characters per sec. Operation is on 12 or 28 v dc. Units can be gang mounted.

Datascope Corp., Dept. ED, 4023 Irving Place, Culver City, Calif.

P&A: $20 up; 4 weeks.

DC Power Supplies 402

Output is 2 to 200 v dc. The 30-series offers 35 different modular units. Input is 105 to 125 v dc at 60 or 400 cps. For most models, line regulation is 10 mv and load regulation is 10 mv. Units have an external potentiometer for output adjustments.

Dressen-Barnes Electronics Corp., Dept. ED, 250 N. Vinedo Ave., Pasadena, Calif.

Price: $140 to $160.

Switching Time Meter 373

Unit measures diode recovery time. Model 140 A, also for measuring switching characteristics, provides six channels of time-difference information. Completely self-contained, the unit includes a collector supply and base drive pulse.

E-H Research Laboratories, Dept. ED, Oakland, Calif.

P&A: $3,750; 30 days.

Materials Tester 403

Unit determines physical properties. In testing elastic, metal, plastic and other substances, this instrument predicts their behavior when exposed to vibration, shock, wear and other kinds of stress. It provides for testing, a temperature range of —50 to +150 C and a frequency range of 25 to 5,000 cps.

Chesapeake Instruments Corp., Dept. ED, Shadyside, Md.

NEW PRODUCTS

Isolated Power Supplies 374

Outputs are 6.8 to 200 v ±5%. Noise introduced by these units into the circuits to which they are connected is less than 10 mv, peak-to-peak, per kilohm impedance to ground. Insulation voltage is 2,000 v dc. Type is A4S.

Elcor, Inc., Dept. ED, Falls Church, Va.

P&A: $36.50; one week.

Card Reader 371

Unit is for automatic control systems. Type CR-201 transports cards from a card hopper past two read stations and into a card stacker at a rate of 30 cards per min. It can be used for continuous scanning, automatic stop at any required row and continuous readout, or individual selection of any required row.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Metal Cone for Shielding 382

Device is self-centering, self-aligning. These Covers can be used in mechanical computers to protect shafts and ball screws. Having cone shape and spring tension, they can be placed over any shaft, rod or screw. Sizes are from 5/8 in. in diameter and 1/2 in. in shut height, up to 48 in. in length.

Elasticone Div., Central Safety Equipment Co., 6601 Marsden St., Philadelphia 35, Pa.

BOURNS TRIMPOT®

Schweber

FOR IMMEDIATE LARGE QUANTITY DELIVERY AT FACTORY PRICES

Yes! Schweber can sell any model of BOURNS TRIMPOT® at factory prices. Sizeable quantities are available for immediate shipment from stock from Schweber's warehouse.

Schweber ELECTRONICS

60 HERRICKS ROAD, MINEOLA, L. I., N.Y.

PIONEER 6-6520, TWX G-CY-NY-580U

CIRCLE 65 ON READER-SERVICE CARD

NUMBER 15 — NEW PRODUCT SERIES

Now—A High-Performance Potentiometer For As Little As $3

Never before could you find a low price tag on this kind of potentiometer performance. Now—for as little as $3 a unit in quantity orders—you can buy a single-turn ½" wirewound rotary that meets the highest standards for computer and industrial control applications.

Weighing in at a scant .05 ounce, the ½" dia. Trimpot® Model 3367 dissipates 0.5 watt, operates in 105°C heat, and holds residual end-setting resistance from 0 to 1.0%. It meets requirements for steady-state humidity and Mil Specs for sand, dust, salt spray and fungus. Designed for convenience, too, it has index points that let you check your setting at a glance.

Reliability well beyond the expected is made possible by the exclusive Bourns Silverweld® termination. Alloyed with multiple turns of the resistance wire, Silverweld eliminates vulnerable single-wire terminations, is virtually indestructible under thermal or mechanical stress. Units are 100% inspected, and subjected to the rigid double-check of the Bourns Reliability Assurance Program.

Model 3367 is available immediately from factory and distributor stocks with resistances of 100Ω to 20K. Your choice of printed circuit pins (spaced for interchangeability with more expensive devices) or solder lugs with bushing mount. Write for complete data and list of stocking distributors.

Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure and acceleration.

CIRCLE 66 ON READER-SERVICE CARD

NEW PRODUCTS

Ceramic Capacitors 354

In square cases. Type CK capacitors are packaged in molded plastic square cases measuring from 0.2 in. sq to 0.6 x 0.5 in. Rated at 200 and 500 wvdc, units have standard tolerances of ±5%, ±10%, ±20%, and −20% +100%. Temperature range is −55 to +150 C.

Component Sales, Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

Recording System 359

Is voice-actuated. Type RA-1651 recorder can be actuated by the sound of a voice, and automatically stamps time and date on the magnetic tape. The unit can operate continuously for 25-1/2 hours at 5/8 in. per sec. Recording begins within 10 msec after a voice signal is detected.

Litton Industries, Westrex Co. Div., Dept. ED, 6601 Romaine St., Hollywood 38, Calif.

Miniature Limit Switches 362

Four-circuit designs are offered. The units are 1 in. in diameter and 2.5 in. high. Two actuator designs are available, a plunger model and a positive-drive, rotary-linkage unit. Rating is 24 amp, maximum in-rush and 7-amp, resistive, at 28 v dc.

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

P&A: $43 up; from stock.

HF Germanium Transistor 361

Oscillating frequency is over 1,000 mc. Type 2N700A meets MIL-S-19500/123 and is a 25-v (V_{CE}), 75-w, pnp mesa unit. Its uses are in vhf-band rf amplifiers and oscillators. Package is the TO-17.

Motorola Semiconductor Products Inc., Dept. ED, 5005 E. McDowell Rd., Phoenix 10, Ariz.

P&A: $9; from stock.

◄ CIRCLE 67 ON READER-SERVICE CARD

Control Relay 352

Has high sensitivity. Model 301 industrial control relay operates with input signal of 1 mv at 1 μa. Output relay controls up to 1.8 kw of 60-cps power. Input stage is a high-gain toroidal magnetic amplifier; second stage is a transistor trigger amplifier which drives the output relay.

Acromag, Inc., Dept. ED, 22515 Telegraph Road, Southfield, Mich.
P&A: $98.75 ea, 1 to 5; stock.

Dual Lamp 357

With single base. High reliability lighting is provided by 2 MS lamps mounted in a base normally used for one T 1-3/4 bulb. The Siamlamp is rated at 5 v, but may be operated intermittently at high voltages in alarm and warning service.

Jay-El Products, Inc., Dept. ED, P. O. Box 25, Gardena, Calif.

Transistorized Chopper 425

Noise is 0.01 μv per ohm. The unit performs as an spdt switch for use in servo-mechanisms, low-level voltage measurements and telemetering. Self-contained, it has an integral drive transformer. It meets MIL-E-5272.

Telecomputing Corp., Dept. ED, 603 Main St., Westbury, N. Y.
***Availability:** from stock.*

CIRCLE 68 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Recorder Control 385

Unit has 15 voltage, 15 current ranges. It converts any fixed-span recorder to a universal multi-range recorder. It can be used with potentiometric recorders and d'Arsonval recorders with vacuum-tube preamplifiers.

Cahn Instrument Co., Dept. ED, 14511 Paramount Blvd., Paramount, Calif.

Price: $75.

Tube-Pin Straighteners 388

Two types are offered. Type SH-79 is a hand tool with a 7-pin straightener on one end and a 9-pin straightener on the other. Type SH-97P offers a separate pair of 7- and 9-pin straighteners, for mounting on a chassis in cutouts for miniature sockets.

CBS Electronics, Dept. ED, Danvers, Mass.

Data-Acquisition System 376

Output is 1-2-4-8 binary. The DAS-22 system reads dc outputs from pressure, temperature, strain, depth and displacement transducers. Output is on punched tape. It accepts transducer outputs of ±0.001 to ±1.000 v in four ranges.

Electronic Controls Inc., Dept. ED, Magee Ave., Stamford, Conn.

Subminiature Lamp 413

Dimensions are 3/16 x 1/8-in. in diameter. The design allows light to be taken directly from the end of the lamp without the distortion found in tipped models. Ratings are 1.5 v, 0.01 amp to 5 v, 0.11 amp. Uses are transistor circuitry, missile and aircraft applications.

Los Angeles Miniature Products, Dept. ED, 17000 Western Ave., Gardena, Calif.

Digital Modules 430

Clock rates are up to 16 mc. Series H logic elements perform gating, clocking, gain and delay functions. Gain is 6 at 16 mc, 10 at 10 mc. Signals transmitted between elements are dc levels. A master oscillator and clock amplifiers generate synchronizing pulses to control the logic elements and active delay circuits.

Computer Control Co., Inc., Dept. ED, 983 Concord St., Farmingham, Mass.

P&A: $66 up; from stock.

Shielded Room 364

With 120 db from 15 kc to 3,000 mc and better than 80 db at 10,000 mc, this shielded room is constructed of 3-oz solid copper. Inside and outside bolting includes friction as well as pressure contact.

Erik A. Lindgren & Assoc., Inc., Dept. ED, 4515-17 N. Ravenswood Ave., Chicago 40, Ill.

Pulse Modifier 360

For low-level pulses. Available in fixed or variable models, pulse modifier drives standard devices such as counting units from a high-speed, light-duty pilot contact. With an input pulse of 50 mw, 1 msec, the unit will provide outputs to 15 w and 10 to 100 msec at 24 v dc.

Programation Div., Guardian Electric Manufacturing Co., Dept. ED, 1621 W. Walnut St., Chicago 12, Ill.

CIRCLE 71 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Power Tester-Recorder 421

Ranges are to 600 v, 150 amp. Model 113 is equipped with test leads for measuring voltages or currents using a clamp-on current transformer. It is useful in checking motor loads and monitoring. The over-all accuracy is 3%.

Rustrak Instrument Co., Dept. ED, 130 Silver St., Manchester, N. H.
Price: $195.

Compression Amplifier 358

For command consoles. General-purpose compression amplifier, made for command consoles has input of −20 dbm, output of +33 dbm. Input impedance is about 10 K. Distortion at rated output is less than 3%. Frequency response is within 3 db from 300 to 5,000 cps, and signal-to-noise ratio is 50 db.

Westrex Recording Equipment Dept., Dept. ED, 6601 Romaine St., Hollywood 38, Calif.

High-Vacuum Ovens 437

Temperatures are to 450 C. Regulation is to ±2 C. Pressures are as low as 10^{-6} mm Hg. A vacuum of 10^{-6} mm Hg can be maintained with a temperature of 350 C. Sizes are 2.5 cu ft with 3.8 sq ft of shelf area and 1.2 cu ft with 1.5 sq ft shelf area. Designation is model 236-H.

F. J. Stokes Corp., Vacuum Processing Div., Dept. ED, 5500 Tabor Road, Philadelphia 20, Pa.

◄ CIRCLE 72 ON READER-SERVICE CARD

Visual Stimulator 355

For research work. The 502-A is a general purpose neuro-physiological stimulator designed for research and clinical work in human vision. Light source is a glow tube. Operating in cw, gated cw, and gated pulse modes, the set controls flicker frequency, intensity, and light-dark ratio.

Industrial Control Co., Dept. ED, Central Ave. at Pinelawn, Farmingdale, L. I., N. Y.

Low-Noise Fan 419

Unit provides 24 cfm. It is 2.25 in. deep and 3 in. in diameter; it operates at 3,500 rpm. Lubrication is sealed in. Life expectancy is 10,000 hr at 71 C continuous duty. It requires 115 v at 60 cps. single phase.

Rotron Manufacturing Co., Inc., Dept. ED, Woodstock, N. Y.

Freezing-Point Standard 424

NBS freezing point-samples are furnished. This apparatus reproduces primary and secondary points in the international temperature scale for calibration of temperature-sensing devices. Freeze-out time is 15 to 20 min.

Temptron, Inc., Dept. ED, 7030 Darby Ave., Reseda, Calif.

Advertisement

Crimp-type Connectors

These solderless, coaxial connectors are available in a variety of mounting configurations, including snap-locking versions. Male and female connectors may be mounted interchangeably. Mated length is $1\frac{13}{16}$". Working voltages: 1,000 V. maximum, at sea level; 500 V. maximum, at 60,000 feet. VSWR; less than 1.2 up to 2,000 mc. Life; 5,000 matings, minimum, without electrical deterioration. Tensile strengths of the crimps exceed the breaking strength of the cable. Hard gold plated Beryllium copper and TFE plastic are extensively used to assure optimum reliability.

Microdot, Inc., 220 Pasadena Avenue, South Pasadena, California

CIRCLE 247 ON READER-SERVICE CARD

Coaxial Switch

SPDT miniaturized switch features a case volume of ½ cu. in. and weight of 1¼ oz. Design allows direct insertion into miniaturized circuit without cumbersome adapters. Toggle action is positive, rf characteristics are highly efficient. VSWR is less than 1.25 to 2.0 kmc. Insertion loss is 0.8 db at 2.0 kmc. Contact rating is ½ amp at 150 V. resistive. Operating is 50,000 operations, minimum. Special stripline manufacturing technique provides low loss, wide frequency band properties.

Microdot, Inc., 220 Pasadena Avenue, South Pasadena, California

CIRCLE 248 ON READER-SERVICE CARD

CIRCLE 249 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Concentric-Scale Dials 368

Diameter is 1 in. With the addition of a finger-tip brake, series 3000 dials have a 1-5/32 in. diameter. They extend 15/16 in. from the panel. Standard units accommodate 1/8 or 1/4-in. shafts. They can be used for positioning potentiometers or shaft-controlled devices of 10 turns or less.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

Heat-Sink Clip 387

Construction is of aluminum. The device protects semiconductors during soldering. It fits around the wire running between the semi-conductor and the joint to be soldered. It absorbs and dissipates the heat that runs up this wire.

Avtron Manufacturing Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

Price: $19.80 per 100.

Pulse-Generating Module 391

Units drive 45-amp pulses. This is at 250 v and lasts 40 μsec when a magnetostrictive transducer is used. Voltage input for the 28A series is 6, 12, 28, 350 or 500 v dc. Construction is epoxy molding and dimensions are 1 x 2-5/8 x 3-1/2 in.

ACR Electronics Corp., Dept. ED, 551 W. 22nd St., New York 11, N. Y.

P&A: $58.50 to $198.50; 30 days.

AVAILABLE FROM STOCK!

C. I. C.

PRECISION FILM POTS

You can have any of these precision film pots on their way to you within hours. No need to wait for "custom" pots.

LINEAR SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Linearity
1/2"	1K	± .5%
	10K	± .5%
	50K	± .5%
7/8"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
1-3/32"	1K	± .5%
	10K	± .5%
	50K	± .5%
	1K	± .25%
	10K	± .25%
	50K	± .25%
2"	5K	± .25%
	20K	± .25%
	50K	± .25%
	5K	± .1%
	20K	± .1%
	50K	± .1%
3"	5K	± .1%
	20K	± .1%
	50K	± .1%
	5K	± .05%
	20K	± .05%
	50K	± .05%

SINE-COSINE SINGLE TURN FILM POTENTIOMETERS

Diameter	Resistance	Conformity
1-3/32"	10K	± .75%
	20K	± .75%
2"	10K	± .25%
	20K	± .25%
3"	10K	± .15%
	20K	± .15%

LINEAR MOTION FILM POTENTIOMETERS

Size	Resistance	Stroke	Linearity
1" Sq.	10K	1" Stroke	± .5%
	20K	1" Stroke	± .5%
	10K	2" Stroke	± .25%
	20K	2" Stroke	± .25%
	10K	3" Stroke	± .1%
	20K	3" Stroke	± .1%

WRITE OR CALL IN YOUR ORDER! POTENTIOMETERS WILL BE IN YOUR PLANT WITHIN 24 HOURS!

