ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

- Components & Van Allen Radiation . . .
- Satellite Antenna Systems
- Measuring Recovery Time of Ultra-Fast Diodes

April 1961

"The definition of a farad unfortunately makes it a unit too large for general use. More convenient are the units micro-farads and micro-microfarads."

It is said that even Michael Faraday doubted if a farad could ever be realized. But then, he hadn't been exposed to the engineering and production capabilities of Sangamo... the first capacitor manufacturer to produce and establish standards in the production of electrolytic energy storage capacitors.

So now the "impossible"—a farad of capacitance capable of being held in one hand—has been achieved. Rated at 1½ volts, the one-half farad Sangamo Type DCM electrolytic carries the highest capacitance per unit volume in the industry. It is the product of Sangamo engineering imagination... the very real result of intimate product knowledge applied to quality materials and progressive production methods. It is ready for application in missiles, computers, and a wide range of power supply applications where peak power requirements exceed the maximum output of the supply. Phone near? Discuss your applications with your Sangamo Representative.

Occasionally applications call for energy-storage capacitors to meet special requirements, including higher temperature and higher ripple current. That's a good time to turn to Sangamo, where yesterday's impossibilities become capacitor facts such as this...

CAPACITY = ONE FARAD

EC61-1

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Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

Engineers and Doctors

JUST recently we learned that engineering students at Lawrence Institute of Technology (Southfield, Mich.) will be required to take a compulsory course in computer programming. Reason: "Computers are fast replacing the slide rule as the engineer's chief tool!"

We wonder,—should engineers be the only ones affected? Why shouldn't other disciplines feel new pressures?

Electronic measuring equipment being produced today is capable of the most accurate and sophisticated forms of measurement. The future of our space program depends on electronic indication and measurement. Yet many of the other fields of science and engineering have made little, if any, attempts to incorporate electronic measurement techniques as a part of their regular activities. Perhaps the great accuracy and precision may not be necessary in all instances, but in some areas they surely are.

We are thinking, for example, of our future man-in-space programs and of the measurement of bio-medical and biophysical quantities. Do the life-scientists know that they are really measuring the proper characteristics? Do they know what can be measured with electronic equipment? Is up-to-date case history type measurement data adequate and available? How can novice life scientists, and even the general practitioners, learn how to measure characteristics which might throw new light on their experiments and diagnoses?

Well, we know of one way—planned and compulsory Electro-Medical Courses.

In many pre-medical courses, the student has the option of acquiring either a B.S., usually in Biology, or an AB-Science. In either case, the student has science courses. Why not have compulsory courses at this level relating to electronic measurement and stimulation? Then the student could see how to apply these techniques as he advances through his undergraduate and graduate life studies. To us, this seems like a more practical approach.

Earlier, we mentioned space travel. We hope that we are making all the proper measurements before, during and after flight. But space travel, like World War II, has opened up a whole new area for electronics. Never before has such interest been shown by the medical profession for the capabilities of our industry.

Let's not lose this golden opportunity to develop a whole new market! There are more than 200,000 physicians and surgeons in this country—and the number is expanding every year. There are also more than 7000 hospitals.

Let's let them know what we can do!

Anti-Trust

WE note with interest that some of the major companies involved in the recent heavy electrical price-rigging decision have established antitrust departments within their organizational framework.

This is a belated, but very important development, with considerable significance for the electronic industries.

Exactly the same kind of self-analysis is needed in our own operations because right now patterns are developing which led to the bid-rigging scandals in the electrical industry.

While the electronic industries consist, for the most part, of small companies we have noted the great trend over the past three years towards mergers and consolidations. Many of these mergers and consolidations are made for the purpose of getting broader research and production facilities in order to capture more attractive government contracts.

History has shown that this pattern of getting bigger to capture larger percentages of the market is typical of our industry. In 1949 for example there were some 125 manufacturers of television sets, and today less than 10 do 90% of the dollar volume. As the number of larger companies becomes smaller the ability and the temptation of price-rigging increases.

Anti-trust departments in new and growing organizations could be an important vehicle to prevent a similar disaster from happening in electronics.

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Highlights of this issue

How Radiation Affects Material page 90

What lies ahead in outer space? What will be the effect on our equipment when it passes through the "Van Allen Belt"? These questions and many others are answered in this timely article.

Flashing Light System for Satellite Geodesy page 94

An explanation of a newly developed flashing light system, the requirements covering its design, and the equipment involved in its operation are outlined in detail.

Measuring Recovery Time of Ultra Fast Diodes page 99

Methods of measuring ultra fast diodes and finding the source for their fast recovery time is the keynote for this article. The equipment used, and the diodes tested, are fully detailed and illustrated.

Eliminating Signal Ambiguity page 101

This article discusses the use of an ambiguity eliminator (Ambel) to convert incoming frequency information to a binary code. Once this is done, the information can be acted upon by delay circuits, thereby eliminating the reception of overlapping signals.

Fundamentals of Space Arithmetic page 104

A mathematical approach to space technology. The common denominator "gravity," is used in the simplified fundamentals of Statellite, Space Ship, and ICBM arithmetic.

The Antenna System of the Reconnaissance Satellite page 108

The antenna system on a reconnaissance satellite is the determining factor for successful information gathering. Characteristic and design variations are fully outlined herein.

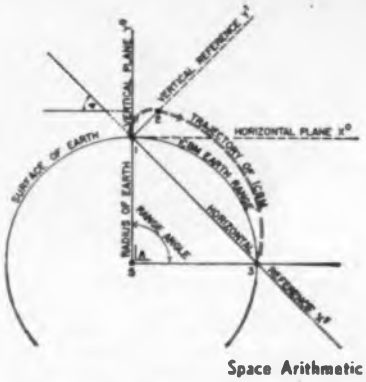
Space Communications page 116

Equipment miniaturization requires the use of low-powered communications equipment. The receiver sensitivity is therefore the most important factor in reliable space communications.

A Simple Inexpensive D-C Restorer page 200

Due to the price struggle, the d-c restorer has been left out of today's television receivers. The importance of the restorer and how the engineer should go about installing it in his receiver is detailed here.

Radiation & Materials



Space Arithmetic

Antenna System

Space Communications

RADARSCOPE

THE AIR-CONDITIONED SUIT

Self-contained air-conditioned suit developed by Westinghouse can keep the wearer comfortable in temperatures from —40° F to +135° F. Heating or cooling is by thermoelectricity. Two small fans are the only moving parts. Batteries make the suit independent of power sources.

"TUNNELING" in thin-film microcircuitry sandwiches at room temperatures has been reported. Republic Aviation researchers have developed a tunnel diode which does not require super-cooling to be functional. The thin-film sandwich is a titanium vapor on a strip of glass. The film is less than one millionth of an inch thick.

IMPORTANT STEP has been made in the nuclear power field. Marquardt Corp. says it has designed a small-sized commercial nuclear power generating plant that would be competitive with conventional steam plants. Capacity of their design is from 5,000 to 20,000 watts. Company has asked for AEC funds to work out design details. They say they can build a working model in three years.

ANOTHER "GAP." A top aviation authority says that cancellation of additional computers in air route traffic control has introduced an "automation gap" of at least two years in many centers throughout the country. He suggested using off-the-shelf equipments and techniques, giving the Bureau of Air Traffic Management more authority, and evaluating thoroughly the R & D effort on ATC as steps to be taken now for building a safe and efficient air traffic control service.

SPACE GARBAGE will be a deadly menace to interplanetary travelers warns a prominent space scientist, Dr. E. Robert Britton. He used the term to describe the huge rocket containers and satellites hurled into outer space by the U. S. and Russia. The two nations are now sending up space vehicles at the rate of 100 per year.

3-D RADAR TESTS by the FAA were successful and show definite promise of preventing mid-air collisions. The Director of the FAA's Bureau of R & D said the air height surveillance radar tracked a small Tri-Pacer aircraft on its first test and gave altitude information "accurate to within 500 ft. at a distance of 20 mi."

WE HOPE TO HEAR OF more give-away programs like this. The Navy's "on-the-spot screening and donations plan" has given surplus electronic equipment to 53 science departments in 7 states. They have given away over $1,000,000 in surplus equipment in the last year.

POOR SECURITY PRACTICES are causing U. S. firms to lose hundreds of millions of dollars annually through pilferage, loss of company secrets, etc. The

COHERENT LIGHT RADAR

Radar uses a "coherent light beam" to detect distant target. Developed by Hughes, the device (Colidar) is a practical application of the "laser" and its nearly parallel light beam. Light pulses from transmitter (top), are reflected, and are collected by the telescope (below).

American Society for Industrial Security (Suite 431, Investment Bldg., Washington, D. C.) points out that pilferage and industrial thievery alone are "a billion dollar annual business."

BETTER PLANNING is urged companies contemplating buying computers. A computer company exec says that the computer is far from the answer to all business problems. He suggests that in many cases the computer has become "the tail that wags the dog" and says that they will do little or nothing to help a poorly managed company.

LOOK FOR stepped-up activities in satellite communications systems. EIA has reaffirmed FCC findings that these systems can be operated without interfering with existing point-to-point surface radio services. EIA recommends amending reservations for radio frequency for surface communications to permit channels to be shared by satellite systems. EIA also recommended hearings prior to licensing earth terminals because of interference possibilities.

ATOMIC CLOCK has been developed which is so accurate that its maximum error will not exceed one second in 1271 years. It uses atomic energy as a power source, requires only a simple on-off switch to operate, and acts as its own primary standard. It was developed by National Co. for the Air Force's ARDC.

LOOK FOR a flurry of complaints over the recent move in Congress to include firms with 1000 employees as small business. Competition for Government business is getting rather rough among small electronics firms, and many feel that this new move only opens the door for larger firms to do business under Small Business Administration rules.

IT WILL BE INTERESTING TO SEE what develops from a study of private non-profit R & D organizations by the House Committee on Science and Astronautics. The committee wants to look into the pay scales under which these organizations operate. They believe that giving Government contracts to these non-profit groups may be just a means of getting around low Civil Service pay scales for scientists and engineers.

INCREASING SIGNS point to an upsurge in new plants and renovation of old ones. Skimpy profits are causing manufacturers to look for more efficient manufacturing operations. They are going heavily into research facilities and technical service labs. One evidence of this is the decreasing time between a new product's conception and its introduction to the market. Eight to ten years used to be an average figure—this is now down to three to five years.

NUCLEAR ROCKETRY got a boost recently from C. H. Weaver, a Westinghouse exec., in testimony before the Joint Committee on Atomic Energy. He said that the development of the nuclear rocket was most important in terms of our national position in astronautics. He pinpointed materials problems as the biggest of the technical roadblocks to developing nuclear rockets.

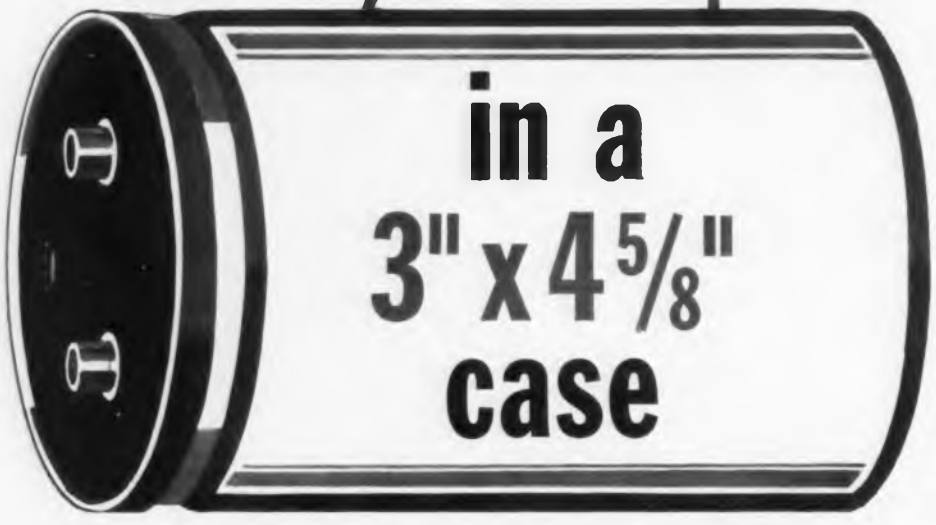
YOU HEAR A LOT THESE DAYS about capital moving out of this country and a lot more about this capital being used to exploit inhabitants of underdeveloped countries. But here's a switch—and we know there are many similar examples. The National Planning Association has released a report showing how GE made an "outstanding contribution to an underdeveloped country's economic development." For example: the company trained citizens of the country (Brazil) to take over the highest positions of managerial and technical responsibility.

PLAN NOW TO EXPAND into European markets says an exec of an international management consulting firm. Europe's business economy will reach a major turning point within the next 18 months and the time is ripe for U. S. companies to begin planning how they can do more business overseas. The liberal tax exemptions and World War II restitution claims for damaged plants and equipment are rounding out and European companies will soon be hard pressed for capital.

SATELLITE COMMUNICATIONS

Proposed communications satellite would orbit 22,300 mi. above the earth. This RCA proposed design is a relay station in a single, all-purpose satellite system. It would be available to all nations for world-wide telephone, radio, television, telegraph, and data services.

150,000 µF



Powerlytic Capacitors are packed with capacitance!*

Designed specifically for applications requiring maximum capacitance in small physical size, Sprague Type 36D Aluminum Electrolytics find wide use in power supplies for digital computers, industrial controls, high-gain amplifiers, and allied equipment. Furnished in case sizes ranging from 1⅜" dia. x 2⅛" long to 3" dia. x 4⅝" long, Powerlytic Capacitors are available with capacitances which were previously impossible to obtain in the various case sizes.

Engineered for 65 C Operation

In Powerlytics, Sprague's many years of research, design, and production experience have produced a capacitor which allows the equipment designer maximum space economy for operating temperatures up to 65 C. This encompasses the great majority of applications in transistorized digital equipment and similar apparatus.

Outstanding Performance Characteristics

Powerlytic Capacitors have not only low ESR and low leakage currents but offer extremely long shelf life as well. Furthermore, they have the ability to withstand unusually high ripple currents.

Superior Seal and Safety Vents

Type 36D Powerlytics use the most reliable seal that Sprague has developed for aluminum electrolytic capacitors. This consists of crimping a beaded aluminum can onto a rubber gasket recessed in a rigid molded cover. Pressure-type safety vents employing silicone rubber are used on all case covers.

Choice of Terminal and Insulating Tube Styles

Tapped terminal inserts, often preferred for strap or bus bar connections, are available as well as solder lug terminals for use with permanently wired connections. In addition to the standard bare case, Powerlytic Capacitors may also be obtained with a new clear skin-tight plastic tube which adds very little to the bare case dimensions. They are also available with a Kraftboard tube.

Broad Range of Standard Ratings

Sprague's standard line of Powerlytic Capacitors includes 183 ratings covering capacitance values from 45 to 150,000 µF, in voltages from 3 to 450 WVDC. Each rating is the maximum capacitance available for a given case size.

• • •

For complete technical data on Type 36D Powerlytic Capacitors, write for Engineering Bulletin 3431 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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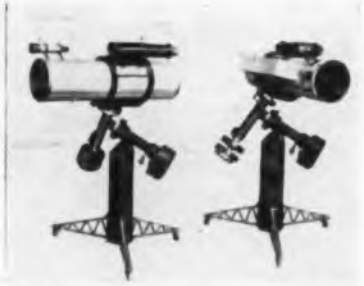
As We Go To Press...

Coherent Light Radar Developed by Hughes

Hughes Aircraft Co. has developed a "coherent light radar" which is a practical application of the laser (optical maser). Called "Colidar" (for Coherent Light Detection and Ranging) it is designed as a practical long-range radar for outer space use.

The Colidar uses the laser as a transmitter and an optical system coupled to a photoelectric tube as a receiver.



Laser transmitter (top) pulses out to target, is reflected back and collected by mirror in telescope (below).

The laser generates a highly collimated, monochromatic beam of light. With the ruby crystal now used, the wavelength of radiation is 6,943 angstrom units. The ruby is surrounded by a spiral flash tube. When the flash tube is discharged, the highly collimated, monochromatic beam of red light emerges from the partly transparent silvered surface at one end. Power outputs in excess of 1 kw have been observed; the beam width is less than ½°; and the spectral line width is less than 0.01 angstroms. Fed through a lens system, the beam width can be narrowed down considerably.

The very narrow beam of light strikes a target and is reflected. Some of the reflected energy is directed back toward the source point. The energy is collected and processed to obtain radar range, range rate, angle and angle rate.

The collector is essentially a telescope. The light is focused by a mirror and passes through a narrow band light filter. The light then strikes a phototube which provides signal amplification.

The Collidar, when fully adjusted, is expected to range on objects up to 10,000 yds with great accuracy on a clear day. If the transmitter and receiver were separated and placed aboard two space ships 100,000 miles apart, and carefully aimed at each other, one would get the same signal intensity in the receiver as from the 10,000 yd. target.

Collision Control

Flight tests are being made of an antenna designed to provide a practical solution to mid-air collisions. The antenna is part of an aircraft collision avoidance system proposed by Sperry Gyroscope Co., Great Neck, N. Y.

The system would warn a pilot well in advance of impending collision and prescribe a proper escape maneuver. The information could also be fed into the plane's automatic pilot which would then execute the escape maneuver. The antenna uses a Luneberg Lens for both directional and omni-directional scanning.

Improved Terrier Flown

A new Terrier ship-to-air guided missile has been successfully flight tested at the Naval Ordnance Test Station, China Lake, Calif. New missile was powered by a high-performance, solid propellent sustainer motor developed by Atlantic Research Corp., Alexandria, Va.

Lightning Research

A Naval Research grant of $15,000 has been given to the Univ. of Arizona for lightning research. Major objective of the project is a well-focused photograph of a single stroke of lightning showing the many lines of the spectrum present in it. The diameter of the heated column of air enclosing the stroke may be measured from such a photo, say University scientists.

DAVY CROCKETT

Nose cones and tail fins for the Army's Davy Crockett projectile are studied by Gim Fong, Raytheon Co. engineer. Davy Crockett gives infantry a low-yield nuclear punch at close ranges.

Visit Marshall Center

Nine Japanese officials, prominent in Japan's space science programs, are visiting the NASA Marshall Space Flight Center. They are members of a Survey Mission for Space Science and Technology sponsored by the Science and Technics Agency of the Japanese Government. They will also visit Canada, the United Kingdom, France, West Germany, and Switzerland.

The visitors are studying the present status and trend of space science programs, means for promoting space science, and measures for implementing international cooperation in the area of space science and technology.

More on Page 8

SATURN C-1

Flight configuration of the giant 3-stage Saturn C-1 rocket is seen at the George C. Marshall Space Flight Center. A Juno II rocket is at left rear and a Mercury-Redstone in front foreground. First flights are scheduled for late this year.

Electronic SHORTS

The Federal Government will obligate about $9.1 billion during fiscal 1961 for supporting scientific research and development. This includes 8.5 billion for R & D and $600 million for increase of R & D plant. Three agencies: NASA, Defense, and Atomic Energy, will share the bulk (about 90%) of the money.

The Weather Bureau, U. S. Dept. of Commerce, is operating a closed-circuit TV system at New York International Airport to provide weather briefings for international flights. The Bureau is encouraging airlines to install their own monitors. Airlines doing so will be required to provide their own receivers and to bear the cost of necessary cable connections.

A new group of materials with ferroelectric properties has been discovered. Researchers were seeking digital computer elements that can be used at high temperatures. Named "ferrielectrics," the new materials are described and evaluated in an Air Force research report available from the Office of Technical Services, Business and Defense Administration, U. S. Dept. of Commerce, Washington 25, D. C.

A much lighter inertial guidance stable platform will be one of the keys to increasing the range of the POLARIS missile from 1200 to 2500 miles. The platform is being developed by the Instrumentation Laboratory, M.I.T., with the assistance of GE's Ordnance Dept.

A new lightweight nuclear-thermoelectric generator has been designed by Westinghouse. The device weighs less than 40 lbs., produces about 150 watts, and is designed for one year of continuous operation. It uses radioactive isotopes, such as Curium 242, as its heat source. It has 144 elements. High temperature side is above 1000°F. Cold side is about 300°F. It will provide a reliable, long-life power source for unmanned surface radio beacons and weather stations.

A liquid-cooled helix traveling wave tube which can multiply by 60 times the strength of radar countermeasurers systems has been developed by Sperry Gyroscope Co. The heat dissipation problem has been overcome by introducing an extremely small diameter hollow tubular helix conductor through which a coolant is pumped under high pressure. This boosts the power capability of a broadband X-band tube from 50 to 3,000 watts.

A study of tunneling effects in thin films produced from metals and oxides is being made by Electro-Optical Systems, Inc. Successful development of an amplifier based upon this principle would enable the actual deposition of a high frequency, minute-size amplifier on a printed circuit board. Previous studies used quantum mechanical tunneling in semiconductor materials but not in metallic substances.

A new microwave link for high speed digital data transfers between computers miles apart is being tested by Control Data Corp. Magnetic core memory-to-memory transfers are used in this technique. Checked data are being transmitted at a rate in excess of 1,200,000 binary digits per second from the magnetic memory of one computer to the magnetic memory of the other. The new system takes advantage of the recent FCC ruling extending microwave licensing.

The use of electrical discharge to form high-strength metals is being studied. Two basic methods are being compared. The first is the deformation of metal by shock waves in liquid. The second is inductive repulsion forming. An induction coil is placed close to the workpiece and insulated from it; during the electrical discharge, opposing currents produce a magnetic force which repels and deforms the metal away from the coil. Republic Aviation is making the study for NASA.

NASA is studying the most economical space vehicle for future payload requirements-beyond Saturn. Vehicles having thrusts of three, nine, and 12 million pounds will be analyzed for a wide range of payload requirements to determine how costs vary with vehicle size. Specifically, the studies will define the costs of vehicle development, production, transportation, launch operations, and propellants.

As We Go To Press (cont)

U. K. Exports To U. S. Drop

Exports of electronic products from the United Kingdom to the U. S. in the first nine months of 1960 were approximately $13.7 million. This is a 3% drop from the same period in 1959. Consumer type equipment dropped sharply, but there were substantial gains in exports of commercial electronic equipment such as test equipment, electro-medical apparatus, and recording tapes.

FOR TROPO SCATTER SYSTEM

This 75,000 w., 50-ft. long tropospheric scatter radio transmitter goes "over-the-horizon" in leaps of up to 500 mi. Developed by Dy-

namics Corp. of America's Radio Engineering Lab., Inc., for a new defense warning system, it will also be available for commercial use.

WESCON Changes

A special radio astronomy session will be held at WESCON (Western Electronic Show and Convention) jointly with the International Astronomical Union. Among the program departures will be special attention to the generation, detection and application of coherent infrared and optical electromagnetic radiation using the latest quantum-electronic techniques.

Stratoscope Tests Ready

Stratoscope II, an attempt to photograph planets and stellar nebulae with new clarity is entering the preliminary testing stage says NASA and the Navy.

Heart of the project is a balloon-borne 36-inch telescope which will be lofted to 80,000 feet. This height will bring it above nearly all of the atmospheric turbulence and dust that distorts or obscures ground-based observations.

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Radio Shack Corp.
Sager Electrical Supply Co.
MINNESOTA, ST. PAUL
Gopher Electronics
MISSOURI, KANSAS CITY
Jones Electronic Sales
MISSOURI, ST. LOUIS
Interstate Supply Co.
NEW YORK, JAMAICA
Peerless Radio Distributors
NEW YORK, MINEOLA
Arrow Electronics, Inc.
NEW YORK, NEW YORK CITY
Harrison Radio
NEW YORK, BUFFALO
Summit Distributors, Inc.
NEW YORK, SCHENECTADY
Schenectady Electronics
NEW YORK, UTICA
Valley Electronics Labs Inc.
OHIO, CLEVELAND
Main Line Cleveland, Inc.
PENNSYLVANIA, PHILADELPHIA
Phila. Electronics Inc.
TEXAS, DALLAS
Central Electronics
UTAH, SALT LAKE CITY
S. R. Ross, Inc.
WASHINGTON, SEATTLE
F. B. Connelly Co.
CANADA, MONTREAL
Atlas Wholesale Radio Inc.

WEST COAST WAREHOUSES

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1060 Evelyn Street
Menlo Park, California
DAvenport 1-4332

Richard A. Strassner Company
Los Angeles 27, California
Hollywood 3-5694

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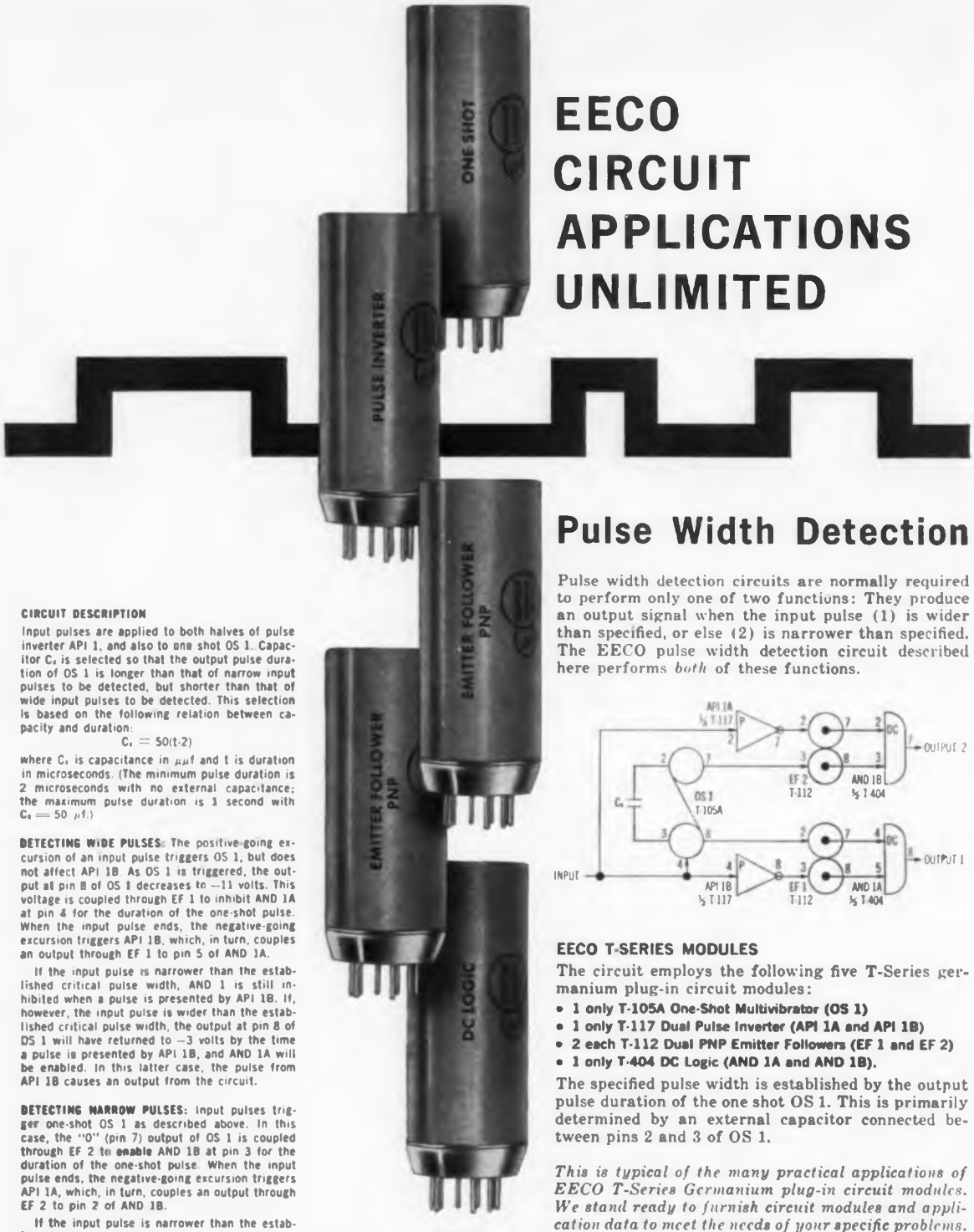
EECO CIRCUIT APPLICATIONS UNLIMITED



Pulse Width Detection

Pulse width detection circuits are normally required to perform only one of two functions: They produce an output signal when the input pulse (1) is wider than specified, or else (2) is narrower than specified. The EECO pulse width detection circuit described here performs *both* of these functions.

CIRCUIT DESCRIPTION

Input pulses are applied to both halves of pulse inverter API 1, and also to one shot OS 1. Capacitor C_x is selected so that the output pulse duration of OS 1 is longer than that of narrow input pulses to be detected, but shorter than that of wide input pulses to be detected. This selection is based on the following relation between capacity and duration:

$$C_x = 50(t-2)$$

where C_x is capacitance in $\mu\mu f$ and t is duration in microseconds. (The minimum pulse duration is 2 microseconds with no external capacitance; the maximum pulse duration is 1 second with $C_x = 50\ \mu f$.)

DETECTING WIDE PULSES: The positive-going excursion of an input pulse triggers OS 1, but does not affect API 1B. As OS 1 is triggered, the output at pin 8 of OS 1 decreases to −11 volts. This voltage is coupled through EF 1 to inhibit AND 1A at pin 4 for the duration of the one-shot pulse. When the input pulse ends, the negative-going excursion triggers API 1B, which, in turn, couples an output through EF 1 to pin 5 of AND 1A.

If the input pulse is narrower than the established critical pulse width, AND 1 is still inhibited when a pulse is presented by API 1B. If, however, the input pulse is wider than the established critical pulse width, the output at pin 8 of OS 1 will have returned to −3 volts by the time a pulse is presented by API 1B, and AND 1A will be enabled. In this latter case, the pulse from API 1B causes an output from the circuit.

DETECTING NARROW PULSES: Input pulses trigger one-shot OS 1 as described above. In this case, the "0" (pin 7) output of OS 1 is coupled through EF 2 to enable AND 1B at pin 3 for the duration of the one-shot pulse. When the input pulse ends, the negative-going excursion triggers API 1A, which, in turn, couples an output through EF 2 to pin 2 of AND 1B.

If the input pulse is narrower than the established critical pulse width, AND 1B is still enabled when a pulse is presented by API 1A, and the circuit generates an output pulse. If, however, the input pulse is wider than the established critical pulse width, the output at pin 7 of OS 1 will have returned to −11 volts by the time a pulse is presented by API 1A and AND 1B will be inhibited, preventing any outputs.

EECO T-SERIES MODULES

The circuit employs the following five T-Series germanium plug-in circuit modules:

- **1 only T-105A One-Shot Multivibrator (OS 1)**
- **1 only T-117 Dual Pulse Inverter (API 1A and API 1B)**
- **2 each T-112 Dual PNP Emitter Followers (EF 1 and EF 2)**
- **1 only T-404 DC Logic (AND 1A and AND 1B).**

The specified pulse width is established by the output pulse duration of the one shot OS 1. This is primarily determined by an external capacitor connected between pins 2 and 3 of OS 1.

This is typical of the many practical applications of EECO T-Series Germanium plug-in circuit modules. We stand ready to furnish circuit modules and application data to meet the needs of your specific problems.

Write or wire today.

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Coming Events in the electronic industry

Apr. 4-5: Plastics Injection Molding Workshop, SPE; Holy Cross College, Worcester, Mass.

Apr. 4-6: Progress in Electrical-Electronic Equipment Exhibit; Kiel Aud., St. Louis, Mo.

Apr. 4-6: 10th Annual Mtg. & Conf., National Microfilm Assoc.; Sherman Hotel, Chicago, Ill.

Apr. 4-6: Int'l Symp. on Electromagnetics and Fluid Dynamics of Gaseous Plasma, Polytechnic Inst. of Bklyn.; Auditorium of Engineering Soc. Bldg., 33 W. 39th St., N.Y.C.

Apr. 4-7: Nat'l Aeronautic Mtg., Production Forum, Eng'g Display, SAE; Hotel Commodore, N. Y.

Apr. 4-7: West Coast Spring Conv. & High Fidelity Show, AES, Inst. of High Fidelity Mfrs; Ambassador Hotel, Los Angeles, Calif.

Apr. 5-7: Annual Mtg. Inst. of Environmental Sciences, IES; Sheraton Park Hotel, Washington, D. C.

Apr. 5-7: Lifting Reentry Vehicles; Structures, Materials & Design Conf., ARS; El Mirador Hotel, Palm Springs, Calif.

Apr. 5-7: South East District Mtg., AIEE; Jung Hotel, New Orleans, La.

Apr. 5-7: Symp. on Materials & Electron Device Processing, ASTM; Benj. Franklin Hotel, Phila., Pa.

Apr. 5-7: Mtg., Radio Tech. Comm. for Marine Services; Sheraton-Palace Hotel, San Francisco, Calif.

Apr. 5-7: Annual Conv., IES; Hotel Sheraton-Park, Washington, D. C.

Apr. 6-7: Management Eng'g Conf., ASME, SAM; Statler Hilton Hotel, N. Y. C.

Apr. 6-8: meeting, AMS; Hotel New Yorker, New York, N. Y.

Apr. 7: Southwestern Reg. Mtg., Soc. American Military Engrs; Oklahoma City, Okla.

Apr. 7-8: Southeastern Section Mtg., Mathematical Assoc. of America; Wofford College, Spartanburg, S. C.

Apr. 8-9: Southeastern Div. Conv., ARRL; Cherry Plaza Hotel, Orlando, Fla.

Apr. 9-13: Oil & Gas Power Conf. & Exhibit, ASME; Jung Hotel, New Orleans, La.

Apr. 10-11: Maintenance & Plant Eng'g Conf., ASME; Bancroft Hotel, Worcester, Mass.

Apr. 10-11: Rubber & Plastics Industries Conf., AIEE; Sheraton Hotel, Akron, Ohio.

Apr. 10-11: Thermodynamics Conf., Okla. State Univ.; Okla. State Univ., Stillwater, Ohio.

Apr. 10-12: 44th Nat'l Open Hearth Steel Conf. & Blast Furnace, Coke Oven & Raw Material Conf., AIME; Sheraton Hotel, Phila., Pa.

Apr. 10-13: 30th Nat'l Packaging Exposition, American Management Assoc.; Exposition Hall (McCormick Place), Chicago, Ill.

Apr. 10-19: Annual Assembly, Int'l Inst. of Welding, AWS; Sheraton-Atlantic Hotel, N.Y.C.

Apr. 11-12: Materials Handling Conf., AIEE; Pick-Congress Hotel, Chicago, Ill.

Apr. 11-12: Electric Heating Conf., AIEE; Sheraton-Lincoln Hotel, Indianapolis, Ind.

Apr. 11-13: Extra High Voltage Cable Conf., AIEE; Mark Twain Hotel, Elmira, N. Y.

Apr. 11-13: 33rd Annual Conv., Petroleum Electrical Supply Assoc. & Petroleum Industry Electrical Assoc.; Moody Center, Galveston, Tex.

Apr. 11-13: Conf. on Ultrapurification of Semiconductor Materials, AFRD, AR&DC, USAF; New England Mutual Hall, Boston, Mass.

Apr. 12-13: 15th Annual Spring Tech. Conf., "Electronic Data Processing," IRE (Cincinnati Sec.), ARS (S. Ohio Sect.); Hotel Alms, Cincinnati, Ohio.

Apr. 12-14: Symp. on Information & Decision Processes; Purdue Univ., Lafayette, Ind.

Apr. 12-14: Int'l Symp. on Agglomeration, AIME; Sheraton Hotel, Phila., Pa.

Apr. 13-14: Army Aviation Mtg., Inst. of Aerospace Sciences, U. S. Army; Sheraton-Park Hotel, Wash., D. C.

Apr. 13-14: Heat Transfer Conf.; Okla. State Univ., Stillwater, Okla.

Apr. 13-14: 8th Annual STWP Conv., Soc. of Tech. Writers & Publishers; Mark Hopkins Hotel, San Francisco, Calif.

Apr. 13-14: Spring Conf., UNIVAC Users Assoc.; Statler Hilton Hotel, Los Angeles, Calif.

Apr. 14: Western Regional Mtg., Soc. of American Military Engrs, Sacramento, Calif.

Apr. 14-15: Mtg., AMS; Chicago, Ill.

Apr. 14-15: Texas Section Mtg. Math. Assoc. of America; Stephen F. Austin State College, Nacogdoches, Tex.

Apr. 15: Nebraska Section Mtg., Math. Assoc. of America; Univ. of Nebraska, Lincoln, Nebr.

Apr. 16-18: Southwest Reg. Conf., Nat'l Assoc. of Music Merchants, Inc.; Shamrock-Hilton Hotel, Houston, Tex.

Apr. 17-19: Conf. on Mfg. Automation, Purdue University; Purdue University, Lafayette, Ind.

Apr. 17-19: Annual General Session of JEDEC; Hotel Syracuse, Syracuse, N. Y.

Apr. 17-19: Conf. for Protective Relay Engrs; Memorial Student Center, College Sta., Tex.

Apr. 17-19: 7th Nat'l ISA Symp. on Instrumental Methods of Analysis; Shamrock-Hilton Hotel, Houston, Tex.

Apr. 17-21: The Business Equip. Expos. Office Equipment Mfrs Inst.; N. Y. Coliseum, N.Y.C.

Apr. 18-19: Conf. on Organic Semi-

(Continued on page 12)

HIGHLIGHTS OF 1961

Apr. 19-21: SWIRECO — S.W. IRE Regional Conf. & Elec. Show, IRE (Region 6); Dallas, Tex.

May 8-10: NAECON (Nat'l Aeronautical Electronics Conf., IRE (PGANE) (Dayton Sec.); Miami & Dayton Biltmore Hotels, Dayton, Ohio.

May 9-11: Western Joint Computer Conf., IRE (PGEC), AIEE, ACM; Ambassador Hotel, Los Angeles, Calif.

May 22-24: 5th Nat'l Symp. on Global Communications (GLOBECOM V), IRE (PGCS), AIEE; Sherman Hotel, Chicago, Ill.

May 22-24: Nat'l Telemetering Conf., IAS, IRE, AIEE, ARS, ISA; Sheraton-Towers Hotel, Chicago, Ill.

June 28-30: Joint Automatic Control Conf., IRE, AIEE, ASME, ISA, AIChE; Univ of Colorado, Boulder, Colo.

Aug. 22-25: WESCON: Western Electronic Show & Convention, WEMA, IRE (L.A. & S.F. Sect.); Cow Palace, San Francisco, Calif.

Oct. 9 - 11: Nat'l Electronics Conf. (NEC), IRE, AIEE, EIA, SMPTE; Amphitheatre, Sherman Hotel, Chicago, Ill.

Oct. 30-Nov. 1: Radio Fall Meeting, EIA, IRE; Hotel Syracuse, Syracuse, N. Y.

Nov. 14-16: MAECON (Mid-America Elec. Conf., IRE (Kansas City Sect.); Kansas City, Mo.

Nov. 14-16: N. E. Res. & Eng. Mtg. (NEREM), IRE (Region 1); Boston, Mass.

Dec. 3-7: Eastern Joint Computer Conf., IRE (PGEC), AIEE, ACM; Sheraton-Park Hotel, Washington, D. C.

ABBREVIATIONS

ACS: American Ceramics Society
AES: Audio Engineering Society
AIEE: American Institute of Electrical Engineers
AIME: American Institute of Mining, Metallurgical, and Petroleum Engineers
AIP: American Institute of Physics
AMS: American Mathematical Society
APS: American Physical Society
ARRL: American Radio Relay League
ARS: American Rocket Society
ASME: American Society of Mechanical Engineers
AWS: American Welding Society
IES: Institute of Environmental Sciences
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
SPE: Society of Plastic Engineers
SAE: Society of Automotive Engineers

Coming Events

(*Continued from Page* 11)

conductors, Armour Research Foundation; Morrison Hotel, Chicago, Ill.

Apr. 18-20: **Annual Mtg. & Welding Exposition,** AWS; Hotel Commodore, Coliseum, N.Y.C.

Apr. 18-20: **Symp. on Chemical Reactions in the Lower & Upper Atmosphere,** Stanford Res. Inst.; San Francisco, Calif.

Apr. 18-20: **Electrical Trade Show,** Electrical Mfrs. Representatives Club of New England; Commonwealth Armory, Boston, Mass.

Apr. 19-21: **Great Lakes District Mtg.,** AIEE; Minneapolis, Minn.

Apr. 19-21: **SWIRECO—S.W. IRE. Regional Conf. & Elec. Show,** IRE (Region 6); Dallas, Tex.

Apr. 19-22: **Annual Conv., Florida Eng'g Soc.;** San Juan Hotel, Orlando, Fla.

Apr. 20: **Plastics—A New Dimension in Buildings,** SPE; Springfield Museum of Art, Springfield, Mass.

Apr. 20-21: **Annual Conf. Soc. of Plastics Industry;** Hotel Del Coronado, Coronado, Calif.

Apr. 20-21: **Railroad Conf.,** AIEE, ASME; Francis Drake Hotel, San Francisco, Calif.

Apr. 20-May 4: **Eng'g Marine, Welding & Nuclear Energy Exh.;** Olympia, London, W14, England.

Apr. 22: **Mtg,** AMS; Stamford, Calif.

Apr. 23-26: **Metals Eng'g Conf.,** ASME; Penn Sheraton Hotel, Pittsburgh, Pa.

Apr. 23-27: **63rd Annual Mtg.,** ACS; Royal York Hotel, Toronto, Canada.

Apr. 23-27: **Annual Mtg.,** Scientific Apparatus Makers Assoc.; The Greenbrier, White Sulphur Sprgs, W. Va.

Apr. 24-25: **Southwest Mineral Industry Conf.,** AIME; Las Vegas, Nev.

Apr. 24-26: **Annual Mtg. Nat'l Acad. of Sciences;** Washington, D. C.

Apr. 24-26: **Spring Conf.,** Assoc. of Iron & Steel Engrs; Jefferson Hotel, St. Louis, Mo.

Apr. 24-27: **Mtg.,** APS; Nat'l Bureau of Standards, Washington, D. C.

Apr. 25-27: **9th Nat'l Conf. on Electromagnetic Relays,** Nat'l Assoc. of Relay Mfrs; Okla. State Univ., Stillwater, Okla.

Apr. 26-27: **Tech. Conf. on High-temp. Materials, AIME;** Carter Hotel, Cleveland, Ohio.

Apr. 26-28: **Propellants, Combustion & Liquid Rockets Mtg.,** ARS; Palm Beach Biltmore Hotel, Palm Beach, Fla.

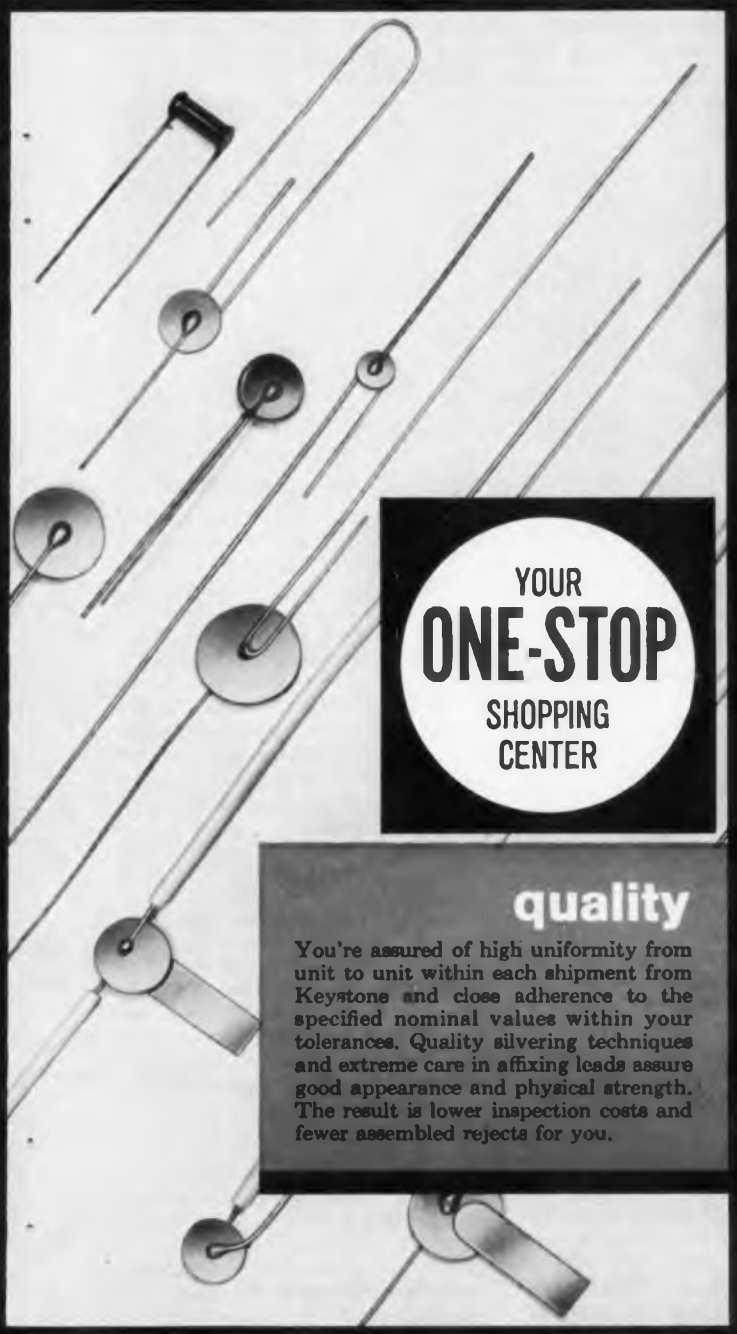
Apr. 26-28: **7th Region Tech. Conf. & Trade Show,** IRE (Region 7); Westward Ho Hotel, Phoenix, Ariz.

Apr. 29-May 3: **53rd Annual Conf.,** Nat'l Assoc. of Electrical Distributors; Cobo Hall, Detroit, Mich.

Apr. 30-May 4: **7th Nat'l Aero-Space Instrumentation Symp.,** ISA; Adolphus Hotel, Dallas, Tex.

Apr. 30-May 4: **Spring Mtg.,** The Electrochemical Soc., Inc.; Claypool Hotel, Indianapolis, Ind.

FROM THE **KEYSTONE** **THERMISTOR** DIVISION



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As We Go To Press . . .

Nerve Net Study Proves Theorems

A study of electronic nerve nets called perceptrons has yielded proofs for a number of theorems of fundamental importance to the theory of such networks. (Report available from Office of Technical Services, Business and Defense Services Administration, U. S. Dept. of Commerce, Wash. 25, D. C.)

Summarized, the proofs are: There exist certain simple memory functions and training procedures by which it can be guaranteed that a perceptron will ultimately arrive at a solution to any given response-association problem, provided only that a solution exists; a variety of problems, involving wide variations in the frequencies and sizes of stimuli in an environment, are shown to be soluble; whereas previously only heuristic arguments could be given, and it was by no means certain that solutions could be found by means of simple training procedures; the same procedures which yield solutions for binary classifications problems can be used to assign arbitrary response functions.

Wiretap Bill Introduced

Senator Kenneth B. Keating (R., N. Y.) has introduced a bill to clarify "the wiretapping muddle." Under terms of the measure, state law enforcment officials would be permitted to wiretap under court supervision.

DARK HEATER

RCA's new "dark heater" wire for receiving tubes has a 20% lower operating temperature than conventional heater wire (left). Heater uses a new gray insulation coating.

Mars Drops AM and VHF Adopts Double Sideband

The Military Affiliate Radio System (MARS)—the ham radio net of the U. S. Air Force—will abandon AM Transmission on High Frequency and VHF nets in favor of the double-sideband technique.

Target date for the changeover is June 1961. MARS will recommend use of the Double Sideband Junior Transmitter designed by J. K. Webb of GE's Light Military Electronics Dept.

Anti-Jam Study

The Univ. of Arizona is studying how to "improve U. S. Army techniques for recovering radio message information that has been reformed or obliterated by 'Jamming'." They call the program, "an analytical study of the individual components of the complex wave form of voice signals."

RUBY LASER

Dr. Lucio M. Vallese of ITT Federal Labs checks operation of experimental ruby laser for generating coherent light. LASER is an acronym meaning "light amplification by stimulated emission of radiation."

Space Communications Study—Recommendations Made by GE

The General Electric Company has made recommendations to the FCC in response to the Commission's request for information needed to form domestic and foreign policy on space communications.

The company stressed that the future communication needs of underdeveloped nations of the world must be given equal consideration with the requirements of highly industrial nations. The equitable allocation of frequencies for space, they said, must be based upon world-wide considerations — both technical and non-technical.

Company scientists divided the technical factors involved into two categories: "Communication for Space" and "Space for Communication." The former involves communication in space missions while the latter involves an extension and expansion of terrestrial communication utilizing equipment in space.

They recommended that the allocation of frequencies should vary with the services to be performed. The services are of three major types: (a) services involving safety (manned flight emergency and distress) (b) services requiring communication (data transmission from space vehicles) and (c) services in which the primary function is communication (telegraph relay).

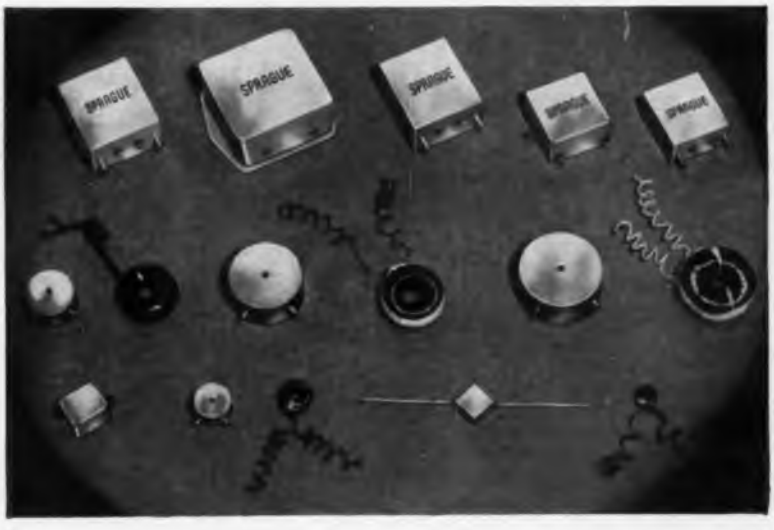
Priority among these types should be given to the services involving safety, then to those for space missions, and finally to those improving utilizations of the radio frequency bands.

The company also released details of its concept for a world-wide satellite system handling long distance communications. They proposed a global system with local, national, or private ownership of ground terminals. The system would provide service to the existing communication companies thereby providing for the maximum growth opportunity both for privately owned U. S. telecommunication carriers and for those carriers operated by other countries.

Further recommendations were: the U. S. should pursue, on its own initiative and on a cooperative basis with other countries, experiments using temporary frequency assignments as a step toward permanent allocation. They said that present information indicates a need for allocation of 10 MC in the 1000-2000 MC band for low density circuits to be used exclusively for space purposes.

They also suggested an allocation of 500 MC in the 1000-10,000 MC band for use on a shared basis with ground services such as microwave.

Broadness of Sprague's Line of Precision Toroidal Inductors Offers Standard Units for Practically Every Application



DESIGNED FOR USE in commercial, industrial, and military apparatus, Sprague Precision Toroidal Inductors are customarily supplied to the close inductance tolerance of ±1%. The broad line of Sprague Precision Toroidal Inductors includes such styles as open coil, plastic-dipped, rigid encapsulated inductors with tapped or through-hole mounting, and hermetically-sealed inductors.

All styles, with the exception of the open coil type construction, meet the appropriate requirements of Military Specification MIL-T-27A.

Sprague Precision Inductors are manufactured in modern plants which are equipped with the most up-to-date facilities for winding, processing, and testing the cores. Production instruments used in the manufacture of Sprague inductors are calibrated periodically to assure desired levels of accuracy. Quality control and inspection departments, which function independently of each other, maintain close surveillance over all production operations.

Several core permeabilities may be obtained in each of the five basic sizes of Sprague inductors to give the circuit designer the optimum selection of desired Q and current carrying abilities. Further, each of the core sizes is available with several degrees of stabilization. Inductors made with cores which have not been subjected to the stabilization process exhibit low inductance drift with time and have a low temperature coefficient of inductance. Where a greater degree of permanence of characteristics is required, cores with two different stabilization treatments can be used for most types of inductors.

All standard inductors by Sprague may be operated over the temperature range of −55 C to +125 C. Temperature cycling of finished inductors is a standard production procedure in order to equalize internal stresses and insure permanence of electrical characteristics.

In those cases where the extensive line of Sprague standard inductors is unsuitable for a particular application, the Special Products Division of the Sprague Electric Company will be glad to work with you to custom-tailor designs to meet specific customer requirements.

For detailed information on standard ratings, package sizes, Q, current carrying abilities, properties, etc., write on company letterhead for portfolio of engineering data sheets on precision toroidal inductors to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Something **NEW** in counting techniques!

Sprague type 73Z1 core-transistor DECADE COUNTERS

Here is a simple yet versatile, low-cost yet reliable component for counter applications. Counting to speeds of 10 kc, the 73Z1 decade counter provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. For higher counting, two or more counters may be cascaded. Typical characteristics are shown below.

CHARACTERISTIC	INPUT	OUTPUT
Amplitude	1.5 to 8 volts	6.5 volts min.
Pulse Width	1 μsec min.	50 μsec nom.
Impedance	100 ohms	20 ohms

Utilizing two rectangular hysteresis loop magnetic cores and two junction transistors to perform the counting operation, the 73Z1 counter is encapsulated in epoxy resin for protection against adverse environmental conditions. It has five terminals −B+ (12v ±10%), input, output, ground, and manual reset.

The 73Z1 counter is available as a standard item. However, "customer engineered" designs can be supplied when other counting cycles, speeds, and package configurations are required for special applications.

For complete technical data or application assistance on the 73Z1 counter or other Sprague components, write to Special Products Division, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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new electronic timepiece uses ALLEN-BRADLEY Type TR Miniature Composition Resistors

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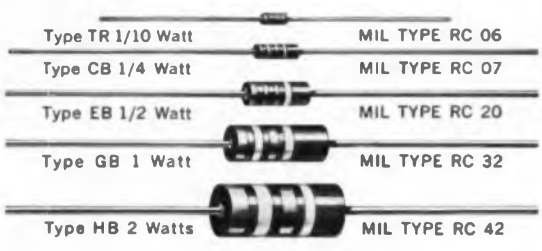
Allen-Bradley Type TR tiny resistors enabled Accutron designers to achieve the required circuit miniaturization for a wrist timepiece—*without sacrificing reliability*. This circuit controls the 360 pulses of power each second—31 million per day—that drive the tuning fork. Although incredibly small, these Type TR miniature composition resistors are made by Allen-Bradley's exclusive hot molding process that *guarantees complete freedom from catastrophic failures!* A-B Type TR resistors are conservatively rated 1/10 watt at 70°C.

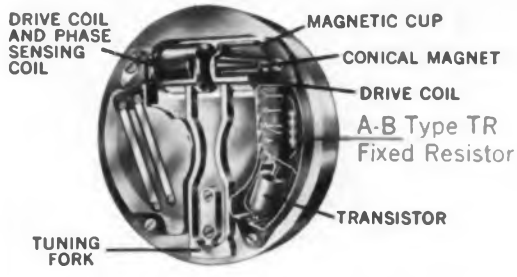
There are also other Allen-Bradley space-saving potentiometers, capacitors, and h-f filters that can help solve your miniaturization problem. And you obtain the same reliability for which the larger Allen-Bradley components have earned a world-wide reputation. For full details, send for Publication 6024.

* TRADEMARK BULOVA WATCH CO., INC.

A-B HOT MOLDED COMPOSITION RESISTORS



DRAWING OF ACCUTRON SHOWS BASIC MECHANISM



ALLEN-BRADLEY Quality Electronic Components

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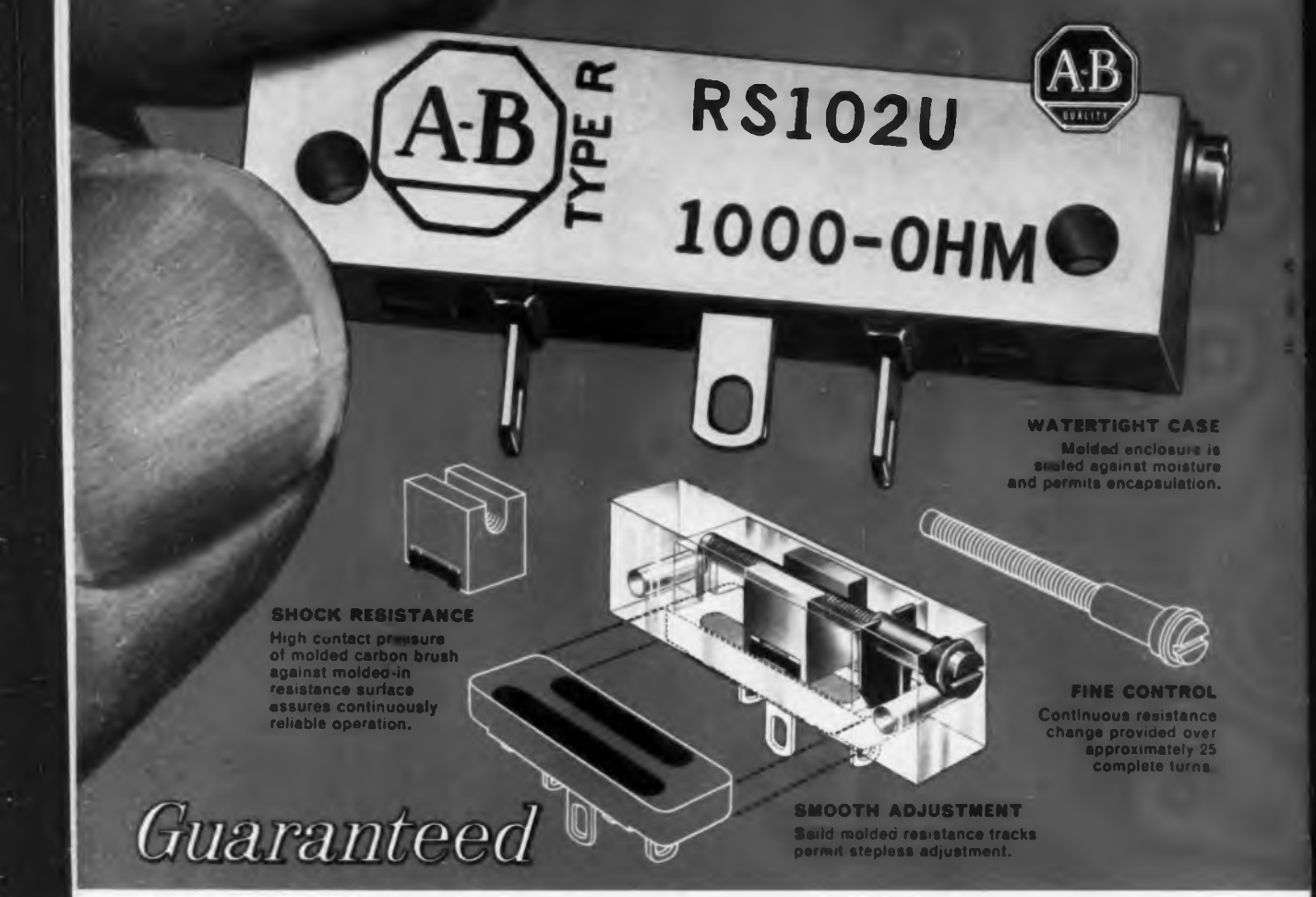

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In critical applications, Allen-Bradley Type R adjustable fixed resistors are *without equal*. For example, in recent tests* Type R resistors successfully withstood acceleration, shock, and vibration *five times* better than the latest MIL Spec requirements. Such wide margin of safety is your assurance of complete reliability. Virtual indestructibility is obtained through an *exclusive* Allen-Bradley process in which the solid resistance elements and the insulating mounting are hot molded into one integral unit. The moving element is self-locking for absolutely stable settings. Also, the Type R control allows "stepless" adjustment of its resistance.

The molded case of the Type R control is watertight and dust-tight. Rated ¼ watt at 70°C, these Type R controls are available in values from 100 ohms to 2.5 megohms.

*Test Report 471801, Sept. 1960, United States Testing Co., Inc.

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Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

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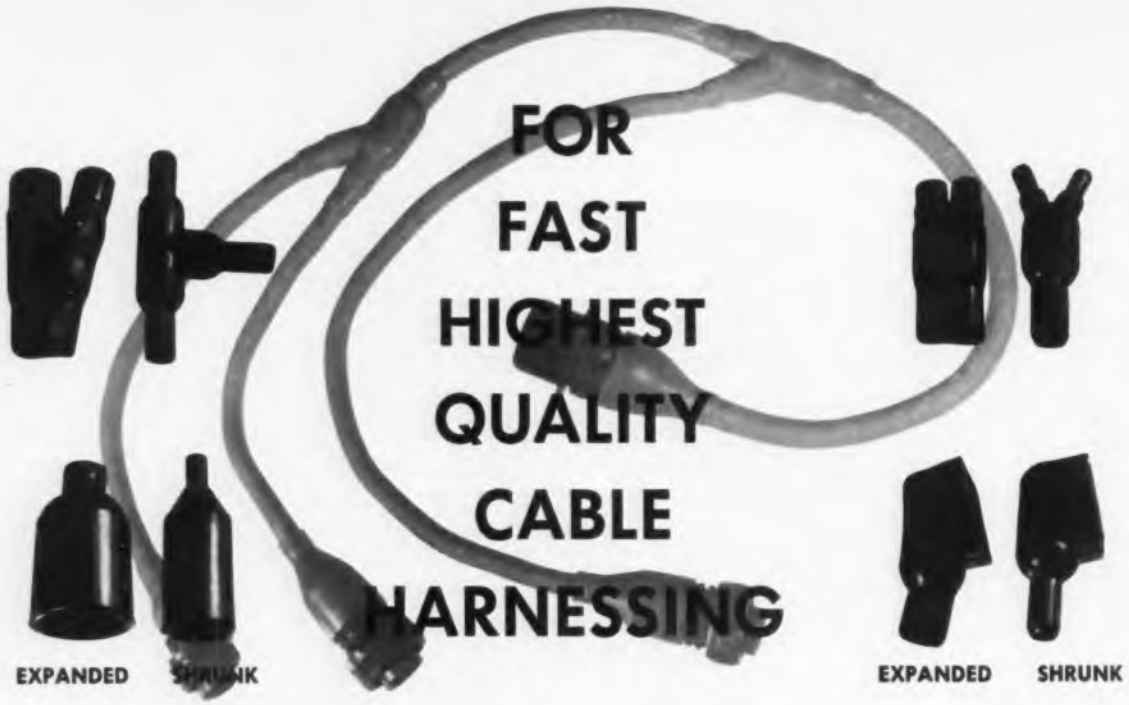

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CORPORATION

Premolded harness encapsulating boots and transitions which, when subjected to the brief application of heat, shrink to as little as 20% of their diameter as supplied. A wide variety of standard configurations are available from stock in four different rubber and plastic materials for difficult environmental conditions. Any moldable configuration is available with short lead time.