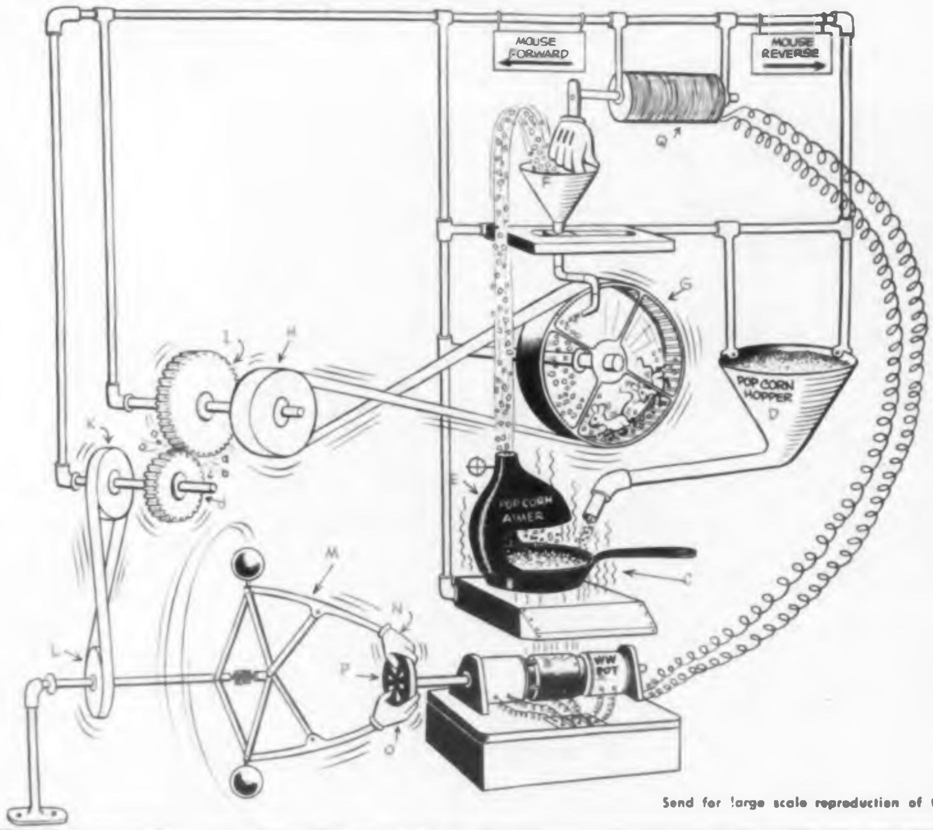
FIRST IN FILM POTS

CIC

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVE., HEMPSTEAD, L. I., N. Y.

CIRCLE 75 ON READER-SERVICE CARD

How To Improve Response Speed of Servos Using Wire-Wound Pots...



Send for large scale reproduction of this unique system.

High starting torque Wire-Wound pot (**A**) stalls Servo Motor (**B**). Motor overheats. Frying Pan (**C**) becomes hot and proceeds to pop corn. (Note Popcorn Hopper (**D**) designed for slow, continuous flow of top quality corn.) As corn pops, Turbo Jet Popcorn Aimer (**E**) directs stream of popped corn to Funnel (**F**). Corn is then directed into Auxiliary Power Treadmill (**G**), causing popcorn-loving mice to start Power Treadmill revolving as they begin to chase falling popcorn. Revolving Power Treadmill then turns Pulley (**H**) which turns Gears (**I & J**), in turn revolving Pulleys (**K & L**). Pulley (**L**) spins Fly-Ball Governor-Grabber (**M**). As momentum is increased Governor-Grabber causes spinning Clutch Hands (**N & O**) to engage Wheel (**P**), supplying the additional torque necessary to start servo rotating.

Reversing input signal flips Solenoid (**Q**) to reverse position, sliding Funnel (**F**) to Mouse-Reverse position. As popcorn is then directed into other side of Power Treadmill, the mice reverse their running action so as to continue catching falling popcorn. Periodic replacement with fresh mice and/or use of cheese-flavored popcorn can be used to increase efficiency of this system.

BUT THE BEST WAY YET... Use C.I.C. Low-Torque Film Pots!

Low torque is an inherent property of C.I.C. Film Pots. The smooth, unbroken, mirror-like surface of film offers minimum friction to the wiper and requires low brush pressures for continuity. As a result, C.I.C. Film Pots have multi-million cycle life.* Write for your free C.I.C. catalog facts today.

*Ask for list of missiles and aircraft currently using C.I.C. Film Pots.

- INHERENT RELIABILITY
- INFINITE RESOLUTION
- PRECISION LINEARITY
- MULTI-MILLION CYCLE LIFE
- LOW OPERATIONAL NOISE
- VIDEO FREQUENCY OPERATION

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK

"first in film pots"
CIC

CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Capacitance Monitor 377

Output is on punched tape. Model 10001 medium-speed digital system automatically measures capacitance, dissipation factor and leakage current. Preset timing allows capacitors to be charged for 1 min and measured at a rate of 10 per min.

Electro Instruments, Inc., Dept. ED, 8611 Balboa Ave., San Diego 11, Calif.

Cabinet Cooling Panel 381

Unit provides vertical air flow. Model PF-5, for cooling rack-mounted equipment, pressurizes the enclosure slightly above atmospheric pressure. Over 2 kw of heat is dissipated with a temperature rise of 10 C. Rate of air movement is 400 cfm.

Deltron Inc., Dept. ED, 4th & Cambria Sts., Philadelphia 33, Pa.

P&A: $52.90; 90 days.

Buffer-Control 380

Unit drives rotary-bar printers. Series RBP offers capacities of 24, 36, 72, 120 and 160 characters. Characters of up to 6 bits are accommodated. They are loaded at rates up to 100,000 per sec. Inputs can be from magnetic tape, magnetic drum, shift register or other devices.

DI/An Controls, Inc., Dept. ED, 40 Leon St., Boston 15, Mass.

P&A: $1,980 to $22,410; 8 to 12 weeks.

Isolation Transformer 372

Rating is 250 kv. Designed for industrial and research applications, model 2-TR-250-21-21 provides dc isolation from the secondary to the primary and ground. Secondary connections are brought through a single insulator. A terminal strip is provided within the corona shield for 220- or 110-v output.

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

Module Fastener 408

Device is for multiple-pin connectors. The assembly is composed of a variable-length stud shank, a nylon guide bushing, and a standard 1/4-turn Airloc receptacle. Steady pressure is exerted laterally across the connector. Various heads are offered.

Monadnock Mills, United-Carr Fastener Corp., Dept. ED, San Leandro, Calif.

Thermistor Thermometer 378

Two types are offered. Both have scale ranges of 20 to 45, 10 to 45 or 0 to 45 C. Typical accuracy for the 20 to 45 C range is 0.25 C for the Multi-Lead model and 0.1 C for the Esophageal model.

Electro-Medical Engineering Co., Inc., Dept. ED, 703 Main St., Burbank, Calif.

Availability: stock to 2 weeks.

Sealed Precision Bearings 404

Life is 3,000 hr at 80,000 rpm. The Flexeal devices are suitable for use in missile electric power units and in computers. The seal is of fiber-aluminum laminate. They tolerate lineal speeds of 6,000 ft per min and temperatures to 300 F.

The Barden Corp., Dept. ED, 200 Park Ave., Danbury, Conn.

NEW PRODUCTS

Add-Subtract Counter 420

Rating is 50 kc. Series F1503 miniature decade counter features in-plane display, modular printed circuitry and computer-type transistors. Grounding one of two control lines reverses the count direction.

Robotomics Corp., Dept. ED, 2422 E. Indian School Road, Phoenix 16, Ariz.

P&A: $139; 4 weeks.

DC Servo Motor 436

Unit operates at high altitudes. Ratings are: 0.5 hp; voltage-field, 27 v dc; armature 0 to 90 v dc; speed, 10,000 rpm; duty, intermittent. Explosionproof, the unit meets MIL-M-8609A and MIL-M-5272. It weighs 15 lb, 8 oz. Type designation is VI-20-1.

Kearfott, Div. of General Precision, Inc., Dept. ED, Little Falls, N. J.

Large-Screen Scopes 435

Linearity is 1%. Resolution is 40 lines per in. at center to 20 lines per in. at scale limits. Plotting accuracy is 0.2 in. Drift is less than 0.05 in. per hr for models 1735D and 2135D and less than 0.5 in. per hr for 1740D and 2140D.

ITT Industrial Products Div., Dept. ED, 15191 Bledsoe St., San Fernando, Calif.

Tape-to-Tape Converter 428

Speed is 300 characters per sec. The TMTC is offered in models to convert perforated paper tape to magnetic tape, magnetic to paper or paper to paper. Conversion accuracy is assured by continuous self-checking at each step in the process.

Daystrom Inc., Control Systems Div., Dept ED, Miramar Road, La Jolla, Calif.

Alarm Scanner 386

Rate is one point per sec. The unit scans up to 200 variables. It records the alarm condition measurements and their location, actuates an alarm lamp and energizes any external alarm system. It is transistorized.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Miniature AC Amplifier 461

Gain is 100. Frequency response is flat within ±0.5 db from 30 cps to 100 kc. The noise level is often so low that two units may be used in tandem, providing a total gain of 10,000. Designated model 203, the unit is transistorized.

Quan-Tech Laboratories, Inc., Dept. ED, Boonton, N.J.

Constant Voltage Transformer 452

Completely automatic. The Permavolt constant voltage transformer is designed for close control of filament, plate and transistor voltages. Standard models have an output voltage tolerance of ±3% for line variations of ±15%. Tolerances as low as ±0.5% can be obtained. Models for applications up to 1.5 kva may be custom designed.

Permavolt Transformers, Dept. ED, P.O. Box 252, Grand Haven, Mich.

Multiturn Potentiometers 460

Resistances are 25 to 200 K. Best linearity tolerance is ±0.1%. Model DV is rated at 2 w at 40 C, model AV, 3 w and model RV, 5 w. End resistance is as low as 0.015% of total resistance. End covers are of anodized aluminum.

Voak Engineering Co., Dept. ED, 129 "A" St., Upland, Calif.

P&A: $9 up; from stock.

NEW PRODUCTS

Printed-Circuit Layout Machine 396

Operation is high speed. The ART-MECH converts free-hand sketches into accurate transparencies. It can be used for drilling the etched circuits. A 0.1-in. grid reference template with a tolerance of ±0.001 or ±0.003 in. is used.

Melpar, Inc., Special Products Div., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

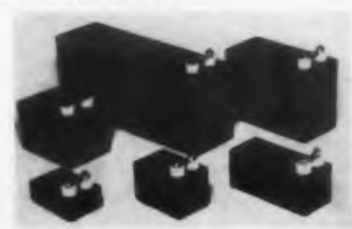
P&A: $2,950; from stock.

DC, Light-Duty Capacitors 407

Minimum life is 1,000 hr. Uses include: dc power-supply filter in X-ray and radar equipment, in small surge generators or linear accelerators for intermittent duty pulse forming, for capacitor discharge welding and energy-storage applications.

Line Materials Industries, McGraw-Edison Co., Dept. ED, Milwaukee 1, Wis.

Precision Capacitors 440



Range is 0.001 to 100 uf. Accuracy is +0.1%. Tpye 282W, for use as a standard in bridge measurements, permits accurate measurements of high-capacitance capacitors in digital power supplies. Type 280W has a rectangular case with integral banana plug and pack terminals. Type 281W with BNC connectors is for 3-terminal measurements.

Sprague Electric Co., Dept. ED, North Adams, Mass.

Dust-Free Cabinet 410

Particles of 0.5 micron are removed. A plunger switch starts positive pressure of 50 cfm. Four-tube fluorescent lamps provide interior light. Interior dimensions are 21.5 x 19.25 x 33.5 in. Model 1801 has a plastic face plate; model 1901, glass.

Plastigage Corp., PlastiCo Div., Dept. ED, 915 E. South St., Jackson, Mich.


"CAPS"


EARTHBOUND
AND BEYOND

NEW PRODUCTS

Flow-Actuated Switches 417

Design is spdt. These units provide remote indication of preset rates of flow in both liquids and gases. Standard bellows rating is 600 psi. Types NT and ET can have up to 1,500 psi. Other types are EPS, EPF and NPS.

Power Equipment and Engineering Co., Inc., Dept. ED, 1836 213th St., Torrance, Calif.

Temperature Recorder 422

Ranges are to 2,500 F. Minimum span is 0 to 500 F and accuracy is 2%. Operating on a pyrometer principle, the device uses the output of a thermocouple junction through a temperature compensator to cause deflection of a sensitive galvanometer.

Rustrak Instrument Co., Dept. ED, 130 Silver St., Manchester, N. H.

Price: *$139.50.*

Plastic Wiring Duct 438

Rounded edges provide insulation. Type E, replacing type B, is available in an extended range of 25 different sizes. Molded from vinyl plastic, it comes in 5- and 6-ft lengths. It can be cut with a fine-tooth hand or power saw.

Panduit Corp., Dept. ED, 17301 Ridgeland Ave., Tinley Park, Ill.

Silicon Mesa Transistors 432

Units are for medium-power use. Types 2N497, 2N497A, 2N498, 2N498A, 2N656, 2N656A, 2N657 and

2N657A are for audio to medium frequency use. Average dissipation is 4 and 5 w, continuous. Saturation resistance is 25 ohms. Base input resistance is 500 ohms.

General Electric Co., Semi-Conductor Products, Dept. ED, 11840 W. Olympic Blvd., Los Angeles 64, Calif.

Arc Switch 414

Rating is 7 to 20 kv. Capacity is 2,500 J. Model AS-25 facilitates controlled discharge of stored electrical energy in laboratory and production applications. It is actuated by spark ejection. Provision is made for four coaxial connectors.

RHD Research, Inc., Dept. ED, P. O. Box 1815, Newport Beach, Calif. *Price:* $800.

Aviation Electrical System 433

Temperature range is −65 to +600 F. It is applicable to requirements of Mach 3 and low-level attack vehicles. Gas diode rectifiers rated at 0.125, 2 and 10 amp operate to +932 F. Magnetic amplifiers operate to +752 F.

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

Epoxy Laminate 426

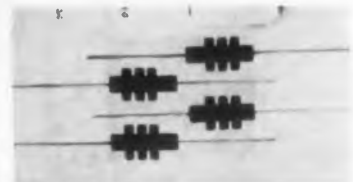
Sheets, strips, coils are offered. Able to meet MIL-P-18177B, this glass-cloth epoxy laminate is 0.015, 0.022, 0.032 or 0.062 in. thick. Designation is X6G-280. Also offered, type X6G-278 has thicknesses of 0.007, 0.01, 0.02, 0.032 and 0.062 in.

Swedlow, Inc., Dept. ED, Box 2324, Youngstown, Ohio.

CIRCLE 87 ON READER-SERVICE CARD ➤

NEW PRODUCTS

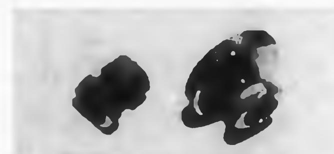
Coil-Wound Chokes 383



Range is 0.5 to 5 mh. Having fixed inductances, series 2953 units are for military and commercial applications. They have high self-resonant frequency, thereby increasing the useful frequency range.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.
P&A: $0.58 ea; from stock.

Shaft Locks 393



Devices fit 1/8- and 1/4-in shafts. They are for use of potentiometers, capacitors, coils and other shaft-type controls. Knurled hand nut or wrench hex nut types are offered. Construction is of passivated stainless steel or black anodized aluminum.

PIC Design Corp., Dept. ED, 477 Atlantic Ave., East Rockaway, L.I., N. Y.
Availability: from stock.

Lug-Type Resistor 394

Rating is 10 w. Wound on ceramic cores 5/8 in. in diameter, units have resistance values from 0.51 to 51,000 ohms. Vitreous enamel anchors the turns and protects the windings. Mounting centers are 2-3/16 in.

Ohmite Manufacturing Co., Dept. ED, 3670 Howard Ave., Skokie, Ill.

Analog Computer 411

Design is simple. Designed mainly for educational purposes, this computer is assembled by unit construction. The basis is a module of 10 operational amplifiers which can be expanded up to 20. Other elements such as servo multiples can be added.

Redifon Ltd., Computer Div., Dept. ED, Gatwick Road, Crawley, Sussex, England.