OAKSIDE AT NORTHSIDE • REDWOOD CITY, CALIFORNIA

News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

GENERAL DYNAMICS CORP., has formed a new division, consolidating separate electronic divisions formerly spread among several divisions. The new division, General Dynamics/Electronics, will absorb the former Stromberg-Carlson Div.

THE SPRAGUE ELECTRIC CO. will build a new 15,000 sq. ft. manufacturing plant at Plymouth, N. H. The plant will supplement the solid tantalum capacitor production facilities at the Company's Concord, N. H. Semiconductor Plant. It is expected to be completed by June.

TENNEY ENGINEERING, INC., Union, N. J., has established a new division to design, develop and produce ground and flight support devices. The new division will specialize in servo, hydraulic, pneumatic, and electrical test stands and launching devices and containers.

YARDNEY ELECTRIC CORP., is taking over a 250,000 sq. ft. plant on 10 acres of land of the Raytheon Co., in Stoningham, Conn. The plant will be used to build submarine batteries.

W. L. GORE & ASSOC., INC., Newark, Del., has moved into a new facility near Newark, Del.

HERMETITE CORP., Boston, Mass., has opened a new half million dollar plant in Avon, Mass. for producing glass, metal, ceramic seals, and ultra high temp. glass seals, for the electronic industries.

REON RESISTOR CORP., Yonkers, N. Y. and **SILICON TRANSISTOR CORP.**, Carle Place, L. I., are holding preliminary merger talks.

APPLIED MICROWAVE ELECTRONICS, INC., Baltimore, is planning to build a new $100,000 office and laboratory building in Baltimore County, Md. The new building, 6,000 sq. ft., is designed to facilitate testing microwave antennas on the roof.

THE WELEX ELECTRONICS CORP., Washington, has acquired Elcor, Inc., Falls Church, Va.

INFRARED INDUSTRIES, INC. and **KRAMER CONTROLS CORP.**, have terminated merger negotiations.

FEDERAL SYSTEMS DIV. OF IBM will develop advanced data transmission technologies for space and military computer information systems at a new center to be located near Washington, D. C.

WESTINGHOUSE ELECTRIC CORP., has completed a new 50,000 sq. ft. building at its Semiconductor Dept., Youngwood, Pa. The new building is devoted to the development in processing semiconductor materials.

PHILCO CORP. has a new 203,000 sq. ft. Research Lab at its Research Center at Blue Bell, Pa.

LING-TEMCO ELECTRONICS, INC., has acquired National Aeronautics & Space Engineering, Inc., a Los Angeles consulting firm specializing in missile base engineering.

IT&T. Agreement has been reached for the acquisition by International Telephone & Telegraph Corp. of Jennings Radio Mfg. Corp., San Jose, Calif.

SPECTROMAGNETIC INDUSTRIES has moved to a new factory at 25393 Huntwood Ave., Hayward, Calif.

LENKURT ELECTRIC CO., INC., is planning the addition of approximately 94,000 sq. ft. to its manufacturing building at Howard Ave. & Industrial Rd., San Carlos, Calif. Most of the new space will be for development and engineering offices and laboratories.

NAVIGATION COMPUTER CORP., has moved laboratory and production facilities to the Valley Forge Industrial Park near Philadelphia, Pa.

LABORATORY FOR ELECTRONICS, INC., Boston, Mass., and **EASTERN INDUSTRIES, INC.**, Hamden, Conn., have voted for a merger agreement.

GENERAL PRECISION EQUIPMENT CORP., is moving into new corporate headquarters in suburban Tarrytown, N. Y. The new address is 50 Prospect Ave., Tarrytown.

RADIO CITY PRODUCTS COMPANY, INC., Easton, Pa., has changed its name to Planetronics, Inc.

MIDWEST

OMTRONICS MFG. CO., INC., a new electronics firm, has been formed. Home office is P.O. Box 1419, Peony Park Sta., Omaha, Nebr. Company has a temperature controller in the pilot run stage.

NATIONAL CONNECTOR CORP., Minneapolis, has moved their entire operation to a newly constructed 20,000 sq. ft. plant in the New Hope Science Industry Center, north of Minneapolis.

COHU ELECTRONICS', Cleveland, Ohio, Massa Division is expanding its present facility with an additional 45,000 sq. ft.

NILSEN MFG. CO., formerly located at Addison, Ill., has moved into its new 14,000 sq. ft. of plant area for laboratory, engineering, production, and office facilities at Haines City, Fla. The company's Electronicast Div. which manufactures investment castings will remain at Addison, Ill.

AUTOMATION INDUSTRIES, INC., has acquired Amco, Inc., of Abilene, Tex. Automation Industries makes ultrasonic, electronic, and magnetic products. Amco is an integrated fabricator of aircraft and missile components.

GENERAL ELECTRIC CO.'s COMPUTER DEPT. is planning a $4 million addition to its manufacturing and headquarters facilities in Phoenix, Ariz. The new expansion will add approximately 190,000 sq. ft. to the department's existing 204,000 sq. ft. manufacturing and administrative building. Construction is scheduled to begin in April.

TEXAS INSTRUMENTS INCORPORATED and **INTERNATIONAL TELEPHONE & TELEGRAPH CORP.**, have agreed to exchange non-exclusive patent licenses and technical information concerning semiconductor components. TI will also supply a portion of ITT's need for semiconductor devices and components.

DORSET ELECTRONIC LABORATORIES, INC., Norman, Okla., has acquired all the outstanding shares of American Missile Products, Inc., Lawndale, Calif.

DOUGLAS AIRCRAFT CO. and **MIDWESTERN INSTRUMENTS, INC.**, Tulsa, Okla., are negotiating an agreement that would give Douglas a substantial interest in Midwestern through acquisition of newly issued stock in the firm.

WEST

SYLVANIA ELECTRIC PRODUCTS INC.'s Santa Cruz plant in Calif. has purchased the printed circuit facility of Curtis Wright Corp. at Santa Barbara, Calif. The equipment will be moved to Santa Cruz.

SPECTROL ELECTRONICS CORP., San Gabriel, Calif., subsidiary of Carrier Corp., has purchased the Bamford Corp. of Santa Monica, Calif., producer of miniature trimmer potentiometers.

OSBORNE ELECTRONICS CORP., has opened a new Component Div. in Southern Calif. Located at 1621 W. 135th St., Gardena, Calif., the new facility has manufacturing space, model shop, and offices for the Los Angeles Sales Group.

LOCKHEED's Missiles and Space Div. will institute a $4 million expansion with the construction of a 172,800 sq. ft. engineering and laboratory building scheduled for occupancy by June, 1961. It will be the first built on the 345-acre Holthouse site, situated between the present Lockheed plant perimeter and the Navy's Moffett Field in Sunnyvale, Calif.

AMPEX CORPORATION, Redwood City, Calif., and **TELEMETER MAGNETICS, INC.**, Culver City, Calif., have proposed a merger, subject to the approval of their respective stockholders. Ampex would be the surviving concern.

LERCO ELECTRONICS, INC., has changed its name to Technical Systems, Inc.

TELECOMPUTING CORPORATION has begun construction on the first building in its Manufacturing and Engineering Facility, embracing 500,000 sq. ft., at Chatsworth, Calif.

COLBUK, INC., wholly owned subsidiary of the Bureau of Engraving, Inc., will locate in a new 6,500 sq. ft. office and manufacturing facility, now under construction, in the Canoga Park Industrial Center, West San Fernando Valley, Los Angeles, Calif. Colbuk will supply printed circuits to the Electronics Industry.

PHILCO CORPORATION has leased a full floor in the new 7715 Sunset Blvd. Building in Hollywood, Calif. Formerly, Philco maintained Los Angeles Headquarters on South La Cienega Blvd.

INFORMATION SYSTEMS, INC., Los Angeles, Calif., has established a "Computer Div." which consolidates ISI's computer operations and broadens the total product line of Western operations.

WEINSCHEL ENGINEERING has opened a Field Engineering Office at 631 Wilshire Blvd., Santa Monica, Calif., to serve the missile, aircraft and electronic industries in the Los Angeles and San Diego areas. The company will "break ground" in early 1961 for a 50,000 sq. ft. laboratory in Gaithersburg, Maryland, near the new National Bureau of Standards site.

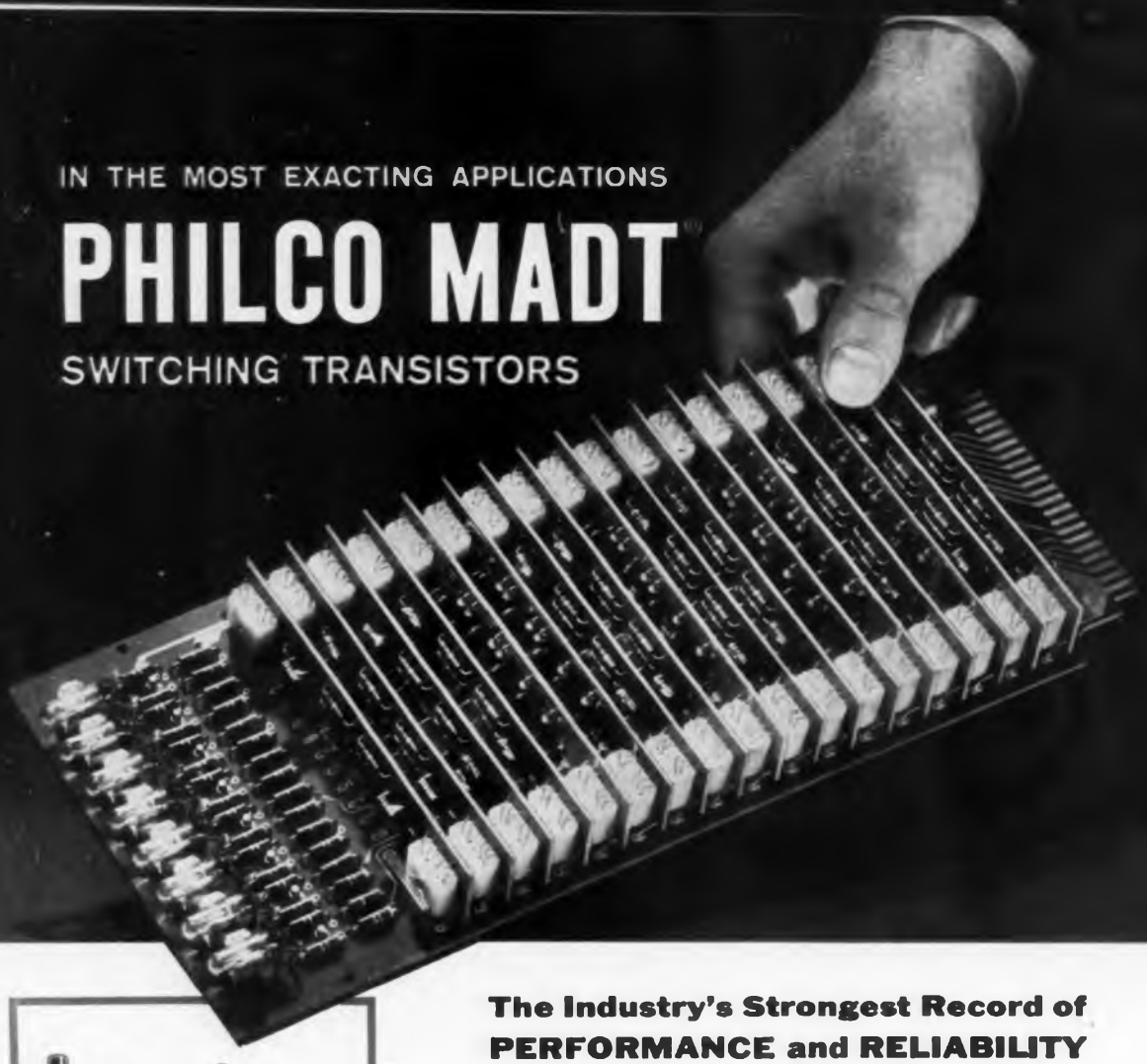
ELECTRADA CORP., Beverly Hills, Calif., has formed a new subsidiary, the Advanced Information Systems Co. to provide a comprehensive service in the research, design, and implementation of complex information systems for government agencies, research organizations, and industrial firms.

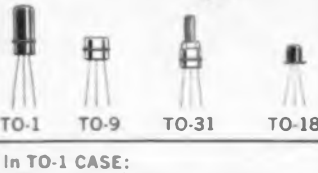
ROYCO INSTRUMENTS, INC., has moved its offices and production facilities from Mountain View, Calif., to a 6,250 sq. ft. structure at 440 Olive St., Palo Alto, Calif.

IN THE MOST EXACTING APPLICATIONS

PHILCO MADT

SWITCHING TRANSISTORS





In TO-1 CASE:
2N501—Ultra high speed switch
2N501A—Military version of 2N501

In TO-9 CASE:
2N1204—Ultra high speed, high current switch
2N1495—High voltage, high speed, high current switch
2N1499A—High speed, low cost switch (MIL version available)
2N1500—Ultra high speed switch (MIL version available)
2N1754—Very low cost, high speed switch

In TO-31 CASE:
2N1494—High power version of the 2N1204

In TO-18 CASE:
2N768—Ultra high speed switch for very low power circuits
2N769—World's fastest switch
2N779A—Ultra high speed switch—very high beta
2N846A—Ultra high speed switch

Immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor

The Industry's Strongest Record of PERFORMANCE and RELIABILITY

In high-speed computers, control systems, guidance systems and many other critical military and industrial switching applications, Philco's patented high-frequency Micro Alloy Diffused-base Transistors are used more widely than any other type. There are many reasons for this broad acceptance. Philco MADTs are available in a full range of types, each designed and produced to tight specifications for specific applications. They are manufactured by Philco's patented Precision-Etch* process on the world's first fully-automatic transistor production lines . . . under rigid quality control. Philco MADTs have proved their outstanding performance capabilities and reliability in *billions of transistor hours of actual field operation* . . . far more than any other type of transistor.

There is a Philco MADT to meet your requirements . . . offering the advantages of cadmium junctions for cooler operation . . . low collector capacitance . . . low saturation voltage . . . high beta with good linearity . . . excellent frequency response . . . low hole storage time . . . and excellent temperature stability.

Specify Philco MADTs with complete confidence. For full information on any specific type write Dept. EI461.

*Trademark Philco Corp.

PHILCO

Famous for Quality the World Over

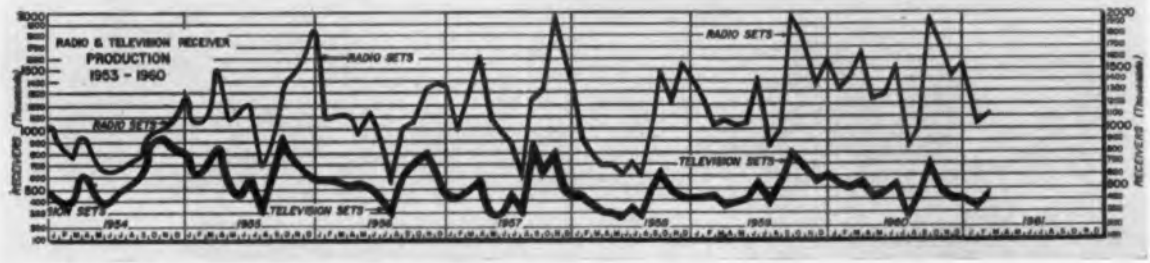
LANSDALE DIVISION, LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.

Circle 73 on Inquiry Card

Facts and Figures Round-Up
April 1961

ELECTRONIC INDUSTRIES TOTALS



ELECTRONIC COMPONENT INDUSTRY OPERATING RATIOS OR AVERAGES, BY SELECTED COMPONENTS AND MAJOR GEOGRAPHICAL AREAS[1]

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in February, 1961.

Amplifiers	334,816
Antennas & Systems	4,276,434
Attenuator	110,689
Battery, dry	298,829
Battery, storage	205,300
Brushes	52,042
Cable, assemblies	52,305
Cable, coaxial	156,200
Cable, r-f	127,912
Cable, special purpose	54,600
Cable, telephone	54,470
Calibration Set	1,262,700
Capacitors	114,013
Chopper, electronic	67,250
Cleaning system, ultra-sonic	33,772
Coil, deflection	34,450
Computer, airborne navigation	150,000
Connector, plug	36,808
Control System, pulse coded	29,387
Delay Lines	161,789
Dewars, cryogenic	27,294
Discriminators	187,080
Fuse, radar	151,578
Gyroscopes	355,277
Headset	41,575
Indicators	575,685
Intercommunication, set	81,534
Microphone	275,100
Monitor, coordinate data	425,600
Motors, servo	63,770
Oscillator	67,329
Oscillator assemblies	58,703
Oscillograph	57,000
Oscilloscope	69,280
Power supplies	712,110
Radar beacons	46,900
Radar set	1,440,843
Radio set	40,528
Radiosonde set	1,568,739
Radome	152,634
Range finder, computer	2,667,720
Receiver/transmitter	259,680
Record/playback system	49,896
Recorder	30,552
Recorder, analyzer	115,283
Recorder/reproducer, magnetic tape	25,977
Recorder system, airborne	149,347
Recording system, PCM telemetry	278,148
Relays	144,524
Relay, armature	60,292
Resistor assembly	43,400
Resolver	230,000
Resonator, selector cavity	34,981
Signal generators	30,251
Static frequency changers	147,892
Switch, fluid flow	33,629
Switch, rotary	80,214
Switch, thermostatic	28,960
Tape, magnetic	56,000
Tape, recorder	125,199
Telegraph system	48,500
Telemetry station, ground	198,584
Television equipment	116,569
Terminal, telephone	6,087,194
Test equipment	648,216
Timers	200,797
Trainers, radar	197,797
Transceivers	252,980
Transformers	79,614
Transistors	56,000
Translator, magnetic tape	46,460
Transmission system, photo	1,250,000
Transmitter	2,530,888
Tube, electron	1,665,577
Tubes, magnetron	72,500
Video mapping groups	79,137
Viewing set, infrared	58,800

UNITED KINGDOM: DOMESTIC EXPORTS OF ELECTRONIC PRODUCTS TO THE U. S. 1958, 1959, AND JAN.-SEPT., 1959 AND 1960

	Quantity in thousands of units				Value in thousands of dollars[1]			
			January–September				January–September	
Product	1958	1959	1959	1960	1958	1959	1959	1960
TOTAL	—	—	—	—	17,184	21,974	14,123	13,697
Receivers	4.4	9.7	7.7	6.9	135	292	231	178
Phonographs	3.8	2.4	1.7	1.9	304	232	168	175
Speakers, microphones	59.0	112.2	86.6	62.5	479	532	397	420
Phonographs	2.8	4.7	2.1	12.3	149	147	100	222
Phonograph parts	—	—	—	—	904	1,207	1,002	564
Record playing mechanisms:								
With record changer	926.3	1,251.7	718.0	574.9	8,678	11,739	6,666	5,083
Less record changer	125.2	102.2	86.6	31.6	520	623	493	164
Electronic, nucleonic tubes[2]:								
Complete	5,375.7	4,591.0	3,718.4	3,155.4	2,303	2,381	1,848	1,763
Parts	—	—	—	—	10	97	62	177
Components, parts	—	—	—	—	1,221	1,243	809	1,115
Communications, navigation, and radar equipment	—	—	—	—	1,388	2,178	1,540	2,218
Other electronic products	—	—	—	—	1,093	1,303	807	1,620

[1] Converted to U.S. dollar equivalents at the rate of £ = US $2.80.
[2] Includes transistors.

Source: Data compiled by the British Radio Equipment Manufacturers' Assoc. from Statistics of H.M. Customs and Excise.

The one cathode alloy you can use for every application

Superior introduced X-3012* just last year. It was the first all-purpose cathode alloy ever developed. Since then, users have put it into all sorts of tubes, for all sorts of service. And the results have proven Superior's laboratory findings.

X-3012 combines both the high emission capacity of active alloys and the long life normally associated with passive alloys. In addition, sublimation and interface impedance are reduced practically to zero. The alloy has twice the hot strength of ordinary nickel alloys. It can take high current and over-voltage abuse. And the cathode coating adheres well.

Superior developed X-3012 in its electronic laboratories. The precise combination of nickel, tungsten and zirconium was carefully derived from a wide range of different heats to insure the most effective proportions. Available in Lockseam†/Lapseam, seamless/WELDRAWN® cathodes and disc cathodes; also tubular parts for all types of electron tubes. Write for detailed report. Superior Tube Company, 2502 Germantown Ave., Norristown, Pa.

*U.S. Patent No. 2,833,647 (Superior Tube Co.)

†Manufactured under U.S. patents

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts.

Snapshots of the Electronic Industries

FIRST SPACE SHIP

Project Mercury space capsule which will carry the first U. S. astronaut into space. McDonnell Aircraft Corp. is building 20 of the capsules for NASA. GE's RTV, room temperature vulcanizing silicone rubber will seal the capsule against air leakage. The capsule is designed to be lowered by parachute gently to the earth after orbit.

HOT FOOD FOR SPACE MAN

Dr. Werner von Braun inspects experimental space kitchen water heater made by Whirlpool Corp. The miniature heater is 17¼ in. high by 5½ in. in dia. The space kitchen is designed to store and dispense all foods and beverages needed by 3 astronauts on a 14-day space mission. Three pints of water can be drawn every 2 hrs.

SOUNDING ROCKETS

Ryan Aerolab Argo D-8 four-stage, solid-propellant rocket vehicle can boost payloads to more than 1,500 miles altitude at speeds greater than 7,000 m.p.h. Rocket is on a launch pad at Naval Missile Facility in California.

THERMOELECTRIC GENERATOR

Gas furnace drives its own blower from a thermoelectric generator. Made by C. A. Olsen Mfg. Co., it is rated at 130 watts at approx. 9 v. There are 47 thermoelectric couples.

TV FOR BALLOON TELESCOPE

Transistorized TV camera will be sent aloft on Stratoscope II, a 36 in. balloon-borne telescope for astronomical studies. Balloon will go up 15 miles. RCA's L. Boyer adjusts camera

SHERWOOD FOREST

Central passageway of U.S.S. Theodore Roosevelt's missile compartment. The 16 Polaris missile launching tubes shown will carry more destructive power than all aerial bombs dropped in WW-II.

READY-AIM-TALK

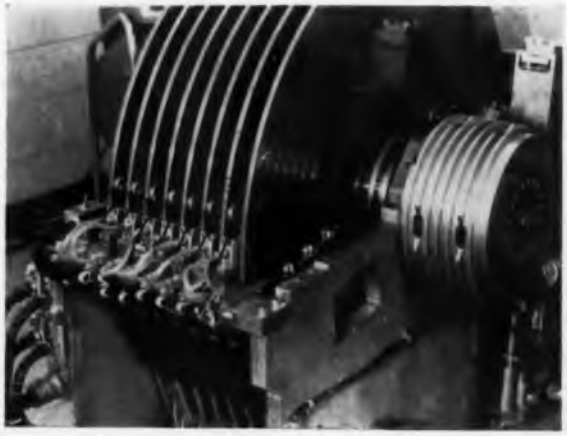
"Ray gun" literally shoots words. Spoken words are converted into infrared beams and transmitted to a similar gun-like receiver several miles away that converts the message back to sound. The system, MAXSECOM, developed by Minneapolis-Honeywell is immune to jamming.

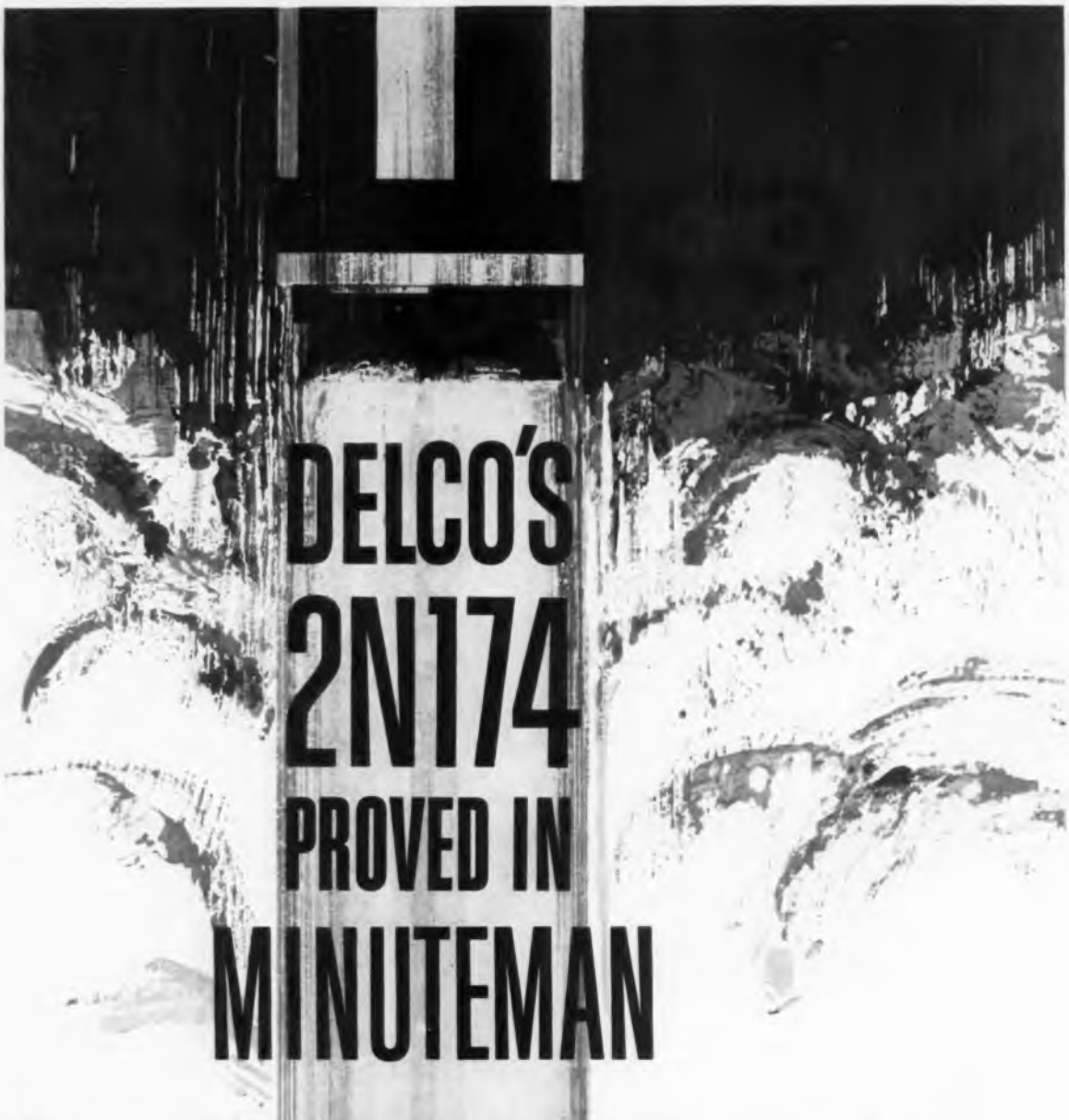
MOON SAMPLER

Scientists operate fullscale model of Surveyor spacecraft payload scheduled to make soft landing on moon. It will sit down on lunar surface at about 6 mi/hr. Model is displayed at Caltech's Jet Propulsion lab in Pasadena, Calif., NASA's planetary exploration center.

MASS MEMORY

Discs and magnetic heads on new Series 4000 Disc files from Bryant Computer Products. It can read and write either a line-at-a-time or a character-at-a-time. It can incorporate from one to 20 discs.





DELCO'S 2N174 PROVED IN MINUTEMAN

. . . and Polaris and Talos and Atlas and Jupiter and Thor and Titan and Bomarc and Zeus and Pershing and hundreds of other military and industrial applications.

For Delco Radio's highly versatile family of 2N174 power transistors meet or exceed the most rigid electrical and extreme environmental requirements.

Over the past five years since Delco first designed its 2N174, no transistor has undergone a more intensive testing program both in the laboratory and in use, in applications from mockups for commercial use to missiles for the military. And today, as always, no Delco 2N174 leaves our laboratories without passing at least a dozen electrical tests and as many environmental tests before and after aging.

This 200 per cent testing, combined with five years of refinements in the manufacturing process, enables us to mass produce these highly reliable PNP germanium transistors with consistent uniformity. And we can supply them to you quickly in any quantity at a low price.

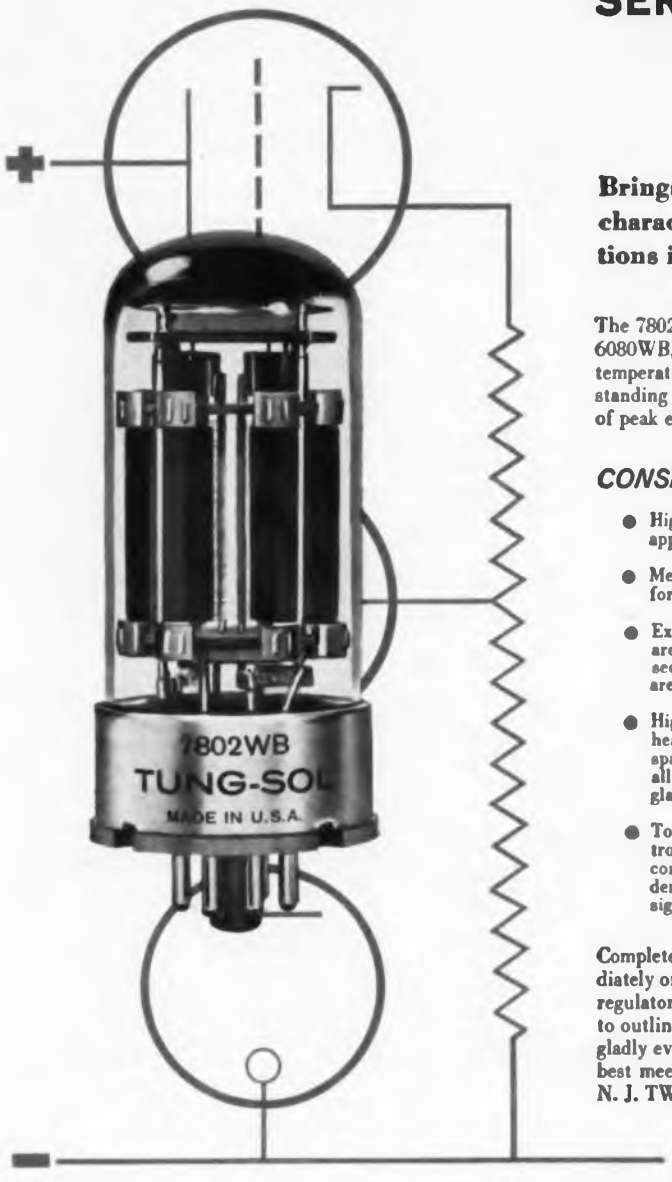
For complete information or applications assistance on the Military and Industrial 2N174's or other application-proved Delco transistors, just write or call our nearest sales office.

Union, New Jersey	Santa Monica, California	Chicago, Illinois	Detroit, Michigan
324 Chestnut Street	726 Santa Monica Blvd.	5750 West 51st Street	57 Harper Avenue
MUrdock 7-3770	UPton 0-8807	POrtsmouth 7-3500	TRinity 3-6560

DELCO RADIO — DEPENDABILITY / RELIABILITY

Division of General Motors · Kokomo, Indiana

TUNG-SOL ANNOUNCES:



NEW MEDIUM-MU
SERIES REGULATOR TUBE
7802WB

Brings together an optimum combination of characteristics that makes it ideal for applications in tough environmental extremes.

The 7802WB twin-triode, medium MU companion to the popular 6080WB, is the newest in the broad Tung-Sol line of rugged, high temperature, long-life series regulators. It combines many outstanding operational and design features in an optimum package of peak efficiency and dependability.

CONSIDER JUST THESE FEATURES:

- High perveance . . . Makes the 7802WB an excellent choice for applications requiring high plate current at low plate voltage.
- Medium-mu . . . Makes only very small signal voltages necessary for precise 7802WB control.
- Extra-tight tolerances . . . Plate current and transconductance are held to rigid limits to provide greater balance between tube sections. This is of particular significance where many sections are operated in parallel.
- High temperature operation . . . Extensive use of ceramics for heater-cathode insulators, anode standoff insulators and element spacers. The graphite anodes used are warp-free and dimensionally stable regardless of operating temperatures. Non-char, glass-bonded mica material is employed in the tube base.
- Top-performance in environmental extremes . . . Where electronically regulated power supplies must perform under severe conditions of shock vibration and high altitude, the 7802WB demonstrates long, trouble-free life, assured by both tube design and specifications.

Complete technical details on the 7802WB will be furnished immediately on request. A description of the full-line of Tung-Sol series regulator tubes is also readily available. Tung-Sol also invites you to outline your design needs to us. Our application engineers will gladly evaluate your circuit and outline the component which will best meet your requirements. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

TUNG-SOL®

Technical assistance is available through: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.

EI's International News

Senate Support for Dry Battery Industry's Fight On Jap Imports

Washington, D. C.—Senator Proxmire (D. Wis.) cited the American dry battery industry as "typical of many American industries facing potentially disastrous foreign competition." He named low production costs, marginal standards of living, and nominal import duties as the reasons that Japanese manufacturers have been able to flood the U. S. market with huge quantities of cheap batteries.

He asked: "why the Japanese themselves do not take action of their own accord, raise their prices at our ports to a reasonable level, establish a secure quota program? Why does our government not act to protect a vital domestic industry?"

He noted the U. S.'s present favorable balance of trade and stated a belief that we should maintain a free trade policy. But, he pointed out, "the battery industry is essential to our total defense effort and we could not afford to have this vital industry deteriorate."

Present import duty on Japanese batteries is about 17.5%. A typical transisitor radio battery (No. 216) sells at U. S. port of entry for about 15 cents. U. S. manufacturers sell the same battery to American distributors for about 70 cents.

The dry battery section of NEMA suggests the Tariff Commission approve higher duties on Japanese-made batteries and that the Office of Defense and Civilian Mobilization be asked to declare transistor radio batteries vital to national security with a recommendation for appropriate action.

Form Japanese Subsidiary

Tokyo—H. & H. Wilson, Inc., has formed a subsidiary, Orientronics, Inc., to import electronic components to the U. S. from Japan. It will market Japanese electronic components under the original manufacturer's names.

Increase Automation to Meet Foreign Competition—Mitchell

New York — "Greatly increased foreign competition and expanding overseas markets present unprecendented challenges to American engineers," says Don G. Mitchell, President of General Telephone & Electronics Corp. He called for these measures: greatly increased emphasis on R&D; far greater automation and mechanization of manufacturing and administrative processes; and more effective marketing, both here and abroad.

He pointed out that the laboratories of Western Europe and Japan (our chief competitors) are engaged in long-range planning of new products and new marketing methods.

Overseas opportunities have resulted in 3,000 American companies investing some $50 billion in foreign manufacturing and marketing. "Because of the magnitude of this investment, there is every probability that sales from overseas operations will at least double in the next ten years."

He said that, "every major segment of the American economy must devote far greater attention than ever before to the impact of its actions on the rest of the economy."

Mr. Mitchell made his remarks in an address at the AIEE's Winter General Meeting in New York.

Assign British Sales Rights

Birmingham — The Lear-Romec Div., Lear, Inc., Calif., has granted to Joseph Lucas Industries, Ltd., Birmingham, exclusive sales rights and option to manufacture (in Great Britain) all of their products.

Gulton Forms French Firm

Ivry (Seine), France — Schneider Radio-Television, S.A. and Gulton Industries, Inc., Metuchen, N. J., have formed a joint manufacturing corporation to market the New Jersey firm's products in France and the Benelux countries.

Joint Marketing Agreement

Montreal — The Consolidated Mining and Smelting Company of Canada, Ltd., has entered into an agreement with its affiliated company, Cominco Products, Inc., Spokane, Wash. The agreement covers marketing of the company's electronic materials and indium in the U. S.

Cominco will make, from high pruity metals supplied by Consolidated, a range of transistor preforms, wire, rod, ribbon, sheet, powder, and salts.

ROYALTY AT EXHIBITION

Sweden's King and Queen inspect Autoanalyzer. Made by Technicon Instruments, N. Y. it automates a host of biochemistry analyses including blood glucose, blood urea, etc. It is completely electronic.

Open Telex Service With Peru

Lima—A new teleprinter circuit has been opened between New York and Lima, Peru. Rates for calls from continental U. S. to Peru are $3.00 per minute with a $9.00 minimum. The new addition brings to 59 the number of overseas points served by RCA's Telex network.

Radio Relay Bids Invited

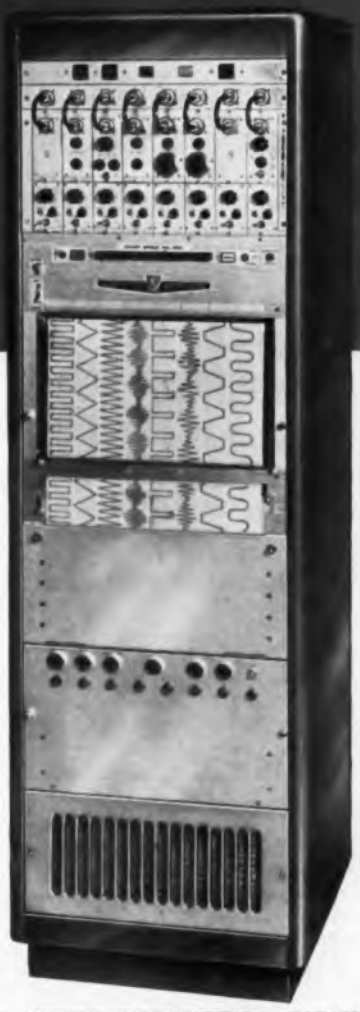
The Australian Postmaster General's Dept. is looking for bidders on the supply and delivery of radio equipment for use between Melbourne, Victoria and Launceston, Tasmania. Estimated cost is $675,000. Schedule also calls for engineering supervision of the installation and the erection of steel towers at the repeater stations to support the antenna systems.

Bids must be submitted in time to reach Controller, Stores and Contracts, Postmaster General's Dept., 114 Russell St., Melbourne C1., Victoria, Australia, by 3:00 pm May 9. Copies of Schedule C. 8532 are available on loan from BFC's Trade Development Div., U. S. Dept. of Comm., Washington 25, D. C.

JET BOMBER IS "MISSILE"

TM-76A MACE missile nose cone is installed in B-57 light jet bomber. Union of missile's ATRAN guidance and the bomber enables it to double as a MACE for training purposes. Goodyear Aircraft modified the bomber.

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!



American Optical Company, famous for precision instrumentation for 138 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

Finest Resolution, Linearity, Stability

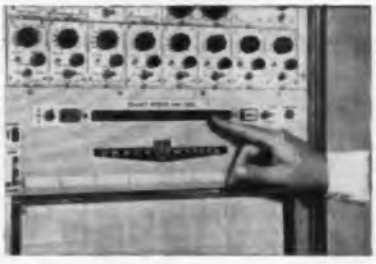
Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

Finest Systems Oriented Compatability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.

Entire channel easily accessible and completely interchangeable as single unit.

Platen tilts to convenient writing angle.



Widest range chart speed... push-button selection through 0.1 mm/sec to 500 mm/sec.

WRITE, WIRE, TELEPHONE TODAY FOR COMPLETE INFORMATION!

Complete Engineering Bulletins available.
Field Sales Engineers at your service everywhere.

American Optical
COMPANY
INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

MISSILES AND AIR-BORNE EQUIPMENT

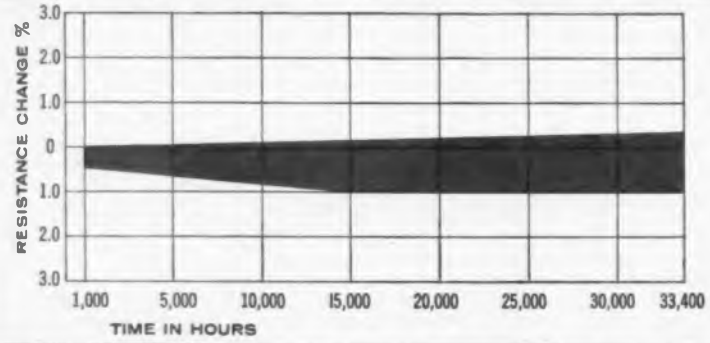
call for resistors that never fail catastrophically. A 30,000 hour load life test* of 150 Corning tin oxide resistors has proved 1% drift capability, and not one failed catastrophically.

Tin oxide and glass are among the most stable materials known, both electrically and environmentally. Fuse the two together and you have the basis for an outstanding resistor.

This holds true whether you buy ten or ten million, because we have developed the manufacture of this type of resistor to a science. Assembly is completely automatic and exact. And, if you think you have to pay a lot extra for this reliability, our price sheets hold some pleasant surprises for you.

The proof of what we say is spoken eloquently by typical specs like these:

TYPE	DESCRIPTION	CORNING MODEL	WATTAGE	RESISTANCE (ohms)	TC	LOAD LIFE	OVERLOAD	MOISTURE RESISTANCE
NF	Glass ENCAPSULATED MIL-R-10509C, Char. B	NF60 NF65	1/8 1/4	100 100K 100 348K	150ppm/°C. −55 +150°C.	0.3%	0.03%	0.2% (Char. B)
N EPOXY	MIL-R-10509C, Char. B	N60 N65 N70	1/8 1/4 1/2	10 133K 10 499K 10 1Meg	150ppm/°C. −55 +105°C.	0.5%	0.03%	0.5% (Char. B.)
N	MIL-R-10509B, Char. X	N12 N20 N25 N30	1/4 1/2 1 2	100 133K 10 500K 10 1.5Meg 30 4.12Meg	150ppm/°C. −55 +105°C.	0.35%	0.1%	0.15% (Char. X)
C	Lowest cost film resistor; silicone insulation MIL-R-11C	C20 C32 C42	1/2 1 2	51 150K 51 470K 10 1.4Meg	150ppm/°C. −55 +125°C.	1.5%	0.2%	0.3%



Results of 30,000 hour load life test on Corning Resistors representing 5,000,000 resistor hours. Resistors were run at 140% of rated load. There were no catastrophic failures.

For data sheets on Corning Type NF, N, N-Epoxy or C resistors, and the names of the distributors nearest you, write Corning Glass Works, 546 High Street, Bradford, Pa. If you also would like a booklet giving 30,000 hour test results, write on company letterhead.

*Test conducted by Remington Rand Univac

CORNING ELECTRONIC COMPONENTS

CORNING GLASS WORKS, BRADFORD, PA.

ALITE® HIGH-ALUMINA HERMETIC SEALS AND BUSHINGS

Combine...

- VACUUM-TIGHTNESS
- SUPERIOR MECHANICAL STRENGTH
- HIGH TEMPERATURE AND HEAT-SHOCK RESISTANCE
- RELIABLE ELECTRICAL CHARACTERISTICS
- HIGH RESISTANCE TO NUCLEAR RADIATION
- PRECISION TOLERANCES

Looking for ways to improve reliability, reduce maintenance problems? The unique advantages of Alite high-alumina ceramic-to-metal seals may be just what you need!

With maximum working temperatures in the range 1300°-1600°C., Alite can be metallized and brazed to metal parts to form rugged, vacuum-tight seals which, in turn, can be welded into final assemblies.

From design to finished part, every manufacturing step — including formulating, firing, metallizing and testing — is handled within our own plant and carefully supervised to assure strict adherence to specifications, utmost uniformity and reliability.

Over 100 standard sizes of Alite bushings in a range of types are available to simplify design problems and speed delivery. However, when special units are called for to meet unusual requirements, a team of Alite engineers stands ready to help you take advantage of Alite's superior properties.

Write for FREE Helpful Bulletins

Bulletin A-7R provides detailed description and specifications of Alite. Bulletin A-40 describes Alite facilities and complete line of standard bushings.

410-G

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

New York Office
60 East 42nd St.

International News

(*Continued from page 30*)

Egypt Gets Communications Loan

Washington—The Development Loan Fund has loaned $1,300,000 to help establish a telecommunications system between Egyptian and Syrian Regions of the United Arab Republic.

A 24-channel telecommunication system will be installed between Damietta in the Egyptian Region and Saroukhia in the Syrian Region. UHF radio connections between Saroukhia and Damascus in the Syrian Region and Damietta and Mansoura in the Egyptian Region will be installed.

The Damietta-Saroukhia link will be a tropospheric scatter system which can simultaneously transmit radio, telephone, and telegraphic messages.

PROJECT MERCURY

First manned space flight will be recorded on these instruments spaced at intervals around the globe. A special Lyon Electro-Pallet shock isolation suspension system protects instruments in transit.

Acquire Trade Center Site

London—The U. S. Dept. of Commerce has acquired the site for the U. S. Trade Center in London. The Center, the first permanent overseas trade center, will be located in the heart of the Piccadilly Circus area at 58 St. James' St. It will have about 5,000 ft² of exhibit facilities on the ground floor and supporting offices on the third floor. The center will open in June.

Install CCTV at Airport

Montreal—A GE closed circuit TV system will be installed by Trans-Canada Air Lines at Montreal International Airport to provide instantaneous transmission of aircraft and passenger traffic information. Two transistorized TE-9-A cameras and 38 monitors are included in the $50,000 order.

Name Canadian Rep

Cambridge, Mass.—Baird-Atomic, Inc. has been named exclusive sales representative throughout Canada (and the U. S.) by Sharp Laboratories, Inc., La Jolla, Calif. Agreement includes nuclear instrument systems made by Sharp Labs.

INLAND

first with solid state 100-watt d-c amplifier

Inland's new **Model 579.35** d-c amplifier has a high power output of 100 watts when used with low impedance loads requiring direct current. And this completely transistorized amplifier is packaged in a hermetically sealed can only **2½" x 3¾" x 2½"**.

Designed for use with d-c torquers, in one typical application Model 579.35 provides 65 db power gain between the output of a d-c driver stage and the input terminals of a permanent magnet torque motor. This amplifier has these outstanding performance characteristics:

- The d-c output has magnitude and polarity proportional to the input signal.
- All amplifier circuits use a combination of silicon and germanium transistors (all-silicon models also available).
- Amplifier null and gain are stable and independent of temperature.

Inland also makes a complete line of rotary amplifiers for matched use with Inland's distinctive pancake shape d-c torquers.

A brochure on this new high-power amplifier is available. For your copy and complete data on Inland torquers and amplifiers, write Dept. 8-4.

TYPICAL SPECIFICATIONS

Maximum Power Output, watts (6 ohm load)	100
Power Gain	4,000,000
Current Gain	200,000
Voltage Gain	15
Frequency Response	DC to 1000 cps
Input Impedance, ohms	50,000
Dimensions, inches	2½ wide 3 3/16 long 2½ high
Operating Temperature Range in °C	minus 50° to plus 50°

INLAND MOTOR

INLAND MOTOR CORPORATION OF VIRGINIA • A SUBSIDIARY OF KOLLMORGEN CORP., NORTHAMPTON, MASS.

Complete RF Detector

R422A

K422A

Two new hp developed mounts offer unique combination of wide band-width, low SWR and high sensitivity for general-purpose and reflectometer uses!

Flat frequency response and excellent sensitivity for rf detection are yours with the new K422A (18 to 26.5 GC) and R422A (26.5 to 40 GC) Waveguide Crystal Detector Mounts.

These broadband instruments cover the frequency range 18 to 40 GC, and provide the same excellent square-law detection characteristics as lower frequency crystal mounts. The unique advantages of the 422A are made possible by design and production of the internal crystal and the detector mount as an integrated unit.

422A extends the coverage of coaxial and waveguide rf signal detectors while maintaining low SWR and high detection efficiency. General-purpose rf detector uses include mixer applications. Excellent frequency response (± 2 db maximum full range) and true square-law characteristics make the mounts ideal for swept-frequency reflectometer applications extending to 40 GC.

SWR: Less than 2.5. Sensitivity: .05 v per mw. Square law characteristics: ± 1 db (−3 dbm to −40 dbm).

K422A, 18.0 to 26.5 GC, $200.00; R422A, 26.5 to 40 GC, $200.00.

hp

WORLD LEADER IN PRECISION WAVEGUIDE INSTRUMENTATION!

Coverage to 40 GC!

420A Coaxial Crystal Detector Mount, 10 MC to 12.5 GC

Detects rf signals over a three decade frequency range from 10 MC to 12.5 GC. Sensitivity is approximately 0.01 v/0.1 mw, and frequency response is ± 3 db over the full range. Maximum SWR is 3:1.
420A, $50.00.

420B Coaxial Reflectometer Mount

Identical to the 420A in frequency range, the 420B is available in pairs matched to within ± 1 db over the range 1 to 4 GC.
420B, $75.00; $150.00 per matched pair.

485 Waveguide Barretter Mounts, 2.6 to 12.4 GC

Reflectometer Mounts—characterized by flat frequency response, low SWR, true square-law characteristics and high sensitivity, the broadband 485D Waveguide Barretter Mounts are supplied with factory selected barretters for maximum accuracy in reflectometer applications. S485D, 2.6 to 3.95 GC, $185.00; G485D, 3.95 to 5.85 GC, $170.00; J485D, 5.2 to 8.2 GC, $170.00.

General Purpose Mounts—S485A, 2.6 to 3.95 GC Fixed Tuned Barretter Mount, $165.00; 485B Tunable Detector Mounts, covering 3.95 to 12.4 GC, use either barretters for lowest SWR or silicon crystals for highest sensitivity. (Detectors not supplied.) G485B, 3.95 to 5.85 GC, $95.00; J485B, 5.85 to 8.2 GC, $90.00; H485B, 7.05 to 10 GC, $85.00; X485B, 8.2 to 12.4 GC, $75.00.

421A Waveguide Crystal Detector Mounts, 7.05 to 18.0 GC

Silicon diodes are employed in these mounts for better SWR characteristics at higher waveguide frequencies. Frequency response ± 2 db maximum over full range, square-law characteristic ± 1 db. Matched pairs are available for reflectometer applications. H421A, 7.05 to 10 GC, $95.00 each, $210.00 per matched pair; X421A, 8.2 to 12.4 GC, $75.00 each, $170.00 per matched pair; M421A, 10.0 to 15 GC, $125.00 each, $270.00 per matched pair; P421A, 12.4 to 18.0 GC, $130.00 each, $280.00 per matched pair.

440A Detector Mount

For use in coaxial or waveguide systems, the 440A covers 2.4 to 12.4 GC. The mount uses either 1N21 or 1N23 silicon crystal, 1/100 amp instrument fuse or Sperry 821 barretter. (Detector element not furnished as part of instrument.) With the 442B Broad Band Probe (not shown), the 440A becomes a sensitive, easily tuned detector for slotted waveguide sections. 440A, $85.00; 442B, $40.00.

HEWLETT-PACKARD COMPANY
1064F Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Sales representatives in all principal areas

HEWLETT-PACKARD S.A.
Rue du Vieux Billard No. 1 Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

Data subject to change without notice. Prices f.o.b. factory

As We Go To Press (cont.)

THIN FILM TESTER

High-speed Programmable Pulse Generator can analyze, test, and program thin film and cryogenic devices. Made by Digital Equip-

ment Corp., it can run at a clock frequency higher than 4 MC, at levels having 25 nanosec rise times and 50 nanosecond widths.

Foundation To Aid Scholarship Programs

A service to companies that wish to sponsor engineering scholarships but do not have scholarship administrative facilities has been announced by the Hertz Engineering Scholarship Foundation, Los Angeles, Calif.

The service is performed without charge. Administrative costs are absorbed by the Foundation. This means that if a company wishes to offer a $1,000 scholarship, all of the money will be applied directly to student aid.

BRAIN CELLS

Ferrite memory cores, integral components of a computer's mem-

ory, are checked by Lockheed scientist. These cells are from 0.030 to 0.080 in. in dia.

Superior performance... greater reliability ... extreme uniformity.... mil-quality! These are the dramatic design advantages you gain from Motorola Silicon Epitaxial Mesa transistors. Performance characteristics include: faster switching speeds, higher voltage breakdowns, reduced capacitance, increased power handling capabilities with reduced saturation resistance, and vastly improved VHF power gain performance. The result — outstanding switching and amplifying devices with a wide range of application potential.

MOTOROLA SILICON EPITAXIAL MESA TRANSISTORS

TYPE NO.	P_D mW	V_{CB} volts	V_{EB} volts	I_C mA	h_{FE} (typ) @I_C = 10 mA	f_T mc
2N706	300	25	3	200	40	450
2N706A	300	25	5	200	40	450
2N706B	300	25	5	200	40	450
2N707	300	56	4	200	12	450
2N707A	300	70	5	200	30	500
2N753	300	25	5	200	75	450
2N834	300	40	5	200	40	500
2N835	300	25	3	200	40	500

For complete technical information on specific Motorola Silicon Epitaxial Mesa transistors, contact your Motorola district office, distributor, or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 10, Arizona.

Immediate availability — All Motorola Silicon Epitaxial Mesa transistors are available "off the shelf" from your Motorola Semiconductor distributor.

MOTOROLA DISTRICT OFFICES:
Belmont, Mass / Burlingame, Calif / Chicago / Clifton, N. J. / Dallas / Dayton / Detroit / Glenside, Pa / Hollywood / Minneapolis / Orlando, Fla / Silver Spring, Md / Syracuse / Toronto, Canada

MOTOROLA
Semiconductor Products Inc.
A SUBSIDIARY OF MOTOROLA, INC.
5005 EAST McDOWELL ROAD • PHOENIX 10, ARIZONA

Circle 11 on Inquiry Card

PROGRESS IN MICROWAVES

How to Minimize RF Interference . . .

GENERAL ELECTRIC HARMONIC FILTERS COVER ENTIRE MICROWAVE SPECTRUM

To alleviate interference problems caused by harmonics generated in high-power transmitters, General Electric offers a broad line of harmonic-absorption filters. Design capability extends from UHF to K-band.

PROVIDE EFFECTIVE CONTROL

Rapidly increasing use of the microwave spectrum by military and civilian systems makes it imperative to establish positive controls on high-power transmitters. General Electric harmonic filters provide an effective means of control by minimizing harmonic and spurious signals to the levels indicated in current military specifications, such as MIL-R-27055 (USAF).

INCREASE POWER-HANDLING CAPACITY

General Electric harmonic filters provide other important benefits. By absorbing unwanted harmonic power, a properly designed filter can often substantially increase the fundamental power-handling capability of the wave-guide transmission line on the load side of the filter. Moreover, elimination of wave-guide arcing and protection of the output tube are provided by the filter.

DESIGN CAPABILITY

General Electric now has five years' experience in the research, development, and design of harmonic filters. Capability gained through this experience enables General Electric to design and manufacture harmonic filters for any application on a relatively short time cycle. The table below describes presently available types. These can be modified to fit particular requirements.

SPECIFICATIONS AND AVAILABILITY

TYPE	PASS BAND (KMC)	PEAK POWER (MW)	WAVEGUIDE SIZE	DELIVERY (IN DAYS)
MPF-400	0.4-0.45 (UHF)	5	WR-2100	90
MPF-800	0.75-0.98 (UHF)	0.1*	WR-975	90
MPF-1001	1.2-1.4 (L)	10	WR-650	90
MPF-2501	2.6-3.1 (S)	5	WR-284	60
MPF-2502	2.6-3.6 (S)	5	WR-284	60
MPF-4000	5.0-6.0 (C)	1	WR-187	60

* CW

TO ORDER, or obtain more information, contact your nearest Power Tube sales office (telephone numbers listed below).

265-05-9545-8481-35

POWER TUBE DEPARTMENT

GENERAL ELECTRIC

TELEPHONE TODAY—Syracuse, OL2-5102 . . . New York City, WI7-4065 . . . Clifton, N. J., GR3-6387 . . . Washington, D. C., EX3-3600 . . . Chicago, SP7-1600 . . . Dayton, BA3-7151 . . . Orlando, Fla., GA4-6280 . . . Los Angeles, GR9-7765

Circle 83 on Inquiry Card

FILTER DESIGNS AVAILABLE FOR APPLICATIONS FROM UHF TO K-BAND

MPF-400 (UHF)

MPF-4000 (C-BAND)

LOOK TO G-E POWER TUBE DEPARTMENT FOR:

- Ignitrons
- Hydrogen Thyratrons
- Magnetrons
- Metal-ceramic Tetrodes
- High-power Duplexers
- Klystrons
- Thermionic Converters
- Traveling-wave Tubes
- Harmonic Filters

PUT THE SQUEEZE ON YOUR PUSHBUTTON PROBLEMS

OAK TYPE 131 PUSHBUTTON SWITCHES will help you make the most of limited panel space. Only 5/8-in. thick, these switches can be mounted on 11/16 in. centers; a stack of 10 separate gangs of switches requires only 6 13/16-in. of panel space. Use Type 131 switches for handling low-power switching in computers, office equipment, communications devices, automatic coin-operated machines and many other military or commercial applications.

Available with from one to 12 buttons having up to 14 contacts per button. "Floating slider" design operates at lighter pressure per number of contacts than conventional pushbutton switches. Oak's vigorous research and testing, careful selection of materials, precision manufacture and quality control assure long operating life with minimum failure. Contact your local Oak sales representative or write for Oak's comprehensive 4th Edition General Switch Catalog.

Creative Engineering • Quality Components

OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • *telephone: Crystal Lake, 459-5000*

OAK ELECTRONICS CORPORATION, *(Subsidiary) Culver City, California*

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION AND FM TUNERS • SUBASSEMBLIES
APPLIANCE CONTROLS • CHOPPERS • ROTARY SOLENOIDS • VIBRATORS

Increase ICAO Size

The International Civil Aviation Organization's Council is considering increasing membership from 21 to 27. Membership in the ICAO is now 84 compared with the original 26 members when the United Nations agency was formed in 1947. One of the Council's major duties is to adopt international standards and recommend practices and to incorporate these as Annexes to the Convention on International Civil Aviation.

It can also settle disputes between member states, on request, and it may investigate any situation which presents avoidable obstacles to the development of international air navigation. In general, it may take whatever steps necessary to maintain the safety and regularity of operation of international air transport.

SIAMESE-TWINS

RCA's new "Siamese-Twin" transistor uses planar design and construction principles. It combines two identical transistors in a single package. It will be offered initially as a dc chopper amplifier.

Long-Range ULF Study

A theoretical and experimental investigation is being made of ultra low frequency and sub-surface propagation of electromagnetic waves at long distances. The program will use 400 CPS over distances of thousands of miles.

Space Electronics Corp., Glendale, Calif. is making the study for the Air Force's Cambridge Research Labs. They will perform field intensity measurements at various ranges and azimuthal directions, measure noise environment at 400 CPS, as well as investigate propagation mechanisms, radiation to medium coupling, noise characteristics and distribution, and propagation anomalies.

REMARKABLE!

Superpower High Voltage Rectifiers
rated to **1 KW PER CUBIC INCH . . .**
with a total system reliability
exceeding that of the
MIL Type components!

Remarkable in concept . . . the rigidly homogenous design of standard International Rectifier Silicon High Voltage Columns expands your design opportunities by providing rectifying capacity up to 1 kw per cubic inch of column . . . in ratings to 120,000 volts . . . current ratings to 50 amp. . . . in limitless proportions . . . with a total system reliability exceeding that of its MIL type component parts.

They were conceived to simplify circuitry, thus dramatically reduce the size and cost of equipment for long-range radar and television transmitters, induction heating, electrostatic precipitation, particle acceleration, pulse modulation, ultrasonic transducers, plasma research . . . wherever an ultra-stable high voltage-high current dc source is required.

They have done just that in countless applications!

They can do the same for you!

WRITE FOR 16-PAGE BULLETIN SR-370 describing these new high voltage, high current devices in technical detail . . . Truly the most advanced design of its type available to industry!

INTERNATIONAL RECTIFIER

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SYMBOL OF QUALITY IN SEMICONDUCTORS

INTERNATIONAL RECTIFIER CORPORATION: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281 • CABLE RECTUSA

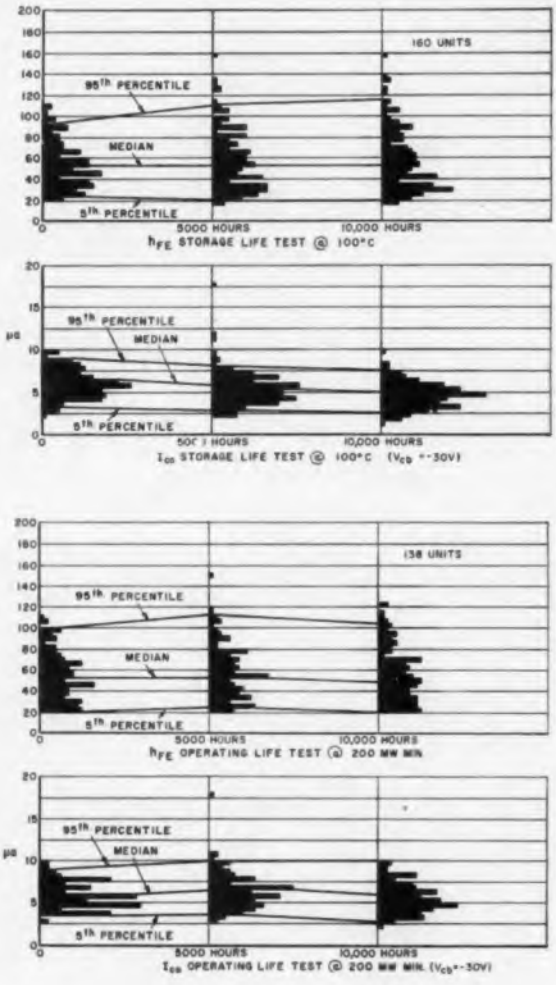
REGIONAL OFFICES: NEW YORK CITY; CHICKERING 4-0748 • FORT LEE, NEW JERSEY; WINDSOR 7-3311 • SYRACUSE, NEW YORK; HEMPSTEAD 7-8455 • CAMBRIDGE, MASSACHUSETTS; UNIVERSITY 4-6520 • ARDMORE, PENNSYLVANIA; MIDWAY 9-1428 • SILVER SPRING, MARYLAND; JUNIPER 5-5305 • CHICAGO, ILLINOIS; JUNIPER 3-3069 • BERKLEY, MICHIGAN; LINCOLN 8-1144 • LOS ANGELES, CALIFORNIA; OREGON 8-6281 • IN CANADA: TORONTO, ONTARIO; PLAZA 8-2291

Circle 15 on Inquiry Card

The industry's most stable low-frequency PNP transistors!

The man in the picture, Hugh Lowry, General Electric authority on semiconductor applications

TO-5 Type	Max. V_{CBO}	Max. V_{CER}	Max. I_C	Max. P_T	Max. Cutoff I_{CO} @ V_{CB}		20 ma h_{FE} Min.	Max.	h_{FE} Min.	Max.	V_{CE} (SAT)	V_{BE}	Max. C_{OB}
2N524	45v	30v	500 ma	225 mw	10μa	30	19	42	16	41	.070v	.255	40
2N525	"	"	"	"	"	"	34	65	30	64	.075v	.243	"
2N526	"	"	"	"	"	"	53	90	44	88	.080v	.230	"
2N527	"	"	"	"	"	"	72	121	60	120	.090v	.216	"
2N1413	35v	25v	200 ma	200 mw	12μa	30v	25	42	20	41	.070v	.255	40
2N1414	"	"	"	"	"	"	34	65	30	64	.075v	.243	"
2N1415	"	"	"	"	"	"	53	90	44	88	.080v	.230	"



General Electric 2N1414 and 2N525 Series carry complete parameters backed up by 10,000-hour life tests

You don't buy a "pig in a poke" when you standardize on General Electric low-frequency PNP germanium alloy transistors, Series 2N1414 and 2N525. Parameters are completely spelled out, including "Minimum," "Typical" and "Maximum" values, and are backed up by 10,000-hour life tests on 138 units to date (see curves above). In fact, 300 new units start life-test each week.

The new lower-priced 2N1413, 2N1414 and 2N1415 types are designed for industrial audio amplifiers and low-frequency switching applications where cost is a prime consideration.

To assure top reliability under adverse environments, all units are hermetically sealed and subjected to 100 hours of high-temperature bake and a detergent pressure leak test. The transistor base is welded to the case for greater thermal efficiency.

For proved reliability in low-frequency PNP's, at a very pleasant price, see your G-E Semiconductor District Sales Manager or Authorized Distributor. General Electric Company, Semiconductor Products Department, Electronics Park, Syracuse, N. Y. *In Canada:* 189 Dufferin St., Toronto, Ont. *Export:* International General Electric Co., 150 E. 42nd St., N. Y. C.

GENERAL ELECTRIC

Microtransistor Research

CBS Labs has a new research program aimed at developing a smaller, more efficient silicon switching transistor for advanced military computer systems. The Army Sig. Res. & Dev. Lab., Fort Monmouth, is sponsoring the work.

A major problem is the heat generated by individual components. One CBS approach will be to develop transistors which use several hundred times less power than conventional transistors.

MOTOR FOR B-70

High-temp. electric motor for throttle system of Air Force's 2,000 mph B-70 bomber is checked by North American engineers, Harry Horii (L) and Larry Opel. It will be subjected to 600°F ambient temperatures in test.

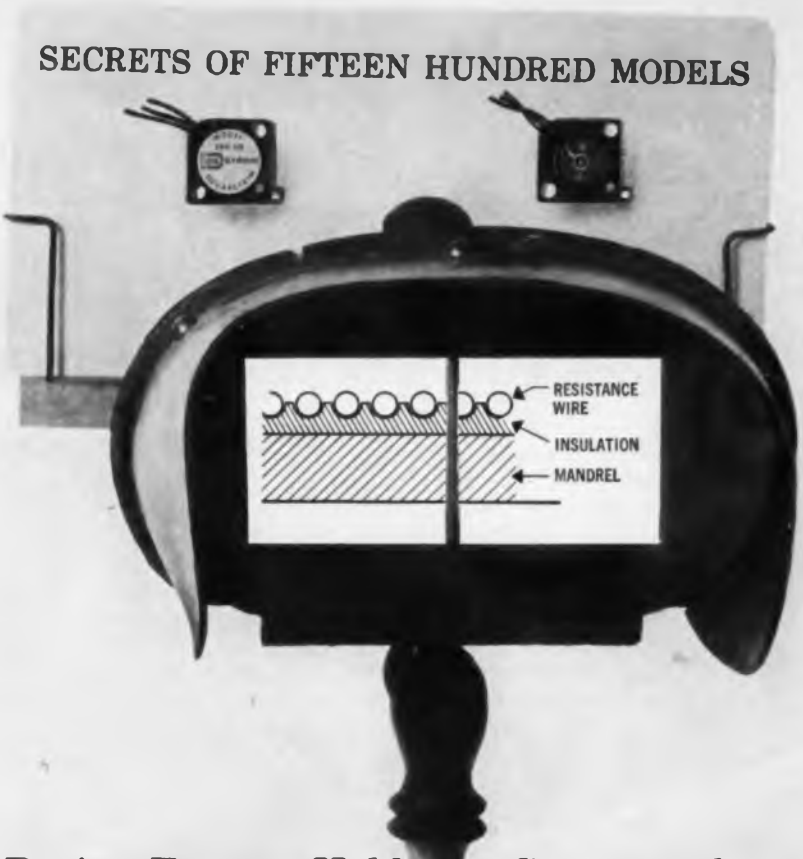
New Fuel Cell

A new type of fuel cell, developed by the M. W. Kellogg Co. for the Navy operates on a mercury amalgam of sodium and oxygen. It develops twice the voltage of hydrogen cells. The prototype will develop about 75 kw. It will weigh between 2 and 3 lbs per kw hr capacity.

ENVIRONMENT SIMULATOR

Environment simulator will test advanced life support systems for space vehicles and submarines. Built by Ionics, Inc., it will test effectiveness of equipment for removing carbon dioxide, generating oxygen, and recovering pure water from waste water.

SECRETS OF FIFTEEN HUNDRED MODELS



This Design Feature Holds the Secret of the Greater Reliability in All 1544 Daystrom Squaretrim™ Models

All Daystrom Squaretrim potentiometers have this in common: our unique wire-in-the-groove resistive element. We start with an insulated mandrel. We then wrap the mandrel with resistive wire. But...and this is our exclusive process...just ahead of the wire is a tiny diamond tool which cuts a carefully controlled groove in the mandrel's insulation. The wire is then wound tightly into this groove throughout the entire helix. As a result, each turn remains securely separate from the adjacent turns, thus anchoring the wire so that it will withstand severe shock and vibration without piling up and shorting out.

Daystrom Squaretrims, with this unique winding technique, offer you only the most reliable performance. Daystrom's wide line of *1544 Standard Models* offers you almost unlimited design latitude.

Send for the catalog of trimming potentiometers that meet your specs and *hold* your specs under environmental stress...Daystrom Squaretrims.

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

DEMANDING ENVIRONMENTS

Connectors are available now for the varying atmospheres encountered by aircraft and missiles on earth, and in space probes to the other planets. MIL-C-26500 (USAF) specification covers present-day environments as well as anticipated environments ten years from today. AMPHENOL Connector Division is manufacturing these connectors in quantity for such programs as Minuteman and is supplying prototype connectors for every new missile and aircraft now being developed.

Example: MIL-C-26500 connectors are rated at 200° C (392° F) for 1000 hours. This is the estimated surface temperature of the planet Venus, an atmosphere in which impact-electronic payloads of the future will have to operate reliably.

MIL-C-26500 (USAF) PERFORMANCE

- **HIGH TEMPERATURE** 1000 hours at 200° C (392° F).
- **THERMAL SHOCK** 5 cycles of variation from −55° C (−87° F) to +260° C (500° F).
- **ENVIRONMENTAL RESISTANCE** Altitude-immersion resistant; Pressurized; Corrosion-resistant; Ozone-resistant.
- **PHYSICAL SHOCK** Withstand transient deceleration force of 50 G's.
- **POKE HOME CONTACTS** Per MIL-C-26636 (USAF), crimp, removable contacts.

AMPHENOL

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AMPHENOL CONNECTOR DIVISION

1830 S. 54TH AVE. · CHICAGO 50, ILLINOIS

Amphenol-Borg Electronics Corporation

Tele-Tips

COFFEE URNS, an absolute necessity for sailors, are guaranteed reliable on the Navy's new nuclear subs. Barry Controls' shock testing lab was recently asked to test a coffee urn to be used on the Thresher-class subs. There were no flying parts, and the urn went right on making coffee even during the sledge-hammer blows of the 400-lb drop hammer.

FIRST ASTRONAUT will get dunked despite recent successful mid-air catches of Discoverer satellite. The astronaut's capsule is specifically designed for a landing in the sea.

ELECTRONIC BIG BROTHER will soon be installed at Thompson Ramo Wooldridge, Inc. Developed to monitor security at the company's Canoga Park plant, it will use 1,250 different signals to check on doors that should be locked, over-heated computers, inoperative valves, etc. A control panel will flash yellow lights for security troubles, red lights for fires, and green lights for maintenance troubles.

NEW ACCELERATOR at M.I.T. will spurt out a pulse of 100 billion electrons with 99.9999996% of the speed of light and 12,000 times their rest mass. It will be the world's largest electron accelerator.

BURGLARS BEWARE. A New York firm has installed: A Holmes Protective Agency radio alert system; an audible burglar alarm at the street doors; a closed circuit TV camera focused on the entrance; and a wire cage in their foyer with electrically operated door. They are also planning to install bullet-proof glass in the reception room.

LOOK OUT LADIES. We recently heard about an electronic gadget that automatically checks a woman's height (seems this is one more vital statistic women hate to divulge). Next step is an electronic age teller.

THREE-PIGEON GUIDANCE SYSTEM (it's no joke) has been developed by the Univ. of Minnesota, General Mills, Inc., and the Naval Research Lab. An optical image of the target is projected on a ground-glass screen. The missile stays on course as the pigeons peck at the image. Why was this apparently crack-pot idea developed? It is for demonstrating the method of imparting knowledge with teaching machines. The scrap of wisdom imparted to each pigeon is small, but the required change in behavior is similar to those which must be brought about in vast quantities in human students.

HOT FOOD FOR SPACE MEN is proposed by Col. A. A. Taylor, chief of the Biomedical Div., Directorate of Life Sciences, Air Research and Development Command, Wash., D. C. He says it will not only increase food acceptability, but will "serve as an important source of social activity and diversion during periods of leisure."

UNDERWATER SWIMMERS urgently need a simple means of communciation. A Naval Reserve officer, Lt. Cmdr. Peter Wisher, who is instructor at a school for the deaf, has devised a sign language. It consists of the alphabet, numerals and a vocabulary of about 100 words. The system is now being tested at various Navy diving training centers.

JUST THE FACTS—MA'M. (Item in EI's "New Tech Data," Sept., 1960) Antenna Systems, Inc., has released a 4-page folder that briefly describes their areas of interest . . . It also gives brief *biological* sketches and qualifications of the principals in the firm. (To which one of our readers couldn't resist writing — "Good heavens, not that detailed!")

DON'T CURSE THE SMOG—USE IT. A Hughes Aircraft Co. engineer has found that VHF signals can be transmitted over distances never before possible by using the temperature inversion layer over Los Angeles which causes the smog to accumulate. He recently transmitted signals to Hawaii from LA—a distance of 2540 mi.—on the 144 and 222 MC bands.

Number two of a series

H

WHY ENGINEERS USE GERMANIUM DIODES

How to characterize specify and use germanium diodes today

Why engineers use germanium diodes

Of late, there has been much discussion as to exactly why, with the apparent superiority of the silicon diode, germanium diodes are being purchased and used at all. Especially today when the price gap between silicon and germanium has been appreciably lowered. To the device engineer the following may appear "old hat"; but, for the engineer who utilizes semiconductor devices intermittently, changing semiconductor technology and market conditions should be constantly examined, summarized and recorded so that he will not lose sight of the exact purpose each component is designed for and where it fits in today's overall engineering picture. Hughes, pioneer of semiconductor devices[1], has attempted to achieve this with the following discussion of the germanium diode.

Price for today's semiconductor devices is a major design factor and should be examined first. Historically, the germanium diode has been less expensive than the silicon. In many instances, however, silicon diodes' costs have been reduced through improved manufacturing techniques so that they now equal those of germanium. But, where requirements call for the characteristics which originally made the germanium diode a valuable and popular device, price is still a most important factor. Where high recovery speed in the millivolt region combined with high conductance is a requirement, the silicon diode is still far more costly to manufacture and therefore more costly to the purchaser than the same device in germanium.

Other characteristics, presently unattainable in silicon, inherently make germanium diodes exteremely attractive for certain applications. Germanium diodes start conducting at low forward voltage as shown in Figure 3. Whereas silicon diodes show a definite lag until approximately 0.5V forward voltage is exceeded. Where low forward voltage drops are required, some germanium types will begin conducting as low as 0.2V. The ability to operate at low temperatures without significant loss of efficiency also makes the germanium diode essential where this characteristic is a major requirement.

Device engineers today then, use germanium diodes primarily for their unique electrical characteristics and for their relatively low price when the desired characteristics are too costly to produce in silicon.

(1) H. G. North, (Hughes Aircraft Company), "A New Germanium Diode of Improved Design," paper presented at WESCON, I.R.E. Convention, September 14, 1960.

T. E. Firle, M. E. McMahon, J. F. Roach (Hughes Aircraft Company), "Recovery Time Measurements of Point-Contact Germanium Diodes," paper presented at WESCON, I.R.E. Convention, August 20, 1953.

R. G. Shulman, M. E. McMahon, (Hughes Aircraft Company), "Recovery Currents in Germanium p-n Junction Diodes," JOURNAL OF APPLIED PHYSICS, Vol. 24, No. 10, pp. 1267-1272, October, 1953.

GERMANIUM DIODE FAMILIES AND TYPES

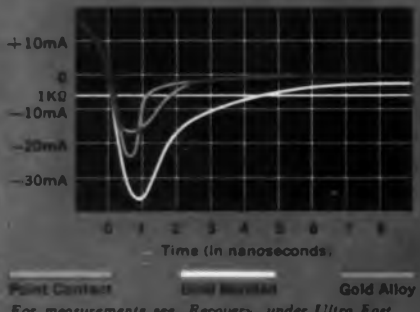
Essentially, germanium diodes can be classified into three basic performance groupings:

(a) general purpose (point contact)
(b) general purpose (gold bonded)
(c) ultra fast switching (gold alloy)

Figure 2 compares typical forward characteristics of the three germanium families listed above. Note the high forward conductance of the latter two. Figure 2 also dramatizes the forward conductance of all three at low levels.

Figure 1 graphically illustrates typical recovery times of the three families for comparison. It should be noted that each curve represents the mean characteristic developed from a large sampling of the more widely used types in each family.

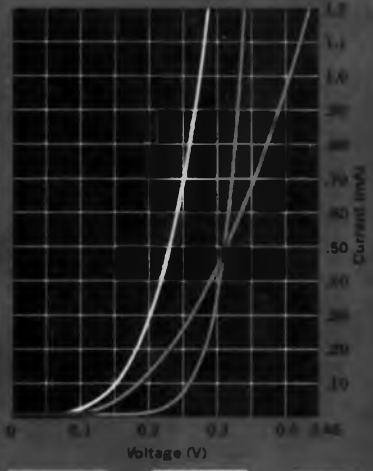
Fig. 1 — GERMANIUM FAMILY COMPARISONS
Typical Reverse Recovery Characteristics



For measurements see Recovery, under Ultra Fast Switching Diodes

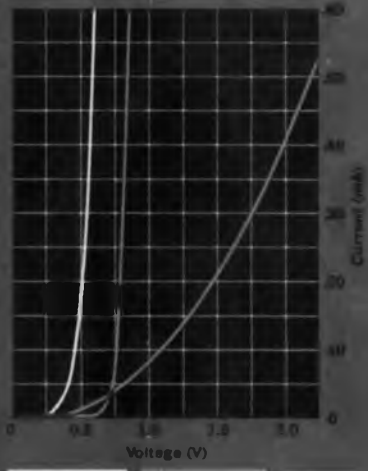
Note: If special body markings or codings are required, allow additional .008" for outside body diameter.

Fig. 2 — GERMANIUM FAMILY COMPARISONS
Expanded Forward Characteristics



NOTE: Detailed specifications on all Hughes germanium diode types are available upon request — see back cover for address of Hughes representative nearest you.

Fig. 3 — SILICON/GERMANIUM COMPARISON
Forward Current vs. Forward Voltage



POINT CONTACT DIODES

PHYSICAL CHARACTERISTICS The original "point contact" diode is actually one in which the active junction is formed by a pressure contact between the whisker tip and the slice of germanium (i.e. the old crystal radio set with its cat whisker). The modern version of this device consists of a germanium N-type die which is soldered to one lead. The other lead is welded to a molybdenum S-shaped whisker whose tip has been indium plated. The tip is then fused to the germanium slice to form the active junction. Externally, they are fusion sealed in a subminiature glass package to ensure complete isolation of the active elements from damage or contamination. They will withstand severe physical shock and vibration

ELECTRICAL CHARACTERISTICS Forward currents range from about 1 to 25 mA at one volt while reverse currents range from 15 to 500uA at 50 volts. Peak inverse voltages range from 50 to over 150 volts. The diode capacity is generally less than 1 pf. Frequency response is about 100 mc. The diode operates efficiently within the range from −55°C to +90°C.

APPLICATIONS The number of uses for these diodes is legion. Examples are tube and transistor driven logic circuits, RF mixers, clampers, modulators, bridge rectifiers, detectors, and instrument rectifiers.

HUGHES RIA TYPES *JAN Versions Available

1N34A	1N66	1N70A	1N90	1N116	1N126A*	1N191	1N198B	1N297
1N38B	1N67A	1N81A	1N95	1N117	1N127A*	1N192	1N268	1N298
1N54A	1N68A	1N88	1N97	1N119	1N128*	1N198*	1N290	1N480
1N58A	1N69A	1N89	1N99	1N120	1N142	1N198A	1N294	1N636

GOLD BONDED DIODES

PHYSICAL CHARACTERISTICS The gold bonded germanium diodes are identical with the point contact types except that the molybdenum whisker is replaced by a gold-gallium doped wire. The forming process or "gold bonding," is a process in which a short pulse of current fuses the gold wire tip into the germanium and forms a small P N junction, giving fast recovery and low shunt capacitance.

ELECTRICAL CHARACTERISTICS These popular Hughes® diodes represent a high conductance series. They have a range of forward currents from 25 to 600mA at one volt. Inherent in this series is a sharp voltage-current reverse characteristic, more like that which silicon displays. That is, the reverse current is linear with applied back voltage until a sharp breakdown region is reached. The reverse currents and peak inverse voltages, as well as the temperature ranges, are the same as those of the "point contact" series.

APPLICATIONS The applicability is also much the same as that of the point contact series except the gold bonded devices offer the advantage of higher forward conductance and higher reverse impedance. It should be noted that the alloy formed at the juncture of the crystal and the whisker (gold, gallium, and germanium) is somewhat more brittle than the corresponding alloy formed in the case of the "point contact" diode. Although considerable progress has been made in improving the mechanical ruggedness of these devices to the point where they are almost as rugged as the "point contact" types, careful consideration should be given to this factor when designing equipment which must withstand severe environmental conditions.

HUGHES RIA TYPES *JAN Versions Available

1N96	1N98A	1N118	1N139	1N143	1N276*	1N279	1N287	1N291	1N770
1N96A	1N100	1N118A	1N140	1N270*	1N277*	1N281*	1N288	1N292	1N835
1N98	1N100A	1N133	1N141	1N273	1N278	1N283	1N289	1N500	

ULTRA FAST SWITCHING DIODES

FEATURES These Hughes® diodes are a modification of the "gold bonded" process of diode manufacture. They combine fast recovery with low voltage drop. Devices in this series switch at nanosecond speeds and have rectification efficiencies ranging from 60 to 75% @ 100 mc. Their forward conductances are much higher than the "point contact" germanium types.

APPLICATIONS Designed especially for high speed computer logic, high-frequency transistor circuits, extremely fast reference switching...and, also, low-noise, low level RF modulation and demodulation.

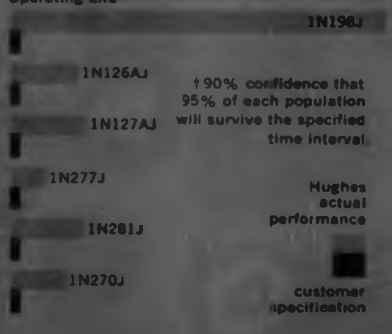
RECOVERY Measured with the Lumatron scope and attachments, see Illustration 1, when switching from 10mA to −6V, $R_L = 100$ ohms, they recover to 1K ohms in 2 to 5 nanoseconds. Typical capacitance @ 0 Volts = 0.8 to 4 pf (measured on Boonton's Model 75A-S8 capacitance bridge with applied signal voltage 50mV peak to peak). Forward switching speeds are too fast for detectable measurement on the presently available "traveling wave" or "sampling scope" equipment.

HUGHES TYPES Two Hughes house types are currently available, HD2963 and HD2967, and registration procedures for additional types are in process.

ILLUSTRATION 1 REVERSE RECOVERY CIRCUIT

Survival Reliability†

Specific reliability data must include a complete definition of test conditions, testing intervals, what constitutes a failure, applicable confidence levels, and many other pertinent facts in order to be at all meaningful. However, the following chart indicates examples of Hughes' actual reliability performance against customer specification for a few representative germanium diode types.



Purchasing Do's and Don'ts

DON'T specify a device that does not exist for your circuits—although this will motivate research and development groups to design better products for the future...the immediate result is long delay in quantity delivery. Be sure you can wait if your requirement is exotic.

DON'T specify inferior products for economical purposes resulting in unreliable circuit performance. This practice creates a vicious reject and replacement cycle between manufacturer and user.

DON'T buy from manufacturers whose facilities are not adequate for testing to rigid military specifications and whose production quantity delivery is questionable.

DON'T attempt to buy reliability by specifying breakdown voltages far in excess of those required. There may be some exceptions, however, this is a very expensive practice. DO buy reliability—not reliability by safety factor!

DO make sure that the diodes you buy meet the manufacturer's advertised and registered specifications.

DO make sure your 1N diode type is "registered" with EIA, not "reserved." When using types with a "reserved" status, the manufacturer may alter his specifications at will.

DO make sure the leakage currents are measured at a reverse voltage as high as your present requirement demands.

DO remember that reliability has to be designed in the diode; it cannot be tested in. No amount of testing will undo poor design. However, it is important that the manufacturer have a sound quality assurance program to insure that the reliability is actually there.

DO make sure that a diode that is to be used as a switch meets your speed requirements by actual test in your circuit; this is the only true test. Manufacturers often show values for switch-speeds that are optimized.

DO be sure to get the leakage currents you actually need. Specify the measurements which match most closely your actual circuit requirements.

DON'T guess what the parameters will be if your circuit is for intended high temperature operation, but DO get the proper data from the manufacturer.

Germanium diode's future at Hughes

Obviously, device engineers *still* need and use germanium diodes and will continue to incorporate them in their circuits for years to come. Hughes also will continue to design and produce better and more efficient germanium devices for the industry. Listed below are some of the goals Hughes' engineers have outlined to achieve that end.

- Leakage current approaching micro-micro-amps
- Minimum parameter change with temperature
- Infinite life expectancy
- Completely defined reliability
- Microminiaturization
- Recovery times in the low nanosecond region

The foregoing information has been gathered from the Hughes Semiconductor Division's reports and records on the germanium diode, compiled with the cooperation of Hughes' staff of skilled engineers. ■ Pioneer in the semiconductor field, Hughes has continued as a top developer and producer of the most advanced semiconductor devices. The Newport Beach plant, with its third of a million square feet of floor space, houses all of the facilities necessary for every phase of design, development and production of diodes, transistors, rectifiers, special devices and semiconductor materials. ■ *For further information call or write your nearest Hughes Semiconductor Sales Office. Or write: Hughes Semiconductor Division, Marketing Dept., 500 Superior Ave., Newport Beach California.*

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What do these 24 Honeywell Precision Meters have in common?

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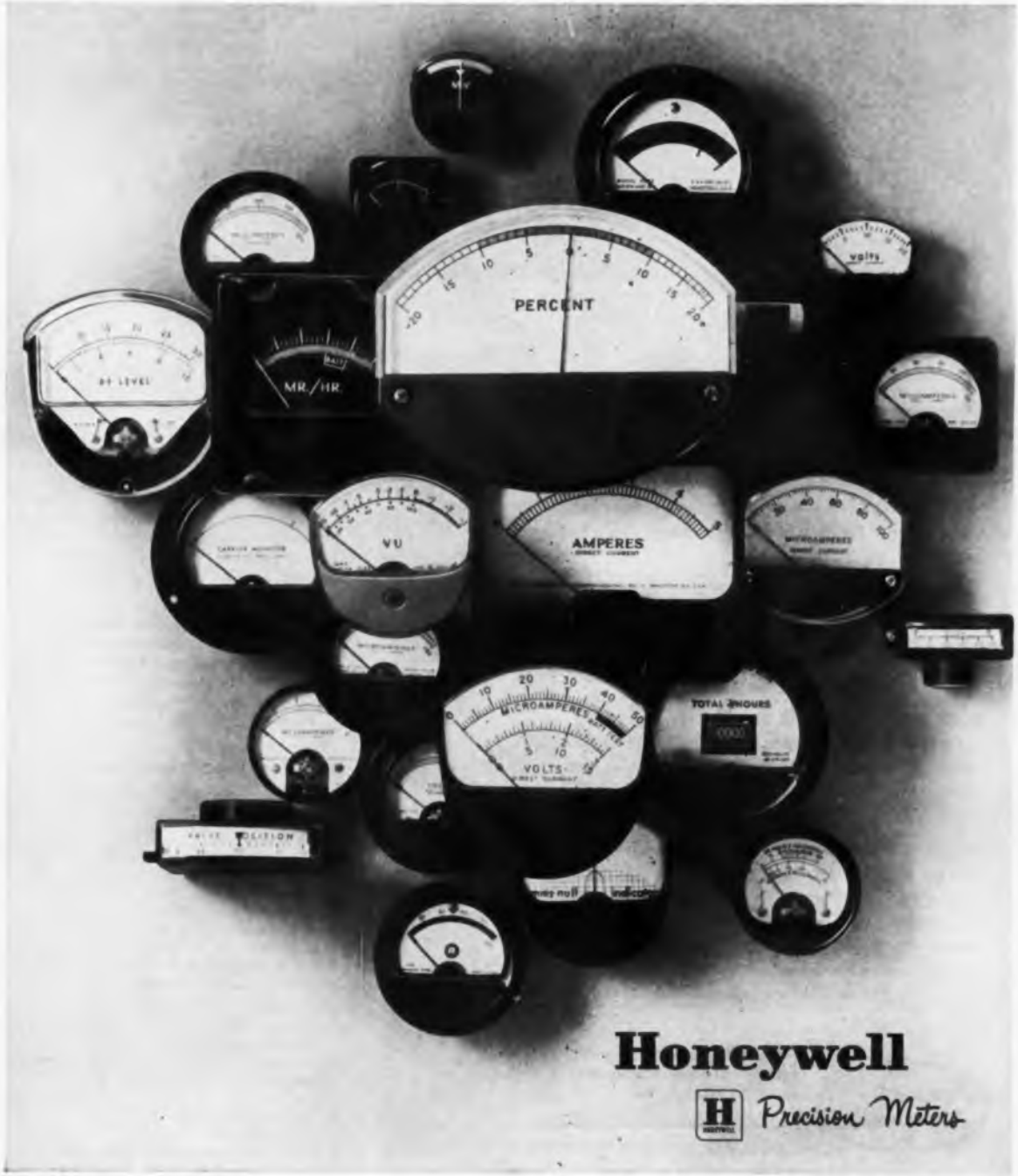

Letters to the Editor

"Transistorized FM Mike"

Editor, ELECTRONIC INDUSTRIES:

In reference to the article "Transistorized F M Wireless Mike" by Samuel J. Lanzalotti would you please explain how you get around the FCC's Rules & Regulations Part 15.206(a). Operation is limited to one second duration and to occur not more than once in 30 seconds. (You quote these rules at the end of the article.)

I am very much interested in this circuit and would appreciate it very much if you could enlighten me.

R. M. Clark
T. V. Supervisor
KFEQ Broadcasting Company
40th and Faraon Streets
Saint Joseph, Mo.

Ed: The section (Paragraph we abstracted from FCC Part 15) was correct. This unit cannot be used for communications by the public. However, government departments can get away with it—Mr. Lanzalotti is employed at Ft. Monmouth—provided their radiations do not interfere with broadcast (FM in this case) reception and no complaints are made to the FCC. Government sites are usually large enough that the energy is not radiated beyond their boundaries, hence no complaints.

Broadcasters can apply for a license to use portable transmitters and remote pick-up on equipment on frequencies set aside for them by the FCC.

In spite of the fact that the exact piece of equipment described cannot be used by broadcasters, the design considerations are much the same as those involved in designing a wireless microphone for operation on other frequency bands.

Filing Technical Articles

Editor, ELECTRONIC INDUSTRIES:

"A Filing System for Technical Articles," by Mr. K. H. Jaensch in the May issue of ELECTRONIC INDUSTRIES presents an excellent idea, which if placed into effect would be a real time saver to all technical personnel. I've made a file of my own and it's a help. But how much more efficient it would be if all articles were coded with a universally accepted filing system.

With only a few minutes for reading one can't keep up with the vast amount of literature that's available. (Note: I'm still on the May issue!)

John Rysuck
505 N. Chapman St.
Ashland, Va.

(*Continued on page* 60)

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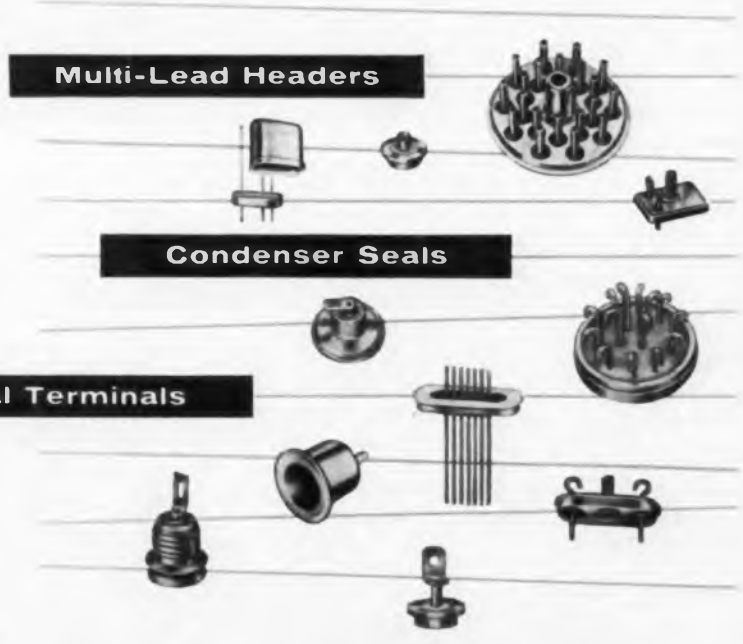

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Relays and related control components

Letters to the Editor

(*Continued from page* 56)

Whose Patent?

Editor, ELECTRONIC INDUSTRIES:

In reply to Dr. Ivey's letter in the February 1961 issue, page 42, please be advised that the patent is granted to the assignee designated in writing to the Patent Office before the patent issues. May I suggest that Dr. Ivey inspect a recent Westinghouse patent to convince himself that the patent is granted to the Corporation assignee.

I am in sympathy with the researcher who seeks no more than recognition of personal prestige for an inventor. However, a patent is a property right and all rights to an invention, as well as the potential monopoly may be assigned even before a patent application is prepared. Note that the Official Gazette weekly cross references the assignee as the patentee in the List of Patentees. Thurman Arnold once decided that a patent could not be granted to Western Electric because the assignment was made before the patent application was filed; however, this has been changed by statute.

I have deliberately avoided strict legal terminology because I am arguing with a scientist for whom I have very high regard. If the statutes and cases are of interest, I will be happy to furnish the information.

Benjamin Bernstein
Patents Department
Sperry Gyroscope Company

"Test Mapping System"

Editor, ELECTRONIC INDUSTRIES:

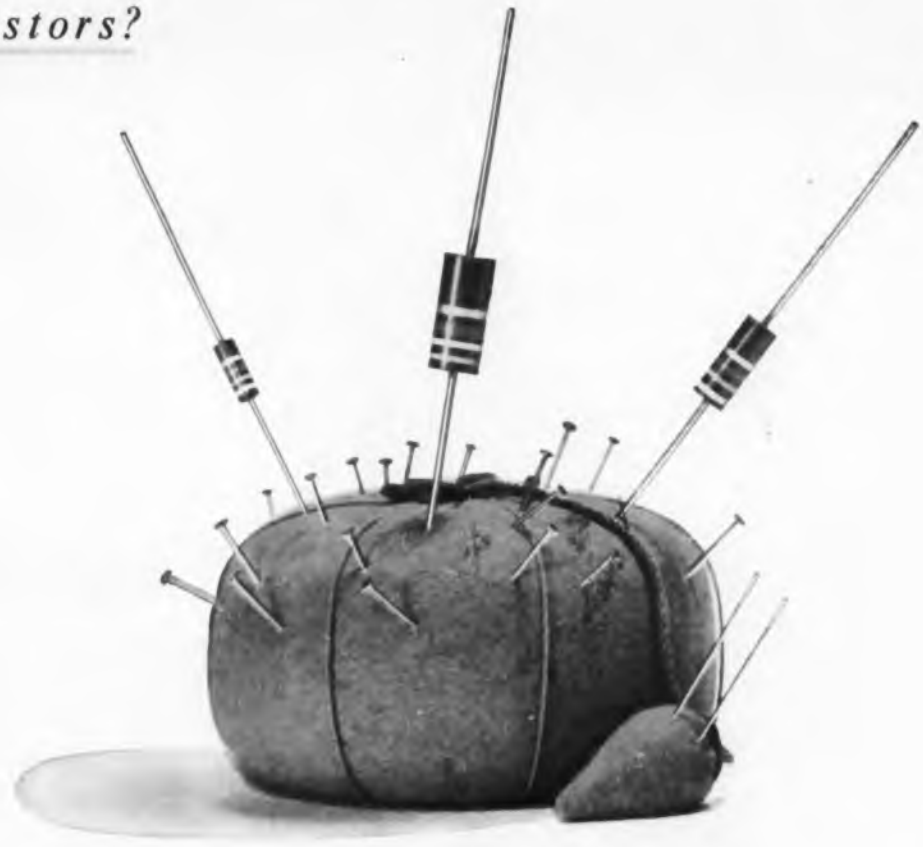
I read with great interest the article on page 194 of the February 1961 issue of ELECTRONIC INDUSTRIES, entitled "Test Mapping System."

You will be interested to know that Benson-Lehner is the exclusive licensee for world-wide development and manufacture of Stereomat. We will shortly have commercial systems automating the Nistri Photomapper Model VI. Later we expect to have available systems automating the Kelsh Plotter. We are engaged in extensive development for automation of high precision compilation and triangulation equipment. Stereomat will be demonstrated at the ASP-ACSM Convention at the Shoreham Hotel in Washington, D. C., March 19-25.

J. C. Pitchford, Vice President
Research and Development
Benson-Lehner Corporation
1860 Franklin Street
Santa Monica, California

(*Continued on page* 64)

Resistors?



Stick with STACKPOLE

It's a known business axiom that getting with—and sticking with—a single, dependable source of supply can reap handsome dividends. When you purchase Coldite 70+ Resistors from Stackpole you provide yourself with an *extra* cushion of dependability and quality. That's because Coldite 70+ Resistors are not only designed to exceed MIL-R-11 requirements in every respect . . . but they are also tops in load life, humidity and moisture tests.

What's more—no other resistors can match Coldite 70+ for production line efficiency because they are far and away the easiest to solder by any method . . . dip or iron. Leads stay tarnish-free and solderable even after months of storage thanks to the exclusive Stackpole extra solder coating applied after the usual tin dipping.

Coldite 70+ Resistors are available in Type RC-20 (½-watt); Type RC-32 (1-watt); and Type RC-42 (2-watts) . . . in all standard resistance values and at regular resistor prices. Write for Stackpole Resistor Bulletin giving complete specs on Coldite 70+ Resistors for MIL as well as commercial uses.

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Penna.

STACKPOLE
Coldite 70®+
fixed composition RESISTORS

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT ELECTRICAL CONTACTS • GRAPHITE BEARINGS, SEAL RINGS, ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

1 kw Hughes traveling wave tubes in S-Band

Now available in production quantities, these new and improved tubes offer you 1 kw of pulsed output power, with low power input, minimum heat generation and high reliability.

All these Hughes S-band tubes are lightweight, compact and ruggedly built to withstand the most severe environmental conditions—and provide long life. Each has been fully tested in the field.

Three of these tubes provide full octave frequency ranges of 2.0 to 4.0 kmc and you have a choice of either ½ or 1% duty, in either ungridded or gridded versions, and with gains up to 37 db. All are permanent magnet periodically focused.

311H Gridded. 1 kw minimum peak power output, 1% duty, 36 db small signal gain @ 50 mw input. Weight: 13 lbs. Length: 17-7/16". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.

312H Gridded 1 kw minimum peak power output, ½% duty, 36 db small signal gain @ 50 mw input. Weight: 11 lbs. Length: 15-3/8". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.

304H Ungridded, 1 kw minimum peak power output, 1% duty, 37 db small signal gain @ 1 mw input. Weight: 12½ lbs. Length: 17-31/32". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.

313H Ungridded, 1 kw minimum peak power output over the center portion of the band, ½% duty, 36 db small signal gain @ 1 mw input. Weight: 17½ lbs. Length: 16-5/8". Meets usual customer requirements of MIL-E-1 environmental tests.

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HUGHES AIRCRAFT COMPANY
MICROWAVE TUBE DIVISION

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Los Angeles 45, Calif.

OHMITE
Tantalum Slug Capacitors
NOW ±10%

Down . . . down . . . down to ± 10%. Ohmite now offers this low "K" tolerance as *standard* for all three *commercial*, "hat-shape" slug capacitors.

Resulting from advanced manufacturing processes and quality control techniques, this new engineering development improves previous broad tolerances of −15+20% and −15+50%.

Ohmite also supplies the three "hat-shape" sizes—T1, T2, T3—in S and T tolerances according to the latest requirements of MIL-C-3965B, styles CL44 and CL45.

For the complete picture of Ohmite's *big, full line* of wet-electrolytic tantalum slug capacitors, *request Bulletin 159F today!*

Fast Delivery of MIL and Commercial Stock Values From Factory and Distributors

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Rheostats Power Resistors Precision Resistors
Variable Transformers Tantalum Capacitors
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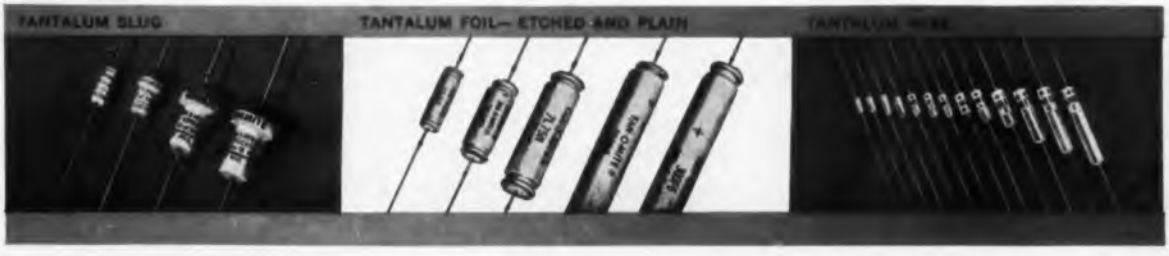


Letters to the Editor

(*Continued from page* 60)

Bulletin Alarm System

Editor, ELECTRONIC INDUSTRIES:

I have been informed by Mr. Robert F. Tilton of Storz Broadcasting Company that the news bulletin alarm system which I gave modifications for as published in "Cues for Broadcasters" of your February 1961 issue was originally designed by them. I gave the credit to the ABC network as this is where we got the original circuit. I was not aware that it had not originated there. I would like therefore to give credit where credit is due. I did not want credit for the origination of the basic circuit as my intent in the write-up was to point out the way we had made it fit our needs.

Will you please give the Storz Broadcasting Company the necessary credit.

Donald M. Wheatley
Chief Engineer WJOY
Burlington, Vermont.

Editor, ELECTRONIC INDUSTRIES:

The February, 1961, issue of ELECTRONIC INDUSTRIES Magazine carried a short article by Mr. Donald Wheatley, Chief Engineer of Radio Station WJOY, Burlington, Vermont. This article described a news bulletin alarm system installed in that station. Mr. Wheatley states that the circuit for the system was originally received from the ABC Network.

To set the record straight, Storz Broadcasting Co. developed the system shown in Mr. Wheatley's article. The equipment, as shown in the schematic diagram in the "Cues for Broadcasters" column is the same as that used at the Storz Stations for the past six or seven years.

We released the information on this system to the United States Weather Bureau in the early part of 1958 as a public service. In a letter dated May 27, 1958, the Chief of the Forecasts and Synoptic Reports Division of the United States Department of Commerce advised this company of plans to publicize the bulletin alarm system to all radio and television stations, and to encourage the construction and installation of such equipment in all such stations.

While I was most happy to see the Storz system publicized in your magazine, I am somewhat dismayed to find that we are no longer identified with the equipment.

Robert F. Tilton
Technical Director
Storz Broadcasting Co.
The Storz Stations
222 South 15th St.
Omaha 2, Neb.

(*Continued on page* 68)

Got a Hermetic Sealing Bottleneck?

If production is all stopped up with a sealing problem, bring your flagon, cannister or container to Deutsch. We can hermetically seal such unique assemblies as ignitor and solenoid cases, or copper braze special adaptors, flanges or fittings to our hermetic connectors. And the Deutsch seal is 100% inspected by mass spectrometer to make sure it is absolutely leak-proof. Contacts are fused right into a solid compression glass insert and easily identified by permanently imbedded numbers. Every step in this sealing process is Deutsch-performed and includes quality control procedures that guarantee the most reliable hermetic seal in the industry.

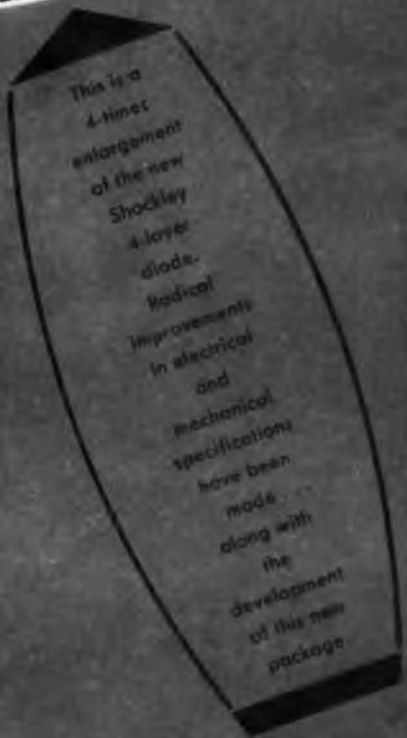
For more information on how Deutsch can help you eliminate those hermetic sealing bottlenecks, contact your local Deutschman today or write for Data File A-4.

DEUTSCH

Electronic Components Division • Municipal Airport • Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

THE NEW SHOCKLEY



5D

ACTUAL SIZE

4-LAYER DIODE

Type E
SHOCKLEY
4-layer "glass" diode

- **Carries 150 milliamperes steady dc**
- **Carries 10 amperes peak pulse**
- **Power rating 150 milliwatts**
- **Improved temperature stability**
- **Reduced size**
  105 diameter x .270 length (maximum)
- **Reduced weight**
  2 grams
- **Increased shock and vibration resistance**
  MIL LINE diodes are shock tested at 1,500 G's for 0.5 ms and vibration tested at 20 G's from 30 to 2,000 cps.
- **Lower prices**
  For COMMERCIAL applications in quantities over 5,000 the price has been reduced 40%.
- **Fast switching of voltages from 20 volts to 200 volts**
  These are some of the proven applications for Shockley 4-layer diodes . . .

sawtooth oscillators	phase shift controls
pulse generators	inverters
pulse modulators	telephone switching
pulse amplifiers	relay driving
time delay circuits	multivibrators
alarm circuits	squib firing
magnetic core driving	emergency power transfer
ring counters	

TYPE E 4-LAYER DIODES ARE NOW AVAILABLE IN PRODUCTION QUANTITIES

Local stocks of Shockley 4-Layer Diodes are maintained by many of our representatives . . . you'll find them listed in EDC and EEM

Our engineering sales representatives or our engineers in Palo Alto are ready to discuss applications with you . . . please write or call whenever you have questions. In the meantime, may we send you specifications and prices?

Shockley TRANSISTOR
UNIT OF CLEVITE TRANSISTOR
STANFORD INDUSTRIAL PARK PALO ALTO CALIF

CLEVITE

Letters to the Editor

(*Continued from page* 64)

"For Technical Secretaries

Editor, ELECTRONIC INDUSTRIES:

The need for secretaries schooled in the terminology of the particular profession that they are associated with has always been regarded as a highly desirable attribute. An individual so educated would not only reap the monetary gains that would be due her but would appreciate to the fullest the advancements that are progressing all around her.

The legal and medical professions have long held courses for their secretaries. It is indeed surprising to find that the physical sciences afford no such formal education for secretaries desiring to pursue a career in either the applied or experimental sciences.

This term the Engineers Association of Sperry Gyroscope Company, Professional Education Service, in cooperation with the adult education authorities of Nassau County, New York, is offering for the first time a course entitled "Technical Terminology for Secretaries." This educational service, for the past five years, has offered only engineering courses of an advanced caliber. However, the need for such a basic course and eventually a manual for engineering secretaries has existed for a long time.

Courses of this type given throughout the country would eventually produce a tremendous saving of valuable scientific time in an era where time is of the essence.

Donald J. Sweeney, Director
Engineers Association
Professional Education Service
Sperry Gyroscope Company

Engineers Association of
Sperry Gyroscope Company
2044 Hillside Avenue
New Hyde Park, New York

"Technical Dictionary—"

Editor, ELECTRONIC INDUSTRIES:

Ref: Letters to Editor, "For Technical Secretaries," Jan. 61 Issue.

A "manual" that I would personally recommend, especially for those interested in electronics terminology, would be; Electronics & Nucleonics Dictionary, by Nelson M. Cooke & John Markus, McGraw-Hill Book Co., Inc.

Harold L. Glass, Technical Writer
Ground Radar & Sonar Drafting
HEAVY MILITARY
ELECTRONICS DEPT.

General Electric Company
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Syracuse, New York

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THIS IS CONHEX® Type 3000/3001 Cable Plug and Jack

Different? Yes. And better, too. "ConheX" sub-miniature r.f. connectors are now in use in the most critical electronic assemblies, and specified by the most discriminating manufacturers of equipment. The many obvious advantages of the "ConheX" design result in easier assembly, greater dependability, and better electrical characteristics. Now "ConheX" is available in two basic styles—Clamp-On for limited runs and easy field replacement, and Crimp-On, designed to save time and money in large production runs. **Write for Complete catalog...**

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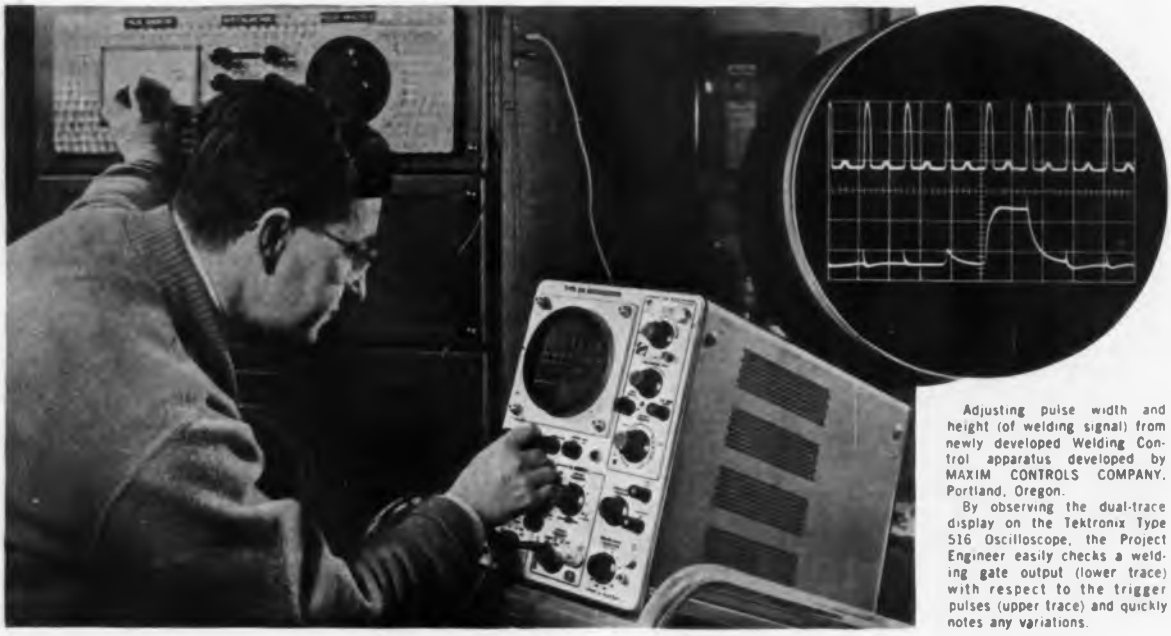
TEKTRONIX TYPE 516 OSCILLOSCOPE

Used in *Development* of High-Speed Welder

New, high-speed, precision welder developed at MAXIM CONTROLS COMPANY utilizes a controlled gate pulse—rather than capacitance decay—for joining high-temperature alloy materials, such as those used in manufacturing structural "honeycomb" cores.

In development of this new welder the Tektronix Type 516 Oscilloscope was used for critical timing and amplitude measurements. It was used by the Project Engineer for monitoring the time length of individual welds—since as many as six welds can be set to occur simultaneously or any number, sequentially—and for observing the constant amplitude and width of gate signals—thus assuring uniform bonds at speeds up to 2000 welds per second.

For your own research and development projects, consider the Type 516 Oscilloscope. Its dual-trace facility—with independent controls for each amplifier channel—permits you to position, attenuate, or invert the input signals as necessary for detailed analysis of their relative amplitudes, phase differences, time-delay characteristics. Its extremely reliable performance ideally suits the Type 516 for laboratory applications within the dc to 15 mc range.



Adjusting pulse width and height (of welding signal) from newly developed Welding Control apparatus developed by MAXIM CONTROLS COMPANY, Portland, Oregon.

By observing the dual-trace display on the Tektronix Type 516 Oscilloscope, the Project Engineer easily checks a welding gate output (lower trace) with respect to the trigger pulses (upper trace) and quickly notes any variations.

Dual-Trace, DC to 15 MC

Type 516 Specifications

4 Operating Modes
Both channels electronically switched — either on alternate sweeps or at a free-running rate of about 150 kc. Or each channel separately.

Vertical Amplifier
Frequency Response—dc to 15 mc (at 3 db down).
Risetime—23 nanoseconds.
Sensitivity—50 mv/div to 20 v/div in 9 calibrated steps.
Continuously variable uncalibrated from 50 mv/div to 50 v/div.
Constant Input Impedance—at all attenuator settings.

Sweep Range and Magnification
Linear Sweep—0.2 μsec/div to 2 sec/div in 22 calibrated rates.
Variable uncalibrated from 0.2 μsec/div to 6 sec/div.
Sweep Magnification—5X-magnifier extends calibrated sweep rate to 40 nsec/div.

Triggering Facilities
Fully automatic or amplitude-level selection (preset or manual) on rising or falling slope of signal, with AC or DC coupling, internal, external, or line—also, high-frequency sync to 20 mc.

Tektronix Cathode-Ray Tube
5-inch crt at 4 KV accelerating potential provides bright trace on 6 div by 10 div viewing area—each div equals 1 cm.

Amplitude Calibrator
11 square-wave voltages, from 50 mv to 100 volts, peak-to-peak, available from front panel.

Regulated Power Supplies
All critical dc voltages electronically regulated.

Size and Weight
13¼" high x 9¾" wide x 21½" deep—approximately 39 pounds.

Type 516 Oscilloscope (50-60 cycles) **$1000**

SPECIAL MODELS AVAILABLE

Type 516 MOD 101 (50-400 cycles) **$1035**

Type 516 MOD 108B (significantly improved writing rate at 6-KV on 6 div by 10 div viewing area—each div equals 0.85 cm) **$1075**

(prices f.o.b. factory)

For a demonstration of the Type 516 Oscilloscope in your own dual-trace (or single-trace) application, call your Tektronix Field Engineer.

Tektronix, Inc. P. O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

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TEKTRONIX ENGINEERING REPRESENTATIVES: Hamilton Electronics, Portland, Oregon • Seattle, Washington. Tektronix is also represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country.

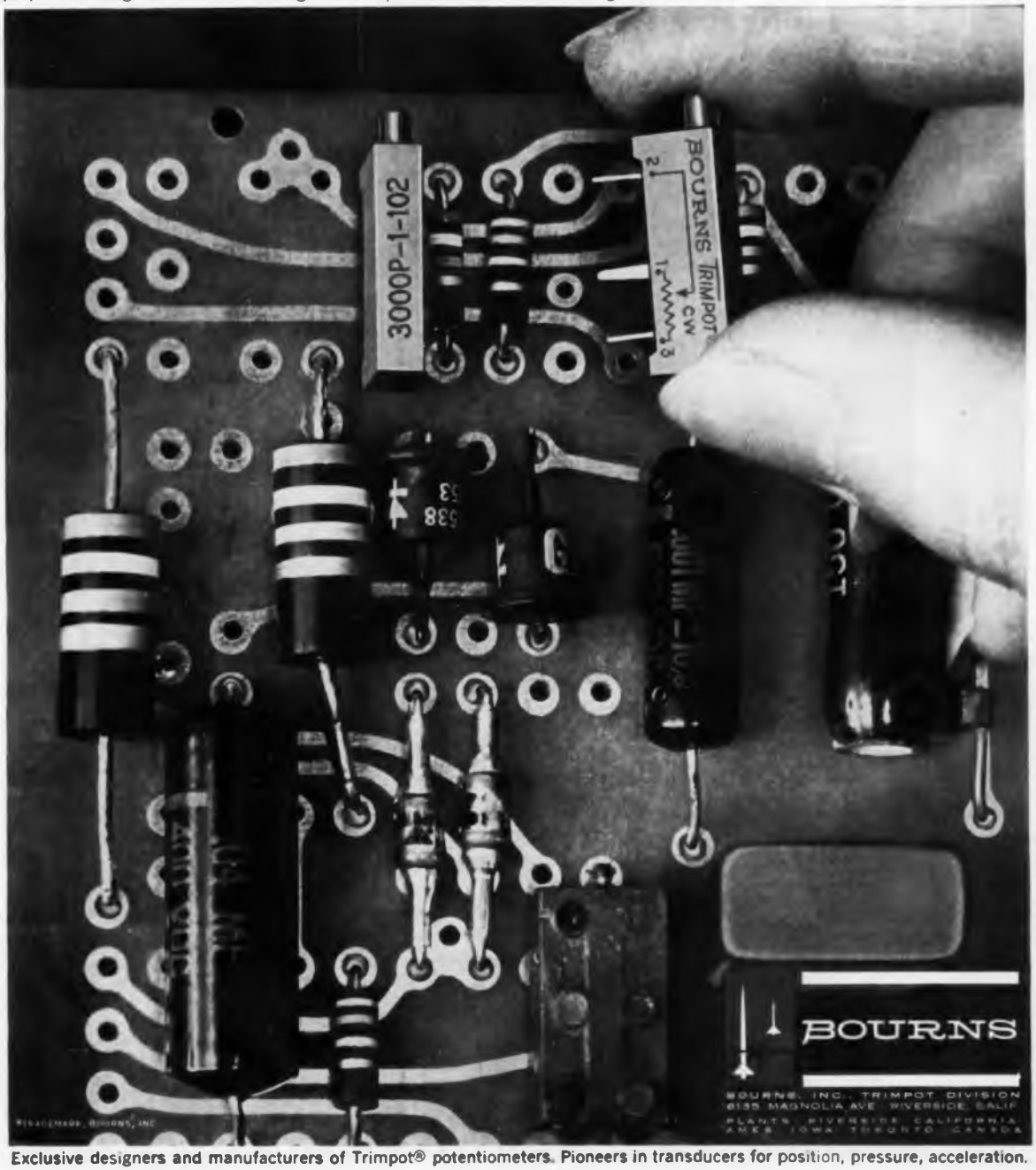
NUMBER 13—NEW PRODUCT SERIES

Now—an Even Smaller High-Temperature Trimpot® Potentiometer

Here, just ¾" in length, is a wirewound potentiometer that is completely humidity-proof and operates at 175°C! Ideal for your printed circuit applications, it withstands 30G vibration and 100G shock, dissipates 0.5 watt at 70°C (0.2 watt at 125°C), and has tapered pins for quick, easy mounting.

Sealed against humidity in a high-temperature plastic case, the Model 3000 exceeds the requirements of MIL-STD-202A, Method 106. The 15-turn screwdriver adjustment permits pinpoint settings and the self-locking shaft keeps them accurate. For maximum stability, the unit incorporates a ceramic mandrel. Reliability is outstanding. The exclusive Silverweld® bond between terminal and resistance wire is virtually indestructible under thermal or mechanical stress.

Available within 24 hours from factory and distributor stocks, the Model 3000 is stocked in resistances of 50 ohms to 20K. A Resiston® carbon version, Model 3001, is available with resistances of 20K to 1 Meg. Write for complete data and list of stocking distributors.



Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure, acceleration.

Circle 55 on Inquiry Card

Books

Progress in Astronautics and Rocketry, Vol. 1: Solid Propellant Rocket Research

Edited by Martin Summerfield. Published 1960 by Academic Press, Inc., Publishers, 111 Fifth Ave., New York 3. 692 pages. Price $6.50.

This volume is the first in a new series which is sponsored by the American Rocket Society. The present volume is an outgrowth of a symposium on solid propellant rocket research held at Princeton University on January 28 and 29th, 1960. Although most of the 27 papers in this volume were actually presented at the symposium, 6 were drawn from the backlog of unpublished manuscripts awaiting publication in the ARS Journal, and several are specially-requested, much-expanded revisions of the papers that were presented. In selecting the papers for the volumes, the editor attempted to meet as nearly as possible the present needs of solid rocket research scientists for up-to-date view of the most promising ideas in certain special areas of research.

Most of the book deals with the combustion of solid propellants. The particular topics singled out for attention are: Steady-state burning of composite propellants, combustion of metals, unstable burning in solid propellant rockets, and ignition. In addition, the book includes a section on mechanical properties of solid propellant grains essentially as a subject in its own right, but partly for its practical connection with internal ballistic design and hence with combustion.

Theory and Application of Ferrites

By Roland F. Soohoo. Published 1960 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 280 pages. Price $12.00.

What sets this study of ferrites apart from others is the fact that it combines the theory and application of ferrites at microwave frequency with those of ferrites below microfrequencies. Also, it includes, in addition to data already available in some form, considerable material that is original with the author.

Dr. Soohoo describes his treatment as comprehensive but sufficiently introductory to serve as a self-study aid for junior physicists and engineers. He includes only material which has been experimentally tested and presents each chapter in such a way that only minimum cross-reference between them is required.

(Continued on page 78)

CANNON AUDIO PLUGS

INDUSTRY STANDARD FOR ALL LOW-LEVEL SOUND CIRCUITRY REQUIREMENTS Since their original design, Cannon Audio Plugs have been accepted as the standard of quality for all low-level sound circuits. Cannon's full line of audio-electronic plugs fulfill all the requirements for use with microphones, radio, television, amplifiers, tape recorders, computers, control devices, and many other audio and instrumentation applications. Available through Cannon Sales/Engineering Offices and authorized Distributors throughout the world. For information on this or other products, write for literature to:

CANNON PLUGS

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BUSS and FUSETRON FUSES

When you specify BUSS and FUSETRON fuses you can be sure of safe, dependable, trouble-free protection for your equipment under all service conditions.

Every BUSS and FUSETRON fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Chances are you will find in the complete BUSS line the fuse and fuse mounting to fit your requirements — but if your protection problem is unusual, let our engineers work with you and save you engineering time.

To get full data for your files, write for BUSS bulletin on small dimension fuses and fuseholders. Form SFB.

461

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.*, UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

NEW DORSETT "20" SERIES

provides maximum telemetry system flexibility!

- Requires Less Power
- Meets Most Rugged Environmental Conditions
- Die Cast Construction

SOLID STATE COMPONENTS AVAILABLE FOR "20" SERIES PACKAGING

- TR-20 2-watt FM Transmitter, 225 - 260 mc.
- TR-21 2-watt FM Transmitter, 136 - 137 mc.
- O-20A Subcarrier Oscillator
- MVO-20 Millivolt Subcarrier Oscillator
- ACA-20 Low Level AC Amplifier
- DCA-20 Low Level DC Amplifier
- PWM-20 Pulse Width Modulator
- PS-20 Regulated Power Supply

MODULAR PACKAGING DESIGN of the new "20" series line of telemetering components and systems lets you put more telemetering equipment in less space. Every system component has been packaged in compatible modules identical in height (2.25") and width (1.875"), with thicknesses of one, two, or four units (.875" per unit). These standard modules permit a wide range of system configurations, and make future modification of basic systems easy and economical.

EVERY "20" SERIES COMPONENT utilizes silicon semi-conductor circuitry—no tubes anywhere. The typical "20" series 12 channel system including transmitter, weighs less than 5 pounds, draws less than 20 watts from a 28 volt supply, and exceeds military specifications for reliability and performance throughout extreme missile environments.

FOR YOUR NEXT TELEMETERING REQUIREMENT let Dorsett take the problems out of system packaging with a "20" series telemetry system. Your inquiries or specifications will receive a prompt reply.

DORSETT ELECTRONICS, INC.

P. O. Box 862, Norman, Oklahoma, Ph: JEfferson 4-3750

THE TAPE THAT CHANGED TV FOR ALL TIME

leads you right to rugged
SCOTCH® BRAND Heavy Duty Tape

THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250°F.

The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 198 and 199.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 158, 159 and 201; High Output Tape 128; Sandwich Tapes 188 and 189; and Standard Tapes 108 and 109.

Your 3M Representative is close at hand in all major cities. For more information, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

SCOTCH BRAND MAGNETIC TAPE

FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

3M

DALE

Type MF resistors completely stable under continuous load

Under any circumstance...placed under continuous load, or held "in reserve" for months...operating under severe environmental conditions of shock, vibration, or humidity . . . Dale precision resistors retain their stability.

Stability is inherent in Dale resistors because it has been firmly infixed by design and methods of manufacture . . . methods which have reached new levels of achievement as the result of Dale's super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

PROMPT DELIVERY: Whether your need is for a short "test run" or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

Hathaway INSTRUMENTS INC.

DALE ELECTRONICS, INC.

1304 28th Ave., Columbus, Nebr, U.S.A.

A subsidiary of **HATHAWAY INSTRUMENTS, INC.**

DALE **TYPE MF** RESISTORS

METAL FILM • MOLDED • PRECISION

These new resistors combine the advantages of Dale molding techniques with advanced high vacuum evaporated metal film procedures to provide the best characteristics of wire wound resistors, while retaining miniature size. Inherently good R.F. characteristics and low noise levels.

- RATED AT 1/8 watt, 1/4 watt, 1/2 watt, 1 watt, 2 watts
- RESISTANCE RANGE from 100 ohms to 4 megohms, depending on type
- TOLERANCE ± 1%
- TEMPERATURE COEFFICIENT ± 50 and ± 100 P.P.M.
- FULL POWER to 125° C.
- COMPLETELY INSULATED; complete protection against moisture and salt spray

Write for Bulletin R 43 and handy cross reference file card

Books

(Continued from page 72)

An Introduction to Electrotechnology

By S. J. Kowalski. Published 1960 by John F. Rider Publisher, Inc., 116 West 14th Street, New York 11, New York. 301 pages. Price $7.00.