NEW PRODUCTS

Step Control System 395

Circuitry is solid state. The Marc IX provides select-before-command control for electric power substations, pipelines and other systems. Time-division multiplex control and coded information is transmitted as dc pulses over telegraph-grade lines, or signals can be sent over carrier, microwave or vhf links.

Moore Associates, Inc., Dept. ED, 893 American St., San Carlos, Calif.

Phase Generator Shifter 390

Accuracy is 0.1 deg. Type 208A offers continuously variable phase angles from 0 to 360 deg and direct reading in degrees at any frequency from 50 to 1,000 cps. Variation of load impedance has no effect on phase-shift accuracy.

AD-YU Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.

P&A: $645; 1 to 2 weeks.

High-Mu Triode 454

Can deliver 10 to 20 megawatts. Operating as a switch tube in hard pulse modulators, the ML-8038 high-mu triode can deliver a pulse power output of 10 to 20 megawatts. The tube has concentric construction and when operating in oil or equivalent dielectric liquid has a maximum plate voltage rating of 125 kv. The anode is capable of dissipating 5 kw when cooled by free convection in oil.

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

P&A: $3,100; 30 days.

Audio Oscillator 451

Frequency range is 20 cps to 12 kc. Model 101 audio oscillator module is designed for use as a frequency standard or a fundamental tone generator. Specifications are: frequency range, 20 cps to 12 kc; output voltage, 4 v into a resistive load of 250 K at an input of 20 v; frequency drift, less than 1% from −25 to +50 C, less than 0.2% at input voltages from 18 to 21 v.

Henry Francis Parks Laboratory, Dept. ED, P.O. Box 1665, Lake City Station, Seattle 55, Wash.

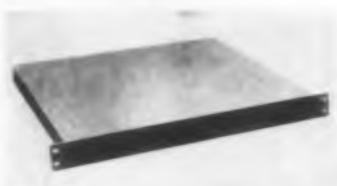
***P&A:** $15 ea; immediate.*

Silicon Rectifiers 464

Piv range is 50 to 600 v. Types SLA 536, 537, 538, 539, 540, 1095 and 1096 are diffused-junction miniature units requiring no heat sink. Ambient temperature is as high as +165 for some units. These replace the previous IN units.

Slater Electric Inc., Industrial Div., Dept. ED, 45 Sea Cliff Ave., Glen Cove, L.I., N.Y.

Digital Recording System 447



Has built-in converter. Model 1150R digital recording system converts analog voltages, in the range of 0 to 9.9 v, to a two-digit, binary decimal code. This eight-line bdc is available from parallel outputs. Range of driving currents is 0 to 30 ma. Conversion time is 200 μsec max. Stacking will give 36 complete channels in a single 6-ft relay rack.

Navigation Computer Corp., Dept. ED, Valley Forge Industrial Park, Norristown, Pa.

***P&A:** $997; 30 days.*

Insulation Sleeving 458

Temperature range is −90 to +600 F. SR-398 silicone rubber-coated fiberglass meets MIL-I-3190B and MIL-I-18057A. The dielectric strength at 23 C for 96 hr at 50% RH is 8,000 v for grade H A-1, 4,000 v for grade H B-1 and 2,500 v for H C-1. Insulation exceeds 1,000 K per ft.

L. Frank Markel & Sons, Dept. ED, Norristown, Pa.

NEW PRODUCTS

Position Indicator 397

System includes magnetic amplifier. Model 1797, composed of solid-state devices, actuates a relay when a control rod of an atomic reactor is in the safe position. No physical contact or coupling with the control rod is necessary.

Lumen, Inc., Dept. ED, P. O. Box 905, Joliet, Ill.
P&A: $672; 7 weeks.

Tantalum Capacitors 448

Range from 0.01 to 150 mf. Tantalum wire electrolytic capacitors have a tantalum wire anode in a silver case insulated with Mylar sleeving. They are intended for coupling, filter and by-pass uses in nonresonant, low-voltage, dc circuits. Range for the 13 case sizes is from 0.01 to 150 mf and voltages are to 150 v. The size E case ranges from 150 mf at 1.25 v dc to 25 mf at 16 v dc.

Ohmite Manufacturing Co., Dept. ED, 3671 Howard St., Skokie, Ill.

Pushbutton Switchlights 375

Units have built-in, lead-lag zeroing. The 6BR dpdt units are for use where two switching functions are needed. They are rated for 25,000 cycles at 28 v dc with a 7-amp resistive load. MIL specs are met. Case is anodized aluminum.

Eldema Corp., Dept. ED, 1805 Belcroft, El Monte, Calif.

Actuator Motor 449

Diameter is 1 in. Available in permanent magnet or reversible series this compact motor is 1-in. in diameter and 2-1/2 in. in length, including gear train. It weighs only 4 oz. Designed to operate 1,000 hr without maintenance, it meets the environmental requirements of MIL-M-8609 (ASG). Duty cycle is intermittent; 20 sec on, 40 sec off. Speed is 270 to 280 rpm with normal rated load of 13 oz-in.

Omega Precision, Inc., Dept. ED, 757 North Coney Ave., Azusa, Calif.

***Availability:** Four to six weeks.*

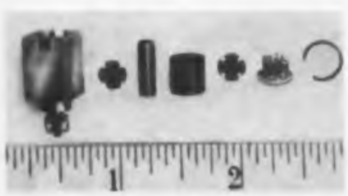
DC Power Supplies 446

Outputs are to 150 v. Units can be furnished with outputs of 0 to 36 v at 1.5, 3 or 15 amp; 0 to 50 v at 1.5 amp; 0 to 60 v at 1 or 7.5 amp; 0 to 150 v at 3 amp. Several units have dual outputs. They are suitable for lab use.

Deltron Inc., Dept. ED, 14th & Cambria Sts., Philadelphia 33, Pa.

***Price:** $240 up.*

Shielded Coil Forms 384



Devices mount horizontally. They are available with polypenco, Kel F or paper-base internal form. Suitable for use in if stages, the forms can be mounted with 2-56 screws. Mounting assembly measures 3/8 x 3/8 in.

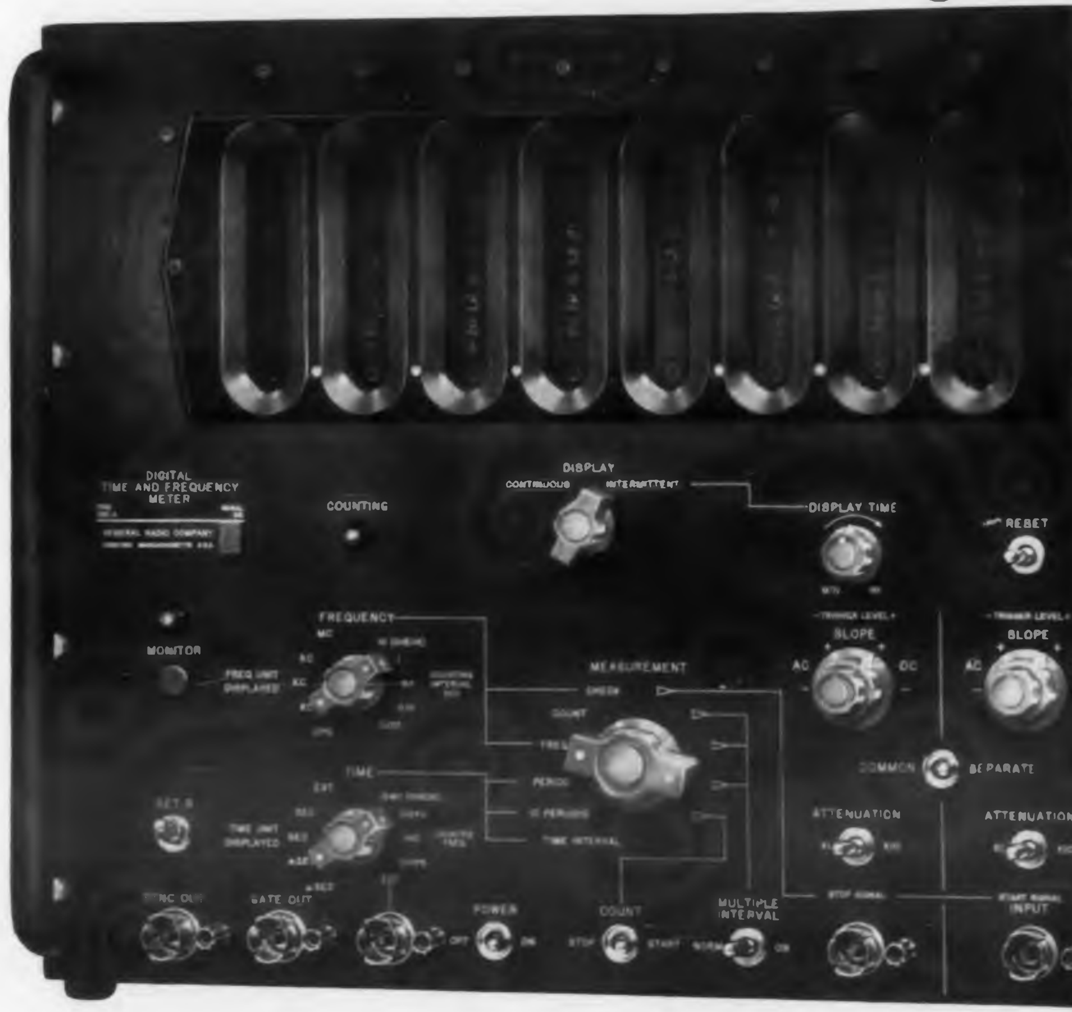
Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

the Counter with a memory

✓ No Flickering Lights

✓ No Waiting for Answers

✓ Continuous Display from dc to 10 Mc . . . another G-R first



With the turn of a switch this instrument can be converted from one with conventional intermittent display to one that is continuously counting and indicating. In the "Continuous" mode, four of the instrument's decades are used for storage and display of any four consecutive digits, while the remaining four decades count simultaneously. At the end of each counting interval, the accumulated count is transferred automatically and quickly (only 100 μsec) to the storage and display decades.

Continuous counting and display offers many advantages — information is sampled more often; pertinent data is always ready for you when you want it; analog recording is simplified; and operator eye fatigue induced by the "dancing lights" of intermittent displays is eliminated.

★ Measures frequency, period, ten-period, time-interval, frequency ratios, pulse durations, and events without special plug-in units.

★ You buy only the time-base-oscillator stability you need. Three plug-in oscillators with different stabilities are available; counter can also be used with frequency standard for maximum accuracy.

★ Input trigger-level controls permit user to minimize effects of noise on the input signal.

★ Display interval is independent of counting interval . . . No longer is it necessary to have long display times when using long counting intervals.

★ Simplified graphic recording . . . Data held by internal storage circuits is ready-made for conversion to dc for all-electronic, analog recording at low cost with the Type 1134-A Digital-to-Analog Converter.

HIGH RELIABILITY BY DESIGN

★ This instrument uses a decade code unlike that in other commercial counters. Counting circuits are practically unaffected by changes in tube characteristics, component values, and supply voltages. This counter will not "go soft" or give erroneous readings.

★ Circuits operate properly under the worst possible combination of cumulative tolerances imposed by tubes, component values, and voltage levels. An extra margin of reliability is gained by designing well below plate dissipation limits and by derating circuit components substantially. This counter will perform properly *even when its tubes approach the half-dead state.*

★ Proven "hard-bottoming" multivibrator dividers make for exceptional stability — eliminate need for periodic adjustments of time-base circuits.

★ No critical voltages. Neither plate nor filament supplies are, or need be, regulated. Even abrupt line changes do not introduce false counts.

Easy to maintain

Down time is reduced to a minimum by simplified mechanical design and accessible circuitry. Every tube circuit is on an etched-ci .uit board or plug-in decade that can be quickly removed and replaced. You can stock spare pre-tested boards for maximum speed in repair and minimum down time.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722
NEW JERSEY, Ridgefield, WHitney 3-3140
CHICAGO Oak Park VIllage 8-9400
PHILADELPHIA Abington HAncock 4-7419
WASHINGTON, D.C. Silver Spring JUniper 5-1088
SAN FRANCISCO Los Altos WHitecliff 8-8233
LOS ANGELES Los Angeles HOllywood 9-6201
IN CANADA, Toronto, CHerry 6-2171

NEW PRODUCTS

Lead-Sulfide Photo Cells 367

Units are hermetically sealed. These infrared cells are for use in computers, guidance systems, temperature measuring devices and other applications. Environmentally stable, they have pins for socket mount or flexible leads.

Cetron Electronic Corp., Dept. ED, 715 Hamilton St., Geneva, Ill.

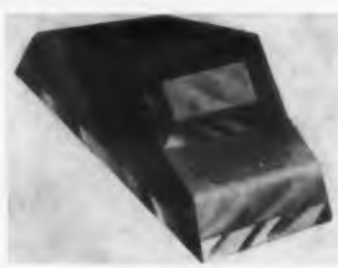
Vapor Degreaser 392

Unit has automatic feedback device. It is for cleaning intricate aircraft and electronic equipment. The chamber is 12 x 12 x 8 in. Liquid level is controlled by an instant-responding, hermetically sealed unit. Recirculation and filtering are automatic.

Powertron Ultrasonics Corp., Dept. ED, Garden City, L.I., N. Y.

Price: \$2,900 to \$6,000.

Interrogator 398



Unit operates remotely with computer. Model 2502 sends and receives information in a few minutes. The keyboard contains 40 alphanumeric keys. A 6- or 7-bit binary code may be used. Bit rate is 1 mc; character transmission rate is 15,800 characters per sec.

Information Products Corp., Dept. ED, 156 Sixth St., Cambridge, Mass.

NEW PRODUCTS

Temperature-Humidity Chamber 441

Temperature range is 0 to 200 F. Humidity range is 20% to 95% RH. Suitable for testing components, the Enciron-Cab meets JAN and Mil specs. A 1/4-hp motor-driven blower supplies air circulation. Interior dimensions are 19 x 19 x 15 in.

Hudson Bay Co., Dept. ED, 3070 W. Grand Ave., Chicago 22, Ill.

Irradiated Wire 462

Material is polyolefin. The wire provides radiation resistance, temperature and dielectric characteristics suitable for the environments of satellites and ballistic missiles. It is 30% lighter than plastic.

Radiation Materials, Inc., Dept. ED, a Div. of Loral Electronics, 825 Bronx River Ave., New York 72, N. Y.

Telemetry Receiver 467

Range is 215 to 260 mc. Model 1455 is for am-fm use in this range, has plug-in if demodulator modules for bandwidths from 100 kc to 1.5 mc and incorporates a video filter with 6 db per octave from 20 kc to 1.2 mc. Bandwidth modules may be changed without calibration readjustment.

Vitro Electronics, Div. of Vitro Corp. of America, Dept. ED, 919 Jesup-Blair Drive, Silver Spring, Md. ***Price:*** *$800.*

Voltage Dividers 445

Three types are offered. Model DV-4003 has three dials and decades, DV-4004 has four and DV-4006, six. Called Dial-a-Viders, the units have dial switches and in-line readout. Input impedance is 10,000 ohms. Resolution is 0.001 to 0.000001. Phase angle is 10 kc in 0.1 deg.

General Resistance, Inc., Dept. ED, 430 Southern Blvd., New York 55, N. Y.

P&A: *$108, $144, $289; 30 days.*

Pressure Tester-Calibrator 389

Range is 5 to 10,000 psi. A pneumatic-hydraulic inspection device, model 1372 is a companion unit to the precision differential pressure tester-calibrator. Units are suitable for military use.

American Research & Manufacturing Corp., Dept. ED, 920 Halpine Ave., Rockville, Md.

***Availability:** made from stock.*

Power Supplies 450

In three models. All models contain a single 2% full scale accuracy meter to monitor voltage or current. Line regulation is ±0.1%; load regulation is ±0.2%; ripple is 1 mv rms. Model TM-03-1A has four output voltages ranging from 6 v dc at 1 amp to 28 v dc at 0.25 amp. Model TM-03-20 is rated for 5 to 32 v dc at 0 to 0.25 amp. Model TM-03-50 is rated 0 to 36 v dc at 0 to 0.5 amp.

PRL Electronics, Inc., Dept. ED, 232 Westcott Drive, Rahway, N.J.

***P&A:** From $100 to $145 ea; stock subject to prior sale.*

Clutches and Brakes 444

Sizes are 6 and 8. The Clutch-Neutral-Brakes and Clutch-Neutral Clutches stand hi-pot test of 750 v ac rms and environmental extremes. Power consumption is 2.5 to 3 w at 24 v dc. Miniature and lightweight, the units can be used in computer, control and servo-positioning.

Guidance Controls Corp., Dept. ED, 110 Duffy Ave., Hicksville, L.I., N.Y.

NEW PRODUCTS

Servo Amplifier 455

High temperature type. Model 50-100 miniature, transistorized servo amplifier occupies a volume of 0.86 cu-in. It can deliver up to 3.5 w at 40 v rms into a center-tapped size 11 servo motor. Nominal gain is 6.500 at 10-K input impedance. Silicon transistors are used to insure operating temperatures to 100 C.

Servo Development Corp., Dept. ED, 2 Willis Court, Hicksville, L.I., N.Y.

Variable Capacitors 443

Range is 4 to 143 pf. Units have 500. 600 or 700 wvdc. Type CT12 is screw-driver operated, CT13 is screw-driver operated with a locking hex nut on the front end, types CT14 and CT15 are shaft-operated for knob control.

Hammarlund Manufacturing Co. Inc., Dept. ED, 460 W. 34th St., New York 1, N. Y.

Heater-Cathode Tubes 463

Warm-up time is 5 sec. Type QV112 is a medium-mu triode and QV113, a sharp cut-off pentode. For missile use, they have the T-3 envelope, operate in the vhf region and have bulb temperatures to 220 C. Type QV112 has a 1-amp per cathode peak current for pulse applications.

Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass.

Silicon Rectifiers 465

Piv range is 100 to 600 v. The rms voltage is 70 to 420 v. Peak one-cycle surge current is 1.5 to 3.5 amp. Types SLA440, 441, 442, 443, 444, 444B, 445 and 445B are for operation at 150 C; types SLA440B, 441B, 442B and 443B, for 165 C. These diffused-junction units replace the series prefixed IN.

Slater Electric Inc., Industrial Div., Dept. ED, 45 Sea Cliff Ave., Glen Cove, L.I., N.Y.

Printing Counter 453

For servo read-out. The basic high speed, add-subtract printing counter, designed primarily for servo read-out, has three digits. Additional digits or decimal points may be incorporated. An automatic indexing mechanism, printing ribbon drives and a printing solenoid are available. Printing speed is up to 5,000 counts per min; starting torque is 0.05 in.-oz.

Radson Engineering Corp., Dept. ED, Macon, Ill.

Transistor-Transformer Kit 456

Transformers cover to 200,000 ohms. They range in size from 3/8 x 3/8 x 3/8 in. to 3/4 x 3/4 x 1 in. Nine units, for servo, audio, instrumentation and control, are furnished.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

P&A: $27.50; from stock.

Radioisotopes 459

Radiochemical purity is 99%. Bismuth 207 and Barium 133 are offered. Both can be used as standards. Cyclotron standards, requiring A.E.C. license for use, can also be furnished.

Nuclear Science & Engineering Corp., Dept. ED, Box 10901, Pittsburgh 36, Pa.

Vibration Machine 442

Acceleration is 50 g max. Designed to drive three tables simultaneously, type RVP-16-50 has a 50-lb test load and operates in the range of 5 to 60 cps with total excursions of up to 0.1 in. It is suitable for military use.

L.A.B. Corp., Dept. ED, 501 Onondaga St., Skaneateles, N. Y.

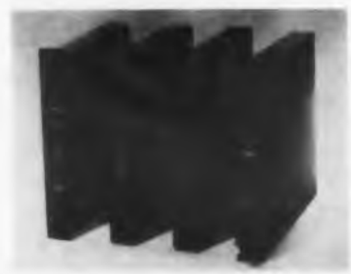
NEW PRODUCTS

Impedance Bridge 478

Is accurate and versatile. Model 710A impedance bridge is useful in measuring capacitance and dissipation factor of capacitors, inductance and storage factor of inductors, and the ac and dc resistance of resistors. Bridge measures 0 to 12 meg in 8 ranges, 0 to 1,200 μf in 7 ranges, and 0 to 1,200 h in 7 ranges. Accuracy is ±0.1% to ±2%.

John Fluke Manufacturing Co., Inc., Dept. ED, Mountlake Terrace, Wash.
Price: $525.

Aircraft Instruments 479



In vertical design. Instrument indicators built in separate vertical housings offer compactness and readability. Included are a Mach speed indicator, acceleration, rate of climb, and altitude indicators. Units measure 1-1/8 in. wide.

Kollsman Instrument Corp., Dept. ED, Elmhurst, N. Y.

RFI Equipment 480

Covers 20 to 400 mc. Model NM-30A is a sensitive, frequency-selective, calibrated vhf microvoltmeter and receiver covering 20 to 400 mc with a constant impulse bandwidth of about 200 kc. Set has if output for panoramic display, and power supply with 0.5% regulation. It is approved for military use.

Stoddart Aircraft Radio Co., Inc., Dept. ED, 6644 Santa Monica Blvd., Hollywood 38, Calif.

Impulse Counter 481

Is surface-mounted. A rectifier incorporated in impulse counter type TCeBZ5A provides reliable dc operation from a 110-v ac source. The 5-digit counter is rated at 667 counts per min. Reset is provided.

Landis & Gyr, Inc., Dept. ED, 45 W. 45th St., New York 36, N. Y.

Proximity Switch 482

With latching action. Proximity switch performs a latching, maintained-contact or 2-position switch function. Switch is actuated by motion in the side or top sensing areas. It has spdt contacts rated at 1,250 w, 120, 240 and 480 v ac. Enclosed in a hermetically sealed brass housing 1-1/2 x 1-1/2 x 4-1/2 in., it is shock resistant, mounts in any position, and operates from −50 to +250 F.

General Equipment & Manufacturing Co., Dept. TPR, Dept. ED, 116 S. Campbell St., Louisville 6, Ky.

Price: $39.25.

Pust-Button Switch 483

Meets MIL-S-6743. Double-break, momentary contact push-button switch is return-spring operated. Case, cover and button are diallyl phthalate. Life is 100,000 cps min; temperature range is −70 to +190 C. Designed for 28 v dc or 115 v, 400 cps, switch has resistive or inductive capacity of 10 amp, motor current rating of 6 amp.

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

Isolation Switch 484

Protects against shock, vibration. The ISO-SKID consists of one or more shock pads attached to a shelter or container. It is re-usable and can be load-matched to any configuration. Temperature range is −65 to +160 F.

Craig Systems, Inc., Dept. ED, Lawrence, Mass.

NEW PRODUCTS

Multiple Sockets 485

Mounted on strip or plate. Multiple arrangements of lamp sockets are supplied assembled with sockets spaced and wired to specifications. A variety of bracket materials, socket types, and lead terminations is available. Prototype samples can be supplied against a submitted sketch or drawing.

Leecraft Manufacturing Co., Inc., Dept. ED, 58 Greene St., New York 12, N. Y.

Displacement Gyro 457

Unit has two-axis design. It is for use in missile programs requiring flight guidance for short durations. A spring device runs the gyro to a maximum speed in 0.1 sec. Hermetically sealed, the gyro resists environmental conditions.

U.S. Time Corp., Dept. ED, Middlebury, Conn.

Printed-Circuit Connector 486

Take over 40 g. Printed-circuit connectors will sustain prolonged vibration of over 40 g from 5 to 2,000 cps without circuit discontinuity. Positive pressure and moisture seals are provided; temperature range is −60 to +450 F. Contact spacing is 0.156 in. Single and double connectors provide circuit combinations for boards, tape and wiring with 5 to 86 contacts.

Matrix Science Corp., Dept. ED, 3311 Winona Ave., Burbank, Calif.

Silicon Rectifiers 466

Piv range is 50 to 1,000 v. The rms voltage is 35 to 700 v. Peak one-cycle surge current is 300 amp at 25 C; forward voltage drop is 1.2 v dc. Units are SLA5, 10, 20, 30, 40, 50, 60, 80 and 100. Temperature range is −65 to +175.

Slater Electric Inc., Industrial Div., Dept. ED, 45 Sea Cliff Ave., Glen Cove, L.I., N.Y.

Delay Lines 578

For printed circuits. A series of lumped constant delay lines features compact design. The delay lines display low distortion, excellent thermal stability, and fast rise times. Units can be cascaded to obtain delays from 0.1 to 10 μsec, and beyond, and can be stacked in any required multiples. They are completely sealed.

Vanguard Electronics Co., Dept. ED, 3384 Motor Ave., Los Angeles 34, Calif.

Cathode Follower 582

Has output impedance of 300 ohms. Model 301 has an input impedance in excess of 1,000 meg, and frequency range from 0.1 cps to 500 kc ±1% Noise level is less than 20 x 10^{-6} v, gain is 0.98. A built-in test signal is provided; the unit is rack mountable or portable in its own case. Weight is 9 lb and size is 2-7/8 x5-5/8 x 10-5/8 in.

United Aerotronics Corp., Dept. ED, Burlington, N.J.

Price: $266.00.

Digital Display 576

Has lamp driver card attached. Digital decade display has 2 transistors per lamp, one for accepting binary coded decimal inputs and the other to amplify the signal to provide the correct power for driving. The lamps operate on a signal level between −6 and −12 v dc. Sizes 2-1/8 x 1-1/4 x 9-1/2 in. deep.

Wang Laboratories, Inc., Dept. ED, Natick, Mass.

P&A: $80.00; from stock.

CIRCLE 109 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Control Switch 490

Reacts to 1.8 μa or less. Up to 15 amp can be switched. The unit operates solenoids, heaters, regulators, instruments and contact meters. The current is amplified by a vacuum-tube circuit which energizes the control relay.

Central Scientific Co., Div. of Cenco Instruments Corp., Dept. ED, 1700 Irving Park Road, Chicago 13, Ill.

Filter Chokes 491

For series or parallel. High-current chokes are rated at 1 v rms, 60 cps, and have dual windings. C-2690 is rated at 0.3 h at 1 amp dc with a dc resistance of 3 ohms, for series operation; it is rated at 0.075 h at 2 amp with 0.75 ohm dc resistance for parallel operation. Model C-2691 is rated at 80 mh at 2.5 amp dc.

Chicago Standard Transformer Corp., Dept. ED, 3501 W. Addison St., Chicago, Ill.

Landing Instrument 492

Provides ILS information. Model 334D-2 provides localizer indication, to-from information, reciprocal bearing, left-right VOR, VOR course selection, glidescope needle and warning flags. It is transistorized and weighs 2.6 lb.

Collins Radio Co., Dept. ED, P. O. Box 1891, Dallas 21, Tex.

P&A: $1,185; from stock.

Delay Line 493

Delay is 1.5 μsec. Rise time of this lumped-constant delay line is 0.03 μsec. Impedance is 500 ohms. Model L966C occupies 6 cu in. and is housed in a can 6 x 2 x 1/2 in. for printed-board mounting. Attenuation is 0.2 db, delay accuracy is ±1% and temperature coefficient is 25 ppm per deg C.

Columbia Technical Corp., Dept. ED, Woodside, N. Y.

Miniature Diodes 494

In glass package. Six diffused silicon mesa diodes, MA-4303 through MA-4308, use an all-glass package with hard glass fused directly to the junction. The rugged diodes have low leakage; switching time is typically 2 nsec. Power dissipation is 200 or 125 mw in a size of 0.060 x 0.125 in., with slightly less dissipation in a 0.060 x 0.090 case size. Allowable junction temperature is 200 C; operating temperature range is −61 to +200 C.

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

High-Voltage Regulators 495

Range is 400 to 2,000 v. Long-term stability is 0.5%; temperature stability is better than 0.01% per deg C. Voltage tolerance is ±2.5%. The CS 3, a low-current, gas-discharge type, is for supply circuits, counter tubes, photomultipliers and general voltage-reference use.

Connolly & Co., Dept. ED, P. O. Box 295, Menlo Park, Calif.

Printed-Circuit Press 496

Operation is automatic, continuous. Roll-feed system provides for dry printing of a thermoplastic in a wide range of widths and lengths of impressions. It can be fitted for conventional production or varied according to customer specs.

Dry Screen Process, Inc., Dept. ED, 1020 Madison Ave., Pittsburgh 12, Pa.

NEW PRODUCTS

Trimmer Capacitor 497

Range is 1 to 18 pf. Four models are offered. Each has one wire lead and one tab lead. Other features are: fixed-cavity tuning, linear tuning curve, thermal stability and combination of glass and hardware for low inductance. Units are designated Mini-Trimmers.

Corning Glass Works, Dept. ED, Corning, N. Y.
Availability: Samples.

X-Band Isolators 498

In 108 models. Isolators are available in 600-mc or 1.1-kmc bandwidth increments. Over a 500-mc band, forward and reverse vswr is 1.1 max; over an extended band, it is 1.22 max. Temperature range is −40 to +85 C. Lengths are 1, 1.25 and 1.5 in.

E & M Laboratories, Dept. ED, Van Nuys, Calif.
Price: $125 to $145.

Carbon-Film Resistors 499

Power ratings are 1/8 to 8 w. Voltage rating is as high as 1,000 v. Coaxial type L and axial types P and S have resistances of 5 ohms to 2 meg. Type V is subminiature in design for printed circuit use. Type F is microminiature for the most stringent space requirements.

Fi-Ohm Co., Dept. ED, Suite 1417A, 360 N. Michigan Ave., Chicago 1, Ill.
Price: 1/2 to 3 cents each.

Synchro Simulator 500

Provides synchro transmitter signal. Model SO-102 Dator synchro signal simulator is suitable for introducing precise angular position data into servo systems for test and evaluation. Models are available to simulate a broad range of synchro types of 50 to 1,000 cps; 3-min accuracy is maintained with up to 3 synchro control transformers connected to the unit at once. Size is 5-1/4 x 19 x 8-1/2 in. deep. Weight is 10 lb.

Angler Industries, Dept. ED, 3 Lexington Drive, Metuchen, N. J.
Price: $285.

Motor Alternator 501

Provides 50-cps power. Motor alternator BG-4-2 operates on 26 v, 400 cps, 3 phase and provides 15-v, 50-cps, 2-phase power. Harmonic content is less than 4% in each phase. Unit conforms to MIL-E-5400.

General Precision, Inc., Kearfott Div., Dept. ED, Little Falls, N. J.

Calibration Tester 502

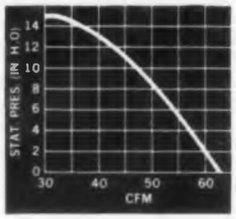
Stimulates transducer output. Calibration tester BH153 is a direct-reading adjustable voltage source, simulating dc output of transducers with a setting accuracy of 0.05%. Scale can be graduated for direct or indirect reference, with up to 1,000 scale divisions. Size is 4 x 2-3/4 x 2-1/4 in., weight 8 oz.

Howell Instruments, Inc., Dept. ED, 3479 W. Vickery Blvd., Fort Worth 7, Tex.

Silicone Insulation 503

For wire and cable. Silicone rubber compound SE-9007 is designed for aircraft, hook-up, motor lead and similar wire applications. Tensile strength is 1,200 psi, elongation 425%. Material has high moisture resistance. Dielectric constant is 3.0.

General Electric Co., Silicone Products Dept., Dept. ED, Waterford, N. Y.



NEW PRODUCTS

Chopper 537

Electro-mechanical type. Model 40 low-noise chopper is designed for 400-cps drive. It withstands 100 g shock and vibration in any direction. Dwell time is 150 to 185 deg. Phase angle is 60 ±15 deg, and signal level is 10 v dc max at 2 ma. It has a working temperature range of −65 C to 100 C, with a rated life exceeding 2,000 hr. Weight is 9 g.