This book presents a highly practical course in alternating-current and direct-current electricity at the college level. The numerous examples given represent a worked-out numerical presentation of a particular technical point. Together with the example is an extensive and detailed solution that provides the reader with a deep insight into all the factors involved in the particular problem.

Design Fundamentals of Analog Computer Components

By R. M. Howe. Published 1961 by D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, New Jersey. 268 pages. Price $7.50.

Describes the design procedure and philosophy in the development of electronic analog computer components. Presents a practical discussion of the influence of component errors, both static and dynamics, on problem solutions and then gives in detail the design of dc amplifiers, multipliers, function generators and miscellaneous equipment. Many examples of current, commercially-available equipment are presented and illustrated including detailed circuit descriptions.

Radio Transmitters

By Laurence F. Gray and Richard Graham. Published 1961 by McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 36, N. Y. 462 pages. Price $12.50.

This book presents a practical analysis of transmitter operation in all its various phases, together with usable information pertaining to specific problems. It shows how the various transmitter circuits work, not only communication transmitters but also radar, telegraph, telephone, mobile, television, and other types.

Transistor Circuit Analysis

By Maurice V. Joyce and Kenneth K. Clarke. Published 1961 by Addison-Wesley Publishing Co., Inc., Reading, Massachusetts. 461 pages. Price $10.75.

The basic methods of analysis involved in the understanding and design of junction transistor circuitry are presented. The transistor models employed are restricted to a small number that are all easily interrelated. Initially the simple low-frequency models are presented and are related to the underlying physical processes that occur in the device. Only after the reader is completely familiar with these simple models are the complications, such as high-frequency effects, noise, or saturation effects introduced.

(Continued on page 82)

2 NANOSECOND MICROWAVE SWITCHING with SOLID STATE RELIABILITY

Microwave Associates' new coaxial switches provide:

- Efficient switching across the microwave spectrum
- Solid-state reliability for military applications
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Solid-state switches are as good as the semiconductors they incorporate. All units described use the most advanced microwave silicon diodes available, specifically developed for this function by Microwave Associates Semiconductor Division.

LOW POWER LEVEL COAXIAL SWITCHES

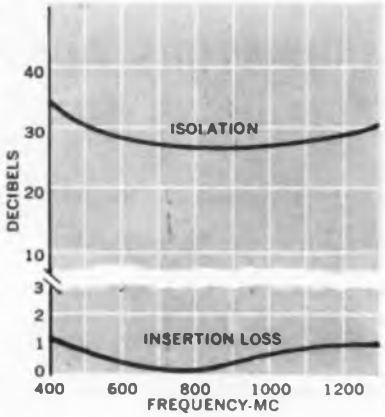
Frequency (Mc)	Insertion Loss (Max)	Isolation (Min)	Switching Power
210-240	0.2 db	20 db	10 mw
260-340	0.2 db	18 db	10 mw
400-500	0.3 db	20 db	10 mw
570-630	0.3 db	20 db	10 mw
900-1000	0.3 db	20 db	10 mw
1250-1350	0.5 db	20 db	10 mw
MEDIUM POWER LEVEL COAXIAL SWITCHES			
200-1000	1.5 db	22 db	70 mw
1000-2000	1.5 db	20 db	70 mw
2000-4000	2.0 db	16 db	70 mw

LOW POWER LEVEL VOLTAGE VARIABLE ATTENUATORS

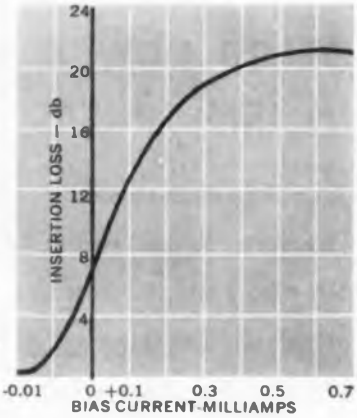
Frequency (Mc)	Attenuation Range
260-340	0.2 db-18 db
400-450	0.3 db-20 db
570-630	0.3 db-20 db
1250-1350	0.5 db-20 db

Narrow-band higher frequency units are available with lower loss and increased isolation.

TYPICAL PERFORMANCE BROADBAND MICROWAVE SWITCH SPST



TYPICAL PERFORMANCE VOLTAGE VARIABLE ATTENUATOR (425 Mc=25)



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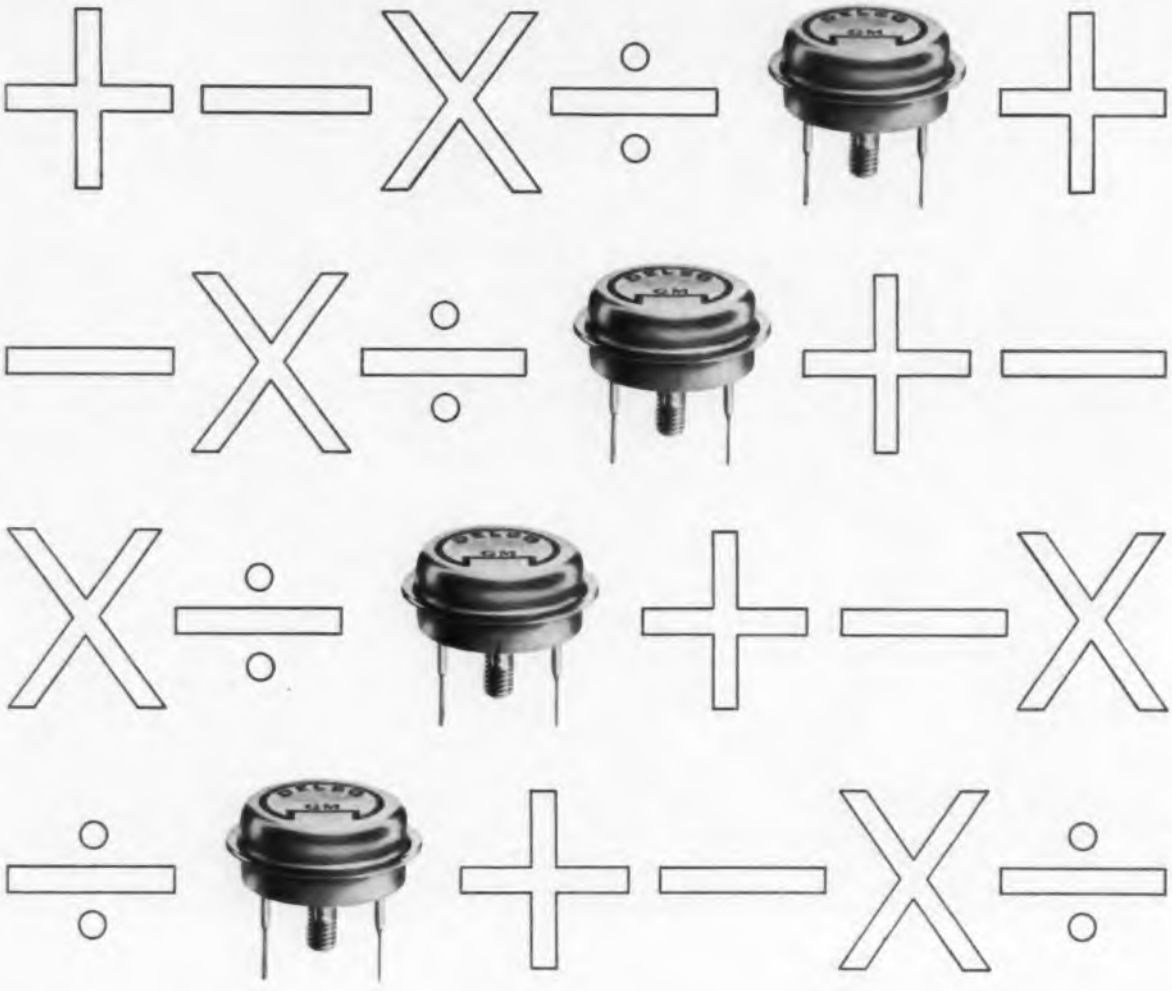

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Books

(*Continued from page* 78)

Airborne Radar

By Donald J. Povesil, Robert S. Raven and Peter Waterman. Published 1961 by D. Van Nostrand Co., Inc., 120 Alexander Street, Princeton, New Jersey. 823 pages. Price $17.50.

Designed to provide an understanding of basic radar technology and its relation to overall weapons system design, this volume emphasizes the basic principles and systems analysis techniques, and how mathematical models may be developed to solve radar design problems. Technical requirements for airborne radar and how the overall system may be treated in a quantitative manner are explored. Various types of radar systems are described, analyzed, and related to the overall weapons systems problem. Factors affecting the design of radar transmitters, receivers, tracking circuits, and indicators are discussed. Particular attention is given to the problem of controlling the flow of information through a radar system to achieve compatibility with the overall weapons system.

Magnetic Tape Instrumentation

By Gomer L. Davies. Published 1961 by the McGraw-Hill Book Company Inc., 330 West 42nd Street, New York 36, N. Y., 363 pages. Price $8.50.

Clear explanations on how to best use magnetic tape equipment and effectively apply it to data recording and reproduction are given in this newly published guide. Ranging from basic techniques used in data recording to major application of magnetic tape equipment, the book brings together up-to-date facts and data needed by those who use such equipment in instrumentation and data acquisition and processing systems.

Emphasis is on data recording methods, with background material on magnetic recording principles, including phase characteristics of a magnetic tape system. Certain aspects of the magnetic recording process which are of special importance in instrumentation applications are stressed. Also considered are those techniques which are particularly employed for the recording of analog and digital information in the business and technical fields.

NMR and EPR Spectroscopy

By the NMR-EPR Staff of Varian Associates Instrument Div. Published 1961 by Pergamon Press, Inc., 122 E. 55th St., New York 22. 320 pages. Price $12.00.

This new publication provides an introduction to both nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) spectroscopy and it assists the more advanced investigators augmenting or bringing their knowledge of these subjects up to date.

(*Continued on page* 86)

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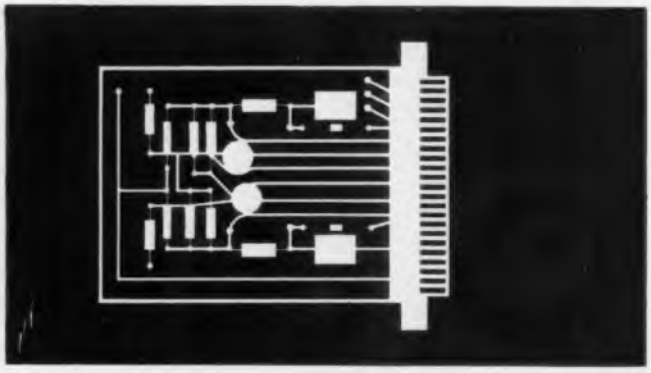

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Books

(*Continued from page* 82)

Essentials of Dielectromagnetic Engineering

By H. M. Schlicke. Published 1961 by John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. 242 pages. Price $9.50.

Intended as an introductory text of graduate level, this book is written in the language and concepts of the electronics engineer and teaches the scientific approach in solving practical problems of modern electronic ceramics. The equivalent circuits and models introduced will appeal to engineering educators and students.

It is written for the inquisitive electronics engineer and advanced engineering student looking for facts and stimuli about the possibilities and limits inherent in magnetically soft ferrites and high-ε dielectrics like barium titanates. These magnetic and/or dielectric polycrystalline ceramics play a fascinating and ever increasing role in modern electronic circuits.

Governmental Publications

Orders for reports designated (OTS) should be addressed to the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Make check or money order payable to: "OTS, Dept. of Commerce." OTS reports may also be ordered through the Dept. of Commerce Field Offices, Prepayment is required. Use complete title and PB number for each report ordered. All other reports may be ordered from the Supt. of Documents, Government Printing Office, Washington 25, D. C.

RADC Reliability Notebook

General Engineering Laboratory, RADC, and Mc Graw-Hill Book Company. 275 pages. PB161894. Price $4.00.

Translations

(Available from OTS U. S. Dept. of Commerce).

Electronics and Cybernetics

By A. I. Berg. 60-31639. August 1960. 13 pages. Price $.50. Translation of Izvestiya Vysshikh Uchebnykh Zavedeniy. Radiotekhnika USSR. 1960

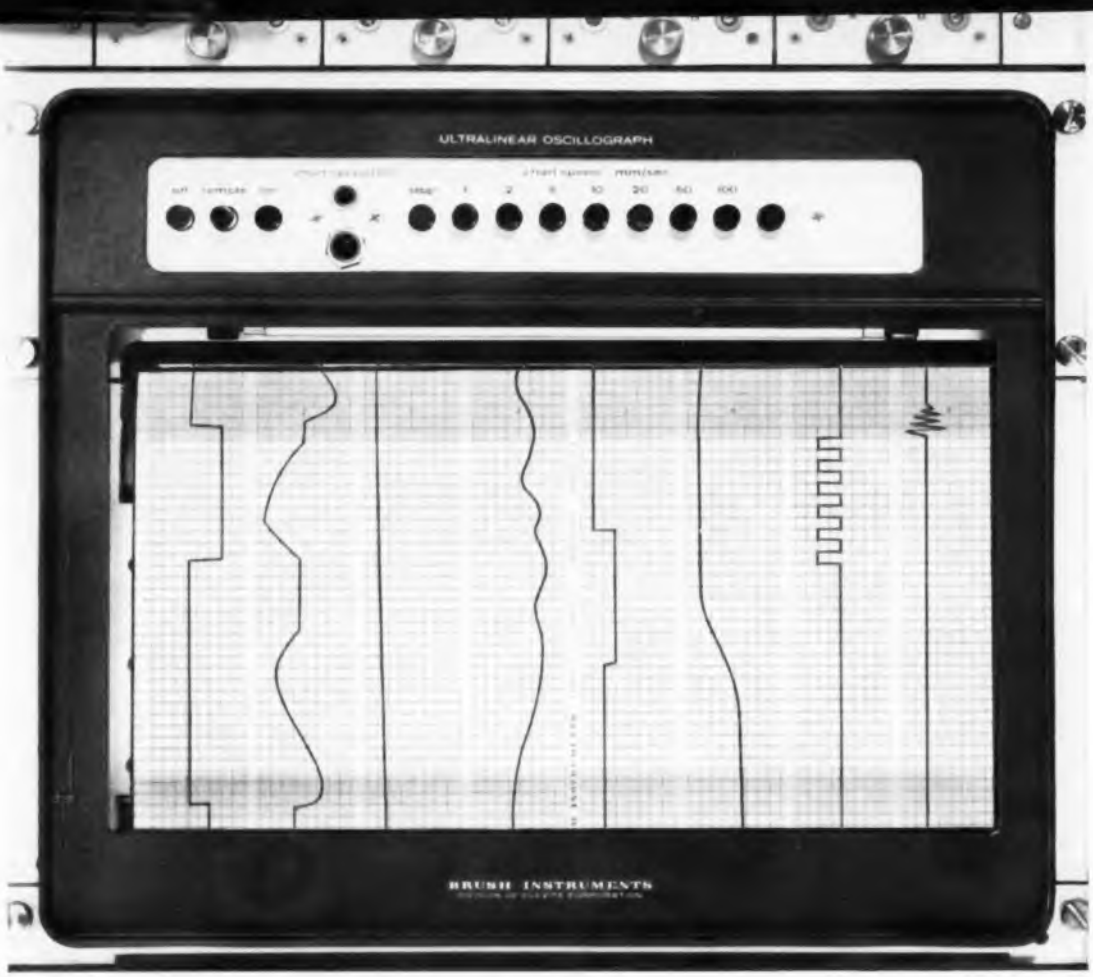
On the Theory of Non-Repetitive Networks

By B. A. Traktenbrot. August 1960. 82 pages. Price $2.25. Translation of Akademiya Nauk USSR, Matematicheskiy Institut, Trudy. 1958.

Use of SRS-L Radio Relay Equipment in Virgin Lands

By B. G. Kislyakov. 60-31355. July 1960. 9 pages. Price $.50. Translation of Vestnik Svyazi USSR. 1960.

(*Continued on page* 264)



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CONFIGURATIONS

1300 SERIES

Model No.*	No. Digits	No. Turns	Brake	Color
1331	3	10	X	Dark Gray
1332	3	10	X	Light Gray
1333	3	10	X	Red
1334	3	10	X	Black
1335	3	10	X	White

*All models available with or without internal illumination — red light (add suffix LR) or white light (LW).

1300 SERIES

Model No.	No. Digits	No. Turns	Brake	Color
1309	3	10	X	Black
1310	3	10		Black
1304	4	100	X	Black
1314	4	100		Black
1305	5	1,000	X	Black
1315	5	1,000		Black

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Next month

• HALL EFFECT ISOLATORS

An "isolator" can be one of many devices: vacuum tube and transistor amplifiers, UHF and microwave ferrite isolators, and electromechanical isolators. These unusual devices, described here, employ the Hall effect in semiconductors. A particular value of shunt resistance can be calculated for which complete cancellation can be obtained. This value is related to the four terminal resistances of the gyrator.

• WHY SOLID NETWORKS?

New manufacturing techniques, developed in the semiconductor field, are being employed in the manufacture of general components. Impurity contents of one part ppm are easily achievable. Techniques Processes have been developed from which a slice of proper resistivity silicon can be transformed into circuit, incorporating resistances, capacitances, diodes and transistors.

• DESIGN OF SOLID STATE COMMUTATORS & DISTRIBUTORS

Commutators and distributors serve many useful purposes in the fields of communications and related arts—data recording, automatic checkout, time division multiplexing, pulse amplitude modulation. This article contains a practical design procedure, including circuit configurations and logical equations. Unlike motor driven, mechanical commutators, the solid state devices have no moving parts, can be easily synchronized to an external clock and can operate at very high speeds.

• BASIC RCTL CIRCUITS USING MESA SWITCHING TRANSISTORS

An explanation of the mesa transistor as to its capabilities and use in different circuits. Also a detailed discussion of inverter and flip-flop circuits used in computers, using the mesa transistor.

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Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events, EI Totals, Snapshots of the Electronic Industries, EI International, News, Briefs, Tele-Tips, Books, Representatives News, International Electronic Sources, Personals, etc.

COMING SOON—

• THE 1961 ANNUAL ALL-REFERENCE ISSUE

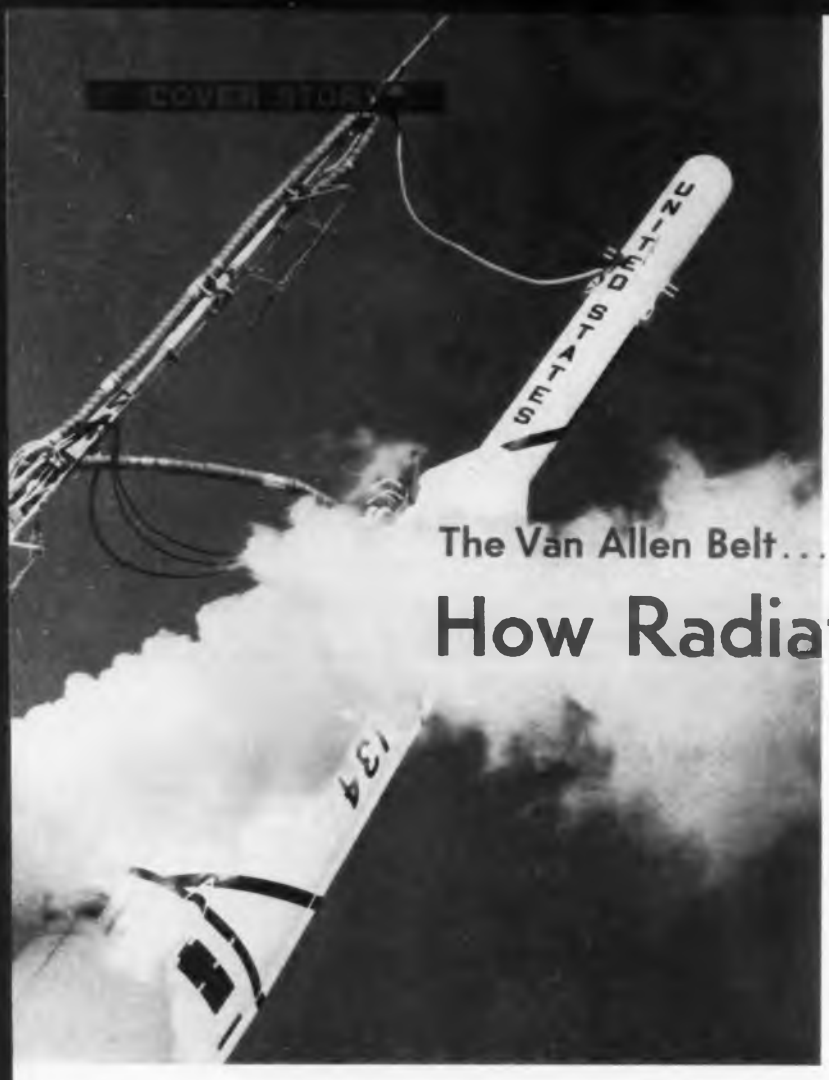
The fourth consecutive annual edition containing year-round technical reference information for electronic engineers. The editorial staff is already at work compiling and selecting data for this issue. Suggestions from user-readers for new topics and compilations to be included will be given careful consideration.

Watch for these coming issues:

*JUNE
Annual All-Reference & Directory Issue

*AUGUST
Annual WESCON Issue

*NOVEMBER
Annual Microwave Issue



Thor-Able III boosted some of the satellite probes which were used to collect the data on radiation effects presented in this article.

The Van Allen Belt...

How Radiation Affects

By DR. ROBERT S. SHANE
Consultant-Materials
Light Military Electronics Dept.
General Electric Co.
Utica, New York

SOON more and more vehicles will enter or pass through the Van Allen Belt; so its effects on circuit materials will be crucial in determining mission success or failure. To design for a reliable, effective mission, the reaction of each component and material to this radiation environment must be known; however, at the present time, the data pertaining to radiation effects is scanty. It consists primarily of extrapolation of other information.

Although all forms of radiation in the Van Allen Belt have important effects upon components and materials, high energy protons and electrons are the most destructive. Though neutrons and protons are nearly equal in weight, the effects of bombardment by each are radically different.

The neutron normally regards matter as empty space to be passed through, barring accidental nuclear collision. The charged proton, however, regards matter as a region of constant and hazardous interaction.

The particle's positive charge produces an ionized path during its journey, resulting in damage to the material through which it travels. Metals will not be seriously disturbed because the charges redistribute themselves easily; but, with covalent bonds such as plastics, the damage will be extensive.

It is relatively simple to shield against the penetration of electrons; therefore, high-energy, deeply penetrating protons, like those in the Van Allen Belt, pose the greatest potential threat to a missile's components.

An average Van Allen Belt proton is able to penetrate 5 gm/cm^2 (four mm) of lead; and, it causes the most severe damage at the end of its path. Fast-moving particles penetrate much deeper, however, into organic materials and cause much more extensive and more serious damage. The average particle will penetrate about 8 centimeters into organic material, causing damage along the full extent of its trajectory. Some higher energy particles may pierce as deeply as 90 centimeters.

Proton Irradiation

The immediate effect of proton irradiation on covalent bonds is the creation of a continuous trail of ion-

Based on a paper presented by DR. ROBERT S. SHANE at the IRE Convention, New York City, March 22, 1961.

The early Sputniks and Explorers gave indications of unknown high-energy bands.
The later probes obtained qualitative data
from which the Van Allen Radiation Belt was formulated.
How will this Belt's 60 mev average peak intensities affect circuit materials?
How can we find out what we need to know?
The author presents logical answers to these crucial questions.

Material

ized particles behind the moving particle. Consequently, there is a drop in dielectric strength of 4 or more orders of magnitude. This ionization effect will also produce structural damage in the material. Fast moving protons interact with orbital electrons, producing molecular excitation and ionization. The excited or ionized molecules tend to break up and form free radicals or atoms. The result is damaged material.

This damage to organic compounds is one of the most serious effects of irradiation. Here is where extensive work must be done to determine the precise characteristics of material when subjected to high-energy bombardment. With the exception of solid-state devices, insulation is the most radiation sensitive component of electrical circuits. Electrical insulators are generally complex organic polymers. The most important effects of energetic radiation on them are ionization and excitation of molecules. These effects lead to the formation of more or less free electrons and free radicals. They are manifested in a variety of changes, both transient and permanent, in the physical and chemical properties of the organic material.

One of the most striking changes is the enhancement of the electrical conductivity of the polymer. This effect is analogous to the photoconductive effect induced by visible (ultra-violet and gamma) light. The conductivity of polyethylene, for example, increases as much as 4 orders of magnitude when in a strong gamma-ray field.

The changes affected in the insulating material's molecular structure will produce alterations in its resistivity. Further, it will alter the performance of the circuit of which it is a part. If irradiated strongly enough for a sufficient period of time, the bombardment will lead to a complete breakdown of the material.

Technician examines the power connections on Pioneer V. Satellites such as these provided the data from which "belt" was determined.

Transient Effects

We must also consider in a radiation-sensitive materials analysis the transient effects of the radiation.

TABLE 1

Resistivity of Insulators After Reaching Equilibrium (of 11 ergs/g/sec. Gamma)

Material	Original Resistivity (ohm-cm)	After Equilibrium (ohm-cm)
Polyethylene Terephthalate (Mylar)	10^{23}	1.43×10^{20}
Amber, molded	2×10^{21}	10^{17}
Amber, natural	10^{21}	10^{18}
Polystyrene	10^{22}	1.43×10^{20}
Unplasticized perspex (Lucite)	10^{22}	2.5×10^{18}
Plasticized perspex (Lucite)	10^{20}	3.33×10^{17}
Red "400" perspex	10^{20}	1.25×10^{16}
Poly-tetrafluoroethylene (Teflon)	5×10^{19}	1.25×10^{16}
Polythene (Polyethylene)	2×10^{20}	3.33×10^{18}

TABLE 2

Breakdown Exposure Doses of Organic Insulators (Total Failure)

Insulators	Total Breakdown Exposure Dosages ergs/cm²
Polystyrene	1.6×10^{16}
Polyethylene	1.6×10^{15}
Silastic 80	1.6×10^{15}
Sil-X	1.4×10^{15}
Teflon	8×10^{14}
Silicone Rubber	6.4×10^{14}
Neoprene	4.8×10^{14}
Formvar	3.2×10^{14}
Polyvinyl chloride	3×10^{14}
Rubber	2×10^{14}
Kel F	1.6×10^{14}
Suprenant A-10 (Polyvinyl chloride)	1.6×10^{13}
Suprenant B-2 (Polyvinyl chloride)	8×10^{12}

* Unit Conversion by R. S. Shane.

TABLE 3

Threshold Damage (25%) Doses of Organic Insulators

Insulators	25% Breakdown Exposure Dosages ergs/cm²
Teflon	10^{6}
Mycalex	10^{10}
Nylon	10^{10}
Polyvinyl Chloride	10^{10}
Formex	10^{10}
Silicone Rubber	5×10^{10}
Phenolic-inorganic filler	10^{11}
Polyethylene	10^{11}
Polyester	10^{11}
Anodized Aluminum	10^{11}
Silicone resin	10^{12}

There is a rapid variation in the conductivity of polyethylene and Teflon, for example, immediately after removal from a radiation field. Moody asserts that, "The transient increase of electrical conductivity of these materials is probably due to the production of free electrons" rather than to the occurrence of ions and free radicals in irradiated polymers.[10] This would account for the rapid variations in the conductivity of polyethylene and Teflon, and also, for the temperature dependence of the conductivity while the materials are in a radiation field.

Other effects of insulator exposure to irradiation are serious and must be more intensively studied. The charge carriers in irradiated polymers produce a reaction similar to semiconductors; thus rectification, nonohmic behavior, and photovoltages can be observed.

The secondary reactions of covalent materials are also important to the effective operation of the circuit. In organic liquids, the phenomenon of gas evolution can produce from 0.2 to 12 volumes of gas per volume of liquid at exposure dosages of 10^{10} ergs/g/(C). In addition, the halogenated hydrocarbons release corrosive halogens and halogen acids which may attack nearby components.

Usually, many of these transient effects could be minimized by proper design and geometrical considerations. But the necessary closeness of components and the extremely high intensity of Van Allen Belt radiation demand that more extensive knowledge be gained about the characteristics of organic materials in irradiating environments.

Existing Knowledge

Some preliminary data exist which, although not extensive, point to the urgent need for a battery of materials tests and evaluations. This program would determine the exact effects of prolonged high-radiation exposure. Because there is very little information on the interaction of high-energy protons with matter, these data must be primarily extrapolations from existing information—scanty though it is.

Table 1 shows the permanent changes in resistivity of several insulating materials when subjected to 11 ergs/g/sec of radiation. Table 2 shows the dosage of radiation energy necessary to affect the complete degradation and breakdown of some organic insulators. And Table 3 presents the amount of energy which will cause threshold damage (25%) to insulating materials.

At the present time, all estimates of high-energy radiation effects on specific components and materials must be extrapolations from data secured from nuclear fission fragment bombardment and gamma irradiation. These preliminary data indicate, however, many important considerations which must be explored further so that design specifications may be formulated effectively. In summary, this information is as follows:

Capacitors: More satisfactory performance is achieved with inorganic dielectrics. Chlorinated compounds should be avoided because of their corrosive effects. Ceramic, mica or glass dielectric capacitors offer more resistance to radiation damage than oil-filled, oil impregnated, plastic or electrolytic varieties.

Gas evolution is a hazard since the gases expand the sandwich construction and rupture sealed units.

Resistors: Borocarbon film resistors are inferior to carbon-film and wire-wound (on ceramic cores) types. Some resistors will show a decrease in noise characteristics when exposed to radiation.

Diodes: Increased heat and the creation of artificial impurities when subjected to radiation will degrade performance seriously. Increased forward resistance and decreased backward resistance will lead to increased dissipation.

Tunnel Diodes: These are extremely tolerant of a high-energy radiation environment.

Silicon solar cells: These will decay.

Germanium Window Thermistor Bolometers: These are the least sensitive of all components to radiation damage.

Transistors: The collector characteristics for common emitter connection collapse, and there are relatively large changes in collector-base leakage currents.

Recommended Study Program

Because component and material degradation information is seriously incomplete, and because the characteristics of each component will vary from one manufacturer to another, we must collect much more information before we can evolve accurate specifications for high-energy radiation environments. Known space conditions demand a thorough knowledge of radiation effects on components and materials to avoid any possible degradation.

Accordingly, we must develop a small test module using components of unknown reliability in radiation environments; and, operate it in a simulated Van Allen Belt. This high-energy environment may be produced by a linear accelerator—if allowances are made for the difference between a typical accelerator's 1 mev and the Van Allen Belt's average peak of 60 mev. In predicting component and material characteristics for a higher energy bombardment, a complete description of the test module and the normal operating characteristics of the test circuit are necessary. The radiation environment, including details of the energy spectrum, flux density, area, temperature, ambient environment, and any other radiation fluxes present must also be defined.

The circuit's operating characteristics should be monitored during irradiation. Comparison of the irradiated and normal characteristics will show the immediate changes in performance caused by the bombardment. Finally, the module should be examined to locate and define the permanent, post-irradiation chemical and physical changes.

Most tests have concerned the pre- and post-irradiation performance of components and materials—but not with the actual circuit operating characteristics under proton irradiation. Tests of this kind—and many more of them—are of importance, of course, but it is also necessary to be aware of the transient effects of radiation while the vehicle is still within the radiation field. The reliability and accuracy of equipments which operate in or through the Van Allen Belt will depend primarily upon our thorough knowledge of component reliability under heavy irradiation.

This is knowledge which can only be achieved through an extensive series of tests and evaluations such as those suggested by this article.

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Editor: Tables of specific material applications in High-Energy radiation fields will appear in the June All-Reference Issue of *Electronic Industries*.

TON OF TAPE

Accumulation of recorded tape on instrumented flights of GE missile re-entry vehicles, or nose cones, totals more than 4,000,000 ft. Tapes cover 32.1 hrs of instrumented flight covering a total of 230,960 nautical miles.

Can a flashing light system be used on a satellite vehicle? If so, a more accurate determination of the shape of the earth, location of points on the earth's surface, and measurement of the earth's gravitational field can be achieved. This article answers the question by describing the development of a breadboard airborne flashing light system.

R. Freed L. S. Klivans

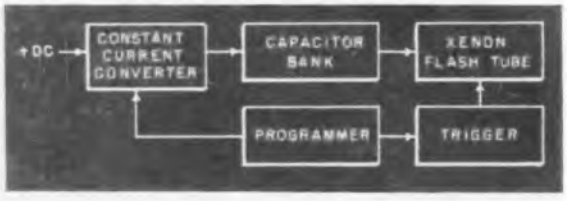
Satellite Flashing Light

FLASHING lights on a satellite vehicle, in conjunction with ground instrumentation in the form of specialized photographic equipment, would allow a more accurate determination of the shape of the earth, location of points on the earth's surface, and a measurement of the gravitational field of the earth. Photographs of the flashing lights against a star background would be used for this measurement.

Development effort included design of a quasi-constant current converter for high efficiency capacitor charging, an electro-mechanical and an electronic programmer for accomplishing sequential control of capacitor charging and flash tube triggering. Also included were a partial evaluation and study of various types of high energy discharge capacitors, and the development of a high voltage trigger circuit for initiating the light flash.

The particular flashing light system developed was tailored to satisfy a given set of requirements which may be summarized as:

Fig. 1: A simplified block diagram of the flashing light system.



a. Input power—22 to 29 volts DC unregulated.

b. Lamp mating—75 watt-seconds at a lumen efficiency of 30 lumens per watt.

c. Flash sequence—Flash groups of four flashes per group spaced 2, 4, and 6 seconds apart with an 8 second interval between groups.

d. Life—Minimum of 600 flash groups under orbital environment.

e. Weight—Minimum weight possible conversant with maximum efficiency.

Fig. 1 presents a simplified diagram of the Flashing Light System. Development time allotted was a critical factor and dictated the use of an off-the-shelf flashing light and non-flyable condensers.

The flashing light used for the development study was a General Electric FT 506 Xenon Lamp. The measured lumen output and electrical-to-light energy conversion efficiency were above the design goal specified. The problems of an adequate reflector design and mounting of the flash tube helix for boost and space environment would be the subject of future development.

Both oil filled and electrolytic high energy capacitors were used in the system. The electrolytic capacitors failed after 1000 charge discharge cycles and are considered inadequate. Several companies are pursuing development of a metallized paper, high energy discharge capacitor, with a much higher energy to weight ratio, and capability approaching a million charge-discharge cycles under a space environment. Future effort would concentrate on evaluating capacitors of this type. In order to demonstrate system feasibility in the shortest time possible, development effort was channeled into the most critical areas, principally the constant current converter, programmer and trigger assemblies.

Discussion

Upon receipt of a command signal from the programmer, power is applied to the circuit, Fig. 1. The programmer controls the start and stop of the charge cycle of the converter to the high energy capacitors. He also controls the trigger signal to the trigger circuit. This circuit causes the light to flash. The mode of operation is:

At T(0), Fig. 3 (receipt of command start pulse) power is applied to the converter under programmer control for two seconds. At T(2) the trigger pulse is applied to the flash tube and the two second converter charge cycle is re-initiated. At T(4) the flash tube is triggered and all power is removed from the converter. At T(6) the charge cycle is again initiated by applying power to the converter.

By R. FREED
and L. S. KLIVANS
Lockheed Aircraft Corporation
Missiles and Space Division
Van Nuys, California

System

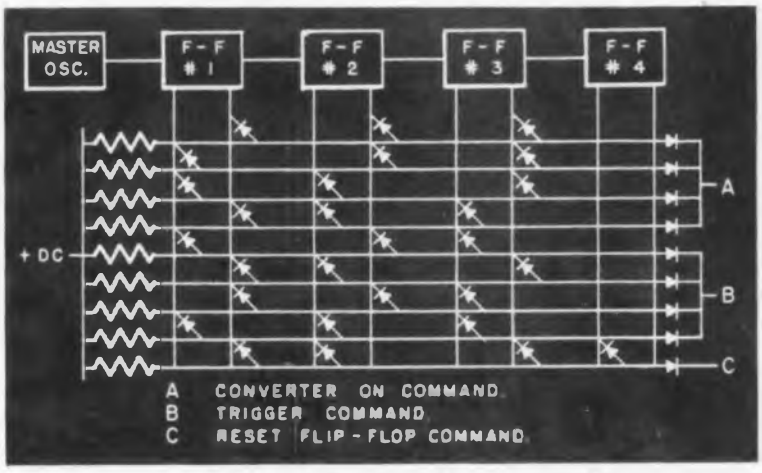


Fig. 2 (above): A unijunction relaxation oscillator serves as the master clock in this all solid-state version of the programmer.

At T(8) the tube is triggered and power removed. At T(12) the power is reapplied for the charge cycle. At T(14) the flash tube is triggered and power removed. At T(20) the programmer is recycled and the sequence repeated until receipt of command stop signal.

While the continual application and removal of power from the converter may seem unduly complex, it is required to attain the highest possible efficiency. Power is applied to the high energy section of the system only at the time and for the duration required. In this way average power consumption is kept to a minimum while peak power delivered is unaffected.

Due to expected difficulties with radio interference it was decided to develop two programmers. The first programmer is an electro-mechanical unit and the second an all solid-state electronic assembly. The former utilized a stepping motor, while the latter was composed of a unijunction relaxation oscillator, which serves as the master clock. Four Eccles-Jordan type flip-flops are used to count clock pulses and drive a diode logic matrix. The matrix is used to drive command amplifiers, Fig. 2.

It should be noted at this time that the approach used in the design of the electronic programmer could be improved. The use of diode triggering is not recommended for high reliability flip-flops in a noisy environment. It was used because of the time schedule involved. Either bi-directional transister triggering or triggering through invertor "and" gates would allow greater stability, and, therefore, a more reliable programmer.

The DC to DC converter is considered the key article in the flash-

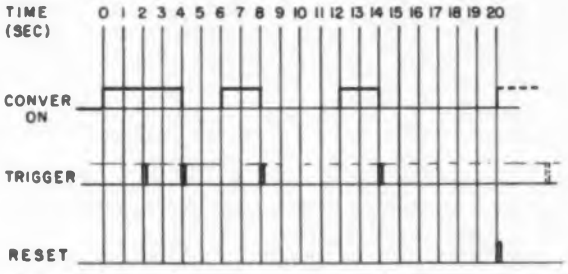


Fig. 3: At the end of 20 seconds, programmer is recycled.

ing light system development. The design goal was highest attainable efficiency while charging the required 200 uf of capacity to 900 volts in 2 seconds at a continuing 2 second rep rate.

Using Fig. 3, the following is an analysis of the efficiency of charging from both constant voltage and constant current sources:

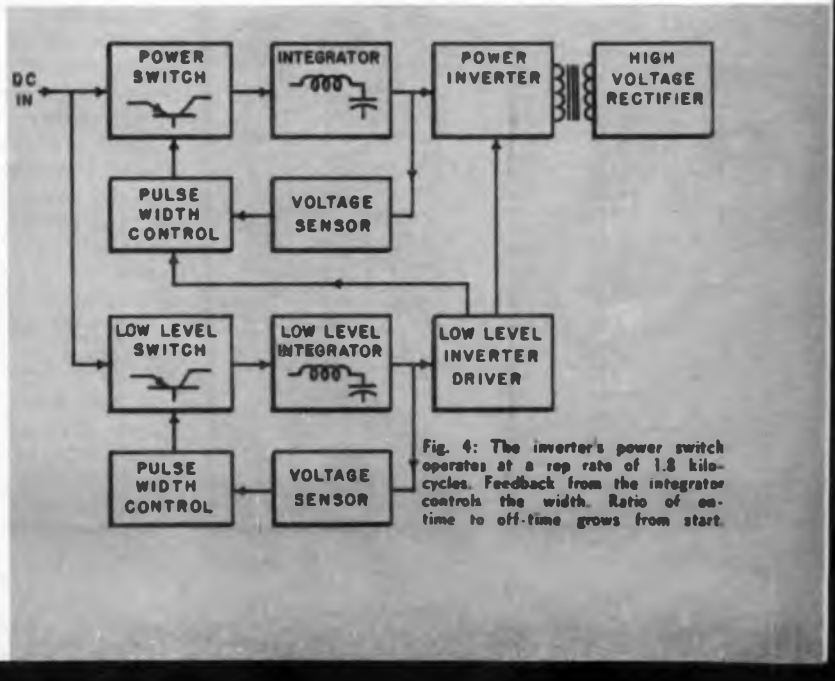


Fig. 4: The inverter's power switch operates at a rep rate of 1.8 kilocycles. Feedback from the integrator controls the width. Ratio of on-time to off-time grows from start.

Flashing Light *(Continued)*

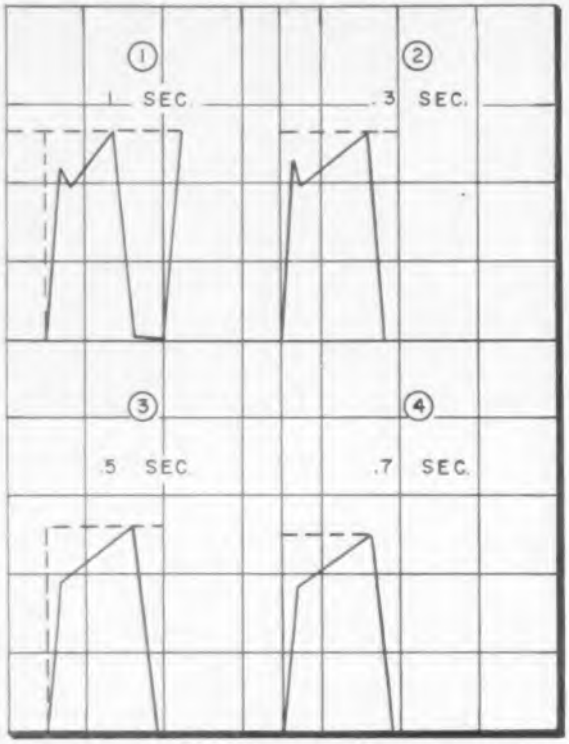
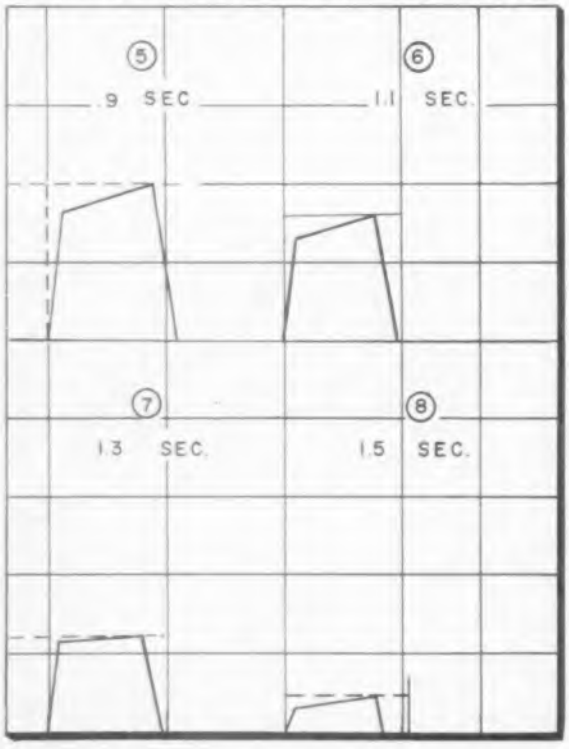


Fig. 5a (above): Oscilloscope traces of input current waveform during the charging cycle. Vertical lines=4 amps; horizontal, 400 μsec.

Fig. 5b (below): Traces for various times in the charging cycle.



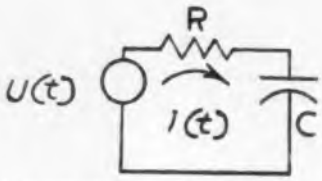


Fig. 6: Diagram used for analysis of charing efficiency from both constant current and voltage sources.

1. Constant Voltage Charging

$$U(t) = E$$

$$\frac{E}{S} = I(S)\left(R + \frac{1}{SC}\right)$$

$$i(t) = \frac{E}{R}\, e^{-t/RC}$$

P_R = Power Dissipated in Resistor

$$P_R = \frac{R}{T}\int_0^T i(t)^2\, dt = \frac{E^2}{RT}\int_0^T e^{-2t/RC}$$

$$= \frac{E^2}{RT}\left(-\frac{RC}{2}\, e^{-2t/RC} + RC/2\right)$$

$$\therefore P_R = \frac{E^2C}{2T} \text{ for } T \gg RC$$

P_C = Power Delivered to Capacitor

$$P_C = \frac{1}{2}\,\frac{E^2C}{T}$$

$$\eta = \frac{P_C}{P_C + P_R} \times 100 = \frac{CE^2/2T}{2CE^2/2T} = 50\%$$

2. Constant Current Charging

$$i(t) = C\,\frac{dE}{dt}$$

If $i(t)$ = Constant then $\frac{dE}{dt}$ = Constant

and $u(t) = Kt$

$$\frac{K}{S^2} = I(S)\left(R + \frac{1}{SC}\right)$$

$$i(t) = KC\ \left[1 - e^{-t/RC}\right]$$

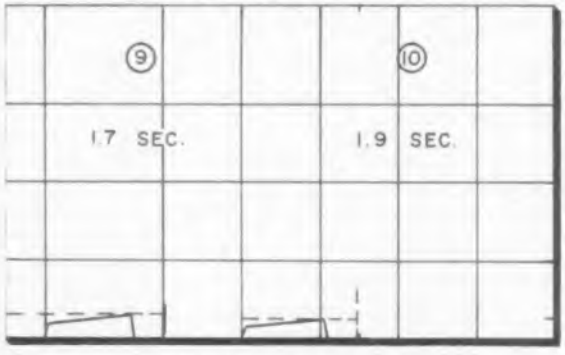
$$P_R = \frac{R}{T}\int_0^T i(t)^2\, dt$$

$$= \frac{K^2C^2R}{T}\int_0^T \left(1 + e^{-2t/RC} - 2\,e^{-t/RC}\right) dt$$

$$= K^2C^2R\left(1 - \frac{3RC}{2T}\right)$$

$$P_C = \frac{CE^2}{2T}$$

Fig. 5c: Final traces during the charging cycle; same scale as 5a & b.



$$\eta = \frac{1}{1 + \frac{CR}{T^2}\left(2T - 3RC\right)}$$

$$= \frac{1 \times 100}{1 + \frac{RC}{T}} \approx 100\% \text{ for } T \gg RC$$

It is evident that constant current charging is desired and that the circuit resistance must be kept to a minimum.

For a 75 watt-second 900 volt system the following constant current is required:

$$75 = \frac{CE^2}{2} = \frac{C \times 81 \times 10^4}{2}$$

$$C = 185\ \mu f$$

$\therefore$ 200 μf was chosen

$$e = \frac{1}{C}\int i\,dt$$

i = Constant

$$e = \frac{it}{C}$$

$$i = \frac{eC}{t} = \frac{900 \times 200 \times 10^6}{2} = 90 \text{ ma}$$

Later, empirical conditions indicated a modification of the constant current to a situation where voltage control rather than constant current is used for the last 10% of the charge cycle. This lowered the power drain on the converter while not materially effecting the efficiency. An elementary block diagram of the inverter is shown in Fig. 4.

The operation of the inverter is as follows: The power switch operates as a 1.8 KC rep rate. Its width is controlled through feedback from the integrator. Initially the ratio of on time to off time of the switch is small, but it gets progressively larger. A voltage ramp from 0 to 20 volts is developed across the capacitive element of the integrator as the pulse width increases. This voltage serves as the collector supply for the power inverter which in turn drives a 50 to 1 step up transformer. The output is then full-wave rectified and applied to the high energy capacity bank.

The low level section works the same way except instead of developing a voltage ramp at the integrator output, this point is regulated at a constant voltage. This is applied to the collectors of the low level inverter, which drives the power inverter.

The only resistive elements in the power section are the saturation resistance of the switching transistors, the wire resistance of the inductor and transformer, and the leakage resistance of the integration capacitors. Assuming a total resistance of 2 ohms on the primary, this becomes 5K reflected into the output and gives a computed efficiency of 66%. This is very close to the measured 61% efficiency of the inverter. It indicates that if the primary resistance can be dropped to .5 ohms, a resulting efficiency of 90% can be obtained.

Triggering, which was initially assumed to be a major problem area was, on the contrary, quite easy. The lamp manufacturer's recommendation for a Class II trigger, namely 20 KV min. at 20 millijoules, 20 KC minimum was followed.

The required coils were designed and ordered. An automotive coil was used as an interim. Upon receipt of the high voltage coils they were inserted into the circuit and performed admirably. There was no case of misfire attributable to the triggering circuit.

Data

The measurement of converter efficiency is a difficult problem. Since the input current is pulse width modulated, the only direct method to measure input power is calimetrically and this equipment was not available, a second method was devised. A .01 ohm resistor was inserted in the input power line to the converter. An adjustable one-shot multivibrator was then used to trigger an oscilloscope at various times in the change cycle. In this manner pictures were taken, Fig. 5, of the input current waveform at .1 seconds, .2 seconds, etc., for the two second charge cycle. The current wave form pictures were then graphically integrated, Fig. 7, which resulted in a figure of 3.65 amps average input current at 23 volts input. The value of 23 volts is an arbitrary figure in that 25 volts was applied but the source was loaded to about 20 volts at the start of the change cycle. The input power is, therefore;

$$P = EI = 3.65 \times 23 = 84 \text{ watts}$$

The output power is the energy stored in the capacitor divided by the time, and is:

$$P = \frac{CE^2}{2} = 244 \times 10^{-6} \times 84 \times 10^4 = 51.3 \text{ watts}$$

$C = 244$

$E = 918$ volts

and the converter efficiency is:

$$= \frac{P_o \times 100}{P/n} = \frac{5130}{84} = 61\%$$

which agrees quite well with the computed efficiency of 66%.

The output, efficiency, and waveshape of the light energy is not affected by the inverter, but by the capacitor and flash tube characteristics.

The light efficiency is:

Anode Voltage	Capacity	w-s	l-s	Efficiency (l/w)	Duration (1/3–1/3)
800	150	48	1492	30.9	.75 m sec
	200	69	2070	31.95	.90
	290	80	2560	32.02	.95
	300	96	3590	32.2	1.05
	350	112	3704	33.1	1.20
	400	128	4180	32.7	1.20
900	150	61	1898	31.1	.81
	200	81	2602	32.19	.90
	250	101	3355	32.2	1.00
	300	121	4180	34.75	1.05
	350	142	4900	34.8	1.12
	400	162	5640	34.9	1.20
1000	150	72	2510	33.25	.81
	200	100	3400	34.0	.90
	250	125	4390	35.05	.90
	300	150	5300	35.3	.90
	350	175	6290	35.9	1.20
	400	200	8640	43.2	1.20

No instrumentation was available for measuring peak light output. Inverter regulation is shown in Fig. 8. Since the probable applied voltage will be 25 ± volt,

Flashing Light

(Concluded)

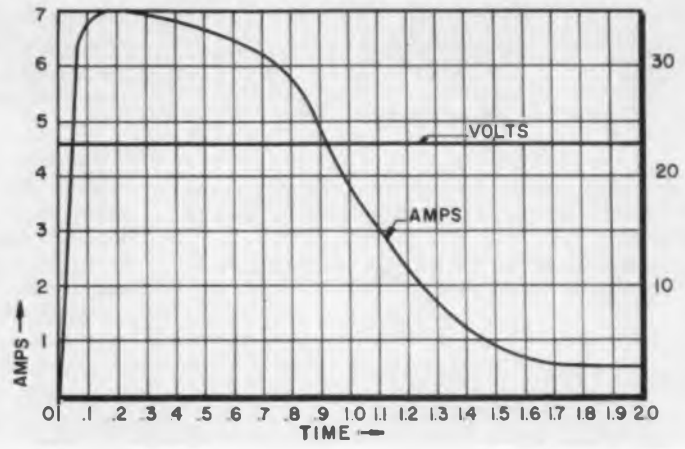


Fig. 7: Graphical integration of current waveform traces of Fig. 5; right axis, volts.

the regulation is 0.55% over this range. The regulation from 22 to 29.5 is 5.1% and should be improved.

Voltage Regulation

Input	Output (1800)	Output (900)	Output (990)
20	775.8	840.1	897
21	781.2	850.7	921.1
22	794.5	856.6	934.3
23	811.7	860.9	943.2
24	818.6	883.6	949.0
25	821.5	895.3	952.6
26	820.6	900.0	980
27	821.9	900.1	988.5
28	821.0	901.1	992.9
29	820.0	902.0	998.0
30	817.6	901.0	999.4
31	815.5	900.0	
32	812.0	899.8	

As a further general test on the inverter the load was raised to 500 uf of capacity, and the time to charge to 900 volts was measured and was 3 seconds.

$$P_a = \frac{\frac{1}{2} CE^2}{T} = \frac{500 \times 10^{-6} \times 81 \times 10^4}{2 \times 3} = 66 \text{ watts}$$

average for 198 watt second
while:

$$P_a = \frac{\frac{1}{2} CE^2}{T} = \frac{200 \times 10^{-6} \times 81 \times 10^4}{4} = 40.5 \text{ watts}$$

average for 198 watt-seconds.

Conclusions

1. The approach and basic design of the converter is considered excellent. The measured efficiency of 61% exceeded expectations and can be raised to 70 or 80% for the flight article.

2. Present developments indicate that 30 to 40 joules per pound weight ratio metalized paper capacitors should be available in the near future for use in a flight article.

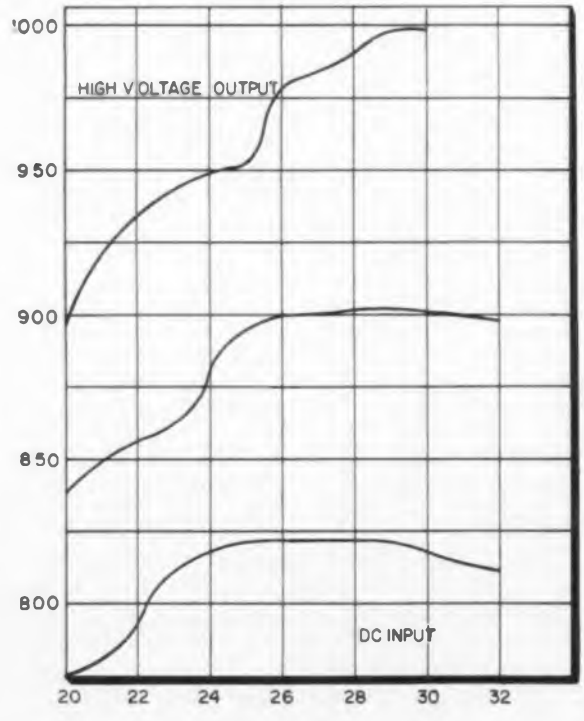
(a) The electrolytic capacitors used in the development program were not capable of meeting the requirements.

(b) The oil filled capacitors used met all requirements insofar as light efficiency and life is concerned, but must be discounted because of excessive weight.

3. The light output efficiency was 32.19 lumens/watt at 81 watt-second and was not affected by the inverter, but was a function only of the individual flash tube characteristics, the lead inductance, and the capacitor used.

4. The trigger pulse was found to be less critical than anticipated, and except for life considerations which were not evaluated, proved to be no problem whatsoever.

Fig. 8: Plot of the inverter regulation made from data at left.



By GEORGE C. MESSENGER
Manager Special Products Operations
Semiconductor Products Division
Hughes Aircraft Company
200 Superior Avenue
Newport Beach, California

Measuring Recovery Time of Ultra Fast Diodes

A direct measurement of recovery time of diodes below approximately 3 nanoseconds has not been practical. This indirect method gives accurate results below 1 nanosecond.

RECENT ultra fast diodes[1] have recovery times much less than a nanosecond. Direct measurement of recovery time is practical down to about 1 nanosecond using a sampling scope or a traveling wave scope. Below 1 nanosecond it is still possible to deduce recovery time from rectification efficiency measurements.

An additional interesting feature of the HD-5000 unit is the apparent lack of any hole storage. Therefore, a method of using the rectification efficiency test to show that the recovery time was primarily due to the RC time constant of the diode was developed.

Direct Measurement Technique

Fig. 1 shows a typical circuit used for direct measurement of the reverse recovery time.

Using the Lumatron Model 12A and taking the pulse from the scope, the overall recovery time of the circuit is about 0.45 nanoseconds.

Using the SKL model 503 pulse generator and the E G & G model 1236A scope, a circuit rise time of about 0.4 nanoseconds is realized. Using this circuit the measured response time of an RD-5000 diode was obtained as is shown in Fig. 2.

The diode introduces some ringing which is due to whisker inductance. Note that the recovery time of the diode is much smaller than the recovery time of the measuring circuit. Notice that no hole storage time is apparent in this trace.

The operation of the circuit is quite simple. A forward bias, usually 10 ma, is applied through the 2K resistor in the dc biasing circuit. The pulse from the generator places a negative bias, usually −6V, at the diode terminals for the duration of the pulse. The scope is triggered on the leading edge of the pulse and records the turn off transient of the diode.

The lower limit of recovery time which is measurable is obviously set by the combined rise time of the pulse generator and scope. For accurate measurements this sets a lower limit of about 3 nanoseconds, although good estimates can be obtained down to about 1 nanosecond.

Rectification Efficiency

The equivalent circuit of a high speed computer diode is shown in Fig. 3. The capacitance is shown as composed of the barrier capacitance plus the dif-

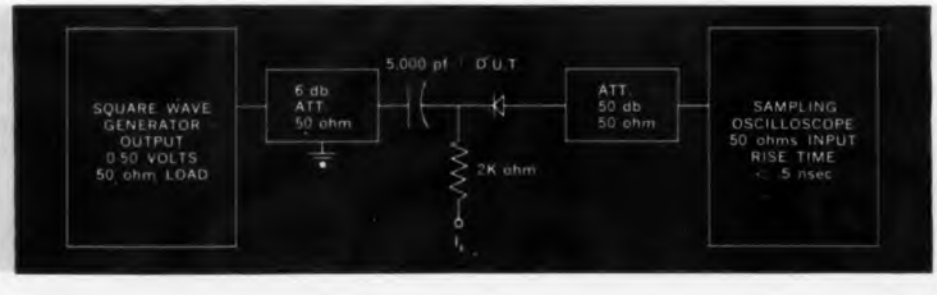


Fig. 1: Circuit for measuring diode recovery time.

Table I

Unit	R_s @ 1 v	C_b @ Ov	R_sC low frequency	I_R @ 60 CPS Input 2 vac	I_R @ 13.5 KMC Input 2 vac	R_sC @ 13.5 KMC	t_R
1	82	0.39x10-12	32x10-12	3.7x10-3	0.12x10-3	65x10-12	0.13x10-9
2	75	0.42x10-12	31x10-12	3.7x10-3	0.12x10-3	65x10-12	0.13x10-9

Fast Diodes *(Concluded)*

fusion capacitance, which accounts for the storage time phenomenon.

The exact equivalent circuit is shown in "a" and a reduced equivalent circuit suitable for rough calculation is shown in "b".

The ringing in Fig. 2 is a result of the whisker induction and the capacitance and occurs at a frequency of about one to two KMC as expected. For rectification efficiency the equivalent circuit is simplified by replacing the variable capacitors C_b and C_d by a single average capacitance C, and the whisker inductance is neglected.

Let us make the following assumption:

$$R_b = 0 \text{ for } V > 0$$
$$R_b = \infty \text{ for } V < 0$$
$$V \gg \phi$$

where ϕ is the voltage at which forward conductance becomes appreciable. Then the rectified current falls off with frequency according to:

$$I_R = I_{RO}\left(\frac{1}{1 + W^2 C^2 R_s^2}\right) \qquad (1)$$

in obtaining equation (1). The fact that the high frequency calculation of R_sC is about twice as high as the low frequency value is probably due to the fact that the average value of capacity which is effective in reducing the rectification efficiency is greater than the capacity at zero volts which is used in the low frequency determination.

The value of recovery time from equation (2) of 0.13 nanoseconds can be regarded as a typical value for these diodes.

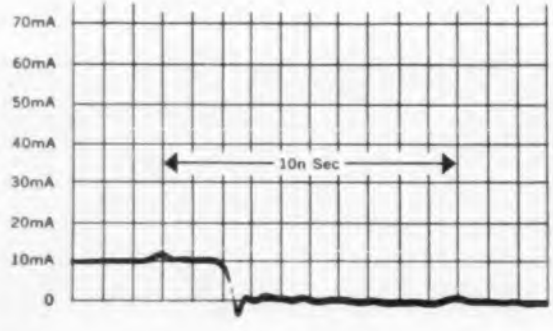
Some selected diodes actually had recovery times measured and calculated using equations (1) and (2) of less than 0.05 nanoseconds.

Hence rectified current falls to 50% of its low frequency value at the frequency where $WCR_s = 1$.

Now the 10% to 90% recovery time is approximately given by:

$$t_R = 2.1\, R_sC \qquad (2)$$

Fig. 2: Reverse recovery characteristics using traveling wave scope.



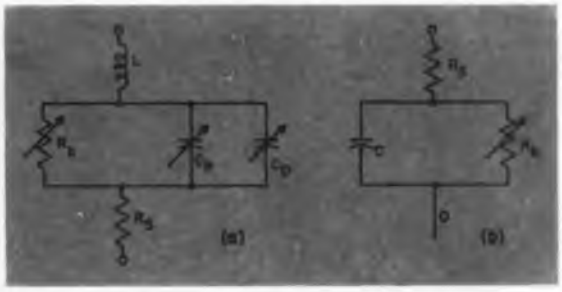


Fig. 3: Diode equivalent circuit. "a" is the exact equivalent and "b" the reduced equivalent circuit.

Therefore, an estimate of R_sC can be made by measuring the rectification efficiency in the microwave frequency range using equation (1). Then, using equation (2) a value of recovery time is deduced.

Further, a low frequency measurement of C and R_s can be made, the product R_sC found, and this result compared with the R_sC product deduced from equation (1). Since a low frequency bridge measurement measures only the barrier capacity C_b in Fig. 3a, and since the rectification method of deducing R_sC integrates both barrier capacitance C_b and diffusion capacitance C_D, a comparison of the two values of R_sC gives a feeling for the magnitude of C_D in comparison to C_b.

The typical HD-5000 units were run through this series of measurements with the results shown in Table I.

The lack of any visible hole storage in Fig. 2 and the fact that the low frequency value of R_sC is nearly[2] one half the value deduced from the high frequency calculation of R_sC in Table I support the conclusion that $C_D = C_b$. These diodes are the only computer diodes the author has seen where hole storage has been eliminated to this extent.

The check betwen the high and low frequency calculation of R_sC must be considered quite reasonable in view of the gross nature of the approximation used.

1. The diodes used in the measurements described here are from the Hughes HD-5000 HD-5004 family.
2. For ordinary computer diodes the low frequency value is usually a portion of a percent of the value deduced from a rectification efficiency measurement.

Multi-Channel receivers can receive two or more signals simultaneously. A decision circuit must decide which signal to accept. The problem is simplified here by converting the incoming frequency information to a binary code.

Eliminating Signal Ambiguity

S. W. Torode

D. L. Freeman

By STANLEY W. TORODE
Department Manager

and DENNIS L. FREEMAN
Development Engineer
Sylvania Electronic Systems
Amherst Engineering Laboratory
1100 Wehrle Drive
Buffalo 21, New York

IN a multi-channel receiver, Fig. 1, incoming pulses are amplified by a broadband TWT. The pulses are then applied to the channel filter. Our example uses a 10 channel filter. Skirt selectivity of individual channels is such that a continuous band coverage is obtained with minimum overlap.

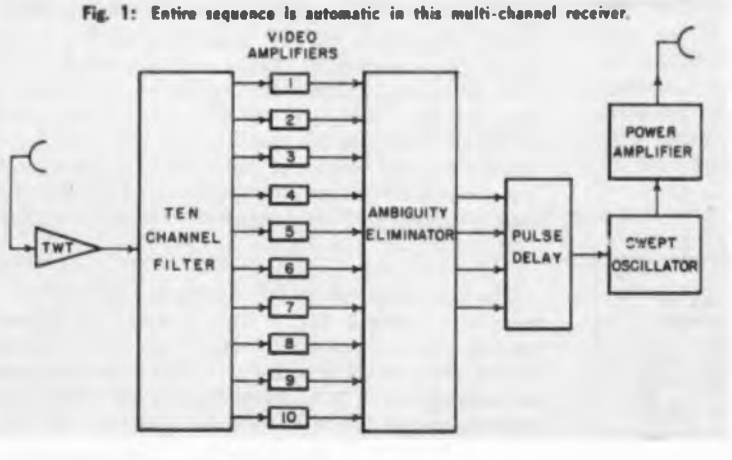
The channel outputs are detected by video crystals, and applied to individual video amplifiers. The amplifier outputs are fed to the Ambiguity Eliminator (Ambel). This device converts the incoming frequency information into a 4-bit binary code. The code is acted upon by delay circuits; eventually, it triggers the oscillator which sweeps through the original incoming frequency. The power amplifier raises the pulses to useful levels for retransmission. The entire sequence is automatic.

Why a Channelized Receiver

This receiver has interesting features. By dividing the frequency band into 10 channels, the problem of determining an incoming signal's frequency is simplified. If the signal is in channel 6, the Ambel produces a code of "1100". This code may be stored for any length of time. Eventually, it activates the swept oscillator. In our example, the oscillator would sweep through the frequency band for channel 6. Thus, the transmitter appears to reply at the original, incoming frequency.

Another useful feature is that each channel's gain may be adjusted. This corrects for TWT gain variations. The result is uniform sensitivity across the band. Unwanted signals may be eliminated by reducing a channel's gain.

Fig. 1: Entire sequence is automatic in this multi-channel receiver.



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Eliminating Ambiguity

(Continued)

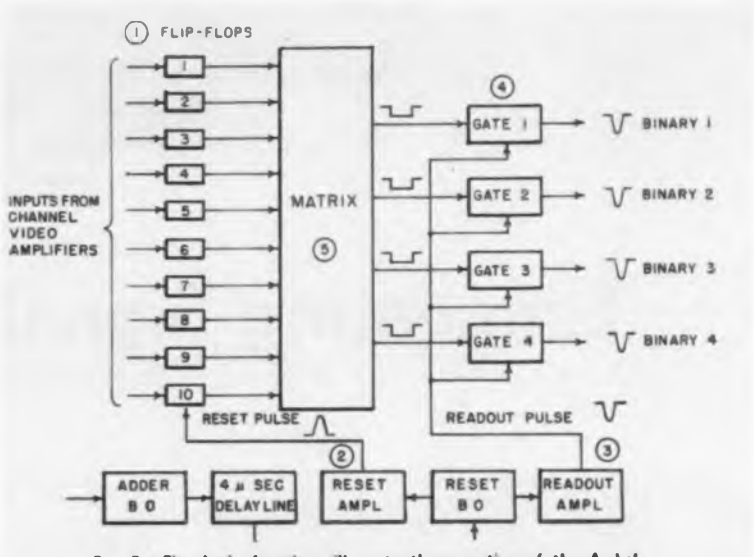


Fig. 2: Five basic functions illustrate the operation of the Ambel.

Multiple Signal Handling Capabilities

Receiver circuits require 30 μsec to recover, after a pulse. Therefore, the TWT is gated off within 3 μsec after a pulse. It remains gated off for 40 μsec, greatly reducing simultaneous pulse reception. The Ambel makes definite decisions when signals are simultaneous or overlap, however.

When the incoming frequency lies between 2 adjacent channels, e.g., midway between channels 5 and 6, the Ambel produces the higher channel code. If two simultaneous signals are received, on adjacent channels, the Ambel produces the higher channel code.

When 3 simultaneous pulses are received on 3 adjacent channels, e.g., 5, 6, and 7, the Ambel produces the center channel code.

If simultaneous pulses are on non-adjacent channels, the Ambel produces an arbitrary code. This code will not, in general, correspond to either incoming channel. This situation rarely occurs.

The swept oscillator produces a logical output for the majority of input situations. Here's how the Ambel's definite, predictable decisions are made.

Ambiguity Eliminator Operation

The Ambel operation may best be understood by considering 5 basic circuit functions. A block diagram of the Ambel, showing the interrelation of the circuits, is given in Fig. 2.

Flip-Flops

There are 10 flip-flop circuits; each is fed by a channel video amplifier. If simultaneous pulses are received on channels 1, 2, and 3, the first 3 flip-flops will be actuated. The flip-flops are bi-stable; therefore, they must be reset after each pulse. The reset pulse is applied to the base of Q2 through diode CR 37. Fig. 3.

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided so as to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can then be filed in standard three-hole notebooks or folders

Reset Pulse

The adder blocking oscillator (BO) is fed by all 10 channel video amplifiers; consequently, it responds to all incoming pulses. The adder BO output pulse is applied to a 4 μsec delay line; the leading edge fires the reset BO at $(T_o + 4)$ μsecs. The reset BO output pulse is 4 μsecs wide (approx.). This pulse is differentiated, and the trailing edge amplified by the reset amplifier. Therefore, a reset pulse is generated at $(T_o + 8)$ μsecs. This is used to reset all flip-flops, Figs. 2 and 3. The flip-flop gate will be 8 μsecs wide.

Readout Pulse

The reset BO fires once for each received pulse. The output of the reset BO is differentiated, and the leading edge of the pulse amplified by the readout amplifier. Therefore, a readout pulse is generated at $(T_o + 4)$ μsecs and applied to 4 gate circuits (Fig. 2).

Gates

A gate circuit is shown in Fig. 3. Two inputs must occur simultaneously to get an output. For each received pulse, a readout pulse appears on the anode of CR34. This diode will not conduct until a negative going gate appears on the base of Q4. Diode CR35 then stops conducting, allowing the readout pulse to pass through CR34 and emitter follower Q5. Diode CR36 and resistors R9 and R10 clip the output, removing residual switching transients. The binary output appears at the junction of R9 and R10 only if a negative going gate has been received from the matrix.

Matrix

The matrix is fed by 10 flip-flops. The number 1 flip-flop is shown in Fig. 3. Upon receipt of a trigger, the Q1 collector potential drops from approximately 20v to 1v; the Q2 collector potential rises from approximately 1v to 20v. After 8 μsec, the reset pulse restores the circuit to its original condition. Q1 pro-

duces a negative going gate, and Q2 a positive going gate. These gates are applied to a matrix numbered 1 to 10, corresponding to the outputs of flip-flops 1 through 10. The lettered terminals receive positive going gates; the numbered terminals, negative going gates.

Single Channel Input—Assume that the number 1 flip-flop is triggered. CR1 conducts, allowing a positive gate to appear across R8. CR2 also conducts, allowing a negative gate to appear on the base of Q4. Thus, gate 4 is activated, and a "binary 4" is produced at the output. The other gates are not activated, and the code produced is "0001".

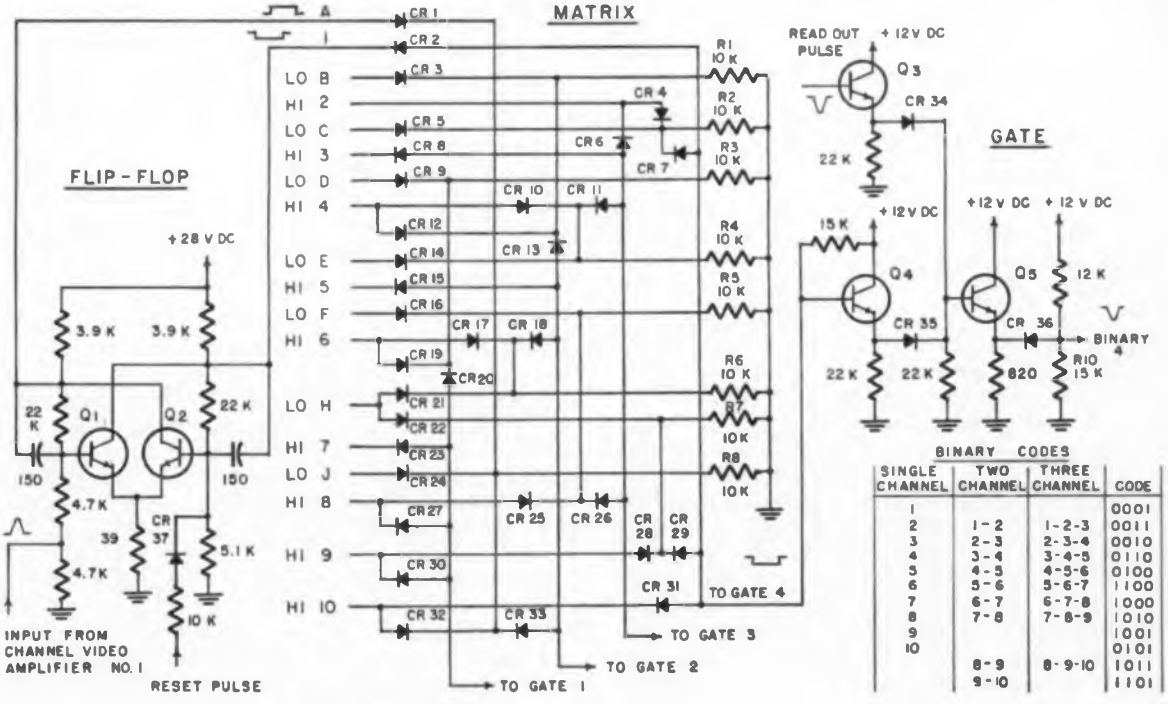
Single Channel Input—Assume that number 4 flip-flop is triggered. Positive and negative gates will be applied to "D" and "4", respectively. CR9 conducts, allowing the positive gate to appear across R3. Diodes CR12 and CR13 also conduct, allowing the negative gate to leave the matrix and form "binary 2". At the same time, CR10 and CR11 conduct, allowing the same negative gate to leave the matrix and form "binary 3". Thus, the code produced when channel 4 is activated is "0110". The other codes produced by the matrix may be verified, in the same way.

Two Adjacent Channel Inputs—Assume that the number 4 and number 5 flip-flops are triggered. Positive gates will be applied to "D" and "E", and negative gates applied to "4" and "5". Diodes CR9 and CR14 will conduct, allowing positive gates to appear across R3 and R4, respectively. This places the cathode of CR10 at a high potential, and CR10 will not pass the negative gate. However, CR12, CR13, and CR15 are in the conducting state. Both negative gates will be passed, and will leave the matrix simultaneously to form "binary 2". The code produced when channels 4 and 5 are activated is "0100". The same code would be produced if only the higher channel had been activated. Other adjacent channel codes produced by the matrix may be verified, in the same way.

Three Adjacent Channel Inputs—Assume that numbers 4, 5, and 6 flip-flops are triggered. Positive gates will be applied to "D", "E", and "F"; negative gates to "4", "5", and "6". Diodes CR9, CR14, and CR16 will conduct, allowing positive gates to appear across R3, R4, and R5, respectively. This places the cathodes of CR10, CR19, and CR25 at a high positive potential, and these diodes will not conduct. The negative gates applied to CR10 and CR19 will not be passed. However, diodes CR12, CR13, and CR15 are in the conducting state. Both negative gates will be passed, and leave the matrix simultaneously to form "binary 2". Thus, the code produced when channels 4, 5, and 6 are activated is "0100". The matrix has correctly produced a code corresponding to the center channel. Other adjacent channel codes may be verified by the same line of reasoning.

Exceptions—It may be seen from examining the binary code table, Fig. 3, that the rules for forming 2 and 3 channel codes are not followed when inputs from channels 8, 9, and 10 are applied simultaneously. This is of no consequence in actual practice, since the succeeding circuitry ignores the extra digit produced under these conditions.

Fig. 3: Typical flip-flop and gate are used to understand the operation of the matrix.



A common denominator governing performance of Satellites, Space-Ships, and Intercontinental Ballistic Missiles is "gravity." This article discusses gravity and other forces affecting these space vehicles.

Fundamentals

A satellite in orbit is subjected to two principal forces. They are the force due to gravity, and Centrifugal Force. The satellite will remain in orbit as long as these two forces are equal.

Arithmetic Relationship

(1) Force due to gravity: $F_1 = Mg$, where m is satellite mass, and g is acceleration due to gravity.

(2) Centrifugal force: $F_2 = \frac{MV^2}{r}$ where V is satellite velocity in orbit, and r is distance between centers of satellite and parent body.

(3) Equating F_1 to F_2: $M\,g = \frac{M\,V^2}{r}$ hence, $V = \sqrt{r\,g}$.

This expression is the basic satellite equation. This equation is applicable to any parent body's accompanying satellite.

Using the Satellite Equation to Determine Orbital Velocities—The constant denoting the magnitude of acceleration in space due to gravity may be expressed as $g = \frac{K\,M.}{r^2}$. The value of the constant K depends on units used. M is mass of body in which originates the particular gravitational field, and r is distance from center of that body to a given point in space. To determine magnitude of acceleration due to Earth's gravity at the moon, typical values are:

$K = 6.66 \times 10^{-8}$ cubic cms per gram per sec^2

M = Mass of Earth = 6.09×10^{27} grams

r = mean distance between Earth and Moon

r = 240,000 miles = 3.8624×10^{10} cms

$$g = \frac{6.66 \times 10^{-8} \times 6.09 \times 10^{27}}{14.918 \times 10^{20}} = 0.271 \ \frac{\text{cms}}{\text{sec}^2}$$

or g=.00889 ft/sec^2. This is the magnitude of acceleration due to Earth-gravity exerted by Earth on the moon. Applying the satellite equation, $V = \sqrt{r\,g}$, to the moon at 240,000 miles distance r, the following result is obtained:

$V = \sqrt{1.2672 \times 10^9 \times 8.89 \times 10^{-3}}$

$V = 3.356 \times 10^3$ feet per sec (fps)

V = 0.635 miles per sec (mps). This value of orbital velocity for the moon traveling around Earth corresponds to approximately one revolution each 28 days.

Space Ship Considerations

Flight Plans Possible for Space Travel—Space craft space will probably be at least "Semi-ballistic" craft. "Semi-ballistic" means that the craft departs from Earth as a projectile. This projectile may be guided into temporary orbit around the Earth, with temporary orbital velocity as shown in Table 1. From this temporary orbit the space craft could again be ejected as a projectile on the second phase of its flight plan. It could also initially be propelled or ejected from Earth's gravitational field. In this case the second phase of its flight plan commencing with space craft capture by the gravitational field of the planet or body in space, marks the terminal point of travel. Thus, of prime interest to space craft and space travel are variations in g applicable to surfaces of and intermediate points between bodies in space.

Travel To And From The Moon—Assuming time of departure from Earth can be arranged so that only the gravitational fields of points of departure and destination are of prime interest, then that point in space where the two fields are approximately equal can be deduced as:

$$\frac{\text{Mass of Earth}}{X^2} = \frac{\text{Mass of Moon}}{(\text{Distance between Earth \& Moon} - X)^2}$$

Mass of Moon = 6.5×10^{25} grs

Mass of Earth = 6.09×10^{27} grs.

Distance from Earth to Moon = 240,000 miles

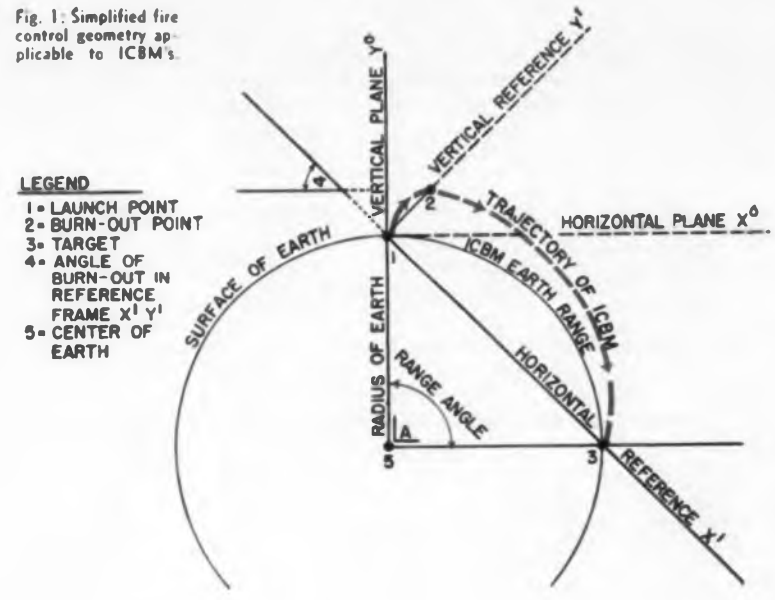
X = Point in space between Earth and Moon where two fields of gravity are equal. Substitute values indicated and X = 217,000 miles.

Traveling straight from Earth to Moon becomes a problem of imparting sufficient initial velocity to the space craft in order that it may reach a point 217,000 miles distant. This point must be on a straight line between centers of points of departure and destination. Velocity of departure is a function of magnitude of g which must be overcome. The effectual constant value of acceleration due to Earth's gravity may be approximated as in (1) and (2) below:

(1) $\frac{\text{Total of column D}}{\text{Column B}} = \frac{168{,}889}{217{,}000} = 0.77829$ fps^2 = average g.

(2) Equivalent constant value of g or RMS average = (0.7071) (0.77829) = 0.550328 fps^2.

Fig. 1: Simplified fire control geometry applicable to ICBM's.



By EDWARD W. JONES

Consulting Physicist-Engineer

# of Space Arithmetic

(3) Launch Velocity or $V_L = \sqrt{2\,X \text{ Equiv. constant } g\,S} = \sqrt{1.10064 \times 11.4576 \times 10^8} = 6.725$ mps.

This value for V_L is escape velocity from Earth, under conditions depicted.

Two values for g are approximated. The first, or so called average value of g is not used to derive V_L necessary to break out of the earth's gravitational field because g and distance are not linear throughout the gravity-distance relationship covered. Table 1 shows this lack of linearity. Accordingly, the RMS value of g is used. Using this *RMS* value for g, approximately 6.72 miles per second (mps) Earth V_L is necessary to reach that point in space where Earth's and Moon's gravitational fields are equal. This derivation is shown in (3) above.

Substitution into $t = \sqrt{\frac{2S}{g}}$ shows that elapsed time from Earth take-off to point of capture in space by Moon's field of gravity is approximately 18 hours. Using this equation for elapsed time between capture of space craft by the moon's field of gravity and impact on the moon, one obtains the figure 7.3 hours. Thus, total time of travel from Earth to Moon should be approximately 25.3 hours. The equation $V = \sqrt{2gS}$ shows that impact velocity on the moon should approximate 1.57 mps. The *RMS* value of g applicable to the last stage of this journey within the moon's gravitational field from 23,000 miles out in space to its surface is 0.313 fps. Impact and escape velocities are equal under the simplifications assumed. The return trip from Moon to Earth entails generation of escape velocity of 1.57 mps. This initial velocity would approach zero at a point in space 23,000 miles from Moon surface and 217,000 miles from Earth. Once the vehicle is within Earth's field of gravity, velocity would increase to approximately 6.72 mps near Earth's surface.

ICBM Considerations

Ballistic Equation—With respect to short ballistic ranges where atmospheric, Earth rotation and oblateness effects can be ignored, equations listed below are valid.

(1) $$\text{Range} = \frac{V_L^2 \sin 2\phi}{g}$$

(2) $$\text{Time of flight} = \frac{2\,V_L \sin \phi}{g}$$

Constant value of acceleration due to gravity is g and the angle between horizontal or range plane and projectile direction at time of attainment of velocity V_L is ϕ.

Assume the following: A straight line can be drawn through the Earth connecting launch point and target. A new frame of reference in terms of coordinates X^1 and Y^1 can be drawn applicable to launch point and target and missile trajectory. An effectual constant value of g can be derived applicable to missile flight in new frame of reference, Fig. 1.

The assumptions make equations (1) & (2) applicable to missiles flying under influence of gravity over long ranges. True Earth surface range, however, is

Table 1

Orbital Velocity as a Function of Distance Above Earth's Surface, Applicable to Earth Satellites

Height above Surface of Earth	Acceleration due to Gravity	Orbital Velocity of Satellite	Period
0 miles	32.2 feet/Sec²	Not applicable	
100 miles	30.8 feet/Sec²	4.89 miles/Sec	87.8 min.
500 miles	25.5 feet/Sec²	4.64 miles/Sec	101.5 min.
1,000 miles	20.7 feet/Sec²	4.42 miles/Sec	118.4 min.
5,000 miles	6.4 feet/Sec²	3.29 miles/Sec	4.77 hrs.
10,000 miles	2.6 feet/Sec²	2.63 miles/Sec	9.29 hrs.
240,000 miles	.0088 feet/Sec²	0.635 miles/Sec	28 days, approximately

Table 2

Acceleration Due to Gravity as a Function of Distance from Earth

A. Distance along straight-line flight path, Earth to Moon in miles	B. Distance changes in flight path from Earth in miles—increments	C. Average values of acceleration due to gravity in feet per second²	D. Product: Column B multiplied by Column C
100	100	$\frac{32.2 + 30.8}{2} = 31.50$	3,150
500	400	$\frac{30.8 + 25.5}{2} = 28.15$	11,260
1,000	500	$\frac{25.5 + 20.7}{2} = 23.10$	11,550
5,000	4,000	$\frac{20.7 + 6.4}{2} = 13.55$	54,200
10,000	5,000	$\frac{6.4 + 2.6}{2} = 4.50$	22,500
50,000	40,000	$\frac{2.6 + 0.205}{2} = 1.403$	56,120
100,000	50,000	$\frac{0.205 + 0.051}{2} = 0.128$	6,400
217,000	117,000	$\frac{0.051 + 0.0107}{2} = 0.03085$	3,709
TOTALS	217,000 = S		168,889

Table 3

Relationships Between ICBM Constants

Engine cut-off or burn-out Time	199 secs.	200 sec.	201 sec.
Engine cut-off error	−1 sec.	0 secs.	+1 sec.
Earth surface Range in miles	6,236 mi.	6,279.2 mi.	6,322.4 mi.
Earth Surface Range error	−43.2 mi.	0	+43.2 mi.
Horizontal Range in New Reference Frame	5,594.1 mi.	5,650.5 mi.	5,707.3 mi.
Horizontal Range error	−56.4 mi.	0	+56.4 mi.
Range Angle at Earth's Center	89° 18′ 45.2″	89° 55′ 52.5″	90° 32′ 59.8″
Range Angle Error	−37′ 7.3″	0	+37′ 7.3″
Angle of Burn-Out	40° 56′ 30″ or 49° 3′ 30″	45°	Not applicable
Angle of Burn-Out Error	±4° 3′ 30″	0	Not applicable
Acceleration due to Gravity	+28.282 fps	28 fps	+27.722 fps
Error in Acceleration due to Gravity	+0.282 fps	0	−0.282 fps
Impact Velocity at Target	5.446 mps	5.474 mps	5.501 mps
Error in Velocity	−0.0273 mps	0	0.0273 mps
Time of Flight	24.208 min.	24.327 min.	24.451 min.

Space Arithmetic

(Continued)

given by the expression $R = r\,A$, where r is Earth radius and A is angle subtended by horizontal range in equation (1). Reference is made to Fig. 1.

Digital Converter

THIS Digital Converter converts pointer-type instruments into digital transducers. A pointer-type instrument can thus be made to perform any of the functions of a conventional digital transducer such as, providing input data to a digital computer, control system, card or tape punch, or registering readings in decimal form on a digital display or digital printer.

The device comprises two basic

(*Continued on page* 212)

Digital Converter attaches to any conventional pointer-type instrument.

Relationships Table Interpretation

Burn-Out Time and Accuracy Connotations Applicable to Angle of Burn-Out—With an assumed engine cut-off error of ± 1 second and no other errors present pertaining to missile acceleration, Earth surface range error corresponding to cut-off error is ± 43.2 miles at a nominal range of 6279 miles. If there is a launch velocity error of ± 0.0273 mps with zero error for equivalent constant for *g*, corresponding range error is ± 43.2 miles. If there is an error of ± 4°3'30" in Burn-out angle, with no other errors present, a range error of − 43.2 miles results at nominal range of 6279 miles. This latter statement is based on the premise that velocity errors are not functions of possible error in angle of Burn-out.

Under conditions shown here, accuracy requirements for generation of final Angle of Burn-out would not appear to be prohibitive. However, accuracy requirements applicable to engine cutoff time and/or missile velocity appear to be somewhat rigorous.

Probability of ICBM Landing on Target. Assuming that no combination of errors affecting missile trajectory can be greater in total effect than the ± one second Burn-out error, and, also that all possible errors occur randomly both in terms of time and magnitude, then the following statements can be made.

I. At Earth surface ranges approximating 6300 miles under conditions shown here; if 100 ICBM's should be launched, 82 could be expected to land within 17.3 miles of target center, range-wise. No Earth rotation or other corrections are made in this simplification.

II. If only one ICBM should be launched under conditions in (I) above there would be an 82% probability that this one ICBM would land within 17.3 miles of target center, range-wise.

III. If 100 ICBM's were launched under conditions in (I) above 99 could be expected to land within 34.6 miles of target center, range-wise.

Range-Probabilities in I, II and III above become Hit-Probabilities under the following circumstances:

A. If missile guidance azimuth error is of the order of ten seconds of arc, maximum, and the target is at least 0.5 miles in width and 35 miles in length.

B. If missile guidance azimuth error is of the order of one minute of arc, maximum, and the target is at least 3.3 miles in width and 35 miles in length.

C. If missile guidance azimuth error is of the order of ten minutes of arc, and the target is at least 33 miles in width and 69 miles in length.

Self-Shuttering Electronic Flash

A SELF-SHUTTERING electronic flash of high intensity has been developed to solve a major lighting problem in Navy missile research. The flash instantaneously achieves and maintains the peak intensity of 10 press-camera flashbulbs before suddenly shutting off without an afterglow.

Flash was developed by scientists at the Naval Ordnance Lab. in Silver Spring, Md., to solve a jam major problem in photographing high-speed motion which lasts only for split-seconds. Negatives exposed with other illumination systems such as chemical flash lamps and flash bombs contained only a few properly exposed frames. These were always found in the system's mid-intensity light range. The remaining frames were always either under-exposed due to too little light as the illumination system commenced and ceased its glow, or over-exposed when the light reached its peak brilliance.

The new flash consists of a gaseous discharge tube coupled with an artificial transmission line made up of a number of capacitors. The charged capacitors are discharged allowing ac to race first back and forth through the transmission line. This keeps the tube's arc burning evenly for three one-thousandths of a sec. The voltage then drops to zero, causing the light to immediately cease shining without any afterglow.

During the time the missile model is illuminated, a high-speed continuous-writing camera takes 82 equally exposed pictures of it as it re-acts to a shock wave.

* * *

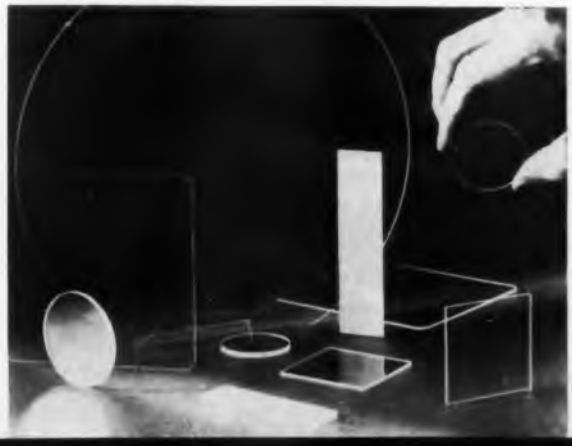
Solar Cell Covers

TWO special kinds of glass are being produced by Corning Glass Works for use as solar cell covers on space vehicles. They are Code 7940 glass, fused silica, and Code 0211 glass, a microsheet optical grade material.

The glasses protect solar cells from high temperatures, thermal shock and micrometeorites, and efficiently transmit wavelengths of use to the cells.

The optical grade material glass darkens under radiation, but the fused silica remains clear even after exposure to 10^9 roentgens of gamma radiation from cobalt-60 (at 1.4×10^{10} roentgens, a slight bluish tint may appear). Fused silica is recommended when the cells are to be operative for long periods of time or when the cells must pass through the Van Allen belt.

Fused silica glass for solar cells. Mechanical working temp. is 900°C —max. limit is 1100°C. Coefficient of expansion is 5.6×10^{-7}°C. Specific gravity is 2.20.



The value of a radio or radar-reconnaissance system depends on its ability to detect, locate, and identify signal information. The antenna system is the key. The antenna system must have sufficient gain, distinguish between adjacent and similar signals, determine the country the signal is coming from, and eliminate unwanted signals.

Factors in the design of . . .

Reconnaissance Satellite Antennas

By ROBERT B. MacASKILL

Project Engineer
The Hallicrafters Co.
5th & Kostner Avenues
Chicago 24 Ill.

MAN can now launch large, useful satellites into orbit. Each satellite opens new fields of scientific and military endeavor. Of the many applications of satellites one of the most urgent is radio and radar reconnaissance.

The military importance is apparent, but the potential utility of a reconnaissance satellite for scientific purposes is not. This is because it deals with complex problems of electromagnetic propagation and reception in an environment which has been relatively unexplored.

The physical and electromagnetic environment imposes restrictions on the antenna system not encountered in conventional airborne or ground based systems. New and improved antenna receiver designs must be used to realize the full capabilities of the vehicle.

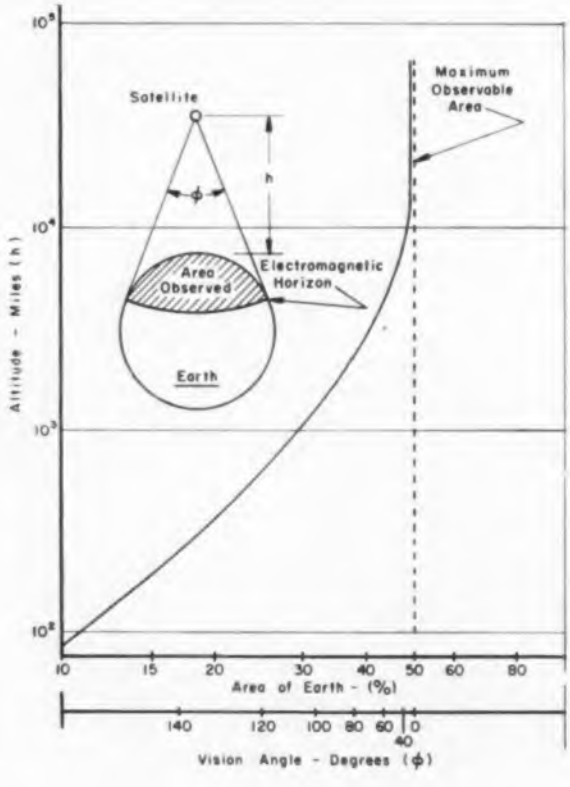
This paper will outline factors which contribute to the problems of implementing an antenna system for satellite reconnaissance and indicate steps necessary to overcome them.

Storage of reconnaissance data and re-transmission of this data to ground based stations is important. However, these considerations are usually independent of the reconnaissance techniques and are outside the scope of this paper.

THE RECONNAISSANCE PROCESS

A radio and radar reconnaissance satellite's antenna-receiver system displays awareness to all signals near the satellite. The value of the system depends upon whether it can detect and locate the source of

Fig. 1: Vision from a satellite. At 300 mi. the satellite can "see" approx. 50 million mi².



signals and retain those signal characteristics, such as amplitude and frequency, that permit identification and whether it can gather other signal information required for the mission.

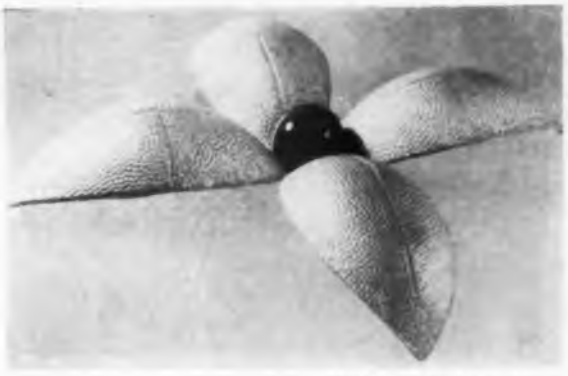
Antenna-Receiver System

The satellite antenna system—antenna and associated receiver—is the key to all reconnaissance data. By linearily summing electromagnetic signals at the satellite, it supplies basic information that cannot be improved upon by subsequent electronic processes. The fundamental properties of the antenna-receiver system are: First, it must be frequency selective to retain the important characteristics of wanted signals while rejecting unwanted signals; Second, it must be sensitive to the weakest and strongest signals that fall within the range of interest; Next, it must be able to distinguish between similar signals that differ in pulse width, repetition rate or other modulation characteristics; Finally, it must supply direction finding information.

The direction finding property usually supplies the most important information. That is, the utility of a system is reduced if it cannot distinguish between adjacent signal sources and determine their direction. The other three properties augment the direction finding property by selecting, rejecting or in general resolving the many signals that are subject to the reconnaissance process.

Field of Vision

In general the reconnaissance satellite will travel high enough to observe a relatively large area of the earth. For example (See Fig. 1), at 300 mi., the arc (ϕ) of the satellite vision is 135° and extends beyond the width of the U. S. or approx. 19% of the earth's surface (50 million mi^2). At 1000 mi. 30% of the surface is visible and as the altitude increases, the observable area approaches 50%. Because of the thousands of signals emanating from the earth's surface the reconnaissance system must be restricted in its field of view. Otherwise, there would be a confusion of signal data. For example, a satellite traveling over Western Europe at a 300 mi. altitude will be immersed in signals from points so far away as London (West), Stalingrad (East), Murmansk (North), and Cairo (South). The signals will be inseparable unless an antenna with some directive powers of resolution is used. It it important that the field of vision be an angle considerably smaller than the angle that subtends the earth's horizon. As the satellite circles the earth it effectively transcribes a narrow path in which signals of interest are detected and recorded. The width of the strip depends primarily upon the beam width of the antenna and altitude of the vehicle. Unfortunately, space and weight economy make the two factors incompatible. Special antenna and receiver designs must be used and certain operational compromises must be made to realize a practical reconnaissance system. These designs and operational compromises, however, must satisfy the fundamental purpose of the satellite system—determining direction, amplitude and frequency of a signal from the earth's surface. The degree to which this basic data can be used depends on certain factors. Among these



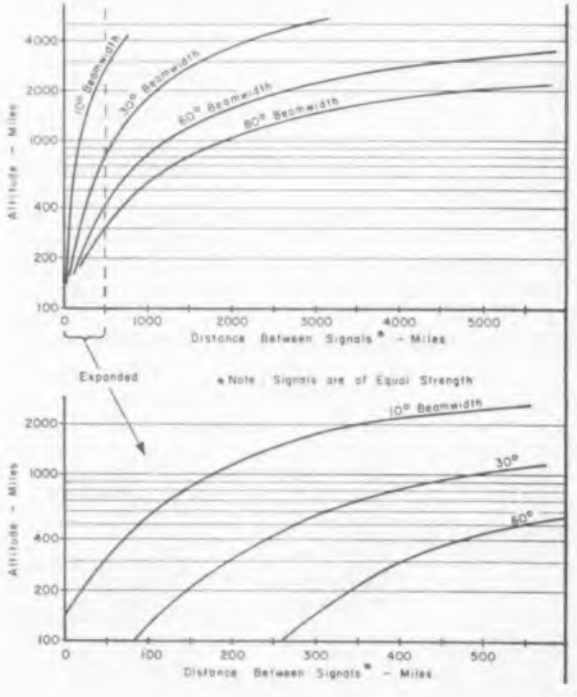
Break-open satellite antenna.

are factors that affect the efficient extraction of data from the signals. Included in this group are: Antenna size, signal environment, receiver design, signal resolving technique, antenna design and construction, and the physical environment of the satellite.

ANTENNA

The antenna structure is, to a degree, limited in size by the dimensions of the satellite vehicle. Other size limitations have to do with the physical interference of other electronic components within the satellite. In general, the solution to the satellite reconnaissance problem reduces to the selection of the proper antenna-receiver device that will resolve adjacent signals and also be sensitive to the weakest signals of interest. Here it is adequate to show the conventional antennas that may be used and indicate the area of antenna de-

Fig. 2: Minimum signal resolution of various satellite antenna beamwidths.



Antennas *(Continued)*

sign leading to improved performance. Table I lists various antennas and their useful electromagnetic range.

Frequency-Bandwidth

For greatest efficiency and versatility, the reconnaissance system should operate over a large band of frequencies. However, frequency bandwidth and beam characteristics of most antennas are usually mutually exclusive. That is, a broadband antenna exhibits low gain and a large beamwidth. A high gain antenna has a narrow response in frequency and beamwidth. In effect, any antenna that has a narrow beamwidth will not operate over a very wide band of frequencies. In general, the useful bandwidth of a conventional broadband antenna is 2:1 or 3:1. These bandwidth restrictions may be reduced, however, by resorting to combinations of antenna designs. The spiral, tapered helix and equi-angular antenna are typical of this approach. New approaches are also required.

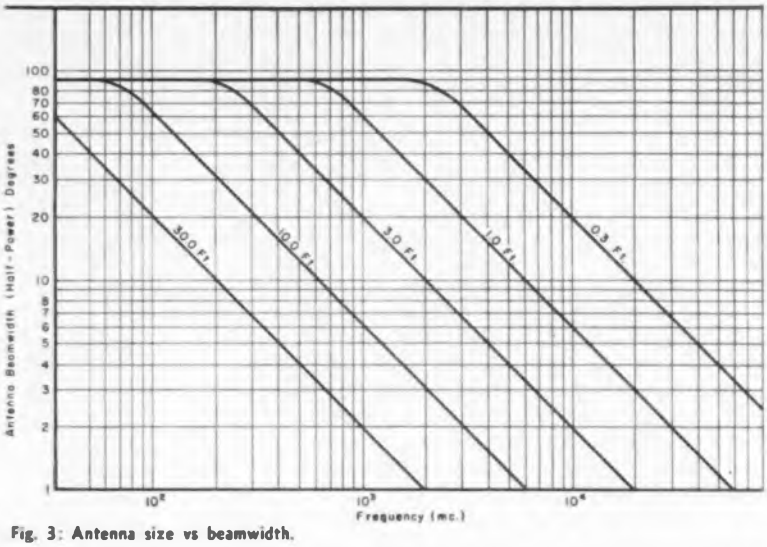


Fig. 3: Antenna size vs beamwidth.

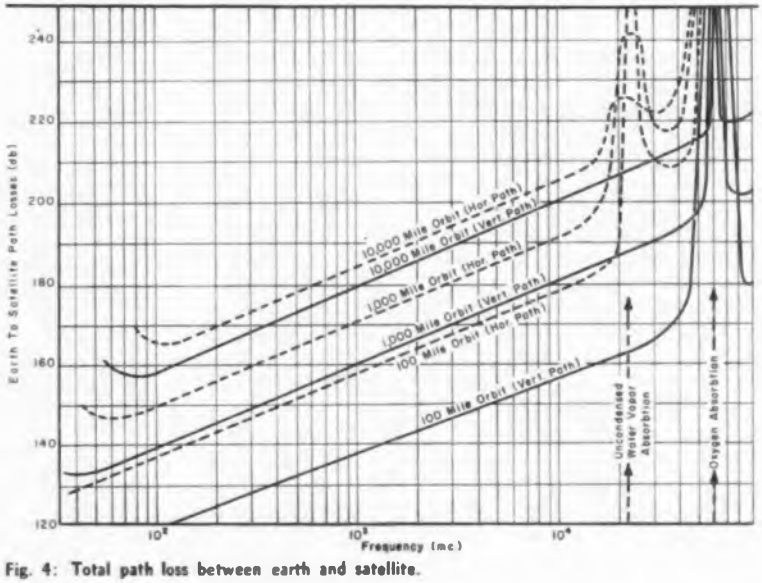


Fig. 4: Total path loss between earth and satellite.

The direction finding properties of an antenna are directly related to it's beamwidth. A criterion used for signal resolution, that is, direction finding, has been set by Rayleigh: Two equal amplitude signals can be resolved if their physical separation falls within 1.1 beamwidths of the resolving antenna. One beamwidth of the antenna, therefore, gives us a useable criterion of good signal resolutions.

Fig. 2 shows, using Rayleigh's criterion, the degree to which this task may be accomplished. It relates the antenna beamwidth to the min. resolvable spacing between signal sources. A 30° antenna pattern at a 300 mi. altitude can resolve two equal amplitude sources separated by 200 mi.; For equal signals 100 mi. apart a 15° antenna pattern is needed. The product of beamwidth and altitude is a constant for resolving signals separated a fixed distance.

Table 1

Frequency Range of Conventional Antennas

1 mc to 50 mc	50 mc to 1000 mc	1000 mc to 50,000 mc
Ferrite loop	Helix	Helix
Spiral	Spiral	Horn
	Yagi	Waveguide Array
	Corner Reflector	Parabola
	Printed Array	Lense
		Printed Array
		Poly Rod
		Ferrite Rod

Size

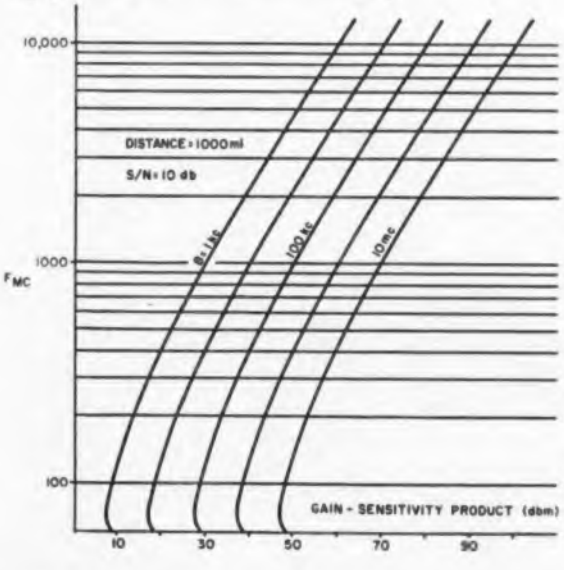
In general, beamwidth is a function of antenna size. Fig. 3 shows the size of a typical parabolic antenna for a given beamwidth over a bandwidth of 1 to 50,000 MC. It shows that practical considerations pre-

clude using extremely narrow beam antennas. Fortunately frequency and normal signal variations will augment the resolving powers of the antenna system several fold. Several receiver-antenna techniques are available which will further improve upon the resolving power of smaller antennas allowing higher resolution systems.

The size of antenna is also important for collecting enough signal to detect. Without a large collecting aperture the reconnaissance system may be ineffective for signals from low power sources. The antenna and its associated receiver must overcome the propagation losses that occur between the earth and the satellite. Fig. 4 shows the typical propagation losses of signals emanating from the earth directly below the satellite (vertical path) and signals on an electromagnetic horizon (horizon path). This plot includes losses due to atmospheric absorption by oxygen, moisture, ionization and Faraday rotational which are more pronounced in the horizon path.

Although these losses increase with frequency they are compensated by the increased gain of a fixed size antenna. Unlike communication systems, where propagating losses may be accommodated by adjusting transmitter power and antenna gain, losses here must be overcome entirely by the antenna receiver system. These losses are overcome by increasing the collecting area, or gain, of the reconnaissance antenna and by using sensitive receivers. In most cases, a balance is made between antenna size and receiver sensitivity. This balance is tempered by the bandwidth of information the system must intercept. Fig. 5 indicates some typical gain-sensitivity products for various receiver bandwidths and antenna gains. From Figs. 3, 4, and 5 a generalization can be made of the relationship between antenna gain, signal strength, and altitude. The ratio of antenna gain and altitude are constant for a fixed signal level to the input of the receiver.

Fig. 5: Antenna-receiver sensitivity vs bandwidth.



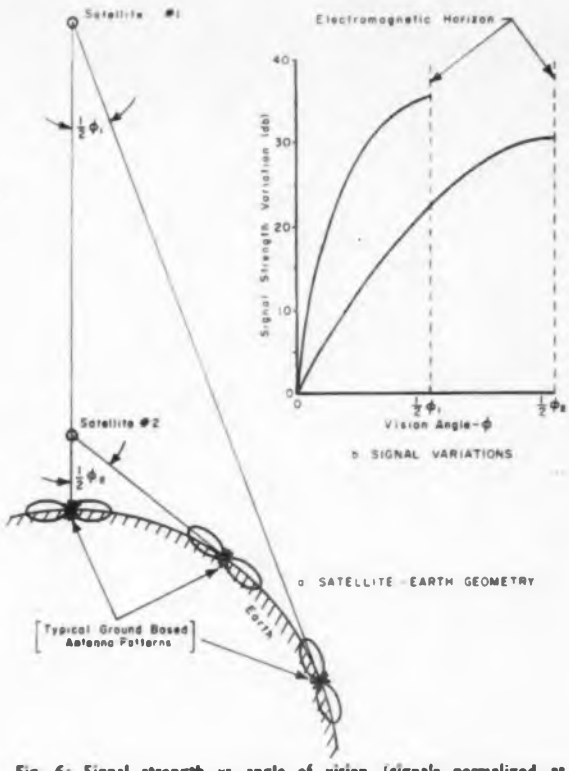


Fig. 6: Signal strength vs angle of vision (signals normalized at $\phi = 0°$)

Orbit

If the satellite has an elliptical orbit, with a large major-to-minor axis ratio, the resolving properties and receiver signal strength of a reconnaissance antenna will vary throughout the orbit. Consequently, orbital altitudes and ellipticity are important factors in establishing and controlling the signal resolving power of the system.

Unless a low altitude is specified or an extremely narrow antenna beamwidth is used it will be difficult to determine the area of the earth from which signals emanate or even the country from which they originate. For the military it may be extremely important to resolve signal sources separated by only a few miles. For scientific applications resolution may not be so critical.

Conventional 6 to 10 foot antennas are now feasible for satellite installation. Antennas of this size are useful only above 1000 mc. Fig. 3 and 4 show that below 1000 mc, antenna beamwidths become too large to resolve signals spaced even hundreds of miles apart. In light of this it appears that the reconnaissance vehicle is restricted to a 250 to 100 mi. range of altitude and a useful frequency range above 1000 mc. These ranges may be extended considerably if the reconnaissance system is designed to detect only extremely strong signals which have unique frequency or modulation characteristics or signals from sources spaced many hundreds of miles apart.

SIGNAL ENVIRONMENT

Signals emanating from the earth's surface have a wide amplitude range. Variation as great as 80 db

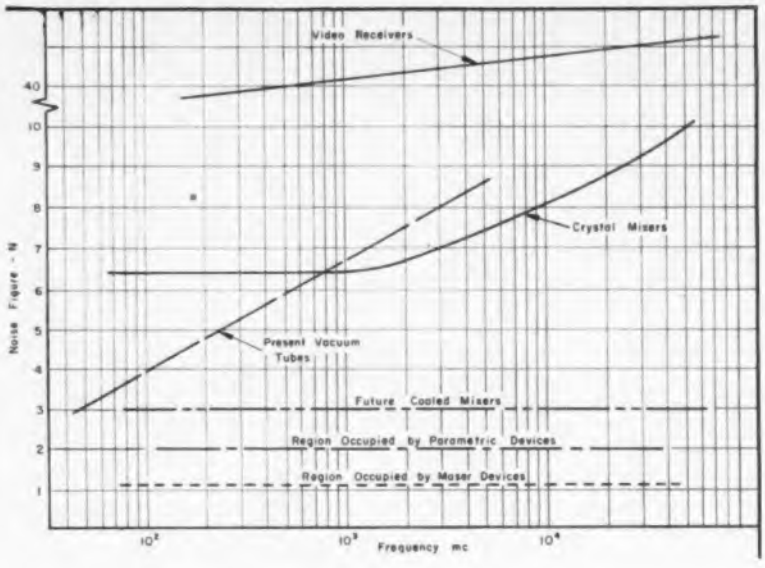


Fig. 7: Noise figures of various types of receivers.

can be expected, though, these may be isolated cases. A more probable variation in any band of frequencies would be 30 to 60 db. These variations can be attributed to the normal variation in effective radiative power and path length losses.

Area Viewed

The area viewed by the satellite may hold from 100 to 10,000 signals depending upon its altitude and the portion of the earth over which it is traveling. These signals will usually not be distributed uniformly but will be concentrated in areas of dense population. Any attempt to distinguish between the numerous signals coming from the earth will be hampered by the presence, or interference, of other signals of the approx. frequency, amplitude, and geographical location. Also, signals emanating from the most remote sources, that is, from the horizon will appear to be stronger than signals emanating from directly below the satellite in spite of the higher horizon path losses. Most ground base stations below 1,000 MC by virtue of their function, have an omnidirectional (donut) pattern, as shown in Fig. 6. As the satellite passes over a ground base station, the signal reaching the satellite is 30 to 40 db down from the main beam of the transmitter corresponding to the nulls of the ground based antenna pattern. A similar antenna located on the horizon has its main beam directed at the satellite. As a result a signal improvement of 3 to 4 magnitudes can be received from the transmitter on the horizon as compared to the transmitter directly below the satellite.

The spectrum above 1,000 MC is usually allocated to radar. Radar operation requires a pencil beam antenna which is not usually pointed very far above the horizon. As a consequence reception from radars fall into the same general classification as the lower frequency systems. However, the possibility of intercepting the narrow beam pattern of the radar is fairly remote. It is more probable to consider operating on the side lobes of these radar antennas. Because of the usually high peak powers of radars, reception on the side lobes is feasible.

Because of the extremely high level signals arriving from directions corresponding to the electromagnetic horizon it is questionable whether a narrow beam antenna on the satellite pointing vertically downward is useful. In fact, it appears that it would be more advantageous to point the antenna toward the horizon in order to take full advantage of the stronger signals there.

The unique signal environment imposes a restriction on the side lobe level of the satellite antenna. The side lobes must be extremely low in order to reject strong signals outside the main beam. Any signals entering the reconnaissance receiver through the antenna side lobes introduce erroneous information and reduce the resolution.

RECONNAISSANCE RECEIVER

The receiver is an important component for it must distinguish signals in the presence of natural noise as well as in the presence of radio and radar interference. The effect of natural noise is normally a function of the type of reception used, that is AM, FM, etc. However, it is sufficient to mention the range of the natural noise and its effects on basic detecting devices such as traveling wave tubes, crystals, and masers.

Noise Effect

The total natural noise in a receiver comprises atmospheric, galactic, terrestrial, antenna, and receiver noise. These noises except for the receiver noise are introduced through the antenna and are thermal in origin. They are caused by electromagnetic radiation losses and the dissipation of these losses by re-radiation. The power level (N) of these noise sources depends upon the temp. (T) of the source and the operating bandwidth (B) of the receiver. $N=KTB$ watts, where K is Boltman's constant (1.37×10^{-23} Joules /°K). T is absolute temp. of the source in

degrees Kelvin (°K) and B is the reconnaissance receiver bandwidth in cycles-per-second (cps). The range of antenna noise will be approx. 15 db which corresponds to the noise from the cold (10°K) sky to the noise emanating from the earth (300°F). Even with the satellite pointing downward, the predominant noise may occasionally be sky noise. This occurs when the satellite antenna beam intercepts a relatively smooth surface of water which is almost a perfect reflector and reflects the radiation from the cold sky. In general, the antenna noise is the sum of all interfering signals and the integrated antenna pattern.

The antenna noise level specifies to a great extent, the required receiver sensitivity. A sensitivity, that is, receiver noise level, that is approx. the same magnitude as the amb. noise provides a compromise between dynamic signal range and sensitivity. Fig. 7 shows the useful spectrum range of various receiving devices as a function of their detecting sensitivities and the background noise levels. The video detector is the least sensitive although the easiest to instrument. The maser amplifier is the most sensitive but is critical in adjustment and operation. The crystal receiver, and to a lesser extent, the parametric amplifier, are best suited for reconnaissance operation. The crystal receiver has a somewhat higher noise figure but is extremely broadband. The parametric amplifier has ideal noise figure characteristics but is relatively narrowband. The crystal and parametric amplifier have adequate sensitivities to compensate for the high propagation losses.

SIGNAL RESOLVING TECHNIQUES

The usefulness of the radar and radio reconnaissance satellite depends to a great extent upon its ability to locate the direction of the signal sources. In general, the accuracy of any antenna system depends on the surrounding environment and the effect of the propagating medium. The bending of rays, that constitute direction finding errors and are external to the system, are prevalent above 5000 MC where atmospheric absorption and precipitation effects are predominated. These errors cannot be eliminated. Below 5000 MC these direction finding errors are negligible.

Various resolving techniques used in more conventional direction finding systems are applicable to satellite reconnaissance use. Each technique has particular advantages. The resolving techniques are

1. Frequency Selection
2. Amplitude Comparison
3. Phase Comparison
4. Scanning Antennas
5. Combinations of Systems

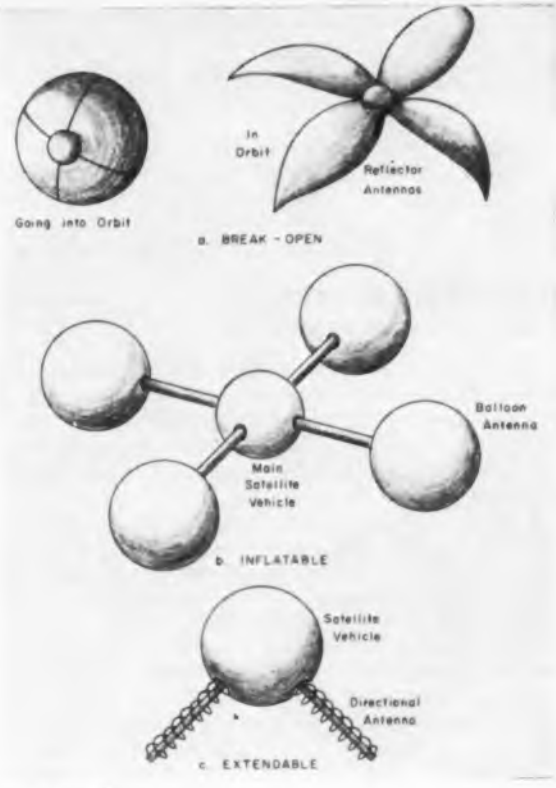


Fig. 8: Possible antenna structures.

Many signals that would normally interfere may be eliminated by using frequency discriminatory techniques. By properly designing the receiver circuitry spectrum mapping may be accommodated. Swept frequencies receivers or discrete frequency band receivers such as traveling wave tubes are adaptable to this technique although the advantages of TWT's are marginal because of their weight.

Amplitude comparison techniques can improve upon the minimum signal resolution set by Rayleigh several fold. These techniques are limited by the antenna beam shape and side lobe level. Unless side lobes are very low the direction finding capabilities may be deteriorated by several beam widths. However, resolving accuracies better than ¼ beamwidth are realizable using amplitude comparison techniques such as amplitude gating, or simultaneous lobing method.

Scanning

Antenna scanning techniques fall into two general categories: Mechanical and Electrical, both of which may be identical in capabilities over a restricted scan angle. The mechanical scanning antenna may scan over extremely wide viewing angles but in so doing introduces prohibitive inertial problems. That is, as the antenna scans or rotates in one direction the satellite tends to rotate in the opposite direction, satisfying Newton's third law of motion. To overcome this oscillatory or unstable condition requires complex stabilization forces.

Electrical scanning antennas do not introduce in-

Antennas *(Concluded)*

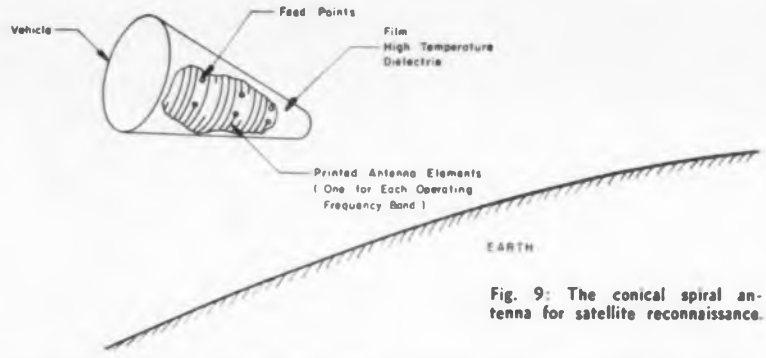


Fig. 9: The conical spiral antenna for satellite reconnaissance.

ertial problems but require more complex electronic equipment. However, this scanning technique does not lend itself to operation in the UHF region and below (up to 1000 MC) but is more practical in the microwave range. Its advantages in reconnaissance satellites are marginal.

A mechanical scanning method with limited stabilization is possible. If the antenna is fixed with respect to the satellite structure and the satellite is made to rotate about a horizontal axis a simple antenna scanning method may be realized. That is, the antenna which is fixed to the satellite structure scans by virtue of the satellite's rotational motion. This technique has been used successfully in the optical instrumentation of Vanguard II and has considerable merit in its application to radio and radar reconnaissance.

Combinations of amplitude comparison techniques and frequency and beam scanning methods are practical and in most cases necessary to overcome the restrictions in antenna size. Such a combination of antenna functions will improve the resolving powers of an antenna by a factor of 5 to 10.

The frequency discriminating method and the antenna scanning method must be consistent with signal recording and utilization processes—a part of any reconnaissance system. The speed and range of the frequency scan must not compromise the information content of the intercepted signals. For best results frequency sampling or scanning must be completed for every scanned beam width of the antenna.

Although these resolution improvement techniques are essential system approaches, improvement can also be found in the type of antenna selected, the construction of the antenna, the integration of the antenna in or on the satellite, and the direction in which the antenna is pointing. These latter considerations embody the approach that is necessary to realize a high resolution, lightweight, antenna for future satellite reconnaissance systems.

ANTENNA STRUCTURE

Some of the more unique antennas for satellite reconnaissance operation are now feasible, others are in the study stage, and many are being developed.

The Extensible Antenna

After the satellite has been put into orbit the antennas are unfolded or telescoped outside of the satellite structure. Many large antennas covering many frequency bands may thus be realized. Extended spring-like helices are typical of this approach (see Fig. 8C). The paddle wheel antenna, similar to the Explorer VI satellite, is another example of how large antennas, covering many frequency bands, may be realized without the restriction of the physical bounds of the satellite main structure.

Break-Open Antennas

After the satellite is in orbit it breaks open. Each unit surface of the satellite is used as a reflecting antenna. Many antennas and frequency bands may thus be accommodated (see Fig. 8 a). This technique is useful mainly in the microwave region.

Inflatable Antennas

Antennas may be inflated like balloons (Fig. 8b). These are reflector antennas and printed antennas that consist of a flexible metalized film coated on an inflatable structure. Antennas many times larger than the satellite structure may be realized resulting in gains and resolving powers that are considered extreme especially at the lower frequencies. The newly developed heliosphere is an example of this type of antenna structure.

Multi-use Antennas

An antenna may be used for more than one purpose. A parabolic type antenna, for example, may have several feeds each operating in a different frequency band or the feeds may obtain various polarization information within a single band of frequencies. The monopulse antenna is an example of this approach. Fig. 9 indicates a multiband antenna structure that uses the vehicle structure for support.

A common requirement of most reconnaissance antennas will be that of omnipolarization, that is, sensitivity of all polarizations. By resorting to the extensible, break-away or inflatable structure techniques there will be adequate room to accommodate this feature and other features that cannot be realized with conventional techniques.

A stated previously, a relaxation in antenna gain can be realized by pointing the antenna at the horizon where apparently stronger signals are emanating. This technique may be put to further use. The use is somewhat subtle but worth mentioning. Ions will form on the leading surfaces of the relatively low altitude reconnaissance vehicle. It is not advisable to direct the antenna beam forward because of the attenuating effects of these ions on the signals. By pointing the antenna rearward the satellite is not ready to intercept

important signals until its presence is known thus giving the operators of the ground station adequate time to turn off the equipment or offer the reconnaissance system erroneous information. If, however, the satellite antenna is pointed toward the horizon, on a bearing orthogonal to its line of flight, the antenna will be unaffected by the ions and the satellite may well perform its mission without causing undue alarm on the part of the ground operators.

ADDITIONAL CONSIDERATIONS

Factors such as temperature, pressure, presence of meteorites, radiation and power source requirements may to a large extent specify the particular system design and the type of electrical and mechanical components used. These consideration ultimately lead to the life expectancy of such a system. Reconnaissance systems that are expected to operate over extended periods of time such as several months must be guarded against failure due to any of these factors. Such a system is relatively complex. Short life systems which are used mainly to check a particular physical phenomenon or to gain quick tactical information may be constructed in a relatively simple manner and may be expected to operate efficiently. It is not profitable, therefore, to unnecessarily equip satellite with the sophisticated antenna-receiver systems that could cope with all possible signal conditions. An operating bandwidth of an octave for each antenna-receiver system is a realiatic approach.

CONCLUSION

One of the greatest problems in realizing a satellite reconnaissance vehicle is space and weight economy. The antenna must be fairly large to provide adequate signal information and the receiver must be efficient and broadband in order to provide the required sensitivity and to reduce the total number of receivers to a practical limit. Components must not compromise the structure of the vehicle or the maximum weight limitation. In order to fulfill these requirements conventional antenna-receiver techniques must be abandoned.

The reconnaissance satellite is immersed in a complex environment of signals and a certain amount of ingenuity and imagination is required to realize a practical system. The techniques that are applicable to this problem are at hand. These techniques deal with advanced antenna structures, space construction and electronic innovations that can only be realized in an environment of close cooperation between the mechanical aerodynamic and electronic engineers.

Linear Accelerator

A NEW radiographic linear accelerator has been installed at the U. S. Naval Ammunition Depot at Concord Calif. Made by Varian Associates, it will be used in inspecting solid propellant rocket motors such as are used in Polaris, Minuteman, and Skybolt missiles.

The machine, Linac, is a giant X-ray machine. Its heart is a powerful "electron gun" which aims a pulsed barrage of electrons at a gold target, causing it to emit X-rays powerful enough to radiograph a 5-foot section of missile fuel in a matter of minutes. A permanent record is made on X-ray film. Flaws as small as a few hundredths of an inch in diameter can be detected. The X-ray head can be rotated 360° in a vertical plane. The Linac is mounted on a turntable which rotates 360° in a horizontal plane and is suspended from a telescoping overhead crane.