Airpax Electronics Inc., Cambridge Div., Dept. ED, Cambridge, Md.

P&A: $49.00 ea, 1-6; 2 to 3 weeks.

Silicon Transistor 567

Beta is 100 to 300. Double-diffused mesa transistor 2N1507, housed in TO-5 package, dissipates 2 w at 25 C case temperature. Operating collector junction temperature is 175 C; collector-to-base voltage is 60 v. The npn device has 10-ohm max saturation resistance.

Texas Instruments, Incorporated, Dept. ED, P. O. Box 5012, Dallas 22, Tex.

Azimuth Theodolite 540

Accurate to 1 sec. Model 23-210 azimuth alignment theodolite permits precise angular alignment to known geographical references and measures or monitors rotation of remote objects. It has a built-in telescope for sighting small or remote targets and an optical micrometer with which the instrument can be zeroed and precise angular measurements made. It is for all-weather use.

Barnes Engineering Co., Dept. ED, 30 Commerce Road, Stamford, Conn.

HF Relay 539

General purpose type. Model RF utilizes low-loss diallyl phthalate molded plastic insulation. It is also available in plastic or metal-covered plug-in types. Suitable for hf current, it has UL type terminal boards; two-piece latches are also available.

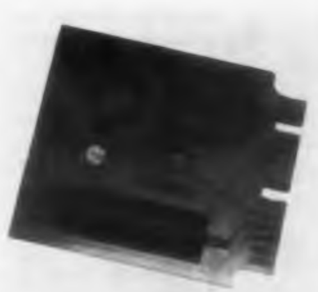
Artisan Electronics Corp., Dept. ED, 171 Ridgedale Ave., Morristown, N. J.

Power Amplifier 541

RF output up to 4 w. Type 230-A employs three tuned, cascaded stages of grounded grid design for a power gain of 34 db min over the range of 10 to 500 mc. It will reproduce am, fm, and pulse modulation signals. With a regulated power supply and rf output voltmeter, the unit is designed for either rack or cabinet mounting.

Boonton Radio Corp., Dept. ED, Boonton, N. J.

Relay Module 563



For switching, gating. This relay building block consists of two transistor-driven relays. Speed of operation is 1 msec, power is 300 mw and life is 200,000,000 operations. It is for use in digital systems where solid-state switches are unsuitable.

Control Equipment Corp., Dept. ED, 19 Kearney Road, Needham Heights 94, Mass.

NEW PRODUCTS

Accelerometer 511

Output is 250 mv per g. Model 2219 accelerometer, for measuring low vibration levels, provides a signal-to-noise ratio of 10 db for 0.0002 g peak. Resonance frequency is 12 kc. Temperature response with 100-pf capacity is ±8% deviation from +32 to +230 F.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

Price: *$200.*

Cooling Units 512

Range from 50 to 50,000 w. The units transfer heat from locations where high temperature is harmful to components, to remote locations. Completely self-contained, they consist of liquid circulators, liquid-to-air heat exchangers and interlocks as required.

Electro Impulse Laboratory, Inc., Dept. ED, 208 River St., Red Bank, N. J.

Power Supply 513

Provides 10 amp. Rack-mounting power supply model TR 10160 has output of 15 to 160 v, 0 to 10 amp. Regulation is 0.1% or 150 mv, ripple 3 mv rms. Transient response is 50 μsec; ambient operating temperature range is 0 to 50 C at full load. Panel height is 10-1/2 in.

Anders Electronics, Inc., Dept. ED, Brook Road, Needham Heights, Mass.

Helical Antenna 514

Lengths to 60 in. This antenna is wound of flat ribbon steel, forming its own spring tension. It can be designed into citizens band and commercial two-way communication systems so that it becomes vertically self-aligning when released. Collapsed, it occupies 1 x 2 in.

Elasticone Div., Central Safety Equipment Co., Dept. ED, 6601 Marsden St., Philadelphia 35, Pa.

Miniature Solenoid 515

For cryogenic applications. Weighing 4-1/2 oz, type 17-4H steel solenoid delivers 10-3/4 lb force at 0.02-in. stroke, at 24 v dc. Temperature range is −420 to +500 F. Missile fuels, oxidizers and other corrosive media do not cause corrosion or contamination in the solenoid cavity.

Electroid Corp., Dept. ED, 95 Progress St., Union, N. J.

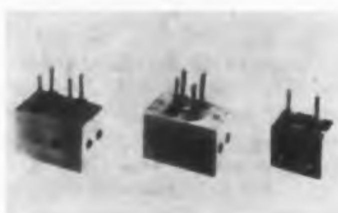
Availability: from stock.

Reactor Tubing 516

With 1% zirconium. Small diameter tubing of zirconium-columbium alloy provides higher oxidation resistance and greater strength at high temperatures than reactor grade columbium tubing. It is made in seamless form, sizes from 0.012 to 1.125 in. OD, lengths to 24 ft.

Superior Tube Co., Dept. ED, 1521 Germantown Ave., Norristown, Pa.

Thermal Conductivity Detector 517



Has high sensitivity. Thermal conductivity detectors are made for gas chromatography, thermal conductivity analyses and other related applications. Units operate in any temperature range up to 500 C. Flow shields are interchangeable; cell arrangements include 4-element, 2-element and microvolume types.

Loe Engineering Co., Dept. ED, 2092 N. Lincoln Ave., Altadena, Calif.

Induction Motors 518

Torque is 0.8 to 3 oz-in. Series M motors, for use alone or with a geared motor, are designed to resist heavy shock. No-load speed is about 3,350 rpm. Die-cast bearing brackets, with projections anchored in the field laminations, are used.

Brevel Products Corp., Dept. ED, 601 W. 26th St., New York 1, N. Y.

NEW PRODUCTS

Piezoid Ceramic 519

For transducers. Composition KE-14 is a piezoid ceramic material with electrical properties useful in transducer applications. Disks, tubes, cylinders, plates and blocks, and unsymmetrical shapes can be supplied. Dielectric constant is stable from 55 to 300 C. Elements can be supplied with electrodes and leads.

Centralab, The Electronics Div. of Globe-Union Inc., Dept. ED, 900A E. Keefe Ave., Milwaukee 1, Wis.

Dust-Free Cabinet 520

Filter unit can be removed. Model A cabinet provides a controlled environment for assembly, test and research. Dust particles of 0.08 to 80 microns in diameter are arrested. The filter stops dust particles of 0.5 to 1 micron at an efficiency of 99.25%. The work chamber is 36 x 28 x 18 in.

Cambridge Filter Products Corp., Dept. ED, 738 Erie Blvd., E., Syracuse 1, N. Y.

General-Coverage Receiver 521

For ssb, am or cw signals. Model 51S-1 provides continuous coverage of 2 to 30 mc in 30 bands, supplemented by a range of 0.2 to 2 mc for broadcast monitoring and laboratory use. A direct-reading frequency presentation uses a counter-type dial for megacycles and a linearly calibrated dial for kilocycles.

Collins Radio Co., Dept. ED, Cedar Rapids, Iowa.

Capacitance Tester 522

For semiconductors. Model 1827 C_{ob} test set provides direct meter readings of collector capacitance. Ranges are: 0 to 3, 0 to 10, 0 to 30, and 0 to 100 pf. The unit can be used with diodes when reversed biased or with transistors. Accuracy is 5%.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N. Y.

P&A: $425; 30 days.

Shock Accelerometer — 523

Resonance frequency is 80 kc. Model 2225, for measuring shock and impact transients, has a nominal sensitivity of 0.6 mv peak per g with 300-pf external capacity. Dynamic range is a maximum sinusoidal 10,000 g and maximum shock is 20,000 g with 75-μsec half-sine pulse. The unit weighs 0.46 oz.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

Price: $175.

Scope Cart — 524

With tilt tray. The 200 series of scope carts provide convenient mobile support for oscilloscopes and auxiliary equipment. Tray can be tilt-locked in 9 positions. A plug-in carrier is optional. Type 201 is 10-1/2 in. wide, type 202 is 14 in. wide.

Tektronix, Inc., Dept. ED, P. O. Box 500, Beaverton, Ore.

Induction Motor — 525

Drives axial-vane blowers. Motor may be used in aircraft equipment and can operate at altitudes to 30,000 ft. Class H temperature insulation is used. Ratings include: 0.5 hp; 200 v at 400 cps, three phase; 11,400 rpm; continuous duty.

Kearfott Div., General Precision, Inc., Dept. ED, Little Falls, N. J.

Filament Transformer — 526

Has low capacitance. Transformer type NT-341 is made for 20-kv continuous-duty pulse applications. Secondary is supported on an insulating boss while both the primary and secondary coils are individually shielded and encapsulated. Total capacitance of the 75-va secondary is 20 pf to primary and ground. Maximum dimension is 6 in. Other sizes are available.

Knopp Inc., Dept. ED, 1307 66th St., Oakland 8, Calif.

NEW PRODUCTS

Semiconductor Bases 427

Steel rings are brazed in place. The base material is copper alloy with electrical and thermal conductivity comparable to oxygen-free copper. Standard sizes are 7/16, 9/16 and 11/16 in. across-flat hexagon dimension. Units have an annular projection for welding.

Standard Pressed Steel Co., Dept. ED, Jenkintown, Pa.

Aircraft Test Device 439

Margin of error is 0.025%. This analog-to-pressure converter simulates flight conditions to insure accurate altimeter and air-speed readings when the plane is in the air. The unit can also serve in industrial applications, indicating pressure.

Motec Industries, Dept. ED, 6344 Arizona Circle, Los Angeles, Calif.

TV Pickup Tube 434

Resolution is 600 lines. The 7037 Vidicon is for use in film scanning, studio broadcasting and industrial applications. It permits live pickup from scenes with 100 to 200 ft-c. It may be used with 2 ft-c min face-plate illumination.

English Electric Valve Co. Ltd., Dept. ED, Chelmsford, England.

Induction Motor 431

Rating is 15.5 hp. Other features of the F-30-3 include: power, 200 v at 400 cps, three phase; speed, 11,600 rpm; duty, continuous. It is designed to drive an axial-vane blower but is adaptable to other military and commercial uses. It is thermally protected.

Kearfott, Div. of General Precision, Dept. ED, Little Falls, N. J.

Epoxy Resin System 415

It is for continuous use at 155 C. Type XR-5029 low-viscosity resin is stable at room temperature. Pot life is 7 days at 65 C or 4 days at 95 C. Curing is 8 to 16 hr at 150 C; extended curing increases electrical and high-temperature properties.

Minnesota Mining & Manufacturing Co., Dept. ED, 900 Bush Ave., St. Paul 6. Minn.

Semiconductor Tester 429

Unit measures six parameters. The ACE-700 is primarily for transistor and other semiconductor measurements but is adaptable to many other two- or three-terminal network measurements. It accepts up to 50 transistors or diodes. Design is modular.

Cook Electric Co., Dept. ED. 2700 Southport Ave., Chicago 14, Ill.

Induction Motor 527

Resists severe environments. Type E-10-1A is suitable for military as well as commercial applications and meets MIL-M-7969 and MIL-E-5272. Ratings are: 1/7 hp; 208 v at 400 cps, three-phase; 5,500 rpm; continuous duty. It weighs 6 lb 10 oz.

Kearfott Div., General Precision, Inc., Dept. ED, Little Falls, N. J.

Computer 528

Processes test data. Binary data is entered directly into the computer, where it is automatically converted to decimal form. Designated 7072, the system is available with a magnetic core of 5,000 or 10.000 10-digit decimal words. It is tape-oriented with speeds of 7,200 or 20,000 characters per sec.

IBM. Data Processing Div., Dept. ED, 112 E. Post Road, White Plains, N. Y.

Price: $860,550.

NEW PRODUCTS

DC Amplifier 529

Gain is 10 to 3,500. Model 11300 uses model I1300 second-harmonic modulator at an excitation frequency of 2,000 cps. Output is bidirectional. Current input is 0.1 to 30 μa. Gain stability is 0.5% of span. Linearity is 10 mv for 2% of span.

Coldstream Engineering Co., Dept. ED, Box 1893, Tulsa, Okla.

P&A: *$375; 4 weeks.*

AC Coupling Card 530

Has 10 circuits. Compatible with the firm's 200-kc digital modules, the solid-state AC-1 allows reduction in the number of basic cards used. It also triggers one-shot delays. The circuits provide collector-controlled steering of shift signals. Dimensions are 4-3/8 x 4-1/2 in.

Computer Logic Corp., Dept. ED, 11800 W. Olympic Blvd., Los Angeles 64, Calif.

Induction Motor 531

Rated at 1/25 hp. Made for military and commercial use, motor D-10-9A operates on 208 v, 400 cps, 3 phase. Speed is 7,200 rpm, weight 3 lb 2 oz. The totally enclosed motor conforms to military requirements.

General Precision, Inc., Kearfott Div., Dept. ED, Little Falls, N. J.

Battery Regulator 532

Regulation is ±1%. Voltage variation in the battery can be up to 20% at 5 to 50 amp and at temperatures to +120 C. Silicon-controlled rectifier circuitry is used.

Crydom Laboratories, Inc., Dept. ED, 12850 Western Ave., Garden Grove, Calif.

Compression Accelerometer 533

Range is 0.5 cps to 2 kc. Response is flat within ±5% throughout range and over an acceleration range of 0.0016 to 1,000 g. Resonant frequency is 15 kc, cross sensitivity is 5% max and capacity is 750 pf nominal. Designation is 410.

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

P&A: $185; 2 weeks.

Slip-ring Assembly 534

With brush lifter. Sealed, 10-circuit slip-ring has a manually operated brush lifter to avoid wear when measurements are not being made. The ring is encased in stainless steel with permanently lubricated bearings and sealed for operation in the presence of contaminants. The unit, model SR10M, is 2 in. in diameter by 1-5/8 in. long.

Michigan Scientific Co., Dept. ED, 730 Bellevue, Milford, Mich.

Moisture Meter 535

Accurate to ±5%. A portable laboratory moisture meter, the Hygromite continuously monitors water vapor in gas. Ranges are 0 to 10, 30, 100, 300, and 1,000 ppm. A special electrolytic cell is used in monitoring gases having hydrogen concentrations greater than 50%.

Technical Information Dept., Beckman Scientific and Process Instruments Div., Dept. ED, Fullerton, Calif.

Terminal Board Assembly 536

All hardware is furnished. No. 1422 assembly is made of GSG laminated silicone cloth as per MIL-P-997B and measures 2 x 13-1/8 in. Spring-loaded diode clips for quick-disconnect use are furnished. The terminal board is suitable for use with all types of components.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

NEW PRODUCTS

Remote Switch 504

Has 8pdt contacts. Remotely operated selector switch has contacts rated at 5 amp. Actuating voltage is 115 v ac; continuous actuating power is not required in any switch position. Life is 40,000 actuations, switching time 100 msec.

Bay-Roy Electronics, Inc., Dept. ED, P. O. Box 7503, Cleveland 30, Ohio.

Dual-Trace Preamplifier 505

For Memo-Scope. Preamplifier model 05-2 is made for use with model 105 oscilloscope. It uses a blanked writing beam during switching time when operated in the chopped mode. Chopped displays are provided simultaneously, alternately or singly. Pass band is dc to 10 mc, chopping rate 270 kc.

Hughes Aircraft Co., Industrial Systems Div., Dept. ED, P. O. Box 90904, Airport Station, Los Angeles 45, Calif.

Transponder 506

For flight testing. Transponder unit consists of a receiver, transmitter and transistorized power supply. It receives on 37 mc and transmits on 74 mc. Input voltage is 5.5 to 10 v; output is 175 ±2.5 v. Ripple does not exceed 0.5% of output.

Frequency Standards, Dept. ED, P. O. Box 504, Asbury Park, N. J.

P&A: $400 to $900; 60 days.

Fractional-HP Motors 507

Offer high torque. Model L is a 117-v shaded-pole induction motor rated at 6.5 oz-in. starting torque, 0.025 hp, 3,250 rpm. Weight is 4 lb. Model H has starting torque of 1.0 oz-in., 0.003 hp, 2,500 rpm. Both motors operate on 117 v.