The ten million volt linear accelerator can examine a large missile engine in 15 exposures of two or three minutes each. Previously, about 60 exposures of about 15 minutes each were needed.

Radiation output is equivalent to 70,000 curies of radium (approx. 70,000 grams). Even if this amount

(*Continued on page* 207)

Polaris missile section set up for radiographic examination with new 10,000,000 volt linear accelerator. Varian Associates made the machine for the U. S. Naval Ammunition Depot, Concord, Cal.

Engineer operates remote control console. A closed - circuit TV lets him watch operations in the exposure room. An Eastman Kodak X-Omat X-ray developing and processing unit is in the background. It can process 140 14 x 17 in. films/hr.

Problems of Space Communication:

I - Sensitivity

First of a Series

TRANSMITTER power, P_t of Eq. 1, is strongly dependent on required receiver power, P_r, for minimization. For any receiver, this can be the input power required to realize a certain output capability. For present-day linear receivers, and those expected in the near future, this required receiver power, P_r, is merely a desired number ρ, times an effective thermal power, N_a, at the input of the receiver, Eq. (2).

The total equivalent noise power, N_a, at the input of a linear receiver comes from two sources: the receiver; and, background noise coming in the antenna. Both of these noise powers have a thermal spectrum. Therefore, they can be added arithmetically to give the total noise power, N_a. Antenna noise factors will be treated in a later article. Here, only the most sensitive of the linear receivers are treated. The frequency range covered is 10 MC to 100 KMC. Receiver types considered are: tubes and transistors, traveling wave, cooled-crystal superheterodyne, maser, and parametric.

Since the equivalent input noise power, N_a, at the input of the receiver has a thermal frequency spectrum, its magnitude can also be expressed[1] in terms of an absolute temperature, T_a (°K), Eqs. (3, 4, and 7), In these equations, K is Boltzmann's constant and Δf is the receiver bandwidth.

Either the power, or the temperature, can be expressed in a normalized unit, t_a, by use of a standard 290°K temperature, T_o. Eq. (5) shows the normalized unit to be in the dimensionless form of power or temperature ratio.

The fourth method of expressing this total noise is in decibels, Eq. (6). All four units have their usefulness for expressing theoretical and practical noise capabilities of receivers.

In this article, the sensitivity units measure a noise quantity at the receiver system antenna input. The units apply equally well to any linear amplifier unit, such as the receiver alone, excluding the antenna transmission coupling. The over-all receiver sensitivity often must be obtained by combining the sensitivity units of a cascade of amplifier units. Quoted sensitivity units must specify to what portion of the receiver system they apply.

Friis introduced the "noise figure" terms which are now accepted as ASA standards.[2] By these terms, the total over-all receiver plus antenna noise is expressed specifically for a standard antenna at the standard reference temperature, T_o, of 290°K. The receiver noise figure, F_r, then means that the total receiver noise (including the standard antenna) is F_r times that of the standard reference power $KT_o\Delta f$, Eq. (9).

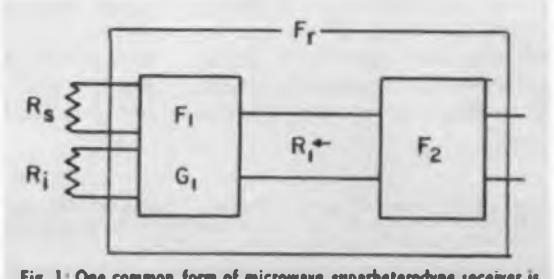


Fig. 1: One common form of microwave superheterodyne receiver is capable of amplifying signals on both "signal" & "image" frequency.

The significant fact to remember when using noise figure terms is that the over-all noise must include that from an antenna at the standard reference temperature of 290°K. Heretofore, this has been a good measure of receiver sensitivity, because on most ground installations antenna noise is approximately 290°K. Further, receiver noise has been so much higher than 290°K that the over-all noise is little affected by the antenna noise.

However, for the low-noise receivers covered in this article, the noise figure terms do not adequately indicate the receiver sensitivity. The antenna noise can be tens of thousands of degrees, if pointed at the sun; or approach absolute zero, if pointed toward empty space. For this reason, the word "sensitivity"

Other articles in this Space Communications Series will be concerned with the sensitivity of nonlinear receivers, antenna noise and propagation, antennas, and system optimazation.

Besides discussing the present and future capabilities of low-noise receivers, this article relates the existing sensitivity nomenclature to the preferred one of "temperature." It also covers practical combinative relations which enhance or degrade the sensitivity.

# of Linear Receivers

By C. T. McCOY
Research Division
Philco Corporation
4700 Wissahickon Avenue
Philadelphia 44, Penna.

is introduced to mean the total receiver plus antenna noise for any given antenna temperature. To avoid conflict with previously established terms, such as noise temperature, the generic term "noise" is used in which the units may be in watts, power ratio, temperature ratio, db, or degrees Kelvin. "Sensitivity" units in this article will be predominantly expressed in degrees Kelvin. As shown in Eq. (10), to convert from "noise figure" units to "sensitivity," remove the standard antenna temperature, T_o, and then add the actual antenna temperature, T_a. The over-all receiver noise, T_s, can then be expressed in 2 terms, Eq. (11). The first term, T_r, is due to the receiver; the second, T_a, the antenna.

T_r often comes from more than one source within the receiver, e.g., the mixer and the i-f. Also, the receiver often has more than one frequency channel for amplifying both signal and noise. One common form of the microwave superheterodyne receiver. Fig. 1, is capable of amplifying signals on both a "signal" and an "image" frequency. This condition is given the standardized term "broadband" receiving. The term does not define the bandwidth of the receiver, but merely means that in front of the mixer there is no selectivity between the signal and image frequencies.

Eq. (13) expresses the over-all receiver noise, T_r, in terms of the receiver as a single black box with noise figure represented by F_r. The second line breaks down the receiver noise sources into two parts: that due to the mixer, subscript 1; and, that due to the i-f subscript 2. F_1 and F_2 are the standard noise figure terms for cascaded black boxes. G_1 is the available gain for the first box. The symbol, n, refers to the ratio of the number of channels of noise amplification, divided by the number of channels of signal amplification.

In "broadband" microwave crystal superheterodyne receivers for coherent radiation there is only one signal channel, although the receiver is open to 2 noise channels. For this case, n has the value of 2. If the image is blocked by a pre-selector filter, the

EQUATIONS

$$P_i = Pr\,aL \quad (1)$$

$$P_r = \rho N_s \quad (2)$$

$$P_r = \rho\,[KT_o\,\Delta f] \quad (3)$$

Power (watts) $$N_s = KT_o\,\Delta f \quad (4)$$

Normalized (ratio) $$f_s = \frac{N_s}{KT_o\,\Delta f} \quad (5)$$

db $$= 10 \log_{10} f_s \quad (6)$$

Absolute Temperature (°K) $$T_s = \frac{N_s}{K\,\Delta f} \quad (7)$$

Standard Ref. Temperature (°K) $$T_o = 290°\,K \quad (8)$$

$$KT_o\,\Delta f = 4 \times 10^{-21} \text{ watts/cycle} = 4 \times 10^{-15} \text{ watts/mc}$$

$$N_s = F_r\,(KT_o\,\Delta f) \quad (9)$$

$$T_s = F_r\,T_o - T_o + T_a \quad (10)$$

$$T_s = (F_r - 1)\,T_o + T_a \quad (11)$$

$$T_s = T_r + T_a \quad (12)$$

$$T_s = (F_r - n)\,T_o + nT_a \quad (13)$$

$$T_s = (F_1 - n)\,T_o + \frac{(F_2 - 1)}{G_1}\,T_o + nT_a \quad (14)$$

$$T_s = T_1 + T_2 + nT_a \quad (15)$$

$$P_{re} = h\nu \times \rho\Delta f_c \left[1 + \frac{K\,(T_r + nT_a)}{h\nu}\right] \quad (16)$$

$$P_{re} = \rho KT_o\,\Delta f_c \quad (17)$$

$$T_s = n\,(F_1 - 1)\,T_o + \frac{(F_2 - n)\,T_o}{G_1} + nT_a \quad (18)$$

$$T_s = n\bar{b}_1\,(L_1 - 1)\,T_o + L_1\,(F_2 - n)\,T_o + nT_a \quad (19)$$

$$T_s = T_r + nT_a \quad (20)$$

$$T_s = n\bar{b}_1\,(L_1 - 1)\,T_o + L_1\,(F_2 - 1)\,T_o + nT_a \quad (21)$$

$$T_a = T_m\,(1\text{-}G_m) + G_m T_p \quad (22)$$

superheterodyne design is given the term "narrow-band." For this case, n has the value of 1. For certain applications, the signal as well as noise could come in on both signal and image channels. For this condition, n would again have the value of 1.

Eq. (14) merely indicates that the equivalent over-all receiver noise, T_e, is the excess noise from the first box, plus the excess noise from the second box, diminished by the gain, G_1, in the first box, plus the antenna noise. This is expressed in Eq. (15) in absolute temperature symbols. The receiver noise is the sum of the first 2 terms, while the antenna noise is the third.

Theoretical Receiver Sensitivity

Eq. (3) relates the required signal power, P_r, to the receiver sensitivity. It is an approximation which neglects the fluctuation noise of the reception of discrete quanta.[3]

Eq. (16) gives the exact relation, assuming a Gaussian distribution. The numerator in the second term of the bracket represents the energy of the total receiver plus antenna noise; the denominator, the energy of one quantum of signal at frequency ν (h is Plank's constant.)

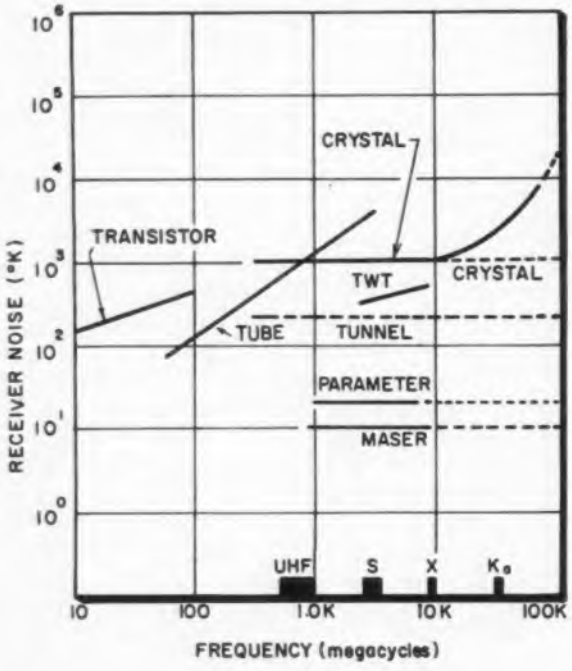
As in Eqs. (1 and 2), ρ is the desired signal-to-noise ratio; and Δf_r, bandwidth of the receiver. The bandwidth reciprocal is an observation or integration time.

The second term in the bracket of Eq. (16) can be made to approach zero with a sufficient reduction in receiver noise, and/or the use of higher energy quanta. For this condition, the receiver signal power, P_r, has a lower limit, represented by the terms in front of the bracket. This limit can readily be seen to be the number of quanti, ρ, of energy, $h\nu$, received in the time, $1/\Delta f_r$. This is called the quantum limitation.

For all present-day linear microwave receivers, the noise energy is much larger than the quantum energy. Therefore, the Eq. (16) simplifies to the more familiar Eq. (17).

Sometimes the quantum energy, $h\nu$, is equated to a noise energy, KT_ν. The terms in front of the bracket of Eq. (16) can then be expressed in the form of Eq. (17) with T_ν replacing T_e. T_ν is given the name "quantum noise." At 10 KMC, T_ν is 0.5°K, and is, of course, proportional to frequency.

Fig. 2: The present and future sensitivity of linear receivers.



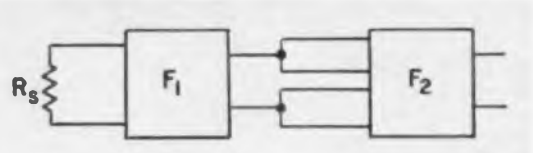


Fig. 3: The front end insert is assumed to have a flat passband, wide enough to cover both "signal" & "image" channel in the conventional superheterodyne. It can enhance or degrade sensitivity.

Receiver Noise

The low-noise capability for the best receivers is indicated, in degrees Kelvin, in Fig. 2 for the frequency range between 10 and 100,000 MC.

Tubes and Transistors

Electron tubes have low-noise capabilities only in the VHF and UHF regions.[1] The receiver noise shown by the line marked "tube" represents the performance of the 416B—the best for low noise. Both in theory and practice, electron-tube receiver noise, or "excess" noise figure, is proportional to frequency. At 100 MC, the 416B has about 100°K of noise, and at 1000 MC, it has about 1000°K.

At present, the low-noise transistor is limited to frequencies below 200 MC. Present-day experimental performance is indicated by the "Transistor" Curve.[5] Though transistors have higher noise than electron tubes for r-f amplification, for i-f amplification the transistor amplifier, behind a mixer with a 20 db gain (section 5 below) would have negligible contribution to the over-all receiver noise. Since section 5 below implies that a low-noise parametric or tunnel mixer can be of the semiconductor form, the future low-noise receivers will probably be all semiconductor. They will have the additional advantages of small size, light weight, and low power consumption.

Traveling-Wave Tube

Traveling wave tubes have achieved receiver noise T_r as low as 300°K at 3 KMC and 500°K at 9 KMC[6, 7] (TWT curve, Fig. 2). A noise figure as low as 2 db has been predicted.[8]

Conventional Crystal Superheterodyne[1, 9, 10]

For all frequencies below X-band (10 KMC), a 7.5-db noise figure or about 1000°K receiver noise is ac-

complished with the best present-day conventional crystal superheterodyne receivers. This is represented in Fig. 2 by the flat portion of the curve marked "crystal." Above X-band, parasitic elements inherent in crystal diodes cause receiver noise to increase rapidly with frequency up to approximately 6000°K at 70 KMC, Fig. 2. A new process called "microetch"[10] promises to drastically reduce the crystal diode parasitics. If this process is successful, it will result in 1000°K receiver noise for all frequencies below 100 KMC. The dotted line marked "crystal" indicates the predicted result.

Maser

30°K noise at 9.3 KMC[10] and 10°K noise at 5.8 KMC[11] has been reported experimentally with a paramagnetic solid-state maser using ruby. MIT and Lincoln Laboratories, using a potassium cobalt-cyanide crystal, have achieved similar low receiver noise at L and S-band. With known wave-guide and front-end insertion losses eliminated in the solid-state maser performance, 10°K or less receiver noise can be expected between 1 and 10 KMC. This is represented by the solid portion of the bottom line, Fig. 2. The dashed portion of the line represents future possibility, for masers have been proposed up to the visible portion of the spectrum.[13]

Parametric Amplifiers

The capacity diode parametric amplifier,[14] also called a reactance amplifier, is a recent device that has a low-noise capability approaching that of the maser—without as much complication (liquid helium cooling, and magnet). The diode form of the parametric amplifier is a superheterodyne mixer that is comparable in size, weight, and power consumption to that of present-day conventional mixers.

65°K receiver noise for room temperature, and 21°K noise for liquid nitrogen cooling has been reported[15] for gallium arsenide 6 KMC amplification. As with the conventional microwave crystal superheterodyne, section 3 above, the parametric-amplifier receiver noise will be independent of frequency below that frequency at which the diode parasitic elements cause degradation. Therefore, the solid portion of the line marked "parametric" in Fig. 2 represents the receiver sensitivity to be expected now or in the near future, and the dotted portion for later.

The "ferromagnetic" amplifier and the "fast electron wave" form of TWT are also parametric amplifier types[16] with low-noise capabilities. A 1-db noise figure (75°K for the receiver) has been experimentally achieved for the "fast electron wave" type. In present form these parametric amplifiers are considerably larger in size, weight, and power consumption than the semiconductor capacity diode form.

Tunnel Amplifiers

The tunnel (or Esaki) semiconductor diode is the latest[17, 18, 19] low noise receiver device, which may be used either as a microwave amplifier or mixer with gain. A lower receiver noise (about 260°K at 210 MC) has been reported[19] for the latter. The solid portion of the "Tunnel" curve of Fig. 2 represents this value. The dotted portion of the curve indicates that the same noise sensitivity is expected up into the millimeter region of the spectrum. As with the parametric and conventional microwave semiconductor diodes, the tunnel diode receiver noise is inherently independent of frequency below a maximum determined by similar parasitic elements. There is good possibility that future development of the tunnel diode will reduce noise at all frequencies below that shown in Fig. 2.

The tunnel diode may not have as low noise capability as the parametric or maser. But as a mixer preamplifier followed by transistor i-f, it seems to offer, in an all semiconductor form, the best receiver combination of unlimited high microwave frequency, low noise, small size and weight, power consumption, and long life reliability.[20]

Certain satellite receivers, whose antenna beam is subtended by the earth, are sensitivity limited by this 300°K antenna noise. Therefore, they could benefit more from the small size-weight feature than from ultra-low receiver noise.

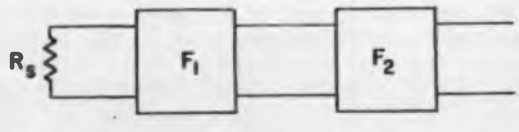


Fig. 4: Insertion loss between receiver and antenna must be low.

Sensitivity Enhancement or Deterioration

Front End Generalization

Parametric, tunnel, or maser amplifiers would, in general, be used as preamplifiers in front of a conventional receiver. Furthermore, low-noise receivers might have passive preselector filters, or gyrators, between the receiver and the antenna to meet stabilization, or frequency selectivity requirements. The losses or gains of these front-end inserts can be a significant factor in the over-all receiver noise.

Amplifier

An insert, in front of the receiver, can be generalized as in Fig. 3. F2 represents a conventional superheterodyne with 2 noise input channels. The front-end insert, box 1, is assumed to have a flat passband that is wide enough to cover both signals and image channel in box 2.

The definition of sensitivity, Eq. (18) requires that all noise be referred to the antenna input. Here, there are 2 noise channels giving n the value of 2. The

over-all receiver noise is the sum of the excess noise from the first preamplifier box (first term in the equation), plus the excess noise from the main amplifier, diminished by the gain of the preamplifier, plus the antenna noise (third term). Thus, sufficient gain in the preamplifier can eliminate the noise contribution of the main amplifier. The receiver noise, then, is due only to the preamplifier plus the antenna.

When the post-amplifier noise is negligible (second term) the over-all receiver noise can be cut in half by blocking one of the amplifier channels, i.e., reducing n from 2 x 1. This should be accomplished by a filter in front of the post amplifier, but included in its excess noise contribution (numerator of second term). The following section shows that when a filter is placed in front of a low-noise amplifier, it seriously degrades noise sensitivity. Whereas when it is placed after the preamplifier, the sensitivity degradation now applies to the post amplifier, and can be nullified with increased preamplifier gain.

Attenuation

When the front-end insert has an attenuation—such as that from a filter, gyrator, or even transmission-line loss between the receiver and the antenna—Eq. (19) applies. Instead of using gain G_1 for the front-end insert, it is more convenient to use the reciprocal term loss L_1. The symbol $\bar{t}_1$, in the first term, is the actual thermal temperature (in normalized units) of the resistive losses in the front-end insert. The noise contribution of this insert can be expressed by the first term in either Eqs. (18) or (19).

Eq. (19) shows that the excess noise due to the insert can be reduced to zero either by reducing the loss to unity or by reducing the thermal temperature to zero. However, only by reducing the insert loss to unity can the receiver noise be reduced to that due to the second box alone. In other words, thermally

cooling the front-end insert can reduce a portion of the degrading effect on sensitivity. But, elimination of this effect comes solely through removal of the loss. When loss is removed, the thermal temperature of the insert piece is immaterial.

The importance of striving for low insertion loss between the receiver and the antenna is shown in Fig. 4. It considers a 20°K single channel ($n = 1$) parametric or maser receiver with a 0.5 db (1.13 ratio) insertion loss gyrator or filter in front. With the insert loss eliminated, the passive front end insert more than doubles the receiver noise. The better the receiver, the lower the loss in the front must be to avoid sensitivity degradation.

Antenna Noise

Receiver sensitivity, T_s, can be drastically affected by the magnitude of the antenna temperature. In free space the antenna noise, T_a, can be much lower than 20°K. On the other hand, the sun can cause the antenna noise to be many thousands of degrees. The sources and magnitudes of antenna noise will be discussed in a later article; but, the effect of atmosphere absorption on antenna temperature, now.

Whenever an absorbing medium, such as an atmosphere, is placed between the antenna and the generator of noise, such as the sun, the antenna noise, T_a, is given Eq. 22, where T_m is the thermal temperature (°K) of the absorbing medium, G_m is its gain in power ratio units (less than unity since it is a loss), and T_g is the noise of the source (°K). Eq. 22 shows that for high absorption ($G_m \rightarrow 0$), the antenna temperature T_a approaches the thermal temperature of the medium T_m; and when the absorption becomes negligible ($G_m \rightarrow 1$), the antenna temperature approaches the generator noise T_g. Eq. 22 combined with Eqs. (18 to 20) is a basis for accurate noise figure instrumentation. For example: From Eq. (20), receiver noise T_r can be calculated from the measured ratio of T_s for 2 known values of T_a. Sometimes, T_a is not directly measurable, but can be calculated with Eq. (1) from known thermal source noises, T_g, measurable transmission line losses G_m, and temperature T_m. Alternatively, the losses, G_m, and temperature, T_m, of a medium can be measured by using known receiver noise, T_r, and noise sources, T_g.

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What's New

Computer Uses ALGOL-COBOL

Fig. 3: The functional inter-relation of components in the system. Components may be deleted to form a system tailored to any size application.

NEW solid state electronic data processing system, the B5000, is designed specifically to use automatic programming languages. The Burroughs Corp. system is designed to use both ALGOL and COBOL.

Although computers have made spectacular progress, they have created some special problems of their own. One of the biggest problems has been that of man-machine communication and the inefficient use of high speed system capabilities.

In the past, computer instruction (programming) was a ponderous task, requiring knowledge of complex numerical machine codes, foreign to all but highly trained specialists. The writing of one program often tied up teams of high-priced talent for many months. Resulting costs, in many cases, rivalled the price of the equipment complex itself. The problem itself often only required a few minutes to solve once all data was entered into the computer.

ALGOL (for ALGOrithmic Language) is an international problem language designed for the concise, efficient expression of arithmetic and logical processes, and the control (iterative, etc.) of these processes. Fig. 1 shows how one typical engineering problem can be translated into ALGOL.

COBOL (A COmmon Business Oriented Language) is designed for expressing problems of data manipulation and processing in English narrative form. Fig. 1 also shows an example of the use of COBOL.

The B5000's master control program will permit maximum, efficient operation with minimum human intervention. Virtually self-regulating, the system schedules and keeps track of its own work load, automatically by-passes certain units if they malfunction, and advises the operator when he makes a mistake.

The computer automatically performs diagnostic maintenance routines to assure max. up-time—either during processing or at the conclusion of all processing. Any size program can be run on any B5000 system. A no re-programming feature makes it possible for computer users to exchange programs.

Multi-processing will be practical. Any two or more completely independent programs can be run simultaneously. The processor can operate in fixed-point (integer) and exponential (floating-point) representation interchangeably. Both scientific and data processing problems can be performed with equal facility.

Fig. 2 (right): The solid state B5000 system. Systems are available for any size scientific or business data processing job. A max. system includes 2 central processors, up to 26 input/output devices, 8 magnetic core memory units, and 4 input/output channels.

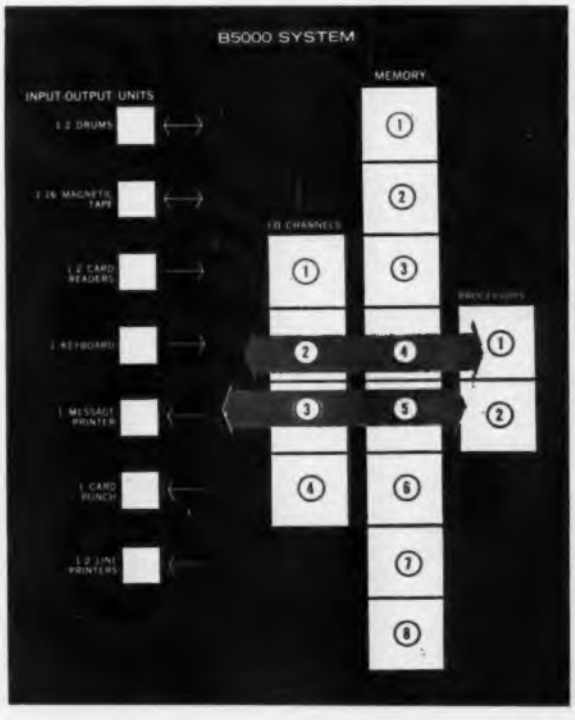


Fig. 1 (below): Examples of the two universal automatic programming languages, ALGOL and COBOL, show how closely they resemble their pure derivatives, algebra and English. Both languages are standard on Burroughs B5000 Information Processing System.

mathematical problem: d=a(b+c)	*data processing problem:* FICA DEDUCTION = FICA RATE (GROSS PAY+RAISE)
ALGOL statement: D := A x (B+C);	*COBOL statement:* COMPUTE FICA-DED EQUALS FICA-RATE TIMES (GROSS-PAY PLUS RAISE)

What's New

Electrolized Drills

Master template guides drill operator as he works on printed circuit card blank.

Philco engineer installs one of over 18,000 printed circuit cards into Philco-2000 computer. A large-scale, all transistor computer, it features a synchronous operation. It permits progression from one operation to another without waiting for a clockpulse.

THE 18,000 printed circuit cards used in Philco's Philco-2000 electronic data processing system are made of a highly abrasive epoxy resin glass fiber. The cards are too rugged for working with conventional drills so Philco's engineers are using a high-speed steel "electrolized" drill made by Morse Twist Drill & Machine Company.

Electrolizing is a patented technique which increases the tool's life up to 10 times by coating its surface with an extremely hard, dense alloy. It allows the drill to be used on highly abrasive materials without losing its cutting ability.

Before drilling, the circuit cards are imprinted with slight depressions to help the operator guide his cutting tool to the proper location. A pre-drilled brass master template controls the positioning of the drill. The drill head is designed so that if the drill is not lowered exactly into the center of a depression, the machine will not operate.

Epoxy Spray

A ONE-PART epoxy resin powder, introduced as an aerated bed coating for insulating electronic parts, can also be applied by the spray method. The resin, "Scotchcast" electrical resin No. XR-5026, is applied with a flocking type gun. It offers advantages when objects to be insulated need only partial coating, or require extensive masking.

Articles to be coated are preheated to 350-450°F. When sprayed on the hot object, particles of the resin adhere, melt and flow to form a uniform, smooth coating. By using a dust collector and spray booth system, the overspray, or unused resin, may be reclaimed.

Result is a permanent, tough finish with a normal edge coating thickness 60-75% of the flat surface finish. Thickness of the resin can be controlled by the flow of resin from the gun and by the temperature to which the part is heated. With experience, coatings ranging from approx. 5 to 30 mils are possible.

Spray coating provides a normal edge coating thickness of 60-75% of the flat surface finish.

In most cases sufficient residual heat will remain to cure the resin. If parts are small, or have a large surface to mass ratio, they may require brief post curing. Curing times and temperature range from 30 sec. at 450°F to 5 min. at 300°F.

Cured resin adheres well to metals, ceramics and glass without special priming. Adhesion strength to steel is 3,000 lb/in.^{2} The Minnesota Mining and Manufacturing Co. material is suitable for continuous operation at 155°C, with short time operation at 180°C.

• • •

Polycarbonate Resins*

ONE of the newest thermoplastics, polycarbonate* resin, offers a combination of properties for business-machine use. It can be readily fabricated by conventional methods using standard equipment.

Fig. 1: Circuit board being inserted.

Properties

The key properties of polycarbonates are shown in Fig. 1.

Dimensional stability is exceptional. The low and constant mold shrinkage of 6 mils/in. enables molding to close tolerances. Low water absorption, low coefficient of thermal expansion, and high heat distortion point assure that the molded part will maintain its dimensions within very close limits.

Polycarbonate creep resistance is more like that of thermosetting materials than of thermoplastics. In both tensile and compressive loading, creep is quite low.

The mechanical properties in tension, flexure, or compression are all on the higher end of the thermoplastic range.

The resin exhibits unusual thermal stability during processing. Molded parts exhibit good resistance to thermal-oxidative degradation up to 300°F, and have a heat distortion temp. of 280-290°F. Polycarbonate is rated as self-extinguishing by ASTM test D635.

Electrical properties are generally satisfactory for applications in insulating parts. Approval has been obtained from Underwriters' Laboratories in the support for a current-carrying part.

General toughness is maintained over the military range from —60°F to +180°F and beyond. The brittleness temp. is lower than —215°F (—137°C).

The present grade of polycarbonate is virgin resin and does not contain corrosive additives. The thermal degradation products of polycarbonate resin are also noncorrosive.

Polycarbonate stock shapes are available for machining prototypes or production parts. The resin machines somewhat like soft brass and can be worked with equipment used for metals.

Opaque, translucent and transparent colors are obtainable. Molded parts will reproduce the highest gloss which can be imparted to the mold finish.

Because of low water absorption, polycarbonate's stain resistance is excellent.

Polycarbonate sheet can be cold formed by equipment and techniques used for metal forming. Although this method of fabrication has not yet been used for polycarbonate business machine parts, it shows future promise.

Polycarbonate is resistant to hydrocarbon oils, and light machine oil is used as a machining lubricant.

In contrast to most metals, polycarbonate offers the combination of toughness and light weight.

Card Guides

Injection-molded, polycarbonate, card guides are snapped into base connector blocks and are used to hold circuit boards in position. They are molded in 4 sizes: 8-position long, 8-position short, 1-position long and 1-position short. Dimensional tolerances are extremely critical and the part must be able to hold the snap fit. Fig. 1 shows

(*Continued on page* 211)

Fig. 2: A card cover.

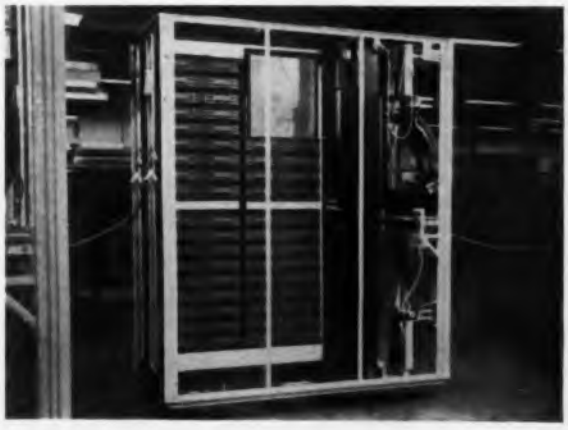


Fig. 3: Actual machine application.

* Abstracted from a speech by R. J. Thompson, General Electric Co., Pittsfield, Mass., before the Binghamton, N. Y., Regional Technical Conf. of the Society of Plastics Engineers, Stamford, Conn.

Table 1

Properties of Polycarbonate Resin

Non-corrosive and corrosion resistant	Toughness with light weight
Transparency	Dimensional stability
Machinability	Creep resistant
Colorability and gloss	Good mechanical properties
Stain resistant	Heat resistant
Cold formability	Electrical insulating properties
Oil resistant	Low and high temperature strength

New Products . . . for the Electronic Industries

COAX CONNECTORS

Coax cable connectors come in miniature or bayonet locking types.

Crimp-On connectors are provided with only three handling parts to afford convenience in assembly, post-assembly inspection and replacement of damaged connector bodies. Manufactured in either weather-proof or non - weatherproof versions, Dage Crimp - On connectors have captive contact construction and a 50 lb. cable pull minimum. Dage Electric Co., Inc., 67 N. 2nd St., Beech Grove, Ind.

Circle 221 on Inquiry Card

TANTALUM CAPACITORS

These micro - miniatures measure 0.100 x 0.090 x 0.065 in.

The design of the Minitan nonpolar solid tantalum capacitor provides small size and stability over a wide range of frequencies and temperatures. These capacitors are available in a range of values from 0.001 to 0.0047 μf which operate at 50 vnp and from 0.0068 to 0.047 μf at lower voltages. The Minitan capacitors operate at full-rated voltage from −55°C to +85°C. Components, Inc., Biddeford, Maine.

Circle 223 on Inquiry Card

INDICATOR LIGHT

Miniature billboard is for use in control consoles and aircraft.

The Model 5950 Indicator Light features compact size, 1.124 x 0.312 in.; legend readable only when indicator is lit; legend engraved on inside of lens; lens available in 4 different colors; lamps replaceable from front of panel. The unit is rated at 0.04 a @ 28 v., 0.08 a @ 14 v. or 0.2 a @ 6 v. Uses 2 MS25237 lamps retained in lens housing by spring contact clips. Control Switch Div., Controls Co. of America, Folcroft, Pa.

Circle 225 on Inquiry Card

MINIATURE RECORDER

Model PMR-500 is designed for use under field or mobile conditions.

This portable magnetic tape recorder measures only 5 x 7 x 10½ in. and weighs 10 lbs. It will handle data from dc to 100KC at 30 ips (upper freq. proportionally less at lower tape speeds) using AM and FM techniques. Any combination of record or reproduce totalling 7 channels can be handled with ½ in. tape on precision 5 in. reels. These reels accommodate 900 ft. of 1-mil tape, allowing 6 min. of recording at 30 ips and up to 96 min. at 1⅞ ips. PEMCO, 942 Commercial St., Palo Alto, Calif.

Circle 222 on Inquiry Card

ENVIRONMENT TESTER

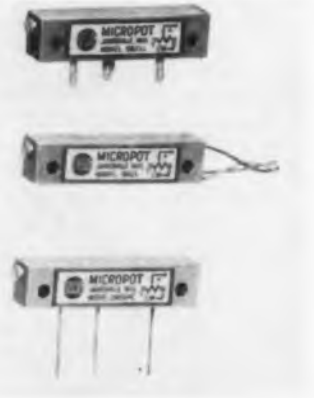
Features include humidity control from 20—95%.

The chamber, SUB-Z-H, is available in 2, 4 and 8 cu. ft. sizes, with temp. ranges of −100 to +400°F. The unit has an illuminated stainless steel chamber affording a net test area 14 x 14 x 14 in. and the cabinet exterior measures 40 x 24 x 29 in. Temp. and humidity conditions are controlled by wet and dry bulb indicating controllers, and an even temp. is accomplished by means of an 8 in. air circulator, with fin coil evaporator. Cincinnati Sub Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

Circle 224 on Inquiry Card

TRIMMING POTS

Pots are for use in computers, telemetering and missile equipment.



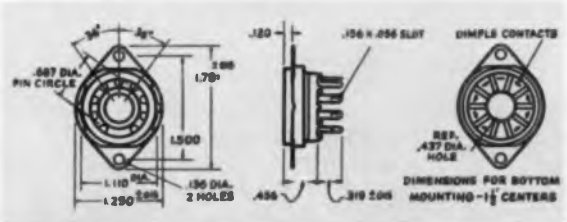
Three new series are offered: the 2800, 992 and 993. The 2800 is wirewound and offers from 10-50kΩ. Power: 1 w at 110°C. Operating temp is −55°C to±105°C. The 992 is wirewound offering 10-50kΩ. Power: 1 w at 40°C. Operating temp: −55°C to +105°C. The 993 is deposited carbon. Resistance is from 20 kΩ to 1 megohms. Power: 0.5 w at 40°C. The Micropot Potentiometers weigh 3.5—5 grams. Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wis.

Circle 226 on Inquiry Card

ONLY FROM CINCH.

NOVAR TUBE SOCKETS

DEVELOPED IN CONJUNCTION WITH THE NOVAR TUBE



ELECTRICAL RATINGS

Recommended Withstanding Voltage	Volts AC RMS	Volts DC
a. Adj. terminals (sea level)	3000	4800
b. Terminal to ground (sea level)	4300	7050

current rating – 9 amperes
contact resistance – 0.05 OHMS MAX.

NOVAR SOCKET ASSEMBLIES

BOTTOM MOUNTING	CINCH PART NUMBER
1½ mounting centers	
GP Black (CFG)	149 10 00 033
Mica (MFE)	149 19 10 034
1-5/16 mounting centers—curled saddle	
GP Black (CFG)	149 19 00 037
Mica (MFE)	149 19 10 038
1-5/16 mounting centers—pressed-on saddle	
GP Black (CFG)	149 19 00 039
Mica (MFE)	149 19 10 040

TOP MOUNTING	CINCH PART NUMBER
1-5/16 mounting centers—pressed-on saddle	
GP Black (CFG)	149 19 00 041
Mica (MFE)	149 19 10 042
1½ mounting centers—curled saddle—high voltage	
GP Black (CFG)	149 18 00 033
Mica (MFE)	149 18 10 036

- Cinch is the *only* source for Novar Sockets.
- Fits Present Chassis Cutouts. You don't have to redesign chassis to accommodate the Cinch Novar Socket; physical dimensions are the same as octal sockets.
- Electrical and mechanical tests performed according to EIA Standard JEDEC-E9-75.
- Contact Design. Contacts are designed for long-lasting resiliency and to withstand fatigue. This means dependable operation and reliability.
- Contact Finishes: insure constant voltage performance. Different finishes are available for extraordinary environmental conditions.

Write for full information today! Complete engineering data and detailed specifications are yours for the asking. Or, phone NEvada 2-2000.

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue • Chicago 24, Ill.

Division of United-Carr Fastener Corporation, Boston, Massachusetts

DOT

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri

Circle 84 on Inquiry Card

New Products . . . for the Electronic Industries

VOLTAGE COMPARATOR

Model VC-12 employs the concept of r-f measurement by comparison.

The instrument provides for the simultaneous display, on an oscilloscope, of the output voltages of the device under test and reference output voltages from either a self-contained source or an outside source for immediate comparison. It features an accurately-calibrated, variable, 2 MC r-f signal reference voltage output, variable from 1 mv to 12 v. and from −40 dbm through 0 to +30 dbm in 8 overlapping ranges. Jerrold Electronics Corp., 15th & Lehigh Ave., Phila. 32, Pa.

Circle 227 on Inquiry Card

SWEEP OSCILLATORS

These microwave units provide leveled power over the swept freq. range.

The sweep oscillators include Model 682C, covering from 1.0 to 2.0 GC (KMC); Model 683C, 2.0 to 4.0 GC; Model 684C, 4.0 to 8.1 GC and Model 686C, 8.2 to 12.4 GC. They provide either CW or swept r-f output throughout their individual bands. Each has a wide range of sweep speeds so that measurements of reflection, attenuation or gain can be displayed on an oscilloscope or recorded on X-Y or strip chart recorders. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 229 on Inquiry Card

IRON CORE R-F CHOKES

They are for use in mobile and marine communications equipment.

This #1700 series is stable from 50 KC to 790 KC and comprises 11 chokes ranging from 0.5 mh to 150 mh. They combine high inductance with low resistance and all coils are rated at 125 ma. The coils are wound on a ⅜ in. dia. x ½ in. long hollow iron core forms which are attached to 15/16 in. dia. phenolic terminal boards fitted with 2 solder lugs. The height of the unit is ⅝ in. The tolerance on inductances is ±5%. Delta Coils, Inc., 1128 Madison Ave., Paterson 3, N. J.

Circle 231 on Inquiry Card

SURVEY METER

This radiation unit is for laboratory or field use.

Model 489 Thyac II, a transistorized portable survey meter, offers interchangeable GM or scintillation probes for detection and measurement of alpha, beta and gamma radiation. These full-scale sensitivity ranges of 800, 8000 and 80,000 cpm, correspond to 0-0.2, 0-2.0 and 0-20 mr/hr of radium, and are indicated on a large meter. Ranges are readliy selected by a single switch. Power is supplied by 4 D flashlight batteries. The HV solid-state power supply is regulated. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 228 on Inquiry Card

WELDING POWER SUPPLY

Dual-range supply delivers 0.004 to 13 w-sec. of energy.

Model 1046 MA Capacitor-Discharge Power Supply is designed to provide extremely critical w-sec., dc stored energy for precision metal-to-metal joining applications. Dual-range feature permits a capacity range of 0.004 to 1.3 w-sec. and a high-range of 0.04 to 13 w-sec. Current from 110-120 vac, 50-60 CPS line is stored in a single 200 μf electrolytic capacitor. Max. repetition rate is 50 welds/min. at max. charge; 150 welds/Min. at min. charge. Weldmatic Div., Unitek, 950 Royal Oaks Dr., Monrovia, Calif.

Circle 230 on Inquiry Card

MULTI-TRACE CRT

New CRT is capable of producing three displays simultaneously.

Display is accomplished by three independently controlled electron guns. Designated Type SC-3061, the new 10-in. tube is available in a variety of phosphors, is electrostatically focused and deflected, and features an astigmatism control electrode. Deflection factors, at 5 kv anode voltage, are approx. 130 v/in. horizontal and 70 v/in. vertical. The useful horizontal scan of each parallel trace is approx 8½ in. Traces are 1⅜ in. apart on a common vertical line. Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y.

Circle 232 on Inquiry Card

Sign up for the Magnetics self-improvement course:

Here's free help to enable you to improve yourself—and your position as a magnetic circuit designer. You need it if:

You don't know how to work with $E = n\frac{d\phi}{dt}$ to reduce the size of magnetic amplifier circuits. Most men who design amplifiers for cramped operation in missiles have found it invaluable.

What's more, you may only vaguely remember $H = .4\pi\frac{NI}{\ell_m}$, so how can you use it to cut circuit size by two to ten times, and shorten response time proportionately?

It's quite possible that you, like many engineers, may have bypassed or been bypassed by magnetic circuit theory *as a working tool* while you were in school. Yet this science has opened frontiers of static control which makes an understanding imperative if you are to do your job—and further your career. For your sake (and for ours, too, because we manufacture and sell high permeability tape wound cores and bobbin cores which are used in amplifier circuits), we have started this course. Lesson 1, "How to Reduce Magnetic Circuit Size and Response Time," will be on its way to you immediately if you use the coupon below.

MAGNETICS inc.®

MAGNETICS INC., DEPT. EI-86, BUTLER, PA.

Please enroll me in your free self-improvement course, and send me "How To Reduce Magnetic Circuit Size and Response Time."

name_____

title_____

company_____

address_____

New Products . . . for the Electronic Industries

COUNTER

Type 1130-A has stable performance with all 100 tubes at 50% efficiency.

The unit measures dc—10 MC, precision 0.1 CPS. Periods 10 μsec.-10^7 sec., precision 0.1 μsec. Time intervals 1 μsec.—10^7 sec., precision 0.1 μsec. Operator has choice of 8-digital intermittent or 4-digit continuous display. Minimum time between measurements is 2/10 of a counting interval. Uses: to count random events, measure freq. ratios, or compute phase shift. Plug-in modules are used in all stages. General Radio Co., West Concord, Mass.

Circle 233 on Inquiry Card

STATIC INVERTER

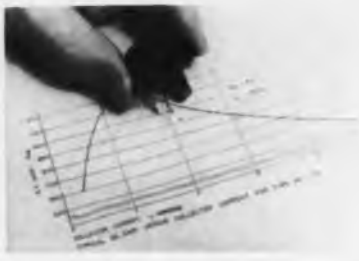
This power supply is for ballistic missile gyro motors.

Model 4333 converts 28 vdc battery power to single phase 400 CPS ac power. The unit features: Freq. precisely maintained at 400 CPS ±0.1%; output voltage regulated to 26 vac ±1%; 30 va.; continuous operation over temp. range −54°C to +71°C without heat sink or external cooling means; vibration 10G's to 2000 CPS; miniature size of 6.1 x 2.9 x 1.6 in.; weight less than 3 lbs. Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.

Circle 235 on Inquiry Card

HIGH GAIN TRANSISTORS

These silicon NPN transistors have power gains to 1000.



Featuring low saturation resistance and low thermal impedance, these high gain devices are for applications in high power, high efficiency power supplies, regulators, amplifiers and switching circuits. Two series, WX118X and WX118U have collector-emitter voltages of 50, 100, and 150 v. The WX118X has a min. current gain of 400 at 10 a, and the WX118U a min. of 100 at 10a. Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Pa.

Circle 237 on Inquiry Card

MINIATURE CAPACITORS

Typical 0.01 μf mylar-epoxy capacitors, 0.525 x 0.225 in.

Units are especially suited for printed circuit and transistor applications. Temperature stability results in a capacitance change of only 1.5% at 85°C. These Type MCA units operate from −55°C to +100°C without derating. May be operated to +125°C with 50% voltage derating. Power factor is less than 0.1% at 1 KC and 25°C. Insulation resistance: 75 K megohms min. at 100 vdc, 25°C, 2 min. Units are available ranging from 0.01 to 0.33 μfds. Hopkins Engineering Co., 12900 Foothill Blvd., San Fernando, Calif.

Circle 234 on Inquiry Card

LOW TEMP. BEARINGS

45 mm bore bearing works under rocket fuel temps. and heavy thrust load.

It meets the requirements of the field of cyrogenics — the application of various liquefied gases in missiles, electronics and industry generally. Operation in this extremely low temp. environment is made possible through improved separator design using teflon filled glass fibre reinforced with stainless steel to provide minimum weight and coeff. of friction, and overcome excessive separator wear. Industrial Tectonics, Inc., Bearing Div., 18301 Santa Fe Ave., Compton, Calif.

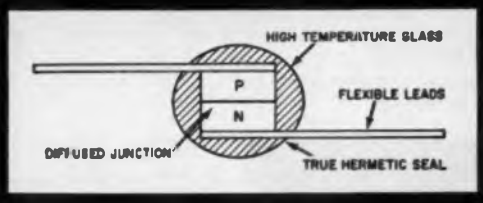
Circle 236 on Inquiry Card

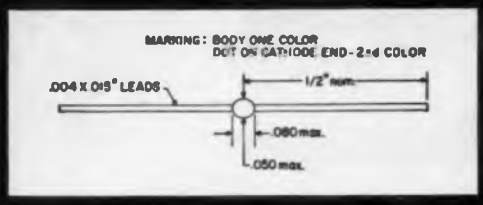
WAVEGUIDE SWITCHES

7 waveguide sizes cover the range of 3.95 to 40.0 KMC.

These manually operated devices are designed for applications in the laboratory or for microwave systems to make alternate connections between 2 waveguide inputs and 2 waveguide outputs. Full waveguide range operation is obtained with a VSWR of 1.10 max. and an isolation greater than 60 db. The switches are normally supplied with rotation in the narrow wall plane (circular bend of the rotor in the "E" plane) and are manually operated by means of a knob. Waveline Inc., Caldwell, N. J.

Circle 238 on Inquiry Card





ANOTHER FIRST FROM

Transitron

WITH A **TRUE** HERMETIC SEAL

MICRO ZENER DIODES

NO COMPROMISE!

Development by Transitron scientists and engineers of a new concept in glass packaging has now made it possible to introduce the industry's first micro-diode with true hermetic sealing. This is the new micro voltage regulator ("zener") series . . . a series in which the glass is melted *around* the silicon body that forms the working part of the device. Achievement of a direct high-temperature glass-to-metal seal means that there are no plastics . . . no multi-part packaging . . . no "gunk" . . . no degrading of characteristics with humidity. Absolute hermetic sealing makes this the most reliable and efficient micro-regulator ever developed, ideal for voltage regulating and reference service wherever space and weight economies are required.

Micro Zener Diodes are produced exclusively by Transitron. The first series is available immediately; other diodes are under development and will be marketed shortly.

For more information write for Bulletin PB-71E.

SPECIFICATIONS @ 25° C			CURRENT RATINGS	
TYPE	Voltage ① @ Iz = 5mA (Volts)	Maximum Dynamic ② Resistance (ohms)	Maximum Average ③ Operating (DC) Current @ 25° C	@ 100° C
TMD-01*	5.1	15	17.8	4.4
TMD-02	5.6	15	15.5	4.0
TMD-03*	6.2	15	14.5	3.7
TMD-04	6.8	15	13.0	3.3
TMD-05	7.5	15	12.0	3.1
TMD-06	8.2	15	11.0	2.8
TMD-07*	9.1	15	10.0	2.5
TMD-08	10.0	15	9.0	2.3

① Voltage tolerance ± 10%. For ± 5% Voltage Tolerance use "A" suffix (e.g. TMD-03A).

② Dynamic Resistance is measured by imposing a small (10% of DC bias) AC current upon the DC Test Current, 5 MADC.

③ Assume linear derating between 25° C and 100° C.

*Production types

ADDITIONAL CHARACTERISTICS AND RATINGS

Operating and Storage Temperature Range — −55° C to + 150° C

Maximum power dissipation at 25° C — 100 mW

Typical forward voltage at 5.0 mA — 0.75 volt

Circle 85 on Inquiry Card

Transitron T.

electronic corporation

wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE · CABLE ADDRESS: TRELCO

New Products . . . for the Electronic Industries

LINEAR ACTUATOR

The dc motorized unit provides 500 lbs. over a 6 in. stroke.

Actuator uses a dc motor to operate a ball screw. Rate of travel is fixed at 10 in./min. Max. allowable tension or compression load is 2500 lbs. Actuator is designed to meet Mil specs for environment and radio noise shielding. Temp. range is −65° to 300°F. Unit operates on 27 to 100 vdc; universal ac/dc operation is available. Unit measures 14 7/16 x 1¾ x 3¾ in.; weight, 3 lbs. 14 oz. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 268 on Inquiry Card

MINIATURE POTS

These ½ in. dia., 10 turn precision pots range from 50-200k Ω

Model 160 has a standard linearity tolerance of ±0.5%. Terminals are mounted on the rear housing lid providing a true ½ in. dia. pot without projections. Key specs are: Operating temp. −55°C to +125°C; power rating (40°C ambient) 2.5 w; voltage breakdown 500 v. RMS; max. starting torque 0.75 oz./in., running torque 0.5 oz./in., (bushing mount); insulation resistance 100 megohm min. at 500 vdc. Spectrol Electronics Corp., 1704 S. Del Mar Ave., San Gabriel, Calif.

Circle 270 on Inquiry Card

COAXIAL SWITCH

This coaxial switch is for use in r-f circuits to 1500 MC.

The TS-1 is a DPDT unit covering from dc to 1000 MC, and useful to 1500 MC. It has a low VSWR rating, less than 1.1 to 1000 MC and its insertion loss is less than 0.1 db for the same range. It has been designed to operate with min. leakage or cross talk. It can be used wherever constant impedance is required when switching from one r-f circuit to another or for switching equipment in and out of series connections. Telonic Industries, Inc., Beech Grove, Ind.

Circle 272 on Inquiry Card

H-F RECEIVER

This HF receiver covers from 0.2 to 30 MC, SSB, AM or CW.

Reception of upper sideband, lower sideband, AM or CW signals is provided at any freq. within the tuning range of the 51S-1. AGC characteristics and a separate product detector contribute to optimum SSB performance. A rejection notch tuning feature provides at least 40 db attenuation of unwanted signals. A level meter may be switched to indicate either r-f signal or audio output levels. Operation is from either a 115 or 230v., 50-400 CPS power source. An optional 28 vdc model is available. Collins Radio Co., Cedar Rapids, Iowa.

Circle 269 on Inquiry Card

DUAL COAXIAL COUPLER

This unit is for use in coaxial reflectometer setups.

It features extremely high directivity and a 4-to-1 freq. range. The directivity of this coupler, Model 3020, is held to 35 db min. assuring a max. error of only 1.035 VSWR. The unit covers the 250 to 1000 MC range. Coupling of each arm is held to 20 db ±1.0 db over the freq. range and the coupling of the forward and reverse arms track each other within 0.3 db total. In addition, the coupler features low main and secondary line VSWR. This model holds the main line VSWR to 1.05 max. Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y.

Circle 271 on Inquiry Card

FAMILY OF FILTERS

These filters are available in hundreds of variations.

They range in freq. from 1 KC to 110 MC. Nearly all are designed for military applications. Typical crystal filters include the large Model 189B (upper right) for commercial applications; the two-crystal Model 202 for Doppler applications; the cu. in. Model 252 very narrow bandwidth high freq. unit in the left foreground; and, with cover off, Model 69A which also has 2 filters. Three of these models, excluding the tiny Model 252, have carrier freq. in the 100 to 200 KC range. Bulova Watch Co., Inc., Electronics Div., 40-01 61st St., Woodside 77, N. Y.

Circle 273 on Inquiry Card

ENGINEERING NEWS-#4

BASIC PRECISION SWITCHES

CHECKED	ENGR.	CONTROL SWITCH DIVISION

Meet Thousands of Application Needs with these Five Basic Switch Types

STANDARD MODELS in a wide range of dimensional and characteristic designs—from the tiny, powerful sub-subminiature type to the large, general purpose type where size is not important. See each switch series for application suggestions and brief specifications.

VARIATIONS—hundreds available—designed and engineered to meet such specific requirements as:

U.L. listings
high temperatures
dry circuitry
extra long life
high electrical ratings
reset for 2-way limit
high in-rush
AN and MS specifications
special terminals

ACTUATORS—toggle, push-button, leaf, roller leaf, lever, roller lever, etc., available.

Choose the Switch Series that meets your basic application needs. Then tell us the specific characteristics you want. Chances are, we have a standard ready for your use. We are fully equipped to make the switch you need in any quantity.

perfect for super-sensitive uses...

T SERIES

SUB-SUBMINIATURE, SPDT,
1/2" x 1/4" x 3/32"
high current capacity in tiny case.
excellent shock and vibration resistance.
solder terminals, others on request.
25,000 ops. min per MIL-S-6743.
7.5 amps @ 125/250 VAC, 60 cycles Ind. & Res.

ideal for compact, precision control uses...

E4 SERIES

SUBMINIATURE, SPDT, 23/32" x 1/4" x 23/64"
low movement differential and operating force permit precision control in critical applications.
solder; single, double and long double turret terminals.
150,000 ops. @ 125/250 VAC, 2.5 amps.

for rugged, low-cost, easy wiring uses...

F SERIES

MINIATURE, SPDT, 1 1/2" x 13/32" x 5/8"
rugged, low-cost design.
convenient terminals simplify wiring.
solder, screw and spade terminals.
150,000 ops. 10 amps @ 125/250 VAC, 28 VDC Res.

good for power circuits, precision control uses...

S SERIES

2-CIRCUIT, SPDT double break. 1 1/4" x 1/2" x 1/2"
combines high capacity, moderate size, long life and precision control.
tested to 10,000,000 operations.
end and side solder, screw and spade terminals.
750,000 ops. @ 125 VAC, 10 amps., U.L. rated.

for general purpose, high in-rush and repeatability uses...

S2B SERIES

SPDT, 1 13/16" x 1 1/16" x 57/64"
tough, durable, compact.
handles high in-rush loads easily.
repeats to 10,000,000 cycles min.
screw terminals.
20 amps, 125/250/480 VAC, U.L. rated.
1/2 amp. 125 VDC; 1/4 amp. 250 VDC.

For more details on these basic precision switch types write for catalog No. 110.

CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1408 Delmar Drive, Folcroft, Pennsylvania • Telephone: LUdlow 3-2100 • TWX SHRH-H-392

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading electronic parts Distributors.

Circle 86 on Inquiry Card

All switches shown actual size.

ENGINEERING NEWS -- Basic Precision Switches

New Products . . . for the Electronic Industries

TOROIDS

Toroids are custom engineered to specifications.

Toroids are expoxy molded. Specs are: Frequency range: 20 CPS to 100 KC; power level: up to 150 w; operating temp. range: −65° to 130°C; size range: approx. 3/16 to 4 in. O. D.; dc current range: depends on the size, freq., & power level. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 274 on Inquiry Card

CERAMIC CAPACITORS

A wide range of capacities is offered in these miniatures.

Style 374 is an enamel coated capacitor only 0.320 in. long and 0.125 in. dia. Style 375 is a dipped phenolic coated capacitor only 0.330 in. long and 0.140 in. dia. Specs are: available in wide range of both TC and Hi-K dielectrics; capacitance, 2 pf−5600 pf; working voltage, 200 vdc; operating temp: to +85°C. Erie Resistor Corp., 644 W. 12th St., Erie, Pa.

Circle 276 on Inquiry Card

MINIATURE DELAY LINE

Model 37-74 has 40/1 delay time/rise time ratio.

Specs. on this new series are: Delay time: 2.5 μsec ±5%; Rise Time: 0.07 max.; Attenuation: 2 db max.; Impedance: 500 Ω; Temp. Coeff.: less than 550 ppm/°C from −55°C to +125°C; Size: 2 x 2⅝ x ⅝ in.; Tapped as required. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 278 on Inquiry Card

EHF SPECTRUM ANALYZER

Model DA 70 displays spectral information between 50 KMC and 100 KMC.

The wide band display of up to 1,000 MC can be used to observe a pulsed signal as narrow as 0.01 μsec. Applications: measuring the spectral characteristics of pulse modulated signals, development of counter-measures equipment, and in general to determine pulse widths and pulse shapes by spectrum analysis techniques. Features: complete freq. coverage with just one tuning head; dispersion continuously adjustable from 50 to 1,000 MC, freq. markers of ±5% accuracy for spectrum calibration; high sensitivity of −50 dbm (nominal) from 50 to 100 KMC. Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.

Circle 275 on Inquiry Card

DC TO DC CONVERTERS

These units are for use with Nixie® indicator tubes.

The units permit the conversion of transistor voltage levels to higher voltages to provide B+ power to the Nixie tubes. The converter can be located by the readout to eliminate high-voltage wiring within the system. Two models: The VC12-170, designed to convert +12 v. to +170 vdc and the VC28-170 designed to perform the same function from +28 v. supplies are available. Full load current output is 30ma for each unit, enough power to operate 10 standard Nixie tubes. Burroughs Corp., Electronic Tube Div., P. O. Box 1226, Plainfield, N. J.

Circle 277 on Inquiry Card

PISTON CAPACITOR

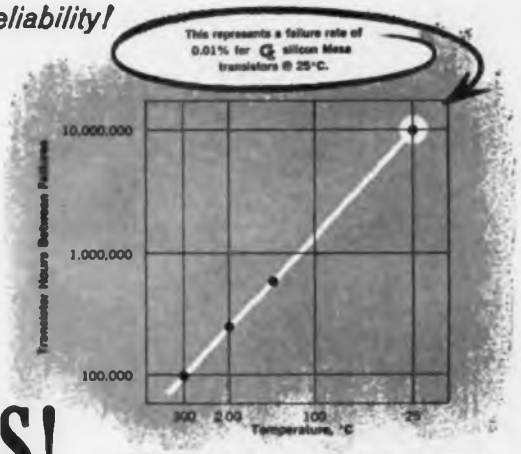
The variable slope VCJ258A is for cam adjusted tuning.

The variable slope is obtained by controlling the amount of overlap of the fixed and movable plates of the capacitor. Features of the unit are: precision machined parts and precision bore glass for fine tuning without reversals; low temp. coefficient of capacitance ±100 ppm/°C; Q in excess of 500 measured at 1 mc; low inductance and low loss for high freq. use; wide operating temp. range of −55 to +125°C.; special alloy plating with 24 carat overplating provides corrosion protection and affords high r-f conductivity; turret cap for rigid mounting of other components. JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y.

Circle 279 on Inquiry Card

General Instrument Semiconductor... Leader in Reliability!

GI ANNOUNCES INDUSTRY'S MOST RELIABLE SILICON MESA TRANSISTORS!



PROOF! Extended life tests at each of temperatures shown above, demonstrate GI superior mesa performance with 0.01%/per 1000 hrs. failure rate at 25°C.

General Instrument Semiconductor has achieved a major breakthrough in transistor manufacture! Through detailed research, careful product development and advanced production techniques we offer *the most reliable silicon mesa transistors available today!*


Microphotograph shows precision of junction metalizing and lead contacting.

Exclusive combination of reliability benefits offered by GI through long-term R & D:

- Advanced techniques of junction metalizing;
- Superior junction contacting;
- Permanent surface passivation;
- 100% lot stabilization with 96-hour bake at 300°C; and
- Critical analysis with automatic equipment for exhaustive parameter testing.

COMPLETE LINE OF GI SILICON MESAS...FROM STOCK

What are *your* needs? General Instrument offers a full line of double diffused NPN silicon mesas for your most exacting applications. Abbreviated ratings and characteristics below indicate a wide range of usefulness: Very high speed saturated switching; VHF tuned amplifiers; and units with high beta linearity for magnetic memory drivers and video amplifiers.

Available in accordance with MIL-S-19500/99A (GI 2N696, 2N697) and MIL-S-19500/120 (GI 2N706). Contact General Instrument today for more information on these realistically-priced units, and the name of your local authorized stocking distributor.

GENERAL INSTRUMENT NPN SILICON MESA TRANSISTORS

Type	Case	RATINGS BV_{CES}	RATINGS BV_{EBO}	RATINGS Maximum Dissipation (T_{case} = 25°C)	CHARACTERISTICS I_{CBO}	CHARACTERISTICS h_{FE} V_{CE} = 10 v I_C = 150 ma pulsed	CHARACTERISTICS h_{fe} V_{CE} = 10 v I_C = 50 ma f = 20 Mc	CHARACTERISTICS V_{BE} I_B = 15 ma I_C = 150 ma	CHARACTERISTICS V_{CE} (SAT.) I_B = 15 ma I_C = 150 ma	CHARACTERISTICS C_{ob} @ I_E = 0 V_{CB} = 10 v
2N696	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1 μa max T = 150°C Ambient: 100 μa max	20 min 60 max	2 min	1.3 v max	1.5 v max	35 pf max
2N697	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1 μa max T = 150°C Ambient: 100 μa max	40 min 120 max	2.5 min	1.3 v max	1.5 v max	35 pf max
2N699	TO-5	120 v	5 v	2 watts	@ V_{CB} = 60 v T = 25°C Ambient: 2 μa max T = 150°C Ambient: 200 μa max	40 min 120 max	2.5 min	1.3 v max	5.0 v max	20 pf max
2N706	TO-18	25 v	3 v	1 watt	@ V_{CB} = 15 v T = 25°C Ambient: 0.5 μa max T = 150°C Ambient: 30 μa max	V_{CE} = 1 v I_C = 10 ma 15 min	V_{CE} = 15 v I_C = 10 ma f = 100 Mc 2 min	I_B = 1 ma I_C = 10 ma 0.9 v max	I_B = 1 ma I_C = 10 ma 0.6 v max	6 pf max
2N1252	TO-5	30 v	5 v	2 watts	@ V_{CB} = 20 v T = 25°C Ambient: 10 μa max T = 150°C Ambient: 600 μa max	15 min 45 max	2 min	1.3 v max	1.5 v max	45 pf max
2N1253	TO-5	30 v	5 v	2 watts	@ V_{CB} = 20 v T = 25°C Ambient: 10 μa max T = 150°C Ambient: 600 μa max	30 min 90 max	2.5 min	1.3 v max	1.5 v max	45 pf max
2N1420	TO-5	60 v	5 v	2 watts	@ V_{CB} = 30 v T = 25°C Ambient: 1.0 μa max T = 150°C Ambient: 100 μa max	100 min 300 max	2.5 min	1.3 v max	1.5 v max	35 pf max

GENERAL INSTRUMENT GENERAL TRANSISTOR

GI SEMICONDUCTOR
DIVISION OF GENERAL INSTRUMENT CORPORATION
55 Gouverneur Street, Newark 4, New Jersey

IN CANADA: General Instrument Ltd., Semiconductor Division, P.O. Box 9, 151 Weber Street South, Waterloo, Ont., Canada.