The Alliance Manufacturing Co., Dept. MJ, Dept. ED, Alliance, Ohio.

Single-Axis Accelerometers 508

Are highly accurate. Pendulum single-axis accelerometers, employing fluid damping and a torsion-bar restraint, feature high accuracy, large electrical output, and low null shift with temperature change. Typical use is in low-cost inertial systems where output is integrated to provide velocity and distance information. Types are C70 2406 001 and C70 2408 000.

General Precision, Inc., Kearfott Div., Dept. ED, Little Falls, N. J.

Wire Stripper 509

Handles AWG sizes 6 to 36. Model TS 400 thermo-electric stripper provides switching from high heat for teflon to low heat for nylon, vinyl and other materials. It has an adjustable wire-stop which may be set to any strip length. Power needed is 30 w.

Flite Electronic Wire & Components, Inc., Dept. ED, 120 S. Hewitt St., Los Angeles 12, Calif.

Gallium Arsenide 510

In single and polycrystal form. Gallium arsenide is available in wide ranges of restivity and carrier concentration. It can be supplied undoped, or doped with zinc, cadmium, manganese, tellurium, or tin. It is made in single crystals, polycrystalline ingots, and microcrystalline powders.

Alloys Unlimited Chemicals, Inc., Dept. ED, 42-73 Hunter St., Long Island City 1, N. Y.

NEW PRODUCTS

Test Vibrator 538

For vibration fatigue. Model 150-HLA-T subjects equipment weighing up to 150 lb to horizontal vibration on selected cycles or through the full frequency band of 5 to 100 cps. Acceleration and deceleration are electronically controlled. It has an overload safety factor of 50%.

All American Tool and Manufacturing Co., Dept. ED, 8021-C Lawndale Ave., Skokie, Ill.

Ferrite RF Switch 552

Range is 225 to 400 mc. Insertion loss is less than 0.2 db, isolation greater than 50 db. Power rating is 12 kw avg and 20 kw peak, switching time is 3 msec. Uses include antenna switching, lobe-shifting and time-division multiplexing.

Cook Electric Co., Dept. ED, 2700 Southport Ave., Chicago 14, Ill.

Servo Repeater 555

Accuracy is 6 min. Servo repeater C70 9752 001 receives analog voltages and provides readout in degrees and minutes. Readout error is ±6 min, with full scale response in 14 sec. Unit can be modified to indicate virtually any information.

General Precision, Inc., Kearfott Div., Dept. ED, Little Falls, N. J.

Rack Cooler 542

For integral mounting. Rack air-conditioning unit model AEG-4003, conforming to RETMA and military standards, provides 1,225 w cooling at 110 F ambient and 80 F return air temperature. Static pressure is 0.50 in. of water. Panel height is 10-1/2 in., weight 150 lb. The unit runs continuously to avoid voltage fluctuations.

Budd Electronics, Inc., Dept. ED, 43-22 Queens St., Long Island City 1, N. Y.

Plastic Tubing — 561

OD range is 0.75 to 6.625 in. Wall thicknesses are 1/16 to 1/4 in. Type 200 transparent butyrate tubing has an impact strength of 2 ft-lb per in. of notch at 73.4 F. Specific gravity is 1.2. It can be drilled, sawed, tapped, lathe-turned or cut.

Busada Manufacturing Corp., Dept. ED, 32-21 Downing St., Flushing 54, N. Y.

Switch Coils — 557

For magnetic reed switches. Stock coils are made in three types for operating switches in any code group. Types S, M, and T are wound on nylon bobbins, and accommodate single-reed to 4-reed switches. They are available in a variety of dc voltages and coil ratings.

Coto-Coil Co., Dept. ED, 69 Pavilion Ave., Providence, R. I.

Price: *\$2.00 to \$0.59 ea.*

Epoxy Adhesive — 548

Cures in 60 sec at room temperature. Cure can be accelerated to 45 sec with the use of infrared heat. Minit-Cure can be used to bond metal to metal, plastic to metal, plastic to plastic, or any other porous or nonporous surfaces.

Allaco Products, Dept. ED, 238 Main St., Cambridge 42, Mass.

Price: *\$6.00 for 8-oz trial kit.*

Tape Handler — 562

Speeds to 50 in. per sec. Unidirectional model 4544 is able to handle 500 ft of 5- to 8-level tape interchangeably. It is designed to be used with the firm's model 3500 tape reader. Dimensions are 10.5 x 19 x 8.25 in.

Digitronics Corp., Dept. ED, Albertson, N. Y.

NEW PRODUCTS

Power Transistors 566

Dissipate 150 w. Alloy-junction pnp germanium transistors 2N174 and 2N1358 operate at 80 v, collector to base, and 60 v, emitter to base. Emitter current is 15 amp, collector junction temperature 100 C max. The 15.3-transistors are enclosed in standard TO-36 packages.

Texas Instruments, Incorporated, Semiconductor-Components Div., Dept. ED, P. O. Box 5012, Dallas 22, Tex.

High-Voltage Resistors 565

For radar power supplies. High-voltage resistor is a visual and audible corona-free voltage dropping unit. Modular design makes it possible to stack modules to conform with voltage requirements in a compact assembly. In addition, the spring-loaded assembly eliminates internal resistor wiring and provides positive continuity.

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

Asbestos Teflon 550

Useful from −425 to 500 F. Material has a high thermal expansion coefficient. The asbestos Teflon is inert to most chemicals and it is completely unaffected by solvents, hydraulic fluids, lubricants, or any of the common fuels. It also shows good dielectric properties.

Auburn Manufacturing Co., Dept. ED, Middletown, Conn.

Multiplier Phototube 564

For low-level signals. Tube operates under extreme environmental conditions. Type WL 7908 has a flat, 1/2-in. diam photocathode having a S-11 spectral response. It has a voltage divider network potted in the base and can be mounted in any position. Maximum ratings include a peak cathode current of 10 μa, average anode current of 1 ma, and peak anode dissipation of 2 w.

Westinghouse Electronic Tube Div., Dept. ED, P. O. Box 284, Elmira, N. Y.

Single-Crystal Silicon 560

With controlled properties. Controlled float zone silicon is offered in crystal diameters ranging from 1/8 to 3/4 in. Material is free from lineage and gross defects. Dislocations may be had in low ranges of 5,000 per cm^2; close resistivity tolerances are held.

Allegheny Electronic Chemicals Co., Dept. ED, 207 Hooker-Fulton Bldg., Bradford, Pa.

Printed Circuits 551

For multi-layer stacking. Made to customer specifications, high component density may be achieved with Intercon circuits because sections of the pattern can be left bare on both sides thus allowing direct welding of conductor ends from one section to another. They are supplied with nickel conductors for welding; gold-plated and copper conductors are available for soldering.

Amphenol-Borg Electronics Corp., Packaged Electronics Div., Dept. ED, 2863 S. 25th Ave., Broadview, Ill.

Electric Boiler 549

Used for steam cleaning. It produces high quality steam, using regular tap water or distilled water. One series is available with aluminized heating surfaces and either stainless steel or brass controls, while another series offers complete stainless steel assemblies, thus eliminating ferrous contamination of components.

Automatic Steam Products Corp., Hot Shot Div., Dept. ED, 142 W. 31st St., New York 1, N. Y.

Availability: Immediately.

IDEAS FOR DESIGN

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The *Most Valuable of Issue Ideas* will be eligible for the $1000 Idea of the Year award.

And after you've voted, why not send in an Idea of your own?

Antenna Axial Ratio Is Read Out Automatically 742

Peak-detecting circuits and an ordinary ratio meter can be used to read out the axial ratio of an elliptically polarized antenna automatically.

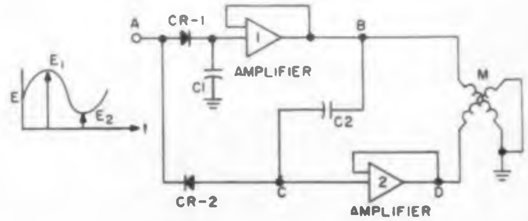
The output response of the antenna, a measure of its axial ratio, is fed into the circuit at point *A*. The axial ratio is given by the quotient E_1 / E_2.

Diode *1* allows the pe positive voltage E_1 to be stored in capacitor *C1*. Amplifier *1*, a cathode follower, reproduced the voltage *E1* at point *B*.

As the input voltage begins to decrease, diode *2* begins charging capacitor *C2*. Point *C* will then charge to the value E_2.

The voltages at points *B* and *D* are applied to the ratio meter *M*. The meter divides two voltages and the quotient is read directly from the dial. Therefore the meter will indicate the ratio E_1 / E_2, which is the desired result. The amplifiers shown are operational amplifiers connected as cathode followers.

George O. Thurman, Project Test Engineer, Hughes Aircraft Co., Tucson, Ariz.



Axial ratio, determined from antenna response characteristics and given by E_1/E_2, is read out automatically on the standard radio meter *M*.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.

Square Wave Generator Has 3.3-10 Mc Range 749

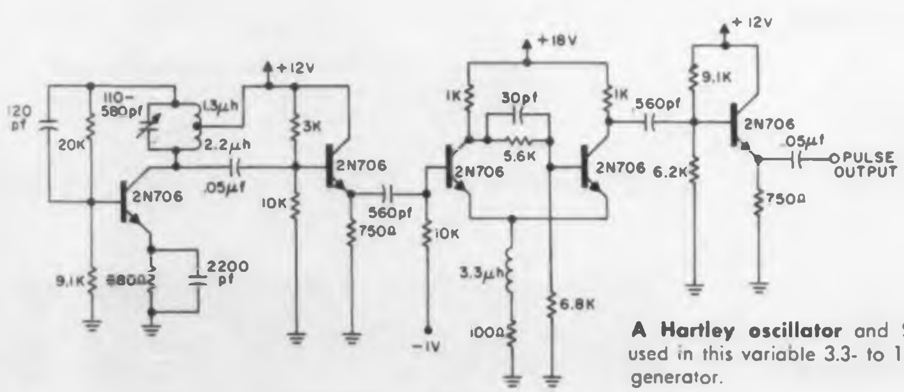
A relatively simple variable frequency square wave generator, using a Hartley oscillator and Schmitt trigger combination, was designed for a frequency range of 3.3 to 10 mc.

The oscillating frequency is set by a variable capacitor in the tank circuit of the Hartley. The sine wave then feeds into the Schmitt trigger circuit.

Emitter followers are used to match impedance between stages. The output signal has a peak-to-peak amplitude of 10 v.

Nicholas Marchese, Assistant Electrical Engineer, Lockheed Electronics, Metuchen, N.J.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.



A Hartley oscillator and Schmitt trigger are used in this variable 3.3- to 10-mc, square wave generator.

Engineer in California Wins First $50 Idea of Issue Award

A California engineer, William D. McCulley of the U. S. Naval Ordnance Test Station at China Lake, has won ELECTRONIC DESIGN's first $50 Most Valuable Idea of Issue Award.

Mr. McCulley's idea, which appeared in the Idea for Design section of the March 1 issue, was titled "Feedback Helps Flip Output of Zero-Crossing Detector."

Readers of ELECTRONIC DESIGN, who choose the most valuable Idea in each issue, gave Mr. McCulley's idea more votes than any one of the five others with which it appeared. A close second was the Idea submitted by H. F. Stearns of the General Electric Co., Syracuse, N. Y.

A $50 award is given for the most valuable Idea in each issue. The winning idea is selected by ELECTRONIC DESIGN readers, who circle keyed numbers on the Reader-Service Card. An eight-week period is allowed from the date of publication for the cards to be returned and the votes tabulated.

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards: All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:

1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:

1. Each Idea published will receive an honorarium of $20.
2. Ideas judged Most Valuable of Issue will receive $50.
3. The Idea judged to be Idea of the Year will receive the Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from amongst those judged to be Most Valuable of Issue.

Most Valuable of Issue and Idea of the Year will be selected by the readers of ELECTRONIC DESIGN. Votes will be cast by circling keyed numbers on Reader-Service Cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

For Additional Entry Blanks, circle **750** on Reader-Service Card.

SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

Entry Blank

Ideas-for-Design Editor
ELECTRONIC DESIGN
830 Third Ave.
New York 22, N. Y.

Idea **(State the problem and then give your solution. Include sketches or photos that will help get the idea across.)**

(Use separate sheet if necessary)

Here is my Idea for Design for possible publication in ELECTRONIC DESIGN. I understand that it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.

Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in ELECTRONIC DESIGN. This right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

Name ______________________ **Title** ______________________

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IDEAS FOR DESIGN

Scope Measures Propagation Delay in Asynchronous Logic 737

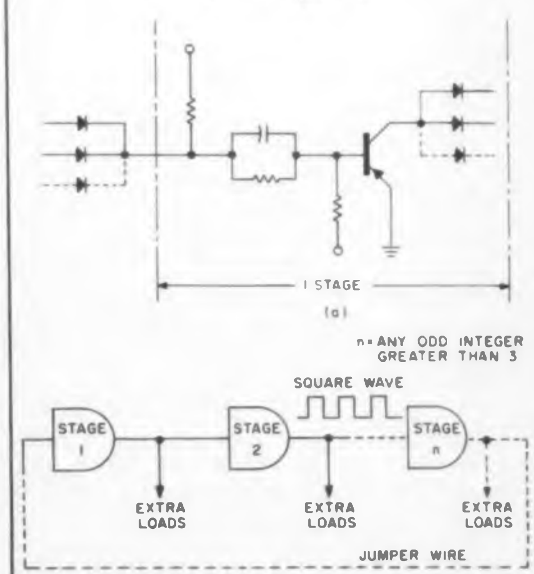
Propagation delay time in asynchronous, high-speed logic stages can be rapidly measured with only an ordinary oscilloscope. The use of a pulse generator or sampling scope is not at all necessary.

Most asynchronous logic circuits, whether they be DTL, RTL, DCTL, etc., are essentially inverters, with the general configuration shown.

To measure the propagation delay time in a cascaded series of such stages, a jumper wire is connected from the output of the n^{th} stage to the input of the 1st stage. With n constrained to be an odd number, a wavefront is initiated as soon as the jumper is added. This wavefront is self-sustaining. This is because when it propagates through the chain a second time, its polarity is opposite to that of the first pass. The wavefront circulates endlessly through the chain at a rate exactly determined by the propagation delays through each stage.

The output of any given stage is a square wave whose period T, or frequency f, can be measured with either an oscilloscope or electronic counter. By inspection we see that:

$$f = \frac{1}{T} = \frac{10^9}{2 \cdot tpd \cdot n} \quad (1)$$



Propagation delay time in asynchronous logic stages can be measured by connecting output to input and observing recurring square wave on an oscilloscope. (a) Typical DTL stage, (b) cascaded stages shows jumper wire, connecting output to input, and the generated square wave.

where f = frequency, in cps
T = period, in sec
n = number of cascaded stages
t_{pd} = propagation delay/stage, in nsec

Rearranging Eq. 1 we get

$$t_{pd} = \frac{10^9}{2 \cdot f \cdot n} \qquad (2)$$

By measuring the frequency of the square wave we can now substitute in Eq. 2 and solve for the propagation delay per stage.

There are a number of additional advantages to be gained from using this measuring technique. By making n small, very narrow pulses can be propagated through the circuits and the effects studied. By making n very large, high speed phenomena can be studied with conventional test equipment. Also, when placing logic circuits in ovens to make heat runs, the number of leads entering and leaving the chamber can be held to a minimum.

Warren E. Milroy, Supervisory Electronic Engineer, U. S. Navy Electronics Laboratory, San Diego, Calif.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.

Grind Your Own "Precision" Capacitor! 741

Everyone knows you can "adjust" the resistance of a common carbon-composition resistor by filing through the body into the carbon until the precise resistance value is obtained. This is a helpful trick for experimental breadboarding.

Value of ceramic disk capacitors can be trimmed down by grinding the capacitor away with a file or grinding wheel.

However, rather few realize that ceramic-disk capacitors can be ground down in the same way. The capacitors can be easily trimmed with a file or grinding wheel.