AIR POLLUTION PROBLEM SOLVED. Lehigh Portland Cement plant at Mitchell, Indiana, removes more than 99% of dust and impurities from kiln exhaust gases with four Buell Electrostatic Precipitators. Westinghouse Silicon Rectifier Stacks in the precipitators have operated without a single failure since installation in February, 1960. Rectifier units (in building above) do not require maintenance, temperature control, or ozone ventilation.

COMPACT HIGH VOLTAGE INSTALLATION. Westinghouse Silicon Rectifier Stacks are housed in Buell Transformer Rectification Unit (left rear). Tank (center foreground) is the separate Immersed Distribution High Voltage Switch Unit. An alternate Buell model encloses both units in a single tank.

SPECIAL TRUCKS DISPOSE OF WASTE. Dust that is not recirculated is transferred from precipitators to special dust-tight trucks. Hoppers and other related precipitator equipment are also designed and manufactured by Buell Engineering Company, New York, N.Y.

Progress in high voltage with semiconductors:

WESTINGHOUSE SILICON RECTIFIER STACKS PROVIDE UNLIMITED FAILURE-FREE LIFE... HELP PRECIPITATORS COLLECT OVER 99% OF CEMENT DUST

Westinghouse Silicon Rectifier Stacks provide the 50 kilovolts required by Buell Electrostatic Precipitators in this Lehigh Portland Cement plant installation. In 12 months of round-the-clock operation these Westinghouse stacks have provided continuous failure-free output —with no parts replacements, no maintenance! Electrical efficiency is 95% plus! For Lehigh Portland Cement Company this means no production downtime, no maintenance costs, and lower power costs. For Buell Engineering Company, it means no service calls, complete customer satisfaction, and a product that is superior to precipitators based on mechanical, vacuum tube or selenium rectifiers.

Electrostatic precipitators impose severe current demands on their power supply. Sparking between electrodes and varying dust deposits cause momentary current surges of large magnitudes. Westinghouse research engineers have developed exclusive fail-safe circuits—the first to provide ideal voltage division under all load conditions. As a result, in electrostatic precipitators and other industrial applications, including radio broadcasting transmitters, pulse generators and radar transmitters, Westinghouse stacks have achieved an unprecedented record of more than 20,000,000 hours of failure-free operation.

For more information on electrostatic precipitators—or how Westinghouse Silicon Rectifier Stacks may provide a more reliable, low-cost source of rectified power for your needs—you are invited to call or write: **Westinghouse Electric Corp., Semiconductor Dept., Youngwood, Penna.** SC-1014

Westinghouse

Circle 88 on Inquiry Card

20,000,000 FAILURE-FREE STACK HOURS! There is no record of a single stack failure since these devices first became available to industry. In Buell Transformer Rectification units, 16 stacks are used to provide power in the 50 kilovolt range.

CO-ORDINATED ENGINEERING AT WORK. Westinghouse Sales Engineer, James Corson (left), discusses design requirements with Buell's Chief Electrical Engineer, L. L. Nagel, and V. P. of Engineering, H. C. Dohrmann. Co-ordinated engineering enables Semiconductor engineers at Youngwood to work closely with equipment manufacturers to develop new products according to parameters specified by customer engineering departments.

New Products . . . for the Electronic Industries

MICROWAVE AMPLIFIER

This 1 w amplifier covers from 12.4 to 18 KMC.

The amplifier can be used as a broadband power amplifier; stable power oscillator using external resonant feedback network; or a narrow band amplifier for freq. multiplication. The unit incorporates: rated gain and power output over each range at one setting of controls and 30 db gain at rated power. The amplifier consists of a TW tube, focusing magnet, and a completely regulated supply. Alfred Electronics, 897 Commercial St., Palo Alto, Calif.

Circle 280 on Inquiry Card

POTENTIOMETERS

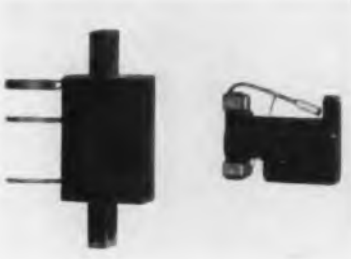
The #8000 miniature multi-turn units are for bushing or servo mount.

The servo mount includes the added features of ball bearings and close mechanical tolerances for servo or machine-driven applications. The resistance element of this ⅞ in. dia. unit is drawn alloy wire, which is wound onto an insulated copper core. Resistance and linearity tolerances are ±5% with a resistance range of 25 Ω to 250K Ω. Power is 3 w at 40°C derated to 0 at 125°C. International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle 282 on Inquiry Card

TINY FUSE & HOLDER

This fuse flashes a colored flag to show an open circuit.



The Buss GMT fuse and Buss HLT holder are designed to permit multiple mounting of fuses in extremely small places. The spring carrying the flag also makes contact with an alarm circuit to light a lamp or ring a bell. Enclosed construction results in shockproof, quick fuse replacement. Holder is designed so fuse cannot be incorrectly inserted. GMT fuses are made in many sizes up to 10a. Bussmann Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

Circle 284 on Inquiry Card

PLUG-IN RELAY

Clapper type relay with 8 or 11 pin octal plug has a plastic case.

Designated Class 88CP, the new relay has been developed to provide long life reliability. For example a rugged, pin type armature hinge with centerless ground stainless steel pin and oversize precision reamed bearing surfaces minimizes friction for max. contact pressure and minimizes wear for long life. IA is available with 10a silver alloy contacts, SPDT, DPDT and 3PDT; for 6, 12, 24 and 115 vac or vdc actuation, also for dc current actuation. Dimensions, 1¾ x 1⅝ x 2 1/16 in. above plug-in socket. Magnecraft Electric Co., 3350H W. Grand Ave., Chicago 51, Ill.

Circle 281 on Inquiry Card

TERMINAL BOARDS

These units are available with 125a terminals.

Designated the CR151A, the complete line of sectional terminal boards are available with box, screw, saddle-clamp, quick-connect, and half quick-connect—half saddle clamp terminals in 25a; with 50a box terminals, 30a fuse blocks and 125a box terminals. Available in pre-assembled forms with mounting lengths from 3½ to 48 in. the sectional boards are also available in building block kits. A new, write on marking strip, that can be marked by any type ink or pencil is available for the sectional boards. General Electric Co., Schenectady 5, N. Y.

Circle 283 on Inquiry Card

SPECTRAL LAMP

Light source is for use in optically pumped resonance systems.

The Model X49-609 Research Rubidium Spectral Lamp consists of a precise amount of alkali metal and noble gas in a transparent bulb mounted in the inductive winding of a free-running 100 MC excitation oscillator. It provides a high-proton flux at a correspondingly high signal-to-noise ratio. Substantially, the only noise present in the spectral output of the lamp is the fundamental limiting optical photon shot noise of the discharge. Potassium, cesium, sodium, and mercury discharge bulbs are also available. Varian Associates, Instrument Div., Palo Alto, Calif.

Circle 285 on Inquiry Card

INVITATION TO INVENTION IN CIRCUIT DESIGN

WHERE HIGHEST QUALITY IS IN VOLUME PRODUCTION

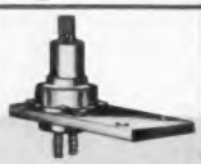
Listed below are silicon rectifiers representative of the Tarzian line. They are available in production quantities, at realistic prices, for both commercial and military applications.

Of particular importance in simplifying your power conversion circuitry assemblies are small size, high efficiency, mounting versatility and wide range of ratings offered by the Tarzian line.

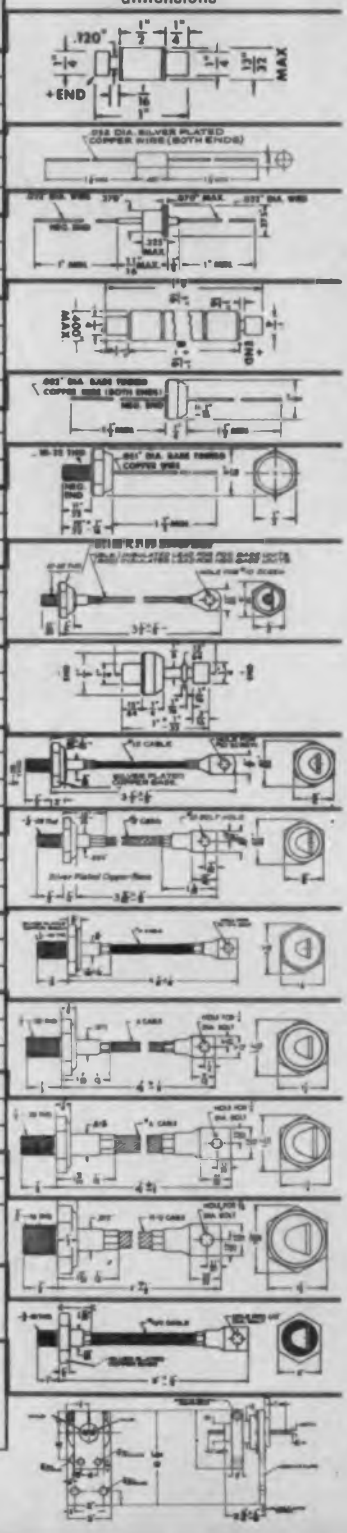
In addition, the entire line features extremely low junction current density for maximum reliability and operating life. This is due to the special Tarzian alloy process with supported junction that produces the largest junctions available.

Altogether, the qualities and availability of the units cataloged here are invitations to invention in circuit design. Application engineering service is also available without obligation. Call the Sarkes Tarzian representative near you, or write Sarkes Tarzian, Inc., for complete catalog information.

SILICON RECTIFIERS

	amps. DC (100°C)		peak inverse voltage	max RMS volts	Max. amps. recurrent peak	Max. amps. surge 4MS	Tarzian Type	Jedec No.	Tarzian Type	Jedec No.
Typical LOW CURRENT units	0.5		200	140	5	30	20M	1N1082		
			400	280	5	30	40M	1N1084		
			600	420	5	30	60M	—		
	0.5		200	140	5	75	F-2	1N2482		
			400	280	5	75	F-4	1N2483		
			600	420	5	75	F-6	1N2484		
	0.5		200	140	5	75	20H	1N2485		
			400	280	5	75	40H	1N2487		
			600	420	5	75	60H	1N2489		
	0.45		800	560	4.5	27	80SM	1N1108		
	0.4		1600	1120	4	24	160SM	1N1110		
	0.35		2400	1680	3.5	21	240SM	1N1112		
	0.325		2800	1960	3.25	19.5	280SM	1N1113		
Typical MEDIUM CURRENT units	1.5		200	140	10	100	20J1	1N1618		
			400	280	10	100	40J1	1N1620		
			600	420	10	100	60J1	—		
	10		200	140	50	150	20J2	1N1622		
			400	280	50	150	40J2	1N1624		
			600	420	50	150	60J2	—		
	12		200	140	72	150	20J3	—		
			400	280	72	150	40J3	—		
			600	420	72	150	60J3	—		
	2		200	140	30	100	20LA	1N1086		
			400	280	30	100	40LA	1N1088		
			600	420	30	100	60LA	—		
							NEGATIVE		POSITIVE	
Typical HEAVY CURRENT units	20		200	140	120	200	20R3N		20R3P	
			400	280	120	200	40R3N		40R3P	
			600	420	120	200	60R3N		60R3P	
	35		200	140	210	350	20S3N	—	20S3P	—
			400	280	210	350	40S3N	—	40S3P	—
			600	420	210	350	60S3N	—	60S3P	—
	50		200	140	300	500	20T3N	—	20T3P	—
			400	280	300	500	40T3N	—	40T3P	—
			600	420	300	500	60T3N	—	60T3P	—
	100		200	140	600	1000	20V3N	—	20V3P	—
			400	280	600	1000	40V3N	—	40V3P	—
			600	420	600	1000	60V3N	—	60V3P	—
	150		200	140	900	1500	20W3N	—	20W3P	—
			400	280	900	1500	40W3N	—	40W3P	
			600	420	900	1500	60W3N	—	60W3P	
	250		200	140	1500	2500	20Y3N	—	20Y3P	
			400	280	1500	2500	40Y3N	—	40Y3P	
			600	420	1500	2500	60Y3N	—	60Y3P	
	350		200	140	2100	3500	20G3N	—		
	1000		200	140	6000	10000	20ZB	—		

dimensions



 Printed in U.S.A.

HIGH VOLTAGE SILICON CARTRIDGE RECTIFIERS

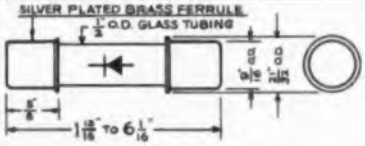
Each of the two series of Tarzian Silicon Cartridge Rectifiers shown below includes 18 different types with operating temperatures ranging from —55°C to 150°C ambient. Both the ferrule mounted series and the axial lead series feature low voltage drop and low reverse current. Tarzian High Voltage Cartridges are manufactured to meet standard Jedec classifications.

FERRULE MOUNTED SERIES—This high voltage series is equipped with a ferrule type mounting of silver plated brass and is available in both hermetically sealed glass or phenolic tubing in voltages ranging from 1000 to 10,000 peak inverse volts.

AXIAL LEAD SERIES—This high voltage series is available in units ranging in size from ½" to 2½" and lead lengths varying from 1" to 2½". Peak inverse voltage ratings are available from 1500 to 16,000 volts.

FERRULE MOUNTED SERIES

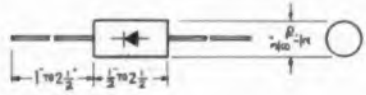
Operating Temperature Range —55°C to 150°C Ambient		Max. Ratings Half Wave Res. Load at 75°C Ambient	
Jedec Type	Sarkes Tarzian Type	Peak Inverse Volts	Max. Rectified DC Output MA
1N1133	S-5490	1500	75
1N1140	S-5497	3600	65
1N1143A	S-5501	6000	65
1N1146	S-5504	8000	45
1N1148	S-5506	14000	50
1N1149	S-5507	16000	45



When ordering phenolic tubing as a substitute for glass tubing, add the letter "P" to S.T. Type No.

AXIAL LEAD SERIES

Operating Temperature Range —55°C to 150°C Ambient					
Jedec Type	S.T. Type	Peak Inverse Volts	Max. RMS Input Volts*	Max. Rect. DC Output (MA) 25°C	100°C
1N1730	S-5518	1000	700	200	100
1N1731	S-5519	1500	1050	200	100
1N1734	S-5522	5000	3500	100	50
1N2375	S-5525	1500	1050	200	100
1N2379	S-5529	4000	2800	100	50
1N2385	S-5535	10000	7000	70	55

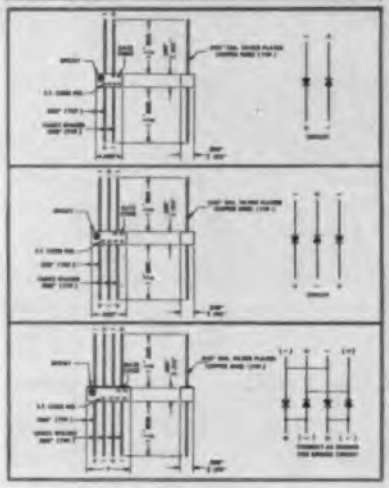


*Derate 50% for capacitive load in half wave circuits. For capacitive, motor, or battery loads, derate DC current by 20%.

MODULAR SILICON RECTIFIERS

Modular Silicon Rectifiers can be used individually—as open bridges—or in a variety of circuit combinations, and are designed for printed circuits on terminal strips. Each of the units illustrated and tabulated below is only one of a series of six in the 18-unit Tarzian line.

Tarzian Code Number	Individual Diode Current Rating	Circuit Connections	Piv
S-5541	500MA	Center tap, Doubler	600
S-5549	500MA	3 phase Half Wave	600
S-5467	500MA	Bridge	600



TUBE REPLACEMENT SILICON RECTIFIERS

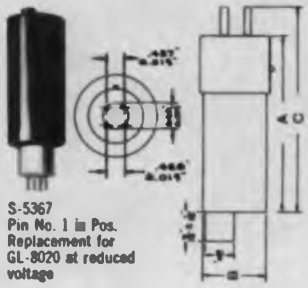
Tarzian tube replacement rectifiers, in addition to being directly interchangeable with over 95% of all popular vacuum tube rectifiers, are smaller, more compact, and carry dc current ratings as much as three times as great as the tubes they replace. They have proved highly satisfactory in applications requiring high efficiency, long life, rugged construction and wide temperature ranges. Tarzian solid state rectifiers are available in ten standard models, with special designs and modifications on request. Special tube replacement units designed by Tarzian engineers include special designs with peak inverse voltages to 19,000 volts.

S-5018
Pin Connection
Pin #8 (Cathode)
Pin #4 and #6 (Anode)
Replacement for types 5AU4, 5AW4, 5A24, 5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4, 5931, 6087, 6106.

S-5019
Pin Connection
Pin #8 (Cathode)
Pin #6 and #4 (Anode)
Replacement for 5R4

S-5130
Pin No. 1 is Pos.
Replacement for 866, 866A, JB29

S-5207
Pin Connection
Pins #1 and #5 are A.C. (Anode)
Pin #7 is Pos. (Cathode)
Replacement for 6X4, 6063, 6202.



S-5367
Pin No. 1 is Pos.
Replacement for GL-8020 at reduced voltage

Tarzian Type	JEDEC Number	Max. Peak Inverse Voltage	Max. RMS Voltage	Max. Peak Current (ma)	Max. DC Current (ma)	Circuit	Type Load	Max. Ambient Temp.	Dimension "A" (inches)	Dimension "B" (inches)	Dimension "C" (inches)
S-5018	1N-1238	1,600	1,100	8,000	750	F.W.	Any	100°C	2 21/32	1 1/8	3 7/32
S-5019	1N-1239	2,800	1,950	5,000	500	F.W.	Any	100°C	3 3/4	1 3/8	4 5/16
S-5130	—	10,400	*7,400	3,000	300	H.W.	Res.-Ind.	100°C	4 7/16	1 7/32	8 1/8
S-5207	1N-2490	1,600	1,100	5,000	500	F.W.	Any	100°C	1 1/2	13/16	1 3/4
S-5367	—	19,000	13,400	2,500	250	H.W.	Res.-Ind.	100°C	6	2 1/16	6 19/32

*For capacitive loads derate input voltage 50%, and current 20%.

NEW BELL LABORATORIES RESEARCH FORESHADOWS COMMUNICATIONS AT OPTICAL FREQUENCIES

A revolutionary new device, the continuously operating Optical Gas Maser, now under investigation at Bell Telephone Laboratories, foreshadows a whole new medium for communications: light.

Light waves vibrate at frequencies tens of millions of times higher than broadcast radio waves. Because of these high frequencies, a beam of light has exciting potentialities for handling enormous amounts of information.

Now for the first time, Bell Laboratories' new Optical Gas Maser continuously generates light waves that are "coherent." That is, the light waves move in phase as seen looking across the beam.

With further research, it is expected that such beams can be made to carry large amounts of information. The beams can be transmitted through long pipes. They can be projected very precisely through space, and might be used for communications between space vehicles.

Research with coherent light is another example of how Bell Laboratories prepares ahead for communications needs.

The Optical Gas Maser (above) was first demonstrated at Bell Telephone Laboratories. Heart of unit is a 40-inch tube containing helium and neon. Interaction between gas atoms produces a continuous, coherent beam of infrared light that may one day be used in communications.

BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

New Tech Data for Engineers

Facilities Brochure

A new 12-page, 2-color illustrated brochure portrays the Magnasync Corp.'s history, research, engineering and production facilities in the field of magnetic recording systems and ground support systems. Generalized proprietary product line is also illustrated. Magnasync Corp., 5546 Satsuma Ave., N. Hollywood, Calif.

Circle 176 on Inquiry Card

Transistor Supply

Harrison Laboratories, Inc., 45 Industrial Rd., Berkeley Heights, N. J., offers a technical data sheet 890A covering their 300 v. transistor power supply. The output is continuously variable from 0-320 v. at any current from 0-600 ma.

Circle 177 on Inquiry Card

Inductive Components

Designed to conserve time for the busy engineer, Catalog #103 of Dresser Electronics, HST Division features nearly 300 off-the-shelf MIL-T-27A transformers, chokes and reactors available from leading electronic jobbers throughout the United States and Canada. Detailed photographs, diagrams, dimensions, performance information and engineering data are provided on all units to simplify selection of the right transformer to meet specific engineering requirements. Dresser Electronics, HST Div., 555 N. 5th St., Garland, Tex.

Circle 178 on Inquiry Card

Valve Data

English Electric Valve Co. Ltd., of Chelmsford, England, has issued a 40-page multi-colored quick reference brochure entitled, "Abridged Valve Data." Included in this handy reference book are rectifiers, germanium rectifiers, triodes, tetrodes, cold cathode tubes, thyratrons, klystrons, magnetrons, BWO storage tubes, TWT's and TV camera tubes. Complete specs are included.

Circle 179 on Inquiry Card

Silicon Photo Cells

Technical data sheets on silicon photo cells, for applications such as perforated tape and punched card readout systems, are offered by Texas Instruments Incorporated, P. O. Box 312, Dallas, Tex. Information covers the LS-222 designed to read columns and the LS-223 designed to read rows of punched holes. The LS-222 is glass encapsulated and illuminated from the side while the LS-223 has an aperture in its head and is mounted in a self-indexing metal case.

Circle 180 on Inquiry Card

Pulse Transformers

A general information catalog on the parameters covered by Datapulse transformers may be obtained from PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif. By means of a series of graphs and charts included in the catalog, an engineer may determine the exact pulse transformer suited to meet his requirements.

Circle 181 on Inquiry Card

Impulse Magnetizer

A new magnetizer provides faster response and cycle time than conventional capacitor discharge type models. Operating manually or by means of a cam, it may be triggered as often as desired without a time-consuming charging interval between cycles. No special dc equipment is required. Indiana Steel Products Div., Indiana General Corp., Valparaiso, Ind. Engineering Bulletin 365.

Circle 182 on Inquiry Card

Capabilities Brochure

A 20-page, multi-colored facilities and capabilities brochure has been issued by Faradyne Electronics Corp., 471 Cortlandt St., Belleville, N. J. The brochure describes the facilities, capabilities and products of Faradyne's 9 subsidiaries. Typical areas covered are Mylar capacitors, solid state tantalum capacitors, tungsten wire, vacuum metalizing coils, lead wire assemblies, high precision coils, magnetic components, glass and ceramic parts, precision glass products and specialized ceramic forms.

Circle 183 on Inquiry Card

Crystal Filters

Systems Inc., 2400 Diversified Way, P. O. Box 7726, Orlando, Fla., is offering a catalog describing their line of precision crystal filters. Photographs, specs. and graphs are included on upper sideband, lower sideband, and band-pass filters.

Circle 184 on Inquiry Card

Materials Tester

A standardized, calibrated, high temp. materials testing apparatus for operation in the 30-200 KW power range, producing 10,000 mph gas streams with stagnation pressures ranging from 1 to 20 atmospheres has been announced by the Thermal Dynamics Corp., Lebanon, N. H. Information and complete specs. are included in Plasma-fax Bulletin PF-15. With this tester, it is possible to measure heat conduction and resistance in thermal shock and ablation environments.

Circle 185 on Inquiry Card

Power Supplies

Christie Electric Corp., 3410 W. 67th St., Los Angeles 43, Calif., has just published an 8-page bulletin, AC-60-1, on silicon rectifier power supplies. This 3-color bulletin describes their line of automatically regulated and manually controlled power supplies. Graphs, specs. and photographs are included.

Circle 186 on Inquiry Card

Repeater Amplifier

A fully transistorized repeater amplifier for the transmission of voice frequencies for telephone line applications has been announced by The Hoover Co., Electronics Div., 110 W. Timonium Rd., Timonium, Md. The amplifier has a min. gain of 38 db with a freq. response within +1 db and −3 db over the range from 300 to 3500 CPS.

Circle 187 on Inquiry Card

Passive Repeater Manual

A 48-page Passive Repeater Engineering Manual No. 161 is intended for use by microwave systems engineers and others concerned with the application of passive repeaters. This manual describes in detail the use of passive repeaters and provides the technical data necessary to properly design passives into microwave systems. Specs., photographs and charts are included. Microflect Co., Inc., 3450-25th St. S.E., Salem, Ore.

Circle 188 on Inquiry Card

Semiconductor Products

Hoffman Electronics Corp., Semiconductor Div., 1001 N. Arden Drive, El Monte, Calif., is making copies available of their November-December 1960 issue of SPAN (Semiconductor Products Application News). Featured in this issue is an article on "Quality Assurance and Reliability" and an application article entitled, "Photovoltaic Readout Circuitry." Also appearing in this issue of SPAN are articles on a new series of diffused silicon transistors, types 2N1717, 2N1718, 2N1644, 2N1252, and 2N1253.

Circle 189 on Inquiry Card

AC Motors

Air Marine Motors, Inc., Bayview Ave., Amityville, L. I., N. Y., is offering a comprehensive catalogue covering their line of fractional and subfractional hp ac motors. This catalogue represents sections of a master catalog listing motors, blowers and fans. Detailed electrical and mechanicals specs. are given on hundreds of motors in the Air Marine line.

Circle 190 on Inquiry Card

FIRST* DC Standards Laboratory

PRIMARY-STANDARD
DC VOLTAGE DIVIDER
0.0001 % ABSOLUTE

PRIMARY-STANDARD
ABSOLUTE DC VOLTAGE REFERENCE
0.0001 % ABSOLUTE

PRIMARY-STANDARD
DC VOLTAGE-CURRENT POTENTIOMETER
VOLTAGE 0.0015% ABS.
CURRENT 0.003% ABS.

ULTRA-PRECISE
DC VOLTAGE GENERATOR-CALIBRATOR
0.0015 % ABSOLUTE

ULTRA-PRECISE
DC CURRENT GENERATOR-CALIBRATOR
0.003 % ABSOLUTE

ULTRA-SENSITIVE
DC AMPLIFIER-NULL DETECTOR
2μV THRESHOLD

This instrument complex is unique.

It provides complete facilities for the performance of every type of DC Calibration and Standardization — at absolute accuracies an order of magnitude better than conventional laboratory potentiometers and references.

Over the past five years, a growing number of standards and calibration laboratories have purchased it to replace less accurate, less versatile, less dependable equipment.

NBS certifications and test reports over five years consistently verify the validity of our absolute accuracy and stability ratings.

May we send you a complete description?

Model PVC-504, $6,400. Available with NBS certification and test data at additional cost.

*and only commercially-available instrumentation
— providing complete DC measurement facilities.
— based entirely on self-contained Primary Standards.

J·R·L

INSTRUMENT NETWORKS, INC. MANUFACTURING SUBSIDIARY OF
JULIE RESEARCH LABORATORIES, INC.
556 W. 168th Street, New York 32, N. Y. LOrraine 8-8700

New Tech Data for Engineers

Auxiliary Test Equipment

Tektronix, Inc., P. O. Box 500, Beaverton, Ore., is offering 3 pamphlets describing their auxiliary equipment. Written in catalog style with complete specs., performance characteristics and pertinent illustrations, the three 8 page pamphlets give a detailed presentation of amplifiers; square-wave and pulse generators; and time-mark and sine-wave generators.

Circle 191 on Inquiry Card

Timing Devices

Minarik Electric Co., 224 E. 3rd St., Los Angeles, Calif., has announced the availability of a catalog listing engineering information, dimensions for small electro-mechanical drive systems, timing devices, variable speed controls, speed reducers and electric motors.

Circle 192 on Inquiry Card

Phase Standard

A 2-color brochure describes a variable phase standard which permits phase between 2 self-generated voltages to be shifted to any desired angle with an accuracy of $\pm 0.05°$ or better. Included in the brochure are technical specs., detailed circuitry description and a simplified block diagram. Gertsch Products, Inc., 3211 So. La Cienega Blvd., Los Angeles 16, Calif. Bulletin VPS-1

Circle 193 on Inquiry Card

Test Meter

A 2-color data sheet describes the "V O Matic 360." It is an automatic volt-ohm-milliammeter with burn-out proof meter. The unit is designed for use on the production line, in factory maintenance or in the laboratory. B & K Mfg. Co., 1801 W. Belle Plaine Ave., Chicago 13, Ill. Bulletin No. C-160-360

Circle 194 on Inquiry Card

Semiconductor Data/Filer

A functional data/filer folder designed for convenience in cataloging Engineering Standards Data Sheets on Microwave Associates microwave video, mixer, special purpose, varactor, and high-speed computer diodes is available from Microwave Associates, Inc., Burlington, Mass. The new data/filer is a file folder also punched so that it may be used in a file or in any standard ring-binder as desired. Individual data sheets on their newest diodes with electrical and mechanical characteristics and featuring application suggestions and operation curves are included.

Circle 195 on Inquiry Card

Printed Circuitry

Information is available about Dielox printed circuitry. It is a new concept in the use of substrate materials and circuit deposition techniques, using dielectric oxides (Dielox) on prefabricated metal bases. Dielox printed wiring is designed for long term, continuous operation at elevated temperatures. Electralab Printed Electronics Corp., Industrial Center, Needham Heights 94, Mass.

Circle 196 on Inquiry Card

Glass Components

A 4-page, 3-color technical data booklet is offered by the Kearfott Div., General Precision, Inc., Little Falls, N. J., on precision glass products. Three different vertical sensing elements are featured with photographs, diagrams, and specs.

Circle 197 on Inquiry Card

Graphic Tube Aid

Amperex Electronix Corp., 230 Duffy Ave., Hicksville, L. I., N. Y., announced the "Computa-Guide," a graphic aid devised for quickly determining the performance of r-f doublers and triplers, as well as straight-through amplifier electron tubes. The computer guide is printed on durable laminate plastic. For convenience, all formulas needed to derive final tube performance are also printed on the guide. Furnished with the guide is a highly detailed, illustrated instruction booklet, which also includes hints and short cuts to enable the engineer to use the guide to its fullest advantage.

Circle 198 on Inquiry Card

Facilities Brochure

The American Society for Metals, Metals Park, Novelty, Ohio, has issued a brochure which outlines ASM's new Information Searching Service. It is a method for retrieving information about metals from the whole world's technical literature, patents and U. S. Government reports.

Circle 199 on Inquiry Card

Facilities Brochure

Consolidated Diesel Electric Corp., Stamford, Conn., has issued a 20-page, 3-color brochure describing their services, facilities and products. Information on their various divisions is included along with photographs. Some of the various fields covered by these divisions is instrumentation and control, data processing, testing, aircraft and missile ground support, power generation and weapons support systems.

Circle 200 on Inquiry Card

Chopper Transistors

A 16-page technical application bulletin #2107 giving a comprehensive discussion of transistor characteristics required in low level chopper applications is now available from the Sperry Semiconductor Div. of Sperry Rand Corp., Norwalk, Conn. The bulletin features a series of circuit diagrams, performance charts, and graphs, equations, and general characteristics.

Circle 201 on Inquiry Card

Jacks

Photographs, diagrams, specs., and components schematics are included in a technical data sheet issued by Carter Parts Co., 3401 Madison St., Skokie, Ill. The sheet describes their line of Imp-Twin molded jacks designed for use in portable equipment.

Circle 202 on Inquiry Card

Telemetry Receiver

Technical data sheet C-002 describes a new addition to the Nems-Clarke Telemetry Receiver line. It is a compact, light weight, precision receiver for FM, AM and CW signals in the 30 to 260 MC range. Vitro Electronics, Div. of Vitro Corp. of America, 919 Jesup-Blair Dr., Silver Spring, Md.

Circle 203 on Inquiry Card

Hydrogen Thyratrons

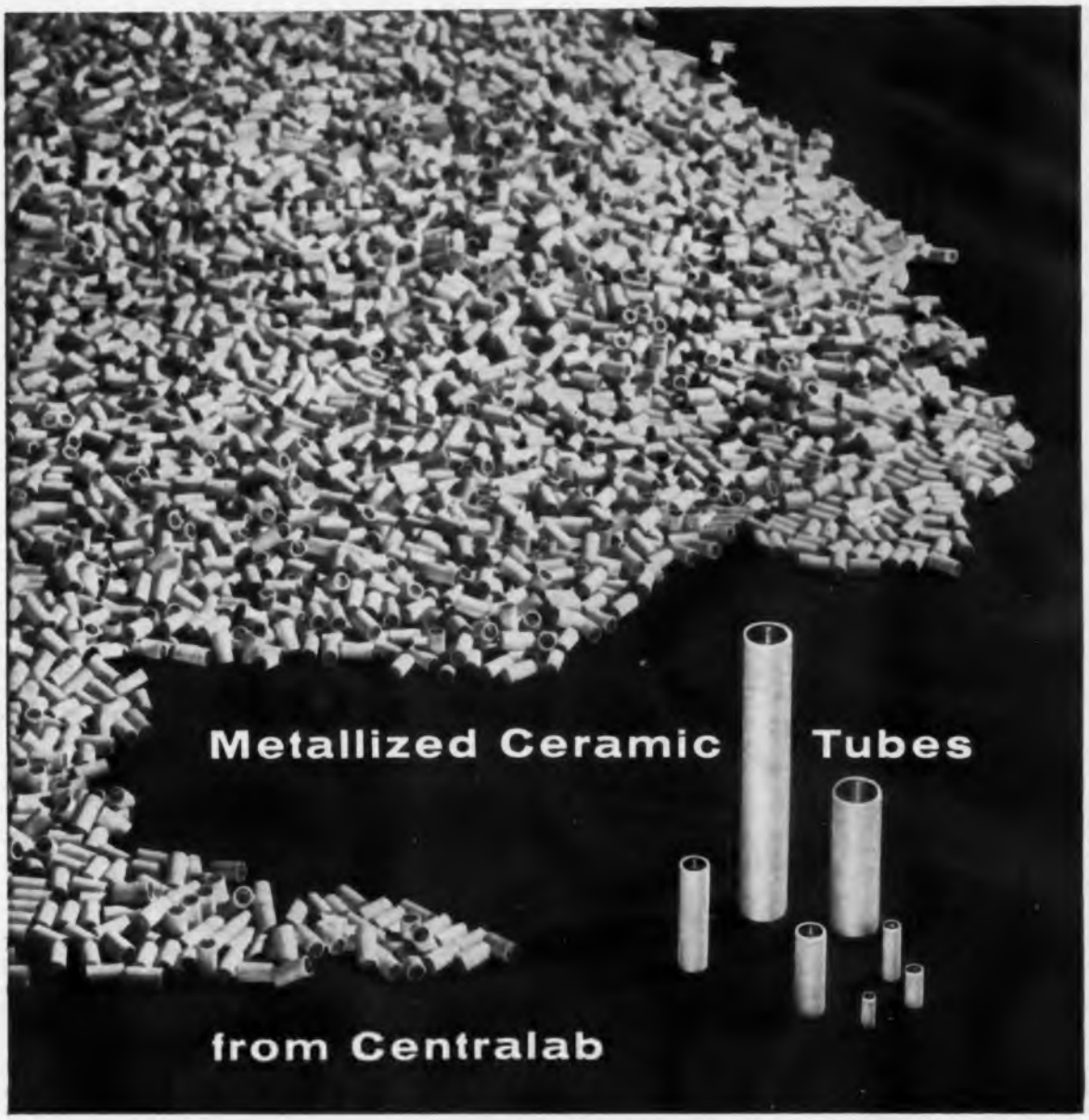
Schematics, graphs and charts detail the construction, operation, applications, and characteristics of hydrogen thyratrons. The general theory and application of hydrogen thyratrons is discussed in the 20-page bulletin with specific reference made to 3 different tubes for data and ratings. The bulletin, PT-49, is entitled "Hydrogen Thyratrons: Theory and Application." General Electric Co., Power Tube Dept., Schenectady 5, N. Y.

Circle 204 on Inquiry Card

Plastic Laminates

The 16-page catalog, designated L-CDL-514, lists a total of 39 grades of Textolite® Industrial Laminates—copper-clad, sheets, tubes and rods. Information is also contained on rolled and molded tubing, insulation and printed circuit applications. In addition, revised data on present and improved grades is included as well as properties, tolerances and thickness ranges of all G. E. industrial laminates. General Electric Co., Laminated Products Dept., Section IS, Coshocton, Ohio.

Circle 205 on Inquiry Card



for component hermetic sealing

Capacitors, resistors, transistors, diodes, coils, and other components will more readily meet MIL specifications for temperature, humidity, and vibration when hermetically sealed in CENTRALAB metallized tubes.

Metallized tubes of steatite or high alumina ceramic are available from CENTRALAB in a comprehensive range of standard sizes—many of which can be delivered in 48 hours. Tubes of other dimensions, including smaller sizes, can also be supplied, with initial delivery in 5 to 6 weeks, repeat orders in 3 to 4 weeks.

These tubes are internally metallized on both ends and will generally meet MIL specifications for thermal cycling from −65°C. to +125°C. Technical assistance for production sealing is provided by the CENTRALAB Engineering Department.

The standard sizes are listed in CENTRALAB Engineering Bulletin EP-978, available free on request.

STANDARD SIZE RANGES

Inner Diameters	Outer Diameters	Lengths
.105" to .300"	.156" to .395"	.250" to 2.250"

Centralab

The Electronics Division of Globe-Union Inc.
938D East Keefe Avenue • Milwaukee 1, Wisconsin
Centralab Canada Limited — Ajax, Ontario

X—6114

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

New Tech Data for Engineers

Optical Comparators

A New 60-page book on Jones & Lamson Optical Comparators contains a section which takes a reader through a step by step illustrated demonstration of how basic measuring is accomplished. Other sections of this completely indexed book provide details on accessories and illustrates over 20 applications, varying from tiny electronic components to large steam turbine blades. Jones & Lamson Machine Co., Springfield, Vt. Catalogue #6013.

Circle 206 on Inquiry Card

Missile Equipment

Aero Geo Astro Corp., 1200 Duke St., Alexandria, Va., offers tech. data sheets on their C-band Radar Transponder C/T Mod 2 and Pulse Height Analyzer S1-200/T. Photographs and complete specs. are included.

Circle 207 on Inquiry Card

Panel Meters

Bulletin P-S35-C on surface mounting panel meters describes Parker Electrical Corp.'s Series S35 and S35S standard and hermetically sealed panel meters. Photographs, diagrams and specs. are included. Interlab Inc., 116 Kraft Ave., Bronxville, N. Y.

Circle 208 on Inquiry Card

Breakdown Testers

A line of Dielectric Breakdown Testers designated Model PA, manufactured by Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J., is fully described in a catalog just released. In addition to general technical information, the catalog includes complete specs. of both standard and multiple range models.

Circle 209 on Inquiry Card

Microwave Components

Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J., is offering a new catalog of microwave components. This catalog consists of 72 pages and includes detailed descriptions and specs. of their line of coaxial attenuators, filters, power dividers, terminations, crystal mounts, tuners and other coaxial microwave components. A large amount of space in this catalog is devoted to design sections for each product which present technical information of a general nature to assist the design engineer in the selection of the proper component. Also included is a special article on "The Application of Matrix Algebra to the Design of Microwave Networks." Catalog No. 10.

Circle 210 on Inquiry Card

R-F Connectors

A 12-page catalog of fast assembly "ConheX" sub-miniature r-f connectors for RG and other coaxial cables, along with a nationwide listing of stocking distributors, is available from Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y. The catalog also describes jacks, bulkhead receptacles, feed-thru, right angle units, cable terminations, tee adaptors, and printed wiring board units along with broad lines of adaptors, BNC and TNC plugs.

Circle 211 on Inquiry Card

Computer

Autonetics Industrial Products, a div. of North American Aviation, Inc., 3400 E. 70th St., Long Beach, Calif., has issued a 4-page, 3-color brochure describing their new Recomp III computer. Block diagrams, photographs and specs are included.

Circle 212 on Inquiry Card

Relay Link

A brochure entitled "Microwave Relay Link" describes Type 420A which is a 0.1 w 5 MC bandwidth system operating in the 10,500 to 13,200 MC. freq. range for point-to-point FM transmission of television signals, one-way voice communication channels, and data channels. GPL Div., General Precision, Inc., 63 Bedford Rd., Pleasantville, N. Y.

Circle 213 on Inquiry Card

Generating Plants

The entire line of Onan Electric Generating Plants, both gasoline and Diesel driven, are listed on a catalog sheet released by Onan Div., Studebaker-Packard Corp., 2515 University Ave., S. E., Minneapolis 14, Minn. Condensed specs. show capacity, model number, electrical details, engine characteristics and overall dimensions.

Circle 214 on Inquiry Card

Silicones

A booklet entitled "Silicones for the Space Age," a 4-color, 16-page brochure is designed as a reference guide to silicones. Properties discussed are extreme heat protection, low temp. flexibility, good electrical properties, resistance to ozone, corona, weathering and thermal shock. Photographs and charts enable the user to quickly decide what silicone compound will fit his application. Also included is comparative data pertaining to silicones and other compounds as high temp. insulating materials. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 215 on Inquiry Card

Capacitors

Efcon, Inc., Patterson Place, Roosevelt Field, Garden City, L. I., N. Y., offers a booklet describing in detail a new polystyrene dielectric high stability capacitor. This product, Efcon Type RH, provides long term stability and exhibits high retrace over a complete temp. range to as close as 0.01%. The booklet covers case sizes and mounting data as well as operating factors and tolerances.

Circle 216 on Inquiry Card

Cathode Ray Tubes

A booklet on industrial and military cathode ray tubes has been made available by Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. The 8-page booklet entitled "Bonded Shield" highlights design and performance advantages of the latest industrial and military cathode ray tubes in which a safety panel is laminated to the faceplate.

Circle 217 on Inquiry Card

Diodes

Shockley Transistor unit of Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif., has just released a new catalog of its line of 4-layer diodes. This new publication gives electrical specs. and dimensional drawings along with a brief note on operating characteristics. The Shockley diode is a 4-layer, 2-lead, silicon switch.

Circle 218 on Inquiry Card

Antennas

The Andrew Corp., P. O. Box 807, Chicago 42, Ill., is making available technical data sheets on their "Island Duty" Antenna Group and 14 in. dia. Air Dielectric Coaxial Line. Five antennas and Andrew's special 14 in. coaxial line are featured along with complete specs.

Circle 219 on Inquiry Card

Terminal Insulators

Coors Porcelain Co. has just released Bulletin #161, "Coors Standard Terminal Insulators" showing 62 different terminal insulators carried in regular stock for off-the-shelf delivery. Complete dimensional data is shown for each insulator, as well as individual corona and flashover voltages. The 24 page bulletin includes a section devoted to special metalized assemblies. A 4 page section, "How Ceramic-to-Metal Seals are Made," gives data for designing special ceramic and metal assemblies.

Circle 220 on Inquiry Card

Test Instruments

A 20-page illustrated catalog describing an enlarged line of instruments for high voltage testing of electronic materials, components and assemblies is offered by Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. Included in this catalog are dielectric breakdown test sets; A line of breakdown instruments to test electronic insulating materials and insulating oils; megohmmeters with ranges to 5 million megohms; and instruments for unusual applications such as corona detection and measurement, portable kilovoltmeters, sphere gap assemblies, and high voltage power supplies.

Circle 239 on Inquiry Card

DC Receivers

A revised 2-page, 8½ x 11 in. illustrated products specs. sheet E12-4, describes various classes of Bailey dc receivers. These dc receivers pick up signals from transducers such as thermocouples, tachometers, and pH electrodes and convert them to pneumatic or electric signals to drive a recorder pen. Included are schematic diagrams and detailed specs. for these units. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle 240 on Inquiry Card

Coaxial Contacts

The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif., has issued technical data sheets on crimp termination coaxial contacts. This new snap-in contact for shielded wire, with crimp type terminations has been developed for use in miniature-environmental, electrical connectors. Minimum contact retention is rated at 25 lbs.

Circle 241 on Inquiry Card

Transistor Booklet

SL-600/2, a booklet entitled "Index of Literature and Circuits" is available from Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif. The booklet includes circuit drawings showing various applications of Fairchild planar diodes and transistors. It also contains a complete listing of current product data sheets for all transistors and diodes manufactured by the company and a listing of all applications and technical papers available.

Circle 242 on Inquiry Card

Differential Amplifier

A technical data sheet is available from Epsco-West, a Div. of Epsco, Inc., 240 E. Palais Rd., Anaheim, Calif., on their Model TDA 875 solid state Differential and Single-Ended Amplifier. This unit features: recovery from 500% overload in 300 usec; output voltage clamped at ±13 v.; cannot burn out delicate recording equipment; and complete isolation, 3000 megohm leakage path to ground.

Circle 243 on Inquiry Card

Circle 168 on Inquiry Card

Tech Data

for Engineers

Terminal Boards

Kulka Electric Corp., 633-643 So. Fulton Ave., Mt. Vernon, N. Y. offers a technical bulletin No. 61-3 containing electrical and mechanical specs. on its line of military terminal boards. The 8-page bulletin includes a quick-selection table, drawings with dimensional information, and details on available hardware and accessories.

Circle 249 on Inquiry Card

Wound Cores

Thomas & Skinner, Inc., Indianapolis, Ind., is offering a new wound core catalog which features quick easy reference. The catalog, W102, contains complete product and price listing, compiled to assist engineers in selecting the correct cores. It lists a complete line of cores made with Orthosil® materials, known for lower core loss and higher permeability.

Circle 250 on Inquiry Card

Resin

A newly published brochure listing properties and data for "Scotchcast" brand electrical resin No. 241 is available from Minnesota Mining and Mfg. Co., (3M), 900 Bush Ave., St. Paul 6, Minn. Suggestions for handling, storage and use are included with the list of physical and electrical properties covering the 2-part filled, semi-flexible epoxy resin system of 100% solids.

Circle 251 on Inquiry Card

Plug Guide

"Cannon Plug Guide," Catalog CPG-5 describes how to select Cannon plugs and includes general information on the application and makeup of plugs. Each Cannon plug series is illustrated along with a listing of the correct catalog to order which describes the series. Photographs are included. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 252 on Inquiry Card

Glass Polyesters

A selection guide for glass polyesters, water-resistant glass-mat laminates and molding compounds for Class B insulation applications is offered by Westinghouse Electric Corp., Micarta Div., Hampton, S. C. The 8-page brochure, B8216, emphasizes features of low water-absorption, lightweight, economy, flame retardance, and arc and track resistance for reliability in contaminated atmospheres. Physical and electrical properties of 10 grades of glass-mat laminates and of 3 grades of glass molding compounds are given.

Circle 253 on Inquiry Card

Circle 95 on Inquiry Card

Circle 96 on Inquiry Card →

THE FIRST SILICON DIODE WITH

All silicon glass diodes of the same type number, regardless of the manufacturer.must meet minimum requirements. Meeting these requirements is one thing, but consistently surpassing them is another.

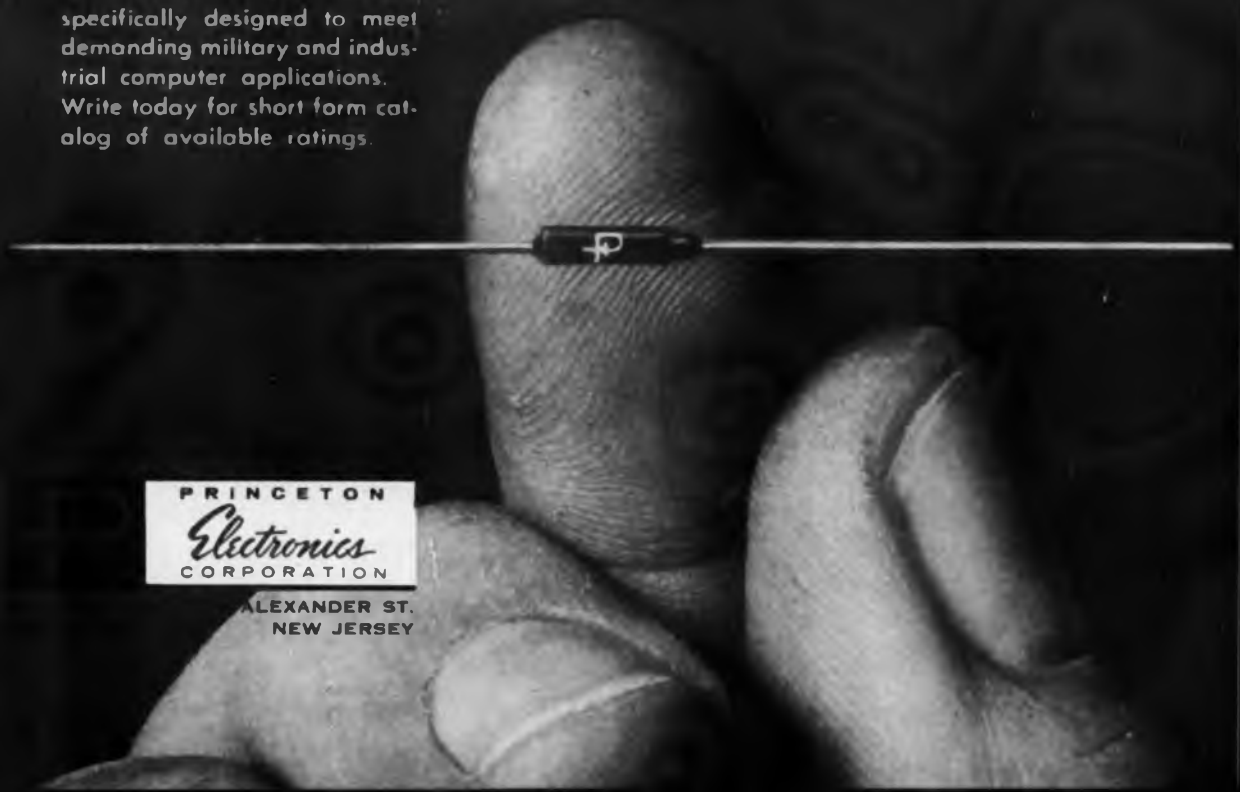
Princeton silicon diodes are subjected to the most rigid control possible . . . computer control. Computer logic applied to both manufacture and testing produces the most reliable ond most predictable silicon glass diodes possible.

Each lot of diodes has a computer control record, containing the complete history of the specific lot. Customers may compare this record with their own standards to analyze and predict the performance of the diodes.

Over 100 types are now available from Princeton Electronics Corporation . . . your most logical source for ultra-reliable, subminiature silicon diodes specifically designed to meet demanding military and industrial computer applications.

Write today for short form catalog of available ratings.

COMPUTER PREDICTED RELIABILITY



PRINCETON
Electronics
CORPORATION

ALEXANDER ST.
NEW JERSEY

Tech Data

for Engineers

Motor Facilities Brochure

An 8-page, 2-color brochure describing their line of special motors and engineering facilities and plant capabilities has been issued by the Kollsman Motor Corp., Subsidiary of Standard Kollsman Industries Inc., Dublin, Pa.

Circle 244 on Inquiry Card

Traveling-Wave Tubes

A new 8-page, 2-color short form catalog has been released by the Microwave Tube Div., Hughes Aircraft Co., 11105 Anza Ave., Los Angeles 45, Calif. The catalog features more advanced high power traveling-wave tubes now in production at Hughes.

Circle 245 on Inquiry Card

Precision Units

A 6-page folder entitled "Precision Products for Precision Control" defines 5 new divisions of Bowmar Instrument Corp.'s control and indicating components and packages. Products classifications include: precision mechanical components; precision counters and indicators; precision timing and programming devices; precision electromechanical devices; and precision servo packages. Bowmar Instrument Corp., 8000 Bluffton Rd., Ft. Wayne, Ind.

Circle 246 on Inquiry Card

Indicator

This newly printed catalog page contains illustration, outline drawings, schematic and complete technical details including specs, component parts and applications, of the 3-in-1 BDH indicator which provides on a single indicator face, information on 2 relative bearings, distance and magnetic heading. John Oster Mfg. Co., Avionic Div., Racine, Wisc.

Circle 247 on Inquiry Card

Magnetic Shields

A booklet of reference data on magnetic shields and shielding materials and a catalog of shaft hardware has just been published by the James Millen Mfg. Co., Inc., 150 Exchange St., Malden 48, Mass. This 16-page booklet contains curves and tables designed to help the design engineer select the proper shield for his particular application. A cross-index of tube type and required shield is included. The catalog section describes bezels for cathode ray tubes, gear drives, shaft locks, bearings, couplings, knobs, dials and dial locks.

Circle 248 on Inquiry Card

PERFECT PROTECTION FOR ELECTRICAL CONTROLS

Oil, Water and Dust can't Penetrate!

McKINSTRY JIC Wiring Boxes provide complete protection against seepage of oils, dust, dirt or water, whether they are installed indoors or outdoors. For dependable performance, look for the McKINSTRY trademark before you buy. You can pay more, but you can't buy better quality JIC Wiring Boxes.

Write: Dept. 70-G for new illustrated catalog and price list on complete line of **McKINSTRY Enclosures and Fittings.**

McKINSTRY METAL WORKS, INC.

285 McKinstry Ave. • Chicopee, Massachusetts

Circle 146 on Inquiry Card

CUT COSTS with READY-TO-GO Silver Electroplated Strip

From Receiving to Assembly in One Operation!

- Eliminates batch plating after stamping or blanking.
- Available in strip form . . . widths from .020" to 5½" . . . with thickness capacity ranging from .002" to .080" . . . priced to sell!
- Rigid quality control. . . complete facilities for plating, rolling, slitting or annealing . . . to suit your most exacting specifications.
- For batteries, switches, contacts, optics, you-name-it.

FREE literature upon request . . . application assistance if desired . . . write today!

METALS & CONTROLS INC.

34 FOREST STREET • ATTLEBORO, MASS.

A CORPORATE DIVISION OF

TEXAS INSTRUMENTS INCORPORATED

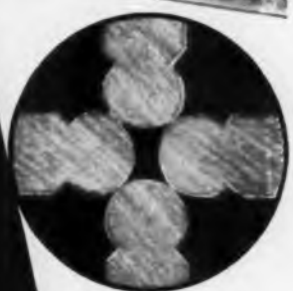
Circle 147 on Inquiry Card

NEW Methode "FORK" CONTACTS

completely interchangeable with available types with FULL RADIUSED CONTACTS for smoother mating

IMMEDIATE DELIVERY!

Available in three different styles for mounting upright printed circuit panel, parallel to printed circuit panel or for 45 angular mating. Fabricated from spring tempered phosphor bronze, finished with gold plating

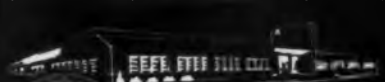


Microphotographic view of Methode Printed Circuit "FORK" CONTACTS

Applications are limitless as determined by our design, ingenuity and needs. We invite your inquiry.

SAMPLES and detailed literature are available.

Special styles can be tooled upon request.



Methode manufacturing corp.

7447 W. Wilson Ave. • Chicago 31, Ill.

Circle 148 on Inquiry Card

Tech Data

for Engineers

Paper Capacitors

A 6-page catalog, 131 B8, contains complete physical and electrical characteristics of Aerovox high-temp. metallized paper capacitors. Temp. characteristics curves and performance characteristics tables are included, along with complete size charts and case style diagrams. Aerovox Corp., New Bedford, Mass.

Circle 254 on Inquiry Card

Fluxless Solder

Photographs and specs. are included in a technical data sheet available from Metals for Industry Inc., 299 Pavonia Ave., Jersey City 2, N. J., concerning aluminum fluxless solder that melts at ordinary soldering temperature. The new solder called Tin-A-Lum will join any metal with the exception of black or cast iron. All metals including aluminum and its alloys can be soldered with an ordinary electric soldering iron.

Circle 255 on Inquiry Card

Solder Information

Technical data sheets are available from Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J., on: "New Solder for Printed Circuit Boards and Semiconductor Devices"; "A New Way to Solder Transistor Can to Header"; "New Tin-Gallium Coated Nickel Strip for Bonding Semiconductor Devices" and "Alloy Spheres for Gallium-Arsenide Semiconductor Devices."

Circle 256 on Inquiry Card

Monitoring Systems

An 8-page, 3-color technical brochure has been issued on Electronic Monitoring System B1020, by Lynch Communication Systems Inc., 695 Bryant St., San Francisco 7, Calif. Photographs, graphs, block diagrams and ordering information is included. Uses of the equipment are: transmitting a large number of alarm or status indications or a large number of digital telemetering "bits" from remote equipment and over a minimum of transmission channels.

Circle 257 on Inquiry Card

Shaft Encoder Translation

Harvey-Wells Electronics, Inc., 14 Huron Dr., Natick, Mass., offers an 8-page technical brochure on shaft encoder translation. The engineering-type dicussion describes in detail the operation of the 2 basic models of shaft encoder translation equipment manufactured by the company, the Model X541 max. sampling rate system and the Model X115 slower-speed system.

Circle 258 on Inquiry Card

KEMET

breaks through with new 75v. Solid Tantalum Capacitor...

REPRESENTATIVES FOR "KEMET" SOLID TANTALUM CAPACITORS

EAST COAST, Williston Park, N.Y.—Electrical Manufacturers Service, P. O. Box 128, 105 Hillside Avenue

FLORIDA, Melbourne—Joseph A. Adams Associates, P. O. Box 1322

MIDDLE ATLANTIC, Cleveland 1—R. G. Sidnell & Co., 1229 W. Lake Ave.

South Whitley, Ind.—Warner, Kesler & Associates, P. O. Box 338

MIDWEST, Chicago 45—D. Dolin Sales, 3553 West Peterson Avenue

MINNESOTA, Minneapolis 19—Stan Clothier Co., Inc., 12 West 58th St.

SOUTHWEST, Dallas, Texas—Ammon & Champion Company, 2714 Bomar Street

NORTHWEST, Seattle 8—Samuel N. Stroum Co., Inc., 621 Michigan Street

ROCKY MOUNTAIN AREA, Denver 26—Barnhill Associates, 1170 South Sheridan

WEST COAST, San Marino, Cal.—G. S. Marshall Company, 2065 Huntington Drive

highest rated working voltage unit of its kind available today!

CAPACITANCE VALUES: .1 to 15 Microfarads • TEMPERATURE RANGE: −55 to +125° C.

A new frontier in capacitor technology has been opened by "Kemet's" successful achievement of a new 75-volt solid tantalum capacitor!

"Kemet's" breakthrough comprises 14 catalog types, hermetically sealed in the four case sizes specified in MIL-C26655A for CS12 and CS13 styles . . . providing Standard E.I.A. capacitance values in tolerances of ±20%, ±10%, and ±5%.

"Kemet's" latest addition to its complete line of solid tantalum capacitors supplements its popular J-Series . . . available in capacitance values ranging from .33 to 330 microfarads and working voltages of 6, 10, 15, 20, 35, and 50.

Solid construction and utmost operating dependability have made "Kemet" tantalum capacitors the leader in their field. They can be specified and installed with confidence, because they have been subjected to the most exacting tests for life, temperature, humidity, vibration, and acceleration.

For data on "Kemet's" new 75-volt J-Series tantalum capacitors, write for Bulletin #38 to Kemet Company, Division of Union Carbide Corporation, 11901 Madison Ave., Cleveland 1.

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION CARBIDE

Tech Data

for Engineers

Microwave Components

Scientific-Atlanta, Inc., 2162 Piedmont Rd., N.E., Atlanta 9, Ga., has issued 2 technical data sheets describing their Series RN coaxial resistive networks, Model S1A-1 synchro isolation amplifier and Model RJ 2 high speed coaxial rotary joint. Photographs and complete specs. are included.

Circle 259 on Inquiry Card

Encapsulating Glass

An illustrated booklet entitled, "Black Glass" covers the use of special black glass for encapsulating diodes. This material, which is available as beads and as cases, protects diodes that are sensitive to visible and infrared wavelengths. Transmittance and other properties are detailed in a chart and a table. Information includes sizes, sealing techniques and recommended applications. Corning Glass Works, Corning, N. Y.

Circle 260 on Inquiry Card

Portable R-F Meter

Plas-Tron Corp., 815 S.W. Viewmont Dr., Portland 1, Ore., is offering a technical sheet on its portable, pocket-size, terminating wattmeter and field strength meter for radio frequencies. Photographs, specs. and a list of applications are included.

Circle 261 on Inquiry Card

Silicones

Illustrated with photographs, charts and graphs, a new and comprehensive booklet on silicones goes into detail about what silicones are, describes their manifold uses and suggests ways in which they may be adapted to new design and product applications. The booklet features a series of charts covering the properties and features of silicon fluids, resins, rubber compounds, water repellents, anti-foams and emulsions, and their adaptability. Silicones Div., Union Carbide Corp., 270 Park Ave., New York 17, N. Y.

Circle 262 on Inquiry Card

Variable Inductor Coils

A 20-page catalog with charts and data information shows what a specific size variable inductor coil will produce under given conditions. The catalog and its charts act as a "yardstick" for the design engineer who is seeking an answer in a variable inductor. The charts may also be employed to reasonably predict electrical parameters if form size, wire size, winding construction, etc., are varied from the set conditions used for the preparation of the curves shown on the charts. Delevan Electronics Corp., 77 Olean Rd., E. Aurora, N. Y.

Circle 263 on Inquiry Card

Circle 103 on Inquiry Card

Circle 104 on Inquiry Card ⟶

HOW TO HANDLE A BOTTLE NECK

These special clean room "nurses" baby our product for your protection — 63 bottle-neck breaking QC checks are performed before and during mechanized manufacture.

Even the youngest engineer has to rest up sometime. It can be quite a strain when you must decide among vendors whose products appear to be about equal, and the choice you must make is your responsibility.

That's why it's so important to consider the overall capabilities of your suppliers. Do they have the skills, the talent and the resources to support the wisdom of your selection? We think we can help you . . . we would like to try.

SPERRY

SPERRY SEMICONDUCTOR DIVISION

OF

SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

SEMICONDUCTOR IS OUR MIDDLE NAME . . . SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES

SALES OFFICES: CHICAGO, ILLINOIS; EL SEGUNDO, CALIFORNIA; WESTWOOD, NEW JERSEY; TEWKSBURY, MASSACHUSETTS; STAMFORD, CONNECTICUT; TOWSON, MARYLAND; MASSAPEQUA PARK, NEW YORK.

SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

Tech Data

for Engineers

Trimmer Resistors

Two technical data sheets illustrate and fully describe Series 170 42-turn square trimmer resistor and Series 180 25-turn rectangular trimmer resistor made for military, computer and similar applications with the reliable hi. temp. CTS metal-ceramic element. CTS Corp., Elkhart, Ind. Data Sheet No. 177 and 178.

Circle 264 on Inquiry Card

Reliability

A 14-page booklet entitled "Reliability — Whose Responsibility?" is available from Hoffman Electronics Corp. Military Products Div., 4730 So. Grand Ave., Los Angeles 7, Calif. The text is the keynote address given by Mr. H. Leslie Hoffman before the 7th National Symposium on Reliability and Quality Control on Jan. 9, 1961 at the Bellevue-Stratford Hotel, Phila., Pa.