Thus, their capacitance can be trimmed down just as the resistance of a resistor can be trimmed up.

Al de la Lastia, Project Engineer, Universal Transistor Products Corp., Westbury, Long Island, N. Y.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.

IDEAS FOR DESIGN

Short-Cut Squares Numbers Rapidly on Sight 738

Here's how any three digit number ending in 25, 50 or 75 may be easily and accurately squared on sight. The correct answer can be written directly to the sixth significant figure.

To square any two-digit number ending in 5, multiply the next lower whole number digit by the next higher whole number digit. Write down the product and, following it, write down 25. Determine the placement of the decimal point by the usual method.

Examples: To square 7.5, multiply 7 times 8 and write down 5625. The answer is 56.25.
To square 950, multiply 9 times 10 and write down 9025. The answer is 902,500.

To square any three digit number ending in 25 or 75, multiply the next lower half-number digits by the next higher half-number digits. Write down the product and, following it, write down 625.

Examples: To square 2.75, multiply 25 times 3 and write down 75625. The answer is 7.5625.
To square 0.825, multiply 8 times 85 and write down 680625. The answer is 0.680625.

This process can be extended to straight multiplication of similar numbers having different magnitudes.

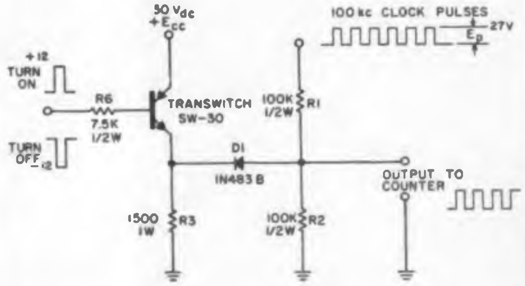
Examples: To find the product of 125 and 0.125, multiply 1 times 15 and write down 15625. The answer is 15.625.
To find the product of 85 and 850, multiply 8 times 9 and write down 7225. The answer is 72,250.

Leo A. Skoubo, Avionics E. E., AiResearch Manufacturing Co., Los Angeles, Calif.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.

Bistable Switch Gates Clock Pulses to Counting Circuitry 747

In many digital counting and control applications it is necessary to measure the elapsed time between controlling pulses. This can be done by counting the number of recurring clock pulses in the time interval. A simple circuit which can start and stop the counting interval is shown in



Pulses applied to base of Transwitch control counting interval by gating clock pulses to counter.

the figure. It uses a bistable, semiconductor switch, such as Transitron's Transwitch.

In effect, the circuit AND-gates the clock pulses to the counting circuitry. Its operation is based on the fact that once turned on, the Transwitch will remain on until pulsed off. The unit can be switched in less than 1 µsec.

A positive pulse, applied to the base of the bistable switch, turns it on. The collector-to-emitter voltage V_{CE} drops to about 1 v, with the voltage difference V_{R3}, between E_{cc} and V_{CEon}, appearing across the emitter resistor $R3$. Since V_{R3} is greater than E_p the diode $D1$ is reverse biased, effectively opening the circuit between $R3$ and the junction of $R1$ and $R2$. The output voltage across $R2$, in this state, is the clock pulse voltage. Its maximum amplitude is $E_pR2/(R1 + R2)$, and for $R1 = R2$, $E_{out} = E_p/2$.

Thus, the clock pulses will appear at the output as long as the bistable switch is on.

If a negative pulse is applied to the base of the bistable switch, the device turns off. V_{CE} rises to E_{cc} and $VR3$ goes to zero. In this state the diode $D1$ provides a high conduction path to $R3$ and since $R2 \gg R3$, the output voltage is closely approximated by $E_{out} = E_pR3/(R3 + R1)$.

R. Goldstein, Project Engineer, Kearfott Div., General Precision, Inc., Little Falls, N.J.

Vote this Idea the Most Valuable of Issue by circling its Reader-Service number.

Block Diagram in Error

An error inadvertently crept into the block diagram of J. A. Webb's Idea for Design, "Servo Loop Frequency Modulates Oscillator Outside Deviation Range," (No. 746), which appeared in our April 26 issue, p 161.

The output from the block labeled "AC Loop Compensation" actually goes to the "Phase Modulator," instead of to the "Frequency Modulator" block as shown.

GERMAN ABSTRACTS

E. Brenner

Locus Plotter Network Displays Transfer Function

THE COMPLEX impedance or transfer function of networks can be expressed as the (complex) quotient of two voltages, V_2/V_1. A basic scheme for performing this operation with phase sensitive detectors is shown in Fig. 1. However, the use of an intermediate frequency makes it possible to design a large part of the apparatus for a comparatively narrow band. In Fig. 2 the coupled generators *G1* and *G2* produce frequencies f and f_h respectively. The difference, $f - f_h$, remains constant. The voltage V_1 and V_2 originating in the circuit under test are frequency-translated in the modulators *M1* and *M2* to the constant if. The voltage V_2 is fed directly to the phase sensitive detectors *D1* and *D2*, while V_1 is applied directly to *D1* but is shifted in phase by 90 deg before being fed to *D2*. The detected voltage V_{d1} and V_{d2} are fed to the deflection plates of an oscilloscope.

To determine the maximum speed with which frequency can be varied, allowance must be made for transient build-up. Changes must be sufficiently slow so that the steady state is approximated. Reasonable estimates can be made by considering tuned circuit measurements.

Assuming a frequency swing F in a time T the applied frequency is within the band B (cycles) for TB/F sec. The build-up time of the circuit is estimated at $2/\pi B$ sec. If the ratio of the build-up time to the time the source is within the band is to be (not more than) 0.1, the band is related to F and T by:

$$B = 2.5\,(F/T)^{1/2}$$

Assuming a voltage current relationship of the form:

$$V\cos(\omega_v t) = I\cos(\omega_i t + \phi)$$

where:

$$\omega_v = \omega_i + d\phi/dt$$

it can be shown that in tracing out the locus a maximum frequency change, b, occurs where:

$$2b = 0.25\,(F/T)^{1/2}$$

Tolerating a phase error ϕ_1 the 3-db band ($2b_i$) of the if is required to be:

$$2b_i = 2b/\tan\phi_1$$

Correspondingly, if an error ϕ_2 is allowed, the low frequency portion has the required band $b/\tan\phi_2$.

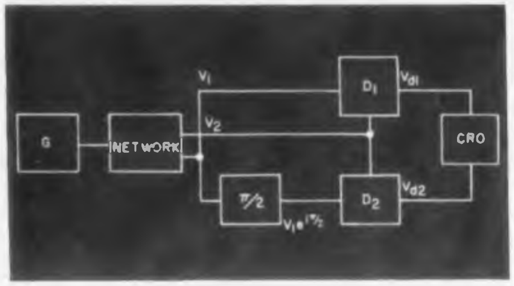


Fig. 1. Block diagram of locus plotter using phase-sensitive detectors.

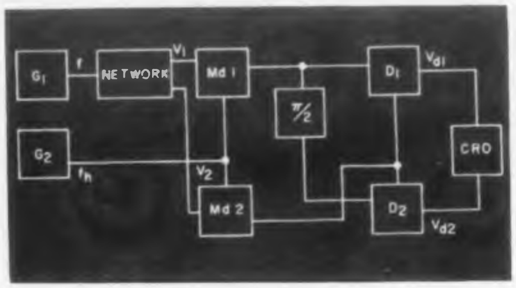


Fig. 2. Block diagram of locus plotter using frequency heterodyning.

By way of example, using $F/T = 300$ mc/sec, $B = 43$ kc, and $2b = 4.3$ kc, the required if bandwidth, allowing 5-deg error, is 50 kc; allowing a 20-deg error in the low frequency portion, its band is 6 kc.

The original paper includes a complete description of all circuitry as well as numerous photographs of loci. The over-all accuracy is estimated at 20 per cent in the band 0.5 to 200 mc and 10 per cent in the band 1 to 100 mc.

Abstracted from an article by P. Thilo, Frequenz, *Vol. 14, No. 12, Dec. 1960, pp 403-412.*

Tables Compare German and Japanese Exports

COMPARISON of West German and Japanese international trade in electrical equipment reveals several interesting facets. Both countries started at virtually the same (zero) level at the end of World War II. Statistics on their industrial recovery have been compiled by K. Schröder, a West German Industrial consultant.

At present, the German Federal Republic is the second largest exporter of electrical equipment (in first place: the U.S.). Two thirds of

GERMAN ABSTRACTS

German exports go to other European countries (See Table I).

Almost one third of Japan's electrical equipment exports are sent to the U.S., Table II. In 1958, of 3.78 million radio receivers exported by Japan, 2.5 million went to the U.S. at an average per unit price of \$7.01. Of 4.74 million transistors exported in 1959, 2.39 million were imported by the United States at an average per unit price of \$0.70. It is Mr. Schröder's opinion that "price-dumping" is no longer Japanese trade policy.

Import-export trade of electrical equipment between West Germany and Japan has reached significant proportions only in the last few years. In 1959 German electrical equipment exports to

Table 1.

Most important customers of the German Federal Republic listed by percentage of electrical equipment exports.

Country	1956 %	1957 %	1958 %
Netherlands	12.3	10.3	9.1
Sweden	7.8	8.2	9.6
Belgium-Lux.	6.6	6.7	5.9
Italy	6.6	6.4	5.8
Switzerland	5.8	5.9	5.9
Austria	4.7	5.1	5.4
U.S.	3.9	5.1	4.1
India	2.5	3.1	4.4
Great Britain	2.4	2.8	3.4
Venezuela	2.0	1.7	1.8
European Countries	66.1	64.5	65.3

Table 2.

Most important customers of Japan by percentage of electrical equipment exports.

Country	1956 %	1957 %	1958 %
U.S.	26.9	32.4	29.6
Formosa	9.5	10.0	7.4
India	6.6	4.0	5.8
Thailand	3.7	3.5	4.4
Ryukyus Islands	3.4	3.1	2.6
Hong Kong	3.5	2.4	2.7
Burma	1.4	5.0	5.7
Korea	1.9	3.0	2.7
China	3.5	1.6	0.4
Philippines	2.3	2.8	2.3
European Countries	5.3	4.7	7.3

Table 3.

Values of electrical equipment exports and imports compared on a yearly basis.

Year	Japan Exports (millions DM)	Japan Imports (millions DM)	Germany Exports (millions DM)	Germany Imports (millions DM)
1951	83.2	17.3	732.0	61.2
1953	79.3	58.5	1272.6	103.2
1955	154.3	76.4	2136.4	211.4
1956	263.7	100.3	2606.4	248.9
1957	378.9	95.4	3115.2	303.8
1958	478.6	135.5	3317.4	525.5

Table 4.

Most important electrical equipment products exported are listed as percentages of total electrical production.

Product	Japan 1956 %	Japan 1957 %	Japan 1958 %	Germany 1956 %	Germany 1957 %	Germany 1958 %
Cable and Wire	15.3	19.4	6.1	10.9	8.0	5.6
Light Bulbs	10.2	11.3	9.4	1.3	1.2	1.2
Electrical Machinery	9.2	9.1	7.6	15.2	17.3	17.0
Radio and TV	7.7	12.5	30.9	10.3	12.1	12.6
Telephone Equipment	6.3	7.0	6.7	6.1	5.6	5.2
Household and Trade	6.4	5.6	5.7	10.8	11.0	10.6
Measuring Instruments and Test Equipment	2.3	1.6	1.5	3.9	4.0	4.9

Japan amounted to 12.6 million Deutsche Marks while Japanese exports to Germany were valued at 6.3 million D.M.

Value of export-import trade of Germany and Japan are shown for the last several years in Table III.

Table IV presents the percentage of production exported, by product type. It is worthwhile noting that the fraction of total production exported by the Federal Republic in each category remained substantially constant over the years. However, the corresponding figures for Japan show greater variation, especially in the case of radio and TV equipment.

Abstracted from an article by Kurt Schröder (Zentralverband der Elektrotechnischen Industrie e.V., Frankfurt a.M.) Electrotechnische Zeitschrift (ETZ), *Edition B, Vol. 12, No. 24, Jan. 28, 1960, pp 591-593.*

ELECTRONIC DESIGN

DIGEST

of recent papers and literature

Why Do Relay Contacts Fail?

POOR relay performance is often traced to the lack of understanding concerning the specific application involved and the operating conditions. Furthermore, two basic errors in relay specifications are usually encountered: 1) one level of quality is specified for all relays in a system even though some are subjected to more severe conditions than others and 2) high performance in all requirements for a relay is demanded where greater gain in reliability could be achieved by relaxing one requirement and tightening another.

Among the variables which affect relay operation are spring tension, gap width between contacts, magnetic strength, contact shape and characteristics of the contact metal. Field test data and lab examinations indicate that 75 per cent of relay failures can be traced directly to contact failure. To minimize faulty operation, careful attention must be given to the following factors:

- ***Contamination***—often introduced into a relay during assembly. Other forms of contamination include frictional polymer, during contact closure, due to platinum rubbing against another metal in the presence of some organic vapor, static polymer as a reaction product of organic vapors, transfer of base metal from the relay structure to the contacts and, finally, adhesion film resulting from physically absorbed oxygen molecules when a clean contact is exposed to air. Sufficient contact pressure must be present to penetrate the deposit for reliable operation.
- ***Constriction***—when a round surface mates with a flat surface, the load-bearing area is small

and the current density at the point of contact may be very large. The high resistive (I^2R) loss can generate sufficient heat to melt the metal. As with contamination, increased contact pressure is needed to combat constriction; however, mechanical wear and permissible size of the magnet structure and available electrical power limit contact pressure.

- *Melting*—the I^2R heat generated during relay operation may be sufficiently high to melt the metal at the point of contact. When the metal cools quickly, the contacts may be welded together or stick, sometimes permanently and other times momentarily. A deep pit may be left on the hot contact (anode) while a bridge is built up on the cooler contact (cathode).
- *Arcing*—as contact pressure is reduced and the relay contacts separate, the area of current conduction is rapidly lowered; current density increases, raising the temperature of the metal and the voltage drop across the contacts. When the conduction area is small enough, the current first melts and then vaporizes the contact material. Physical contact is lost between contact surfaces but conduction continues by virtue of an ionized metal vapor or arc. The arc may cause loss of anode material, loss of cathode material or transfer of material from cathode to anode.
- *Mechanical wear*—after a given number of cycles, a set of contacts experiences sufficient wear to require relay replacement. Excessive contact pressure to reduce constriction and contamination effects are often causes of short contact life. For optimum electrical and thermal conductivity, soft contact materials are desirable; however, long life could not be expected. The wear problem is of particular concern in subminiature and microminiature relays where changes in contact dimensions, due to wear, are large compared to the gap.

Specifying Parameter To Reduce Contact Failure

The relay user should specify a quantitative requirements list (not loaded with safety factors) of the following parameters:

1. Load current and circuit impedances.
2. Open circuit voltage.
3. Coil current.
4. Number of operations per unit time.
5. Number of total operations.
6. Response time.
7. Ambient temperature.
8. Military specifications, if involved.
9. Atmospheric pressure and composition.
10. Shock, vibration and acceleration factors.
11. Permissible size, shape, weight and cost.

Digested from "Why Do Relay Contacts Fail," by Leon D. Carr, Sperry Engineering Review, *Vol. 13, No. 4, Dec. 1960, pp 36-40.*

LETTERS

Misled by Soviet Statistics?

Dear Sir:

"The Soviet Engineer," in your Feb. 1 issue, is most interesting. Author Amatneek is to be commended for the interesting report about his three-week observations in Riga, Latvia. As a Lithuanian and somewhat of a student of Soviet life, I cannot refrain from offering this commentary.

The reference to Riga's high schools implies that Soviet Latvia progressed in education from four high schools in 1928 to over 40 in 1960. It is a standard Bolshevik dodge to employ statistics to create misleading impressions.

In this case, comparison is made of two different things: The 1928 Latvian High School (gymnasium) was an eight-year school, carrying the pupil from his seventh through fourteenth year of education, while the Soviet high school, by Mr. Amatneek's admission, comprises a three-to four-year program. Inasmuch as Latvia was an independent republic from 1918 through 1940, the credit for the growth of schools over the comparison period is not due to the Soviet regime.

A fair comparison would require growth statistics on the number of high schools and pupils between 1928 and 1940, on the number of pupils completing the fourth year of the Latvian gymnasium in 1940 and the number of graduates from Soviet high schools in Riga in 1960.

It must also be borne in mind that admission to Soviet universities requires 10 to 11 years of schooling, while admission to pre-war Latvian University called for 14 years. Therefore let us have a comparison of the total of 1939 or 1940 diploma engineering graduates with the 1960 total of Soviet Latvian engineers who received degrees after apprenticeship and qualifying examinations.

The two-year work assignments prior to admission to the university and apprenticeship assignments upon the completion of the Soviet university are handled on a union-wide basis. That is, the Latvian youth and engineers have little choice in location and often serve outside Latvia.

Such "voluntary" training assignments represent nothing but another form of forced labor and are part of the Russianizing program to which non-Russian captive nations are subjected.

It should be mentioned that a form of universal military training is also mandatory for all male youths for three or more years, depending on the branch of service.

Job changes are not free and require a release, acceptance and official approval, though this bureaucratic red tape can be overcome when personal contacts or good Communist Party affiliation are exploited.

It is interesting to note the author's observation regarding job security, advancement and the role of labor unions. I must agree that job security does exist; perhaps this is attributable to the shortage of professional personnel.

On the other hand, the engineer in the Soviet Union is placed in an unenviable position between management and labor. Often he incurs the wrath of both, either for inability to fulfill the production quota; or not being able to improvise designs in spite of facility inadequacy; or for placing production demands upon labor (quality control, tolerances, etc.). Considerations for promotion take into account the above, but Communist Party membership and a favorable evaluation of the individual's concepts and "proletarian" attitudes form a strong, if not a determining, influence on the engineer's position.

Inasmuch as most factories operate under a production plan, pay and privileges to individuals are commensurate with fulfillment of quotas. Fringe benefits in the way of housing provisions, plant recreational facilities and resort accommodations are primary incentives for workers.

Leo L. Grinius
Motorola, Inc.
Military Electronics Div.
Riverside, Calif.

Dear Sir:

With great interest I read Mr. Amatneek's article "The Soviet Engineer" in ELECTRONIC DESIGN.

Having experienced the conditions in Latvia throughout its existence as a free country up to 1940, as well as the conditions under German and Soviet occupations until 1944, and also being relatively well informed about the present standards under Soviet occupation in Latvia, I feel compelled to add the following to the article.

Not quite understanding the intentions of the article, I cannot quite understand the meaning of the footnote: "An indication of the growth of education in the USSR—in 1928 there were four city high schools in Riga, now there are more than 40." Could it be construed from this that the number of schools has increased from 4 to 40 under the Soviet rule?

In my opinion this statement is untrue, not to use the word distorted. Interpreted in this manner it unduly and mistakingly points to the virtues of Soviet government in increasing the number of schools in Latvia and apparently increasing the educational level.

Why this comparison with the conditions of 1928 and not with the last years of independent Latvia? Already in 1935-36 there were 48 high schools (29 general and 19 special) in the city of Riga attended by 11,150 students.

If in 1920-21 there were 90 high schools with 12,842 students in Latvia, then in 1936-37 there

LETTERS

were already 112 high schools with 22,620 students, the number of students almost doubled. As the statistics prove, in 1914 there were 67 students per 1,000 population, in 1939 there were 137 for every thousand—the number had doubled. With 30 university students per 1,000 population, Latvia occupied the first place among European nations.

It is more than wrong to assume that an increase in number of students and schools and the resulting rise in the nation's educational level is the result of Soviet domination.

Whoever has experienced the Soviet slave-state regimented school system, cannot have any misgivings about its attractiveness. These schools are preparing the badly needed personnel for the state and the party. The students of today will be only small wheels in the Soviet machinery tomorrow—exactly where the government and party want them to be.

It is known to me that the free choice of employment you mention in your article, is only so on paper. I can name cases and names in which as late as 1960 the engineers were appointed to the jobs as far as behind the Lake of Baikal, against their will. But, as you may know, in the Soviet-ruled countries this generally is called "volunteering for jobs"—quite similar to that recently heard from Red China—starving China—where the Youth Organizations are begging to reduce the food rations!

I fully agree with you about job security, the guarantee to work in the Soviet Union. True enough, no one can be relieved of employment. If someone is not needed or wanted, he is transplanted into one of the numerous slave camps in Siberia, where everyone is accepted.

Robert Lidums
E. I. duPont de Nemours & Co.
Wilmington, Del.

I appreciate the comments on my article by Mr. Grinius and Mr. Lidums. In turn, may I reminisce a bit?

In 1928 I received my "certificate of maturity" from the First Municipal Riga High School. This was a "realskola" leading toward engineering and sciences, not a Latin-oriented "gymnasium." I was then 16, and I had just completed the four-year high school course following the six-year course at Riga P. S. 23. So I know that the requirement for entering the Latvian State University then was 10 years of schooling. Now, I am told, it is 11 years.

I fancy myself as sensitive to propaganda as any man. I was exposed to it by some of the brass in Latvia last summer. But, to repeat, my report was not a "bird's eye view"; it was rather a "worm's eye view," gathered in the grass roots; it was "inside dope," if you will.

I did not pick up any information about military training. However, in 1928 there was compulsory military training—three years at age 21, if memory serves me right.

On Russianization: Russianization is officially denied. But I was there, and this is what I observed. Riga has become a bilingual city in place of the trilingual one that it was in 1928 (Latvian, German and Russian). Most, if not all, of the signs and marquees on the streets are first in Latvian, then Russian. By and large, about half of the conversations in public were in Russian.

On the other hand, I got the impression that the government can't be working very hard at Russianization. I was told by a relative I visited that Russian language study is no longer a prescribed subject in his son's public school. The pretty stewardesses aboard the Moscow-Riga turboprop made their announcements in Latvian, then Russian. After 20 years of Soviet government, Riga and its culture obviously retain a wholly Latvian character. The opera, movies, theatre were in Latvian. (Needless to say, no translations except in program notes.) And so was the magnificent, spectacular, quintennial Song and Dance Festival, at which a chorus of 8,000 voices by my count (propaganda had it at 10,000), dressed in newly woven, colorful, national costumes, sang two long programs of Latvian songs, of which only one or two were in Russian.

On the question of involuntary job assignments, I have no doubt that Mr. Grinius is right so far as the past is concerned. I gathered as much when I was there. I was also told that in this as in many other respects there has been substantial improvement—in general "since the old man died," and in particular in the last year or two.

Regarding my implication that the number of city high schools in Riga rose from four to over 40 during the Soviet regime—that was my own personal observation, not a government handout. The numbers quoted by Mr. Lidums evidently include private schools. Surely we don't consider the preponderance of private schools a credit to the public education system of a country. There are no private schools in Riga today, of course.

Regarding the merits of their education—Soviet engineering achievements in recent years have aroused the interest of the world in the Soviet educational system. The younger Latvian engineers that I met are products of that system —products of the University and the Polytechnic Institute at Riga. It is their background that I attempted to describe as an eyewitness.

Karl V. Amatneek
8603 Hull Drive
Philadelphia, Pa.

Stop Hunting For Lost Design Hints!

Thousands of electronic hints, thousands of circuit diagrams are published each year. How does the engineer keep track of those that interest him? Author R. Wayne Crawford explains a filing system that is simple, yet flexible.

R. Wayne Crawford
Ohio Semiconductors
Div. of Tecumseh Products Co.
Columbus, Ohio

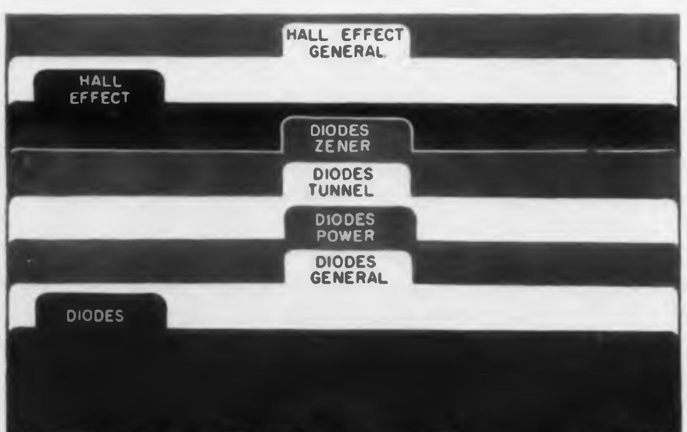
DESIGN engineers must keep abreast of developments in their fields, and one of the best ways to do it is by clipping the design articles that appear in trade magazines.

Using current design information eliminates duplicate effort, and it permits the user to benefit from an effort someone else has paid for.

But to be of use, the design information has to be available when needed. A vague recollection of having seen a particular article, followed by a "brute force" search through a stack of magazines, is all too often the method of retrieval. It is an expensive one.

The problem is: What to file? How to file it?

It is doubtful if one reader is very keenly interested in every design article in a magazine. A simple rule to follow is to file only those articles that are of interest to you.



How a typical file should look, viewed from the bottom up. The main subject headings are arranged on the left guide tabs, with the subheadings in the middle. The subjects themselves should spring from the engineer's own interests and be expanded as those interests expand.

Author R. Wayne Crawford, who has been filing circuit diagrams according to his filing system for more than three years. He makes about 100 entries a year.

Don't Wait! Choose Articles For Filing As You Read

Choose your articles as you read. This is very important, or else the whole system breaks down. The articles to be filed should be removed as soon as the magazine has been read. Once a backlog of magazines has built up, it is a tremendous task to go back through them sorting out articles.

How should the articles be filed? There are a great many filing systems and cataloging techniques. Filing by subject is particularly suited to a technical file, because related material is brought together and searching time is reduced. Another advantage of the "Subject" technique of filing is the ease with which the file can be expanded while still keeping the related material together. Subheadings for main subjects permit larger quantities of material to be handled in this way.

The following points should be kept in mind when selecting the subjects for a file:

1. Select the most important subjects of interest, keeping the number to a minimum at the start. Add subheadings as the material expands.
2. Keep the subject titles as short as possible—one or two words wherever possible.
3. Put related subjects together under one major subject heading whenever this is logical.

The range of subjects will vary widely with the interests of the individual. What may be a

Keep File Simple and Compact

The following sample subject outline shows how related material can be drawn together simply and compactly under main subjects:

Amplifiers:	*General*
	af
	rf
Choppers:	*General*
	Applications
	Mechanical
	Transistorized
Diodes:	*General*
	Power
	Tunnel
	Zener
Hall Effect:	*General*
	Applications
	Devices
Indicators:	*General*
	Audio
	Visual
Networks:	*General*
	Filter
	Impedance Matching
Oscillators:	*General*
	af
	Multivibrators
	rf
Powers Supplies:	*General*
	Bias
	High Current
	High Voltage
	Regulated
Temperature:	*General*
	Stabilization

major subject in one individual's file might be a subheading in another's.

The table accompanying this article shows how related material is drawn together under main subjects. Each of the subheadings represents a heading on the tab of a file holder (See accompanying representation.) Main subjects and subheadings are arranged alphabetically.

Note that the first folder in each main subject grouping is marked "general." This is the folder out of which all of the subheadings grow. Articles concerning a particular main subject are accumulated in this general folder until there are three or more articles concerning a particular subtopic. Then a separate subheading folder is set up to store these articles. An extremely large, bulky article that would crowd the general folder may also be filed in a separate subheading folder.

Accumulating the material in the general folder until there is enough to warrant a separate subheading folder avoids having folders set up and then not used. When the material in a subheading folder becomes so great that that folder is bulky and hard to handle, one of two courses

may be taken: the material may be broken down further into sub-subheadings, or additional folders carrying the same subheading and numbered 1, 2, 3, etc., may be set up.

Mark Articles Clearly So They Can Be Spotted

To facilitate quick and correct filing and refiling of articles, underline the appropriate filing word or words in the title or in the first paragraph, or write this information in the upper right hand corner of the article. A heavy colored underline is most easily seen. The underlined words are the main heading or subheading under which the articles are filed.

When an article refers to more than one major subject, make a simple cross reference on an 8-1/2-by-11-in. sheet of paper showing:

Title.
Author(s).
Publication.
Date.
Where article is filed.
Where this cross reference is to be filed.

Make the appropriate underlining on the cross reference sheet, showing where it is to be filed.

The folders for filing are merely the standard 8-1/2-by-11-in. manila ones, probably available from your company's office supply.

Many design magazines use a page size that will not fit in a standard file folder. Simply fold the pages of such articles to 8-1/2-by-11-in. size.

Articles of more than one page should be stapled together to prevent loss of pages. Small one-column articles may be pasted on standard 8-1/2-by-11-in. sheets of paper to prevent their loss in the file. Occasionally articles of interest appear back-to-back in a magazine. The best way to handle these, if a duplicate magazine is not available, is to make a photocopy of one side of the page. If copying facilities are not available (and one doesn't have the time to drop a card to the magazine to ask for a tearsheet), the cross reference technique may be used here, too.

A stiff cardboard guide tab at the upper left

Don't Be a Loser

The engineer with a haphazard information-retrieval system is a loser.

He loses time hunting for an article that could be at his fingertips. When time is worth money, his company loses, too.

ELECTRONIC DESIGN's Reader-Service Dept. is all too aware of this. Some of the 200 to 500 requests is received each week go like this:

"Gentlemen—I am interested in obtaining a copy of an article on transistor multivibrators, which I believe was in one of your early 1960 issues (though it may have been in one of your late 1959 issues). I am sorry to say I can't recall the exact title of this article or the name of the author, though I do believe he was with a West Coast aircraft firm. I hope you can help me with this request, for the information will be very helpful in my present design project. Thank you . . . ."

ED's Reader-Service Dept. works as fast as it can to answer elusive requests like this. But when it has a backlog of similar ones, the process, understandably, takes time.

Meanwhile the engineer who could have helped himself—and his project—waits.

of the file is best for indicating the main subject headings (see accompanying representation). Subhead folders should have both the main heading at the left and the subheading at the upper center.

A Small Abstract File Can Also Be Useful

An extremely useful supplement to the main file, especially after it has grown, is an abstract card file. It is a great deal easier to look through a stack of abstract cards than to look through the articles themselves. If an abstract card is desired and the article does not contain one, it is best to abstract the article at the time of reading. The abstract cards may be 3 by 5 in. or 4 by 6 in. and can be stored in boxes or small file drawers of corresponding size. They should be filed in exactly the same manner as the articles, with the same headings, subheadings, etc.

A cross-reference card file of authors may also be valuable. An author card need carry only the name of the author, the title of the article, the publication and the date.

A touchy problem that always arises when one has a good technical file is the borrowing of articles by others. It is a sad but true fact that when it comes to articles, one's fellow engineers do not seem to know the difference between a loan and a gift. If an article is lent, it should be signed out with a definite time limit on its use. Others should respect your file. ■ ■

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(11)

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(Please print with a soft pencil or type.)

Name ____________________ *Telephone* ____________

Home Address ____________ *City* ________ *Zone* ____ *State* ________

Date of Birth ____________ *Place of Birth* ____________ *Citizenship* ____________

Position Desired ____________________

Educational History

College	Dates	Degree	Major	Honors

Recent Special Training ____________________

Employment History

Company	City and State	Dates	Title	Engineering Specialty

Outstanding Engineering and Administrative Experience ____________________

Professional Societies ____________________

Published Articles ____________________

Minimum Salary Requirements (Optional) ____________________

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

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602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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Old Company Name ____________________

Old Company Address ____________________ City ____________ Zone ______ State ______

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USE BEFORE JULY 5th, 1961

D

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Company ____________________

Company Address ____________________ City ____________ Zone ______ State ______

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299

300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	540	550	560	570	580	590
301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
303	313	323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473	483	493	503	513	523	533	543	553	563	573	583	593
304	314	324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474	484	494	504	514	524	534	544	554	564	574	584	594
305	315	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595
306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599

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