Circle 265 on Inquiry Card

Silicon Bridge Rectifier

Information about low-cost, medium power range silicon bridge rectifier is available from Semiconductor Div., Syntron Co., Homer City, Pa. The unit called the Syntron Power Point is compact and is for use in battery charging units, dc motor control drives, laboratory and aircraft power supplies.

Circle 266 on Inquiry Card

Magnetic Preamplifiers

Acrostats are for measuring weak dc signals from thermocouples, strain gages, and other low-level signal sources. The units feature very high gains and deliver 1 vdc output/μa of dc control signal. The equivalent input drift is less than 10 μv under moderate environments and 50 μv under severe environments. Acromag, Inc., 22515 Telegraph Rd., Southfield, Mich. Tech. Bulletin 10-C.

Circle 267 on Inquiry Card

SWITCH 1 MILLION WATTS

Dr. William Shockley demonstrates a solid state circuit switching one million watts in thirty nanoseconds. Pulser uses fifty Shockley 4-layer Type J diodes.

ELECTRON TUBE NEWS
...from SYLVANIA

...outstanding advantages of new

BIKINI CATHODES
plus STRAP FRAME GRIDS

in 4 new Gold Brand Subminiature Tubes

From Sylvania comes an important new cathode design—*Bikini Cathode*—destined to upgrade industry standards for high performance tubes. Sylvania complements this remarkable cathode design with the advantages of *Strap Frame Grid* in exceptionally rugged, premium-quality Gold Brand Subminiature Tubes. The end effect: high reliability tubes for superlative VHF and UHF performance in compact, environmentalized equipment.

Exceptionally smooth, ultra-uniform in density . . . *Bikini Cathode* is a precast film of emissive material, of precise dimensions, bonded to the *two major sides* of a flat cathode sleeve. *Bikini Cathode* minimizes stray emission. Further, consistent density of cathode material eliminates "hot spots," assures uniform temperature and emission over the entire cathode surface. Smooth cathode surface minimizes possibility of grid-to-cathode arcing.

Bikini Cathode is ideally mated with Sylvania *Strap Frame Grid*. Both possess exceedingly flat surfaces, providing outstanding uniformity in grid-cathode spacing with resultant narrow dispersion of electrical characteristics, improved cutoff control, high stability and improved speed and uniformity of electron transit time. Add to this the singular advantages of rugged *Strap Frame Grid*—very fine grid wire, high T.P.I., extreme accuracy of grid pitch—and the result is a near ideal combination for high db gain, unusually low noise and exceptional ratio of Gm per mA of plate current.

New Sylvania Gold Brand Subminiature Tubes

featuring Bikini Cathodes and Strap Frame Grids

AVERAGE CHARACTERISTICS	SR-2662B	SR-2662C	SR-2941A	SR-2942B	Units
Ef	6.3	6.3	6.3	6.3	V
If	235	375	125	125	mA
Eb	60	100	110	150	V
Ec	–	–	−1.0	–	V
Rk	220*	270*	–	100	ohms
Ib	8.0*	7.5*	9.0	14.3	mA
Gm	9,000*	13,000*	12,000	13,560	μmhos
Gm/Ib	1,120*	1,730*	1,300	945	μmhos/mA
Mu	20*	40*	58	55.2	
Noise-matched Conditions	**Grounded Cathode Circuit (200MC)**			**Grounded Grid (480MC)**	
Gain	14.8*	15.1*	17.5	14.5	db
Bandwidth	8.0*	9.5*	11.8	9.5	MC
NF	4.0*	4.0*	4.4	7.2	db

*Single section

. . . *for cascode RF amplifier-mixer, high-speed multivibrator service.*

SYLVANIA SR-2662B is a medium-mu double triode (similar to 6111) featuring *very low heater power of 0.7W per section* and low Eb of 30V per section. Gm per mA of Ib for a single section is 1120. Gm per section is 9000 μmhos, 80% higher than Gm of conventional prototypes. It is subjected to the intensive testing characteristic of all Sylvania Gold Brand Subminiature Tubes. Examples: shock tests of 500g; vibrational acceleration of 2.5g; heater life tests of 2000 cycles, one minute "on", four "off." It's capable of withstanding ambient bulb temperatures of 220°C and intense radiation dosage.

SYLVANIA SR-2662C, medium-mu double triode, is a high-performance version of the popular, general purpose 6021 with a Gm of 13,000 μmhos. Ratio of Gm/Ib provides a figure of merit of 1730 per section.

. . . *for grounded-cathode RF amplifier applications*

SYLVANIA SR-2941A is a high-mu triode with Gm of 12,000 μmhos. It only draws 125 mA @ 6.3V heater power. Gm per mA Ib is 1300. SR-2941A provides 2.5 db better gain than usually encountered in present high-performance types.

. . . *for grounded-grid RF amplifier applications*

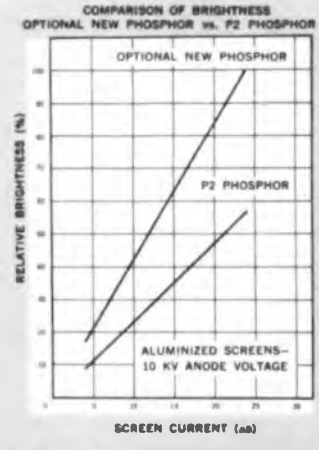
SYLVANIA SR-2942B, high-mu triode, featuring low heater power of 125 mA @ 6.3V and high Gm of 13,500 μmhos. It offers a 2.5 to 7 db gain improvement, 1.5 to 4 db noise improvement at 480MC than usually encountered with popular grounded-grid RF amplifier types.

These are the first types to utilize *Bikini Cathodes* and *Strap Frame Grids*. Ask your Sylvania Sales Engineer to keep you up to date on further developments. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. D1, 1100 Main St., Buffalo 9, N. Y.

SYLVANIA SPIRAL ACCELERATORS -5BGP-, -5BHP-

- High deflection sensitivity
- High resolution
- High reliability
- High writing speed

now available with new, brighter phosphor and "Bonded Shield" safety cap



Graph illustrates the improved brightness of new phosphor, a medium-short decay phosphor having green fluorescence and phosphorescence. Sylvania-5BGP-, -5BHP- are available also in a wide range of other phosphors.

Every Spiral Accelerator gun is inspected on a high-magnification optical comparator for spacing and dimensions.

Sylvania Spiral Accelerator cathode ray tubes provide superior-quality displays with minimal pattern distortion. Consider the reasons—guns, for example, are assembled on Sylvania-developed mounting jigs accurate to 0.001". High-magnification optical comparators critically inspect spacings and dimensions. The internal helical resistance coating, too, undergoes extremely tight controls for linear resistance, and uniformity of application. Further, completed tubes receive extensive tests for electrical characteristics, distortion, brightness. Spot size is microscopically measured at extreme corners of required minimum scan. Perpendicularity of horizontal and vertical scan lines is physically measured to meet 1.0° acceptance standards. In addition, Sylvania-5BGP-, -5BHP- must meet severe cycled life tests.

Sylvania Spiral Accelerators are also available with "Bonded Shield" safety cap for increased image readability. "Bonded Shield" improves mounting and styling, strengthens tube face, simplifies cleaning of tube face.

Development is now under way at Sylvania on square-faced Spiral Accelerators. Ask your Sylvania Sales Engineer for price and delivery information. For technical data, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. D2, 1100 Main St., Buffalo 9, N. Y.

MICROWAVE DEVICE NEWS from SYLVANIA

120KW

20 KW
to
120 KW
peak power output

with Sylvania Ka Band Magnetrons

20KW

Sylvania Ka Band Magnetrons offer a remarkable range of powers, fill virtually all your Ka band requirements. They include extremely compact types with exceptional power-to-weight ratios. All are fixed-frequency types for pulsed operation, utilize stabilized magnets, and exhibit outstanding reliability and longevity.

SYLVANIA-5789, first commercially available U. S. type for Ka band, uses 22-vane "rising sun" anode, and improved dispenser-type cathode. With hermetically sealed input and pressurized output, it is highly adaptable to high altitude operation.

SYLVANIA-6799 features 120KW peak power output and is a proven high-power millimeter wave source. It is available for use with longer pulses and higher duty cycles at slightly reduced power.

SYLVANIA M-4155A, *ruggedized* version of the 5789, features compact size and weight of only 9 lbs., improved heat dissipation and excellent stability. It utilizes a special cone-shaped cathode support and "building block" mounting arrangement for added mechanical strength. M-4155A possesses both long- and short-pulse capabilities.

SYLVANIA XM-4064, *ruggedized* magnetron, offers exceptional stability under severe environmental conditions. Only 9 lbs. in weight, it provides peak power output of 70KW for a remarkably good power-to-weight ratio.

SYLVANIA XM-4158, *ruggedized* magnetron, provides 120KW peak power output. Weight is only 27 lbs. It uses E type magnets for a uniform, flat surface configuration that can be used as a structural part of the chassis. XM-4158 is compatible with either long- or short-pulse operation.

SYLVANIA XM-4218, *ruggedized* tube, provides a power-to-weight ratio of 8:1 making it especially suited for portable, field-type radar. It uses metal-to-ceramic seals, ceramic cathode capsule, cantilever cathode support. The tube withstands 50g shock, 10g vibration tests. XM-4218 provides a lower pushing factor than tubes of comparable performance.

SYLVANIA XM-4206 is a *ruggedized*, compact tube with encapsulated cathode. Only 10.5 lbs., it provides 40KW peak power output.

SYLVANIA Ka BAND MAGNETRONS

	Frequency (KMC)	Peak Power Output (KW)	Max. Duty Cycle	Max. Pulse Width (μsec)
5789	34.512 to 35.208	40	.0006	1.0
6799	34.512 to 35.208	120	.0005	1.0
M-4155A	34.512 to 35.208	40	.0006	1.0
XM-4064	34.512 to 35.208	70	.0008	1.0
XM-4158	34.512 to 35.208	120	.0006	1.0
XM-4218	34.512 to 35.207	32	.0006	0.4
XM-4206	34.7 to 35.0	40	.0006	1.1

Investigate the design advantages of Sylvania Ka band magnetrons *and* associated Ka band TR tubes. Contact your Sylvania Sales Engineer for complete information. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. MDO-D, 1100 Main St., Buffalo 9, N. Y.

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

N-9741-3

International Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

ANTENNAS, PROPAGATION

Leading of Aerial Supports, Fritz Staiger. "Rundfunk." Dec. 1960. 5 pp. So far, owing to a lack of suitable specifications, the manufacturers of aerial supports have taken precautions against ice formation in very different ways. Inadequate measures may lead to under-dimensioning and thus to endangering the building, whereas, on the other hand, the reverse might result in unnecessary outlay in material and thus in uneconomical designs. The present article constitutes a contribution towards the solution of this problem. (Germany.)

The Permissible Mismatch in Antenna Equipment for Television Reception, A. Fiebrant. "Nach. Z." Jan. 1961. 7 pp. The possible effects of mismatches on the television picture are discussed. (Germany.)

Satellites as Passive Relays for Multichannel, Long Distance Communications, W. Mansfield. "Freq." Jan. 1961. 9 pp. A satisfactory solution of the problem of multichannel radio communications over very long distances will probably be found only in the application of artificial reflectors in the form of satellites. The paper studies the requisite conditions with respect to equipment technique, under which satellites can serve as passive relay stations. The shapes and dimensions of the reflectors, the antenna diameters, and the transmitter outputs are discussed. (Germany.)

CIRCUITS

Industrial Applications of Decimal Counter Tubes, P. Perrot. "El. et Auto." Jan. 1961. 5 pp. Counting frequencies exceeding 1 Mc/s are now possible with recent decimal counter tubes of the decatron type. Operation and utilization of these tubes are reviewed. Then, several associated tube circuits are described. They are used with decatrons to build multistage decimal counters. Finally, several transistorised driving circuits are presented and their operation analysed. (France.)

Automatization of a Tensiometer, P. Rousseau. "El. et Auto." Jan. 1961. 3 pp. The usefulness of a laboratory-type tensiometer can be considerably enlarged if it is made automatic, on the one hand, and if it is completely by a pen-recorder, on the other hand. This paper describes a simple circuit used to this effect. It uses 2 photoelectric cells and an electronic amplifier to drive a servo-mechanism. (France.)

A Circuit for the Compensation of the Voltage Drift in the Input Stage of a Direct Coupled Transistor DC Amplifier, H. Holken. "Nach. Z." Jan. 1961. 5 pp. An amplifier circuit has been tested in which the temperature drift of the base-emitter voltage is compensated to almost the theoretical limit which is determined by scatter values between samples. (Germany.)

A Bistable Transistor Multivibrator for Operating a Relay used in Telecommunications, N. Kleber. "Nach. Z." Jan. 1961. 7 pp. The dynamic response of the electrical properties of a relay winding gives rise to instabilities in a given multivibrator circuit. A compensating circuit is designed by means of a less known method which is particularly suitable for a representation of the stability conditions for multivibrators. (Germany.)

Frequency Tripler with a Capacitance Diode, D. Lohrmann and W. Marks. "Freq." Jan. 1961. 4 pp. A frequency tripler circuit with a capacitance diode is analyzed mathematically, an equivalent circuit is devised, and the circuit itself is set up in practice. The results of analysis and measurement are compared at the end of the paper. (Germany.)

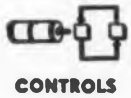
COMMUNICATIONS

Telecommunication Engineering in Hungary, Dr. Pal Vajda. "Brit. C.&E." Feb. 1961. 5 pp. This article describes the progress of communications and electronics in Hungary. (England.)

The Electronic Generation of Sounds on the Principle of Flying Spot Scanning of Patterns, G. Holoch. "Nach. Z." Jan. 1961. 6 pp. An equipment and a method are described with which sounds and mixed sounds can be produced with dynamic structures having response of almost any speed. (Germany.)

A Graphical Method for Cross-Talk Compensation on Carrier Operated Balanced Pairs in Communication Cables, O. Breitenbach. "Nach. Z." Jan. 1961. 4 pp. A graphical method is given for the selection of circuit elements used for the compensation of cross-talk between balanced transmission lines in carrier frequency links. (Germany.)

The Features of the Teleprinter Type T 100, C. Brader. "Nach. Z." Jan. 1961. 8 pp. The features in respect of telegraphy and operational techniques are reported. (Germany.)



CONTROLS

Sensitometric Control in Film Making, L. J. Wheeler. "BBC Mono." Dec. 1960. 17 pp. This monograph describes the calibration and operation of the Type X6 Sensitometer and the Type MND Line Densitometer installed at Alexandra Palace, together with a detailed description of the system of sensitometry established to control the continuous processing of films used in the BBC television news programs. It also discusses the subsidiary factors which must be controlled when any form of sensitometry is employed and the working tolerances which apply to each variable. (England.)

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El Tech. Electronic Technology
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequens-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemekhanika
Radio. Radio
Radiotek. Radioteknika i Elektranika
Rad. i Elek. Radioteknika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

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The new NLS 481A digital voltmeter features both plug-in stepping switches and a snap-out readout that virtually eliminate use of a solder gun or other tools in servicing. Note the "finger-control" leverage bars for easy switch removal.

Applications include production testing, instrument calibration, laboratory testing, receiving inspection.

The 481A features the basic circuitry of the NLS 481, today's most widely used digital voltmeter.

Announcing the NLS Low-Cost 481A Digital Voltmeter

Here is the time-proved 481 with new features to permit replacement of all stepping switches and decade resistors in minutes instead of days. Plug-in stepping switch assemblies in the 481A also allow trouble-shooting by the substitution method. Like the thousands of 481s in use today, the new 481A features ±0.01% accuracy and completely automatic operation at low cost. It measures DC volts from ±0.001 to ±999.9; AC or low-level DC with plug-in accessories. Input impedance is 10 megs . . . balancing time is 1 second, average . . . internal standard cell verifies calibration.

Although the 481A features exclusive plug-in stepping switches previously found only on higher cost NLS digital voltmeters, it sells for only $1,525, complete. Delivery is from stock – 15 days are required if stocks are temporarily depleted. NLS will continue to manufacture the 481 in volume for customers who have standardized on this instrument or where initial price is more important than the long-term savings in servicing offered by the 481A.

A statement of policy: The 481A – like other new NLS instruments to be announced in the coming months – is not a "pie-in-the-sky" instrument or prototype. It has long since undergone complete testing and is now in volume production to assure you prompt delivery of a fully-tested, quality instrument.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

Circle 107 on Inquiry Card

—*International* ELECTRONIC SOURCES

On Realization Methods for Finite Automaton Which Time Pace is Defined by Change of Input State, M. A. Aizerman, et al. "Avto. i Tel." Dec. 1960. 19 pp. Three methods of realization, which are economic from the viewpoint of number of states, of a finite automaton set by an equation (or table) and operating in a time pace regime caused by change of the input states of the automaton are considered. The methods are distinguished by an amount of information which defines the automaton input. (U.S.S.R.)

Automatic Systems and Regulation Devices for Freeze-Drying-Plants, Dr. Louis R. Rey. "Vide." Nov.-Dec. 1960. 13 pp. Freeze-drying not unlike any other modern technique that has known a quick development with numerous applications, very soon reached the era of automatic systems and regulation devices. This is not merely derived from a wish to achieve plainer and cheaper work or running of machinery, but more precisely from the aim of attaining a steady running on of machines and a uniform and constant quality of end products. (France, in English.)

GENERAL

Three-Channel Multiplying Device with Frequency-Division of Signals, A. A. Maslov. "Avto. i Tel." Dec. 1960. 12 pp. The survey of combined type of multiplying devices with amplitude-division channels is given. A new structure of a multiplying device with frequency division of input signals is proposed and its properties are considered. The data of the experimental check of a reversive step selector circuit are given. (U.S.S.R.)

The Behavior of Continuous Hydraulic Copying Systems, W. Backe. "rt." Dec. 1960. 6 pp. Investigations carried out on continuous hydraulic copying systems have proved that their static behavior is characterized by two parameters: the speed amplification C_o and force amplification E_o. Errors of position or speed can be reduced by choosing higher values for the system constants. However, the system parameters must not be increased to such an extent that the system becomes unstable. (Germany.)

Infra-Red Scanners for Airborne Reconnaissance, C. M. Cade. "Brit. C.&E." Feb. 1961. 9 pp. This article surveys the advantages which infra-red systems offer, together with some of the practical problems of system design. (England.)

Wide-Band Operational Amplifiers Based on Principle of Cascade-Successive Switching-Off, D. E. Polonnikov. "Avto. i Tel." Dec. 1960. 10 pp. A principle of designing operational amplifiers which is based on cascade successive switching-off is proposed. The principle permits to enlarge the pass band on approximately two orders. Brief description of operational amplifiers of two types designed according to the proposed principle and the data of their test which confirm theoretical results are given. (U.S.S.R.)

The Determination of the Quantity of Barium Evaporated from Getters, P. Della Porta and S. Origlio. "Vide." Nov.-Dec. 1960. 10 pp. The complexometric method for titration of barium with EDTA in the presence of Phthaleincomplexone as indicator is briefly described. As an example, the results obtained in the study of the dependence of the quantity of barium evaporated on the time of flashing and energy dissipated by the eddy current induction heater are presented. Finally, this method of analysis is employed to determine the distribution of barium on the screen of a television picture tube when using getters having different types of deflectors. (France, in English.)

Radio-Isotope Generator for Astronautics, A. V. J. Martin. "El. et Auto." Jan. 1961. 4 pp. SNAP 1-A is a 125 w radio-isotope generator. It uses cerium 144 and derives from the experimental SNAP-3 introduced last year. It can operate for one year at full rated power. In operation, the heat produced by the radio-isotope is transformed into electrical energy with the help of 277 thermocouples. Astronautics constitutes a particularly well suited field of applications. (France.)

Computing Mechanical Filters, M. Borner. "El. Rund." Jan. 1961. 4 pp. A brief presentation of the importance and application limits of mechanical filters is followed by a description of the basic components of such filters, electromechanical converters and two-circuit coupling filters. (Germany.)

Design Curves Aid Proper Utilization of Thermoelectric Devices, A. Gelbtuch and C. A. A. MacPhee. "Can. Elec. Eng." Feb. 1961. 4 pp. Diagrams are given from which the performance data of frigistors under various conditions can be obtained. Their use is illustrated by two examples: a refrigerated box and a vacuum pump baffle. (Canada.)

The Transient Behavior of a Continuous Elastic Member Between Consecutive Pairs of Cylinders, G. Kessler. "rt." Dec. 1960. 4 pp. The article shows how to calculate the static and the dynamic behavior of the length, the stretch and the stress of an elastic member for various arrangements with the number freely movable or running under tension in a predetermined path. (Germany.)

A Preliminary Spectrographic Analysis of Polish Speech Sounds, W. Jassem. "Ros. Elek." Vol. 4, No. 3, 1960. 29 pp. This is a first attempt to find the characteristics of the acoustic signals corresponding to the sounds of Polish speech made with the aid of a sound spectrograph. Three kinds of information-bearing elements have been distinguished: near-periodic, noise-like, and such as form a superposition of a noise-like signal on a near-periodic. (Poland.)

Linear Electric Networks Excited Periodically, J. Osiowski. "Ros. Elek." Vol. 4, No. 3, 1960. 41 pp. This paper discusses in a systematic way the problems of existence and determination in a closed form of periodic solutions for a set of integro-dicerential equations with the form (6) or (12), the right-hand sides of these equations being periodic functions regular in intervals. (Poland.)

Operational Calculus in Linear Spaces, S. Bellert. "Ros. Elek." Vol. 4, No. 3, 1960. 44 pp. The author presents a method constituting the generalization of the classical methods of operational calculus. The foundations of this method were published by the author in 1957 (1) and the present paper constitutes an extension of the method with respect to theoretical assumptions as well as to practical applications. (Poland.)

Foundations of the Geometrical Theory of Dislocations in Crystals, A. Kobus. "Ros. Elek." Vol. 4, No. 3, 1960. 25 pp. Fundamental problems connected with the presence in crystals of certain kinds of imperfections, called dislocations, are introduced in the paper. (Poland.)

Chemical Methods of Disclosing Dislocations in Germanium Crystals, A. Kobus. "Ros. Elek." Vol. 4, No. 3, 1960. 17 pp. This paper presents a review of chemical methods for disclosing dislocations in germanium crystals. A number of reagents applied to disclosing dislocations are given and their usefulness is discussed. (Poland.)

An Introduction to Unitized Shielded Coils, William A. Melanson and Norton H. Reamer. "El. & Comm." February 1961. 5 pp. Some of the common uses of unitized shielded coils are presented. (Canada.)

International ELECTRONIC SOURCES

The Heating of Food in a Microwave Cooker, W. Schmidt. "Phil. Tech." #3, 1960/61. 14 pp. Microwave cookers have definite advantages in hotels and restaurants, where large numbers of meals have to be served in a short time, but it may well be that they will eventually find their way into the home kitchen. (Netherlands, in English.)

A Property of Passive Lossless Four-Terminal Networks and its Application to Ladder Filters, Y. Peltier. "Cab. & Trans." Jan. 1961. 24 pp. It is shown that the insertion loss of a passive four-terminal network, measured between equal terminal resistances, can be expressed as a function of the iterative parameters of a fictitious network built from the same elements as the given network. (France.)

INDUSTRIAL ELECTRONICS

Instrumentation in Mine Shafts, O. H. Critchley. "Brit. C.&E." Feb. 1961. 5 pp. This article tells of the application of electronic instrumentation to the old and well-established engineering practice of constructing a mine shaft, and it is expected that the data obtained will lead to improvements in design and to economy in the use of materials. (England.)

Approximate Calculation of Pneumatic Nozzle/Flapper Devices, R. Winckler and K. Kramer. "rt." Dec. 1960. 8 pp. Particulars are supplied for calculating the characteristics for the static behavior of pneumatic nozzle/flapper devices, such as are required for instance as basic components for pneumatic transmitters, controllers and positioners. (Germany.)

Ignition Analyser, E. Dawance. "El. et Auto." Jan. 1961. 2 pp. The Heath ignition analyzer is described and its diagram analyzed. (France.)

MATERIALS

Low Impedance Thermoelectric Device Powers Tunnel Diodes, E. L. R. Webb and J. K. Pulfer. "Can. Elec. Eng." Feb. 1961. 4 pp. Tunnel diodes, being very low impedance devices, require low impedance power sources. Conventional supplies are bulky and inefficient. Introduction of new thermoelectric materials made it feasible to build supplies with desirable characteristics. (Canada.)

Semiconductor Materials Provide Key to Thermoelectric Developments, Roman Post Poslawski. "Can. Elec. Eng." Feb. 1961. 4 pp. Recent developments in semiconductors have made it feasible to produce thermoelectric devices which can compete commercially with small compressor-type cooling units. Research is opening up new market prospects for such devices. Surveys show that supply of raw materials can keep up with demand. (Canada.)

MEASURE & TESTING

Industrial Measurement Oscilloscope, A. Aronsohn. "El. et Auto." Jan. 1961. 8 pp. This paper describes in detail the design of an industrial oscilloscope which can be used for all dc and ac measurements and at the same time display the signal being measured. (France.)

Water-Level Surge Recorder, E. G. Sandels. "El. Tech." Jan. 1961. 9 pp. Describes an instrument which was developed for measuring the amplitude and frequency of standing oscillations in an experimental wave channel. The oscillations to be measured are significant, but small and difficult to measure in the presence of the waves. An electrical transducer is employed in the channel, its signal being passed through a low-pass filter and displayed with the unfiltered signal on a duplex pen recorder. The filter has a cut-off frequency of 0.07 c/s and a change of attenuation greater than 1,000 over one octave about its cut-off frequency. (England.)

Testing of Linear Distortion in Transmission Systems with Square Waves, and the Use of this Method for the Explanation of Differentiating Equalization in Magnetic Tape Instruments, H. Kumfert. "Freq." December 1960. 6 pp. The relation between the distortion which a rectangular shape suffers by a linear system and the complex image transfer constant of the system is delineated in the simplest form. Some examples of distortion of rectangular shapes as encountered in laboratory practice time and again are shown combined for typical networks. (Germany.)

Investigation of the Variations with Time of the Intensity of Spectral Lines Produced by Light-Flashes of Very Short Duration. D. Drechsel. "Vak. Tech." Oct. 1960. 6 pp. (Germany.)

Double Trace Portable Oscilloscope, C. Young. "El. et Auto." Nov.-Dec. 1960. 4 pp. There is no need to emphasize the usefulness of a good portable oscilloscope. The difficulty is to design an instrument offering high performance along with small volume and reasonable weight. The Solartron oscilloscope fulfills these requirements. (France.)

Methods of Power Measurements at Radio Frequency, W. H. Otto. "Proc. AIRE." Oct. 1960. 5 pp. A short survey of r-f power measuring methods is given and a self-balancing bolometer bridge is described which has been developed in the Research Laboratories of the Postmaster-General's Department. (Australia.)

Solid State 1000 Mc/s Generator, J. C. Ascher. "El. et Auto." Nov.-Dec. 1960. 2 pp. Ordinary transistors cannot readily be used for powers of the order of a few watts at frequencies exceeding a few hundred Mc/s. The proposed solution is based on frequency multiplication. (France.)

Objective Method to Determine the Tone Quality of a Musical Instrument, E. Leipp and A. Moles. "El. Rund." Nov. 1960. 2 pp. The evaluation of the tone quality of a musical instrument has been a subjective function to this date. However, modern electro-acoustical equipment permits to establish an objective method. (Germany.)

Modern Laboratory Oscilloscopes, C. H. Moulton. "Proc. AIRE." Oct. 1960. 7 pp. The improvement in performance of oscilloscopes over the past decade is outlined with particular attention to voltage and timing measurement, versatility conferred by plug-in units, sweep generation and the development of special purpose instruments. (Australia.)

Frequency Standards and Measurements, E. Sandbach. "Proc. AIRE." Oct. 1960. 7 pp. The paper discusses the definition of frequency in terms of its reciprocal time, and then describes the state of development of various forms of quartz crystal and atomic frequency standards. (Australia.)

An Automatic Resistance Tester, H. J. Ashfield and P. S. Roper. "Proc. AIRE." Oct. 1960. 3 pp. This paper describes an automatic device for the testing of line assembled radio and television chassis, prior to the application of supply voltages. The system can be adapted for any electronic device, an economic quantity being the limiting factor. (Australia.)

Laboratory Model of Digital Voltmeter, A. Sowinski. "Prace ITR" Vol. 4, #2(11). 4 pp. This voltmeter measures a dc voltage from 10 to 100 v. with accuracy of 0.1% ±1% digit and displays the result on 3 "nixie" indicator tubes. The method of measurement based on time encoding principle is also presented. (Poland.)

Measurement of Complex Voltage Ratio Technique with Inherent Error Determination, E. R. Wigan. "El. Tech." Nov. 1960. 7 pp. It is shown that precise measurements of the vector ratio between two alternating voltages can be made, even if the apparatus delivers two independent reference voltages which are not in phase, and which can be adjusted in known fractions. The measurement technique to be described consists in forcing the apparatus to measure its own errors. (England.)

Screened Rooms and Enclosures. D. L. Hollway. "Proc. AIRE." Oct. 1960. 9 pp. The theory of continuous sheet, single and double mesh screened rooms and enclosures is discussed briefly. The attenuation of different screen materials is presented in the form of design curves. The design and construction of rooms having high attenuation is considered and illustrated by descriptions and performance measurements of typical sheet and mesh rooms. (Australia.)

Errors Arising in the Use of Electrical Indicating Instruments, H. A. Smith and D. B. Armitage. "Proc. AIRE." Oct. 1960. 6 pp. The factors giving rise to errors in the use of instruments are explained and ways of dealing with them are suggested. Factors dealt with are those associated with the choice of instrument, the location and manner of using it and the way in which readings are taken. Errors due to "ageing" of instruments and the need for recalibration are discussed. The necessity for an assessment of the uncertainty in results is emphasized. (Australia.)

Calibration of Signal Generators, R. W. Archer. "Proc. AIRE." Oct. 1960. 5 pp. The equipment and techniques used in the calibration of signal generators are discussed. Emphasis is placed on methods using equipment which will be found in most well equipped laboratories. Particular attention is given to the frequency range 50 kc/s to 300 Mc/s. (Australia.)

Measurement of the Constants of Piezoelectric Vibrators, D. G. Bulat. "Proc. AIRE." Oct. 1960. 5 pp. A method is given which allows a comparison of the equivalent inductance of a piezoelectric vibrator with that of a standard physical inductor. All that is necessary to calculate the ratio between the two is the knowledge of the two resonant frequencies of the inductor and vibrator when connected in series, and the resonant frequencies of the vibrator alone. (Australia.)

Calibrating Waveguide Attenuators, A. P. Hook. "Brit. C.&E." Dec. 1960. 2 pp. When a standing wave meter (slotted section) is terminated in a short-circuit, the power sensed by the detector probe is, with negligible error, a sinusoidal function of position falling to zero at the minima. Once the guide wavelength is known, it is a simple matter to calculate the locations of points at which the power ratio is equal to any assigned number of decibels. The readings of the indicating meter can be noted and repeated by varying the attenuator preceding the S.W.M., the detector being positioned arbitrarily while the short-circuit is preferably replaced by a matched termination. (England.)

A Curvetracer for Frequencies between 10 Kc and 200 Mc, P. Thilo. "Freq." Dec. 1960. 9 pp. The paper explains the duties of a locus tracer and the demands placed on it. From this information it is derived how to dimension the individual parts of such a device. Finally an embodiment of a locus tracer is described for measurements on two-terminal and four-terminal networks between 10 Kc and 200 Mc/s. (Germany.)

International ELECTRONIC SOURCES

Energy Spectra of Random Sequenced Overlapping Pulses. M. I. Dorman. "Radiotek" 15, No. 12, 1960. 2 pp. The author considers the possibility of using known methods to calculate the energy spectra of random sequences of overlapping pulses. Particular examples are considered. (U.S.S.R.)

Electromyography. B. S. Post. "El. et Auto." Jan. 1961. 4 pp. Electromyography is an electronic method for measuring and recording muscle activity. This article describes practical application methods, a high signal-to-noise ratio preamplifier, an amplifier for aural control and an oscilloscope for visual display. (France.)

A Survey of Signal Generators. Part II—Above 500 Mc/s. R. Brown. "Brit. C.&E." Feb. 1961. 5 pp. The second part of this survey shows the latest developments in signal generators for use above 500 Mc/s, and comprehensive charts list British instruments available in Great Britain. (England.)

An Audio Vibration Tester. R. Buttery. "Brit. C.&E." Feb. 1961. 4 pp. The article describes a vibration tester which uses the changing resistance of a contact under vibration to produce amplitude and phase modulation of an audio signal. The modulated signal is then filtered to remove the test frequency and one sideband and the remainder is passed to a loudspeaker. (England.)

Numerical Display Automatic Digital Voltmeter. M. Colombelle. "El. et Auto." Jan. 1961. 6 pp. A numerical display automatic voltmeter is a highly useful instrument in many cases. It is particularly well suited to the application envisaged here, where the problem was to sort cold cathode tubes according to their starting voltage. The complete circuit used to this effect is described in detail and its operation is analyzed. It uses mainly cold cathode tubes in a reliable industrial design. (France.)

High Resistance Analog Output Computed for Low Resistance Flip-Flops (Transistors or Switches) Forming a Decimal Decade. H. Wachholz. "El. Rund." Jan. 1961. 2 pp. A matrix of 8 resistors is employed as the analog output. The internal resistance of the instrument is high compared with these values. Repeated application of Ohm's and Kirchhoc's laws permits to express the measured output voltage as a function of the differences of the switch voltages. (Germany.)

Transistor Measurements. B. N. Harden, et al. "El. Tech." Feb. 1961. 5 pp. Equipment for the direct measurement, at frequencies from 0.5 to 100 Mc/s, of the power gain and noise factor of transistors, operating as small-signal common-emitter amplifiers is described. The results of a few typical measurements are included, made under defined conditions of external feedback. (England.)

Corona in Coaxial Cables. John P. Agris. "El. & Comm." February 1961. 2 pp. Preparation of cable specimens for corona testing, test circuits and the calibration of equipment are discussed in the following articles as a guide to cable manufacturers. (Canada.)

New Floating Laboratory Facilitates Underwater Acoustic Measurements. G. W. McMahon. "Can. Elec. Eng." Feb. 1961. 4 pp. The Defence Research Board's Naval Research Establishment at Dartmouth, N. S., has a new floating laboratory in which underwater acoustic experiments and measurements are made. This article describes the laboratory and typical experiments on transducers, sound sources, and domes. (Canada.)

Hybrid Parameter Simplifies Calculation of Transistor Current Gain Versus Load. M. A. Gullen. "Can. Elec. Eng." Feb. 1961. 3 pp. The computation required to construct the forward current gain versus load admittance curves of a 4-terminal network is very greatly reduced if the output hybrid parameter of the network is measured. The theory is illustrated by application to a transistor. (Canada.)

Generator for Delayed Pulses and Sawtooth Voltages. R. W. Frank. "El. Rund." Jan. 1961. 4 pp. A general radio equipment incorporating 42 tubes that will meet many requirements are described. It is in the main a precision delay generator combined with a sawtooth and a pulse generator. (Germany.)

The Measuring of Low Reflection Coefficients at High Frequencies. K. Kohler. "Freq." Jan. 1961. 6 pp. A method is described for measuring low reflection coefficients at high frequencies in terms of magnitude and phase. An accuracy of 0.1% can be attained with the use of commercial equipment. The paper states also the theoretical fundamentals of this method which can be applied with coaxial systems and waveguides. (Germany.)

Calculation of Voltage-to-Earth of the Top of a Power-Line Tower Stricken by Lightning, by Methods Used for Transmission Lines. J. L. Maksiejewski. "Roz. Elek." Vol. 4, No. 3, 1960. 29 pp. The aim of the paper is to examine the practical value of calculation of this voltage by means of general methods used for transmission lines i.e. D'Alembert method and Fourier method. (Poland.)

SEMICONDUCTORS

Report from the 1960 INTERKAMA in Dusseldorf, Germany. W. Taeger. "Freq." Dec. 1960. 7 pp. This is a brief synopsis of the Dusseldorf electronics fair, giving a brief description of some of the major items shown in the following fields: controls, electronic measuring devices and data transmission, various recorders, electronic computers, and semiconductor devices. (Germany.)

Simple Transistor Circuits. R. Gondry. "El. et Auto." Jan. 1961. 2 pp. Three simple circuits are described. They use power transistors OC 26 or equivalent. The first one is a dc to dc converter from 12 v. supply providing 160 v. with a power output of 25 w. The second one is another converter for high output voltages of the order of several kilovolts. The third one is an industrial proximity detector based on the saturation of a ferrite magnetic core by a permanent magnet. (France.)

Thermal Problems of Transistors. H. J. Thuy. "El. Rund." Jan. 1961. 4 pp. The paper gives a survey of the various thermal problems encountered in transistor work. Particular attention is paid to the transistor-life dependence on the junction temperature, calculation and measuring of internal thermal resistances and problems of cooling surfaces. (Germany.)

Transistorized AFC for Picture Synchronous Magnetic Tape Recording and Reproduction. H. Lennartz. "El. Rund." Jan. 1961. 4 pp. The perforation of magnetic film, when scanned by light beam and photocell, supplies a frequency which is an exact measure for the tape speed. The tape-recorder motor is driven by a power amplifier fed by an LC oscillator with AFC. The control voltage is obtained by comparing the phases of the perforation frequency and of the line frequency. This voltage automatically adjusts the LC oscillator so that both frequencies are always in phase. The result is a highly constant tape speed over the whole length of the tape. (Germany.)

Applications of Miniature Transistors. M. Asti. "El. et Auto." Jan. 1961. 2 pp. Miniature transistors are particularly useful in the design of compact circuits. Three typical practical applications are given. The first circuit uses a transistor as a straight power amplifier to control a relay. The second circuit is a bistable multi-vibrator with crossed collector-base couplings. The third circuit is a triggered blocking oscillator, able to operate at high recurrence frequency. (France.)

Characteristic Properties of Transistors Used in Circuit Design and Their Interrelationship. W. Benz. "Freq." Jan. 1961. 13 pp. A transistor can be operated in two different ways, either as an amplifier or as a switching device. This report is mainly dealing with the transistor working as an amplifier. Having made some introductory remarks about this kind of operation, the dc conditions and the relations between dc voltages and dc currents are briefly considered, as well as their dependencies on temperature. (Germany.)

Super-Conducting Thin Film Tunneling Effect. Ivar Giaever. "El. & Comm." February 1961. 3 pp. An electronic process known as "tunneling" which has previously proved useful in carefully prepared semiconductor materials, has been observed for the first time in devices of simpler configuration. (Canada.)

Image and Working Parameters of the Transistor. W. Majewski. "Ros. Elek." Vol. 4, No. 3, 1960. 26 pp. The present paper constitutes a trial of applying the classical theory of 4-poles to transistor circuits. Basic formulae of the theory of 4-poles are presented and then applied to transistor circuits. Formulae for image impedances and image transfer coefficients in 3 basic circuits are deduced in the paper. (Poland.)

TRANSMISSION

Guide Irregularities and TE_{01} Wave Transmission. M. Jouguet. "Cab. & Trans." Jan. 1961. 24 pp. When a TE_{01} wave propagates in a circular cross-section waveguide, parasitic waves arise from the various irregularities located at the junctions between adjacent guide lengths. The author estimates the relative amplitudes of these waves and the corresponding power, assuming a random distribution of the irregularities to exist. From the so obtained results, losses and attenuation increase values are derived. (France.)

Exploring the Atmosphere with Radio Waves. H. Bremmer. "Phil. Tech." #3, 1960/61 10 pp. In recent years important new discoveries have been made possible by the development of space research, enabling radio transmitters to be sent out beyond the ionosphere, and by the application of highly sensitive radar methods to observations from the earth. (Netherlands, in English.)

TUBES

Cold Cathode Thyratrons for Continuous Current of Several Amperes. H. E. Seifert. "El. Rund." Jan. 1961. 4 pp. The functions of individual components of these tubes, illustrated by quantitative characteristics are described. Three circuit models show the efficiency and the life of the tubes as far as known from tests. (Germany.)

Experimental Traveling-Wave Tubes. G. M. Clarke. "El. Tech." Feb. 1961. 8 pp. Tubes are described with 150 w and 300 w c.w. output with gains greater than 20 db over the band of 7.5 to 11.5 kMc/s which, because of the small size, probably involve greater difficulties than would occur in higher power tubes using the same technique. (England.)

Microphony in Electron Tubes. S. S. Dagpunar, E. G. Meerburg and A. Stecker. "Phil. Tech." #3, 1960/61. 18 pp. The article which embodies contributions from British, Dutch and German laboratories, gives some idea of the investigations and of the progress made in recent years in combating microphony. (Netherlands, in English.)

10 nsec t_s max.

with 2N783

0.16 Volts V_{CE} (sat) max.

with 2N784

NEW!
SYLVANIA SILICON

epitaxial mesas

SYLVANIA 2N783 ... world's fastest NPN silicon switching transistor

t_{on}	$I_{B(1)} = 3$ mA, $I_{B(2)} = 1$ mA $V_{CC} = 3$ V, $R_L = 270$ Ohms	16 nsec
t_s	$I_{B(1)} = 10$ mA, $I_{B(2)} = 10$ mA $V_{CC} = 10$ V, $I_C = 10$ mA, $R_L = 1000$ Ohms	10 nsec
t_{on}	$I_{B(1)} = 3$ mA, $I_{B(2)} = 1$ mA $V_{CC} = 3$ V, $R_L = 270$ Ohms	30 nsec

SYLVANIA 2N784 ... an optimum combination of high speed switching and low V_{ce} (sat)

$I_C = 10$ mA, $I_B = 1$ mA	0.16 V

For speed, meet the fastest silicon switch on record—try Sylvania 2N783. Utilizing the proven mesa structure and advanced techniques for epitaxial growth, Sylvania 2N783 provides exceptionally fast turn-on, turn-off, and storage times. Sylvania 2N784 is a remarkable combination of ultra-fast switching speed and unusually low saturation voltage.

Packaged in TO-18, both types possess high reliability and the excellent power dissipation capabilities typical of the mesa structure. They exhibit high electrical uniformity, characteristic of highly automated Sylvania batch-mesa manufacturing techniques.

Investigate the advantages offered your designs by performance-proved Sylvania Epitaxial Silicon Mesa Transistors. Available from your Sylvania Sales Engineer or Sylvania Semiconductor Distributor. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 194, Woburn, Mass.

ABSOLUTE MAXIMUM RATINGS (AT 25°C)

	2N783	2N784	UNIT
Collector to Base Voltage	40	30	V
Collector to Emitter Voltage	20	15	V
Emitter to Base Voltage	5	5	V
Collector Current	200	200	mA
Power Dissipation (free air)	300	300	mW
Power Dissipation (case at 25°C)	1	1	W
Storage Temperature	−65 to +300	−65 to +300	°C
Junction Temperature	+175	+175	°C

ELECTRICAL CHARACTERISTICS (AT 25°C)

Symbol	Conditions	2N783 Min.	2N783 Max.	2N784 Min.	2N784 Max.	UNIT
BV_{CBO}	$I_C = 100\ \mu A$, $I_E = 0$	40	–	30	–	V
BV_{EBO}	$I_E = 100\ \mu A$, $I_C = 0$	5	–	5	–	V
BV_{CER}	$I_C = 1$ mA, $V_{BE} = 0$, $R_{BE} = 10$ ohms	20	–	15	–	V
I_{CBO}	$V_{CB} = 25$ V	–	250	–	250	mμA
	$V_{CB} = 25$ V, $T = 150°C$	–	30	–	30	μA
h_{FE}	$I_C = 10$ mA, $V_{CE} = 1$ V	20	60	25	–	
V_{BE}	$I_C = 10$ mA, $I_B = 1$ mA	0.7	0.9	0.7	0.9	V
V_{CES}	$I_C = 10$ mA, $I_B = 1$ mA	–	.25	–	.16	V
C_{ob}	$V_{CB} = 10$ V, $I_E = 0$, $f = 1$ MC	–	3.0	–	3.5	mmf
h_{fe}	$V_{CB} = 15$ V, $I_C = 10$ mA, $F = 100$ MC	2.0	–	2.0	–	
t_{on}	$I_{B(1)} = 3$ mA $I_{B(2)} = 1$ mA $V_{CC} = 3$ V, $R_L = 270$ Ω	–	16	–	20	nsec
t_s	$I_{B(1)} = 10$ mA, $I_{B(2)} = 10$ mA $V_{CC} = 10$ V, $I_C = 10$ mA, $R_L = 1000$ Ω	–	10	–	15	nsec
t_{on}	$I_{B(1)} = 3$ mA, $I_{B(2)} = 1$ mA $V_{CC} = 3$ V, $R_L = 270$ Ω	–	30	–	40	nsec

SYLVANIA

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GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

PRODUCTION QUANTITY TI SIL

MAXIMUM 12 nsec t_{on}
MAXIMUM 40 nsec t_{off}

$V_{CE(sat)}$ PRACTICALLY INSENSITIVE TO TEMPERATURE... CONSTANT 1 VOLT FROM −55 to +170°C

The fastest silicon switcher in the industry! Design today with Texas Instruments new 2N743 and 2N744 silicon epitaxial transistors and get *two-times faster switching than possible from any other commercially available silicon transistor!* This outstanding new epitaxial series gives you an optimum combination of ultra-fast switching times, temperature-stable R_{CS}, very low collector capacitance, and high f_T, to make the 2N743 and 2N744 *ideal for application in current ranges from 1 to 100 ma.*

Utilize the low R_{CS}/high current characteristics of these new epitaxial units to *replace large size medium-power transistors* and cut your overall switching times as much as two-thirds. Cut cost and reduce the complexity of your NOR logic designs with the new TI 2N743 series — these new epitaxial units give you a guaranteed I_{CEX} of 30 µa at a V_{CE} of 10 volts and V_{BE} of 0.35 volts to eliminate additional circuits previously required for an I_{B2} turn-off source in your computing systems.

Apply the new 2N743 and 2N744 to your designs today and get *guaranteed d-c betas at three current levels.* The 2N744 gives you a guaranteed h_{FE} of 20 at 1 and 100 ma and a 10-ma beta spread of 40 to 120, while the 2N743 features a minimum h_{FE} of 10 at 1 and 100 ma, and 60 maximum at 100 ma.

New TI 2N743 and 2N744 silicon epitaxial transistors are immediately available from distributor stocks or in mass production quantities at prices competitive with conventional silicon mesa and micro-alloy transistors.

Compare the 2N743 and 2N744 with conventional transistors!

Parameter	Approx. Test Conditions	TI 2N743	TI 2N744	2N834	2N706B	2N708
T_s(nsec)	$I_{B(1)} = -I_{B(2)} = I_C = 10$ ma	14	18	25	25	25
t_{on}(nsec)	$I_{B(1)} = 3$ ma $I_{B(2)} = -1$ ma $I_C = 10$ ma	11 (TYP)	10 (TYP)	35	40	35
t_{off}(nsec)		22 (TYP)	25 (TYP)	75	75	75
t_{on}(nsec)	$I_{B(1)} = 40$ ma $I_{B(2)} = -20$ ma $I_C = 100$ ma	12 6 (TYP)	12 6 (TYP)	NO SPEC	NO SPEC	NO SPEC
t_{off}(nsec)		40 18 (TYP)	45 23 (TYP)	NO SPEC	NO SPEC	NO SPEC
$V_{CE(sat)}$	$I_B = 1$ ma $I_C = 10$ ma $T_A = +170$°C	0.35 v	0.35 v	No High Temp. Guarantee (0.19 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)
I_{CEX}	$V_{CE} = 10$ v $V_{BE} = +0.35$ v $T_A = 100$°C	30 µa	30 µa	No Guarantee	No Guarantee	10µa (MAX.) @$V_{BE} = +0.25$ $V_{CE} = 20$ v $T_A = +125$°C

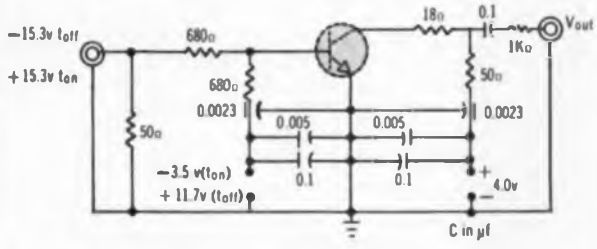
NOTE: All limits are max. unless otherwise noted.

ICON EPITAXIAL TRANSISTORS

@100 ma

MAKE YOUR OWN COMPARISON FROM THESE TYPICAL CIRCUITS

50-ma SWITCHING CIRCUIT



USE THE TI 2N743 TO SWITCH IN 1/3 THE TIME!

2N706
t_{on} = 10 nsecs
t_{off} = 50 nsecs
60

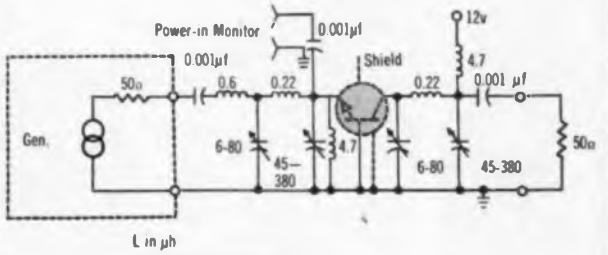
2N743
t_{on} = 7 nsecs
t_{off} = 15 nsecs
22

USE THE TI 2N743 TO DOUBLE POWER OUTPUT AND EFFICIENCY!

2N706
P_{out} = 225 mw
Eff = 32%
P.G. = 6 db

2N743
P_{out} = 500 mw
Eff = 65%
P.G. = 6 db

70-mc POWER AMPLIFIER



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New Products

ILLUMINATED SWITCHES

Push button switches are available in many modular forms.

The contact arrangement is up to 8 PST with mounting in one of three methods: sub-panel, surface or matrix. A selection of solenoid, momentary, alternate, interlocking or lock-out action is offered. These units come in two types, sealed and unsealed. The compact sized ⅞ in. sq. panel space (¾ in. sq. button) unit comes in four color illumination, buttons and bodies to specification. Luminator, Inc., Display-Control Div., Costa Mesa, Calif.

Circle 312 on Inquiry Card

SWEEPING OSCILLATOR

Vari-Sweep, Model 860-B, covers the freq. range from 2 to 215 MC.

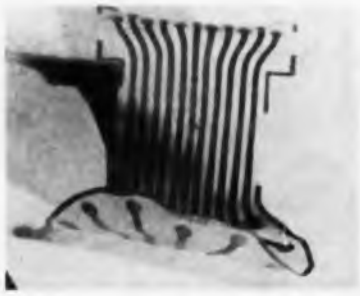
The new model incorporates many desirable new features. The specifications include the following: R-f Output: 1.0 v. RMS into 50 or 70Ω AGC'd; sweep width: to 30 MC; sweep rate: continuously variable, 10 to 40 CPS—locks to line frequency; sweep output: regular sawtooth, synchronized with sweeping oscillator. Amplitude 7.0 approx.; power supply: input approx. 100 w, 117 v. (±10%), 50-60 CPS—regulated B+; dimensions: 9⅛ x 19⅛ x 13 in. Kay Electric Co., Dept. E.I., Maple Ave., Pine Brook, N. J.

Circle 313 on Inquiry Card

. . . for the Electronic Industries

FLEXIBLE ETCHED CIRCUITS

These circuits are for use in curved or bent areas.



The circuits are backed by Teflon, Kel-F, or polyester materials having flexibility, toughness and electrical properties exceeding those of materials for rigid circuit boards. The flexible circuits also resist chemical action, making them usable in many environments that rule out customary etched circuits. The circuits reduce assembly time and increase reliability. U. S. Engineering Co., 13536 Saticoy St., Van Nuys, Calif.

Circle 286 on Inquiry Card

SMALL RELAY

This 4PDT relay is for use in computers and telephone carriers.

These KHP relays are rated for loads from dry circuit up to 3 a @ 30 vdc or 115 vac resistive. Contact arrangements of 4 Form C and 2 Form Z are available. Coil operating voltages range from 6 to 110 vdc. These general purpose relays operate on as little as 0.5 w min. power, 0.9 w nominal, and 2.0 w max. @ +25°C. Potter & Brumfield, Princeton, Ind.

Circle 288 on Inquiry Card

IMPEDANCE PLOTTER

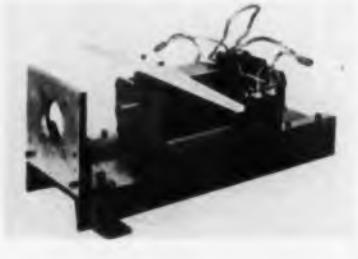
Automatic plotter covers from 0.1 to 1700 MC.

Used with an external oscillator, the Type 14 provides continuous impedance information, displayed as a trace on the Smith-chart-calibrated CRT of the presentation unit. If a permanent record is required, a separate X-Y recorder can be added to the system without affecting the indication on the CRT. The equipment can be furnished for rack mounting or in portable form. Alford Mfg. Co., 299 Atlantic Ave., Boston, Mass.

Circle 290 on Inquiry Card

MOTOR TESTER

The Dynamometer D-1101 checks speeds to 20,000 RPM, loads to 7 hp.



The unit, used for load and life testing of direct drive motors, consists of a generator constructed from an EEMCO motor frame mounted in ball bearings to allow free movement in the horizontal axis. Across the top of the generator is a 20 in. arm, the end of which is attached to a common weight scale which indicates in./lbs generated by the test motor. This unit was used for motor testing of the Minute Man missile. EEMCO Div., Electronic Specialty Co., 4612 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 287 on Inquiry Card

DC POWER SUPPLY

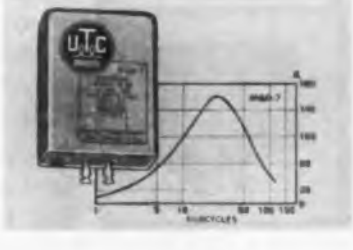
Unit is for filament supply and computer applications.

Specs are: output, 6.3 vdc at 0-5a; regulation, 0.05% for ±10% line voltage and 0-5a load; ripple, under 1mv RMS; internal impedance, less than 0.05 Ω dc to 10 KC; power input, 105-135v., 60 cps, 45w; automatic overload and short circuit protection. Under complete short the regulating transistor dissipates less than 1w, push-button reset; line transients are suppressed in less than 10 μsec; dimensions, 2½ x 8 x 5 in.; weight, 6 lbs. Dynex Industries, Inc., 170 Eileen Way, Syosset, L. I., N. Y.

Circle 289 on Inquiry Card

TOROIDAL INDUCTORS

Eight new types provide high Q factor with miniature dimensions.



A typical unit, the MQD-7, is illustrated with curve in the photo. All units are hermetically sealed, and meet or exceed Mil-T-27A specs; laboratory adjusted to 1% tolerance —0 dc. Hum pickup is extremely low due to the toroidal winding structure, with windings uniformly spread over the core. The cases are of high permeability, affording additional shielding to permit close spacing of units, the coupling attenuation being approx. 80 db. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 291 on Inquiry Card

New Products

CAM UNITS

Adjustable cam assemblies are miniaturized.

Designed for use in precision timing applications, the new assemblies feature positive locking at any predetermined operational setting, within a range of 0 to 180°. Machined from #303 stainless steel, with clear passivated finish, these are stocked in 0.1248 in., 0.1873 and 0.2498 in. bore sizes, in pin or clamp type hub styles. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

Circle 292 on Inquiry Card

MAGNETRON TEST SET

BLP-002K is for testing Beacon Magnetrons.

Plumbing components include: well-matched coaxial line to waveguide transition; pulling device; folded cross guide directional coupler; thermistor mount; freq. meter; waveguide to coaxial line transition. The modulator, capable of producing 0.5 and 1.0μs pulses having a peak amplitude of 3.0 kv at 2.0a, is provided with internal trigger source, necessary control and meters, plus test jacks for pulse shape viewing through an oscilloscope. Available for C-Band or X-Band testing. Bomac Laboratories, Inc., Salem Rd., Beverly, Mass.

Circle 293 on Inquiry Card

New! 1000-Megacycle FREQUENCY STANDARD

Any or All of These Outputs with Stability of 5 Parts in 10^{10}

1120-AH
1000-Mc Frequency Standard

...$6450

A 5-Mc Crystal Oscillator with Decade Dividers to 100 cps. and Decade Multipliers to 1000 Mc.

INCLUDES:
1103-B Syncronometer
1114-A Frequency Divider
1113-A Standard-Frequency Oscillator
1112-A and -B Standard-Frequency Multipliers

1120-A
5-Mc Frequency Standard

...$3640

With Decade Dividers to 100 cps.

INCLUDES three top instruments only

For Use With These Standards...

1105-A Measuring Equipment provides high selectivity for the measurement of weak signals in the presence of noise;

1130-A Digital Time and Frequency Meter for general laboratory work.

- High performance at reasonable cost with 5-Mc fifth-overtone Warner crystal and two-stage oven.
- Short-Term Stability: 1 part in 10^{10} per min, using 1 sec samples.
- Long-Term Stability: 5 parts in 10^{10} per day, averaged over 10 days after 60 days operation.
- Low Noise: *Below 5 Mc* — pulse-type dividers provide fail-safe operation and minimize phase noise. *Above 5 Mc* — phase-locked crystal oscillators provide clean signals — f-m noise less than 1 part in 10^{9}.
- Syncronometer gives resolution (±0.2 msec) for time comparisons consistent with stability of sky-wave signals from WWV and other stations. Direct digital readout.
- 10-kc and 100-kc square waves for triggering purposes.
- Harmonics for measurements well beyond X-band can be produced with simple distorting and mixing diode.
- Additional Plug-In Units provide 400 cps and 60 cps; 1114-P6 $85 and 1114-P7, $115, respectively.
- Type 1116-A Emergency Power Supply available as an accessory.

Write for Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

The Best Instruments In Electronics

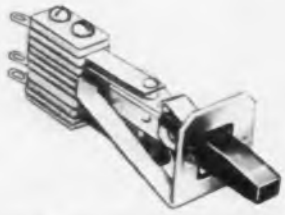
NEW YORK, WOrth 4-2722
NEW JERSEY, Ridgefield, WHitney 3-3140
CHICAGO, Oak Park, Village 8-9400
PHILADELPHIA, Abington, HAncock 4-7419
WASHINGTON, D.C., Silver Spring, JUniper 5-1088
SAN FRANCISCO, Los Altos, WHitecliff 8-8233
LOS ANGELES, Los Angeles, HOllywood 9-6201
IN CANADA, Toronto, CHerry 6-2171

Circle 114 on Inquiry Card

New Products . . . for the Electronic Industries

TOGGLE SWITCH

This 23000 Series is built for long life.



The "TT," Tini-Toggle Switches provide long "spring-action" life which is accomplished by the use of relatively long springs without any "forms" at the point of flexing. Features are: multiplicity of circuits; 3-position toggle-type switch or a 2-position switch with momentary or locking action; choice of contacts, fine silver rated at 3a, 120 vac non-inductive load (300 v. max.), or; Palladium contacts on special order. Military insulation and finishes are available. Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Circle 316 on Inquiry Card

AMPLIFIER-CONVERTER

This unit can function well in radio astronomy equipment.

The RF51 is a r-f - i-f assembly comprising a broadband VHF amplifier and a converter to intermediate freq., with coaxial i-f output. Used with separate local oscillator, the RF51 is useful as a receiver front end for countermeasures, radio astronomy or noise-survey purposes. Typical specs are: center freq. 300 MC, r-f bandwidth 70 MC ±1 db, i-f output freq. 70 MC, i-f bandwidth 3 MC, and overall noise figure 6 db. LEL, Inc., 75 Akron St., Copiague, N. Y.

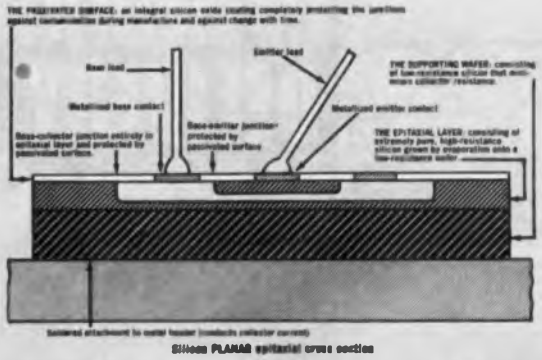
Circle 317 on Inquiry Card

DIGITAL MODULES

Series 5000 transistorized modules operate up to 5 MC.

Consisting of cards with indicating and non-indicating flip-flops, a 1-shot multivibrator, a free-running multivibrator, two 5-input nors, three 3-input nors, and 4 gates, all items are fully compatible with the series 200 modules operating at 200 KC and below, and are mounted on the same compact size card—2 11/16 x 3½ in. The logical "1" is −6 to −8 vdc and the logical "0" is 0 ±0.5 vdc so that power supplies are not regulated. Wang Laboratories, Inc., 12 Huron Dr., Natick, Mass.

Circle 318 on Inquiry Card



Silicon PLANAR epitaxial cross section

PLANAR

- GREATEST RELIABILITY, STABILITY AND UNIFORMITY
- LOWEST GUARANTEED I_{CBO}

EPITAXIAL

- LOWEST GUARANTEED V_{CE} (sat)
- HIGHER MAXIMUM I_C
- NO SACRIFICE IN VOLTAGE BREAKDOWN

COMBINED IN ONE TRANSISTOR FAIRCHILD SILICON 2N914

This combination means extremely fast propagation time in digital circuits, excellent high-frequency response in amplifiers, high-speed performance in current drivers. Typical f_T is 300 mc.

To the EPITAXIAL advantages, PLANAR adds extreme stability, reliability, low leakage and low noise figure. PLANAR and EPITAXIAL TOGETHER achieve usable current gain over a broader current range than either alone.

Write for full specifications.

ELECTRICAL CHARACTERISTICS AT 25°C — 2N914

	Min.	Max.	Conditions
h_{FE}	20	80	$I_C = 10mA, V_{CE} = 1.0V$
BV_{CBO}	40V	—	$I_C = 10\mu A, I_E = 0$
BV_{EBO}	5.0V	—	$I_E = 10\mu A, I_C = 0$
$V_{CE(Sat)}$	—	0.18V	$I_C = 10mA, I_B = 1mA$
$V_{CE(Sat)}$		0.7V	$I_C = 200mA, I_B = 20mA$
h_{fe}	3		$I_C = 10mA, f = 100mc$
C_{ob}		6pf	$V_{CB} = 10V, I_E = 0$

FAIRCHILD SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF.-YORKSHIRE 8 8161-TWX: MN VW CAL 853

A wholly owned subsidiary of Fairchild Camera and Instrument Corporation

New Products

POTENTIOMETER

The ½ in. pot has glass-sealed terminals for high temp. operation.

The new Series 57EM potentiometer is a wire-wound, 2.0 w unit available in resistance up to 100 K Ω. It is encased in a metallic housing with terminals brought out through the rear in glass-sealed construction. Resistance linearity is of the order of 2%. The unit is derated to 0 at 150°C. It meets the application sections of Mil-R-19, Mil-R-12934 and Mil-R-27208. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 322 on Inquiry Card

AUDIO MIXER

CustoMixers employ plug-in shock mounted preamps and input transformers.

The mixer amplifiers are for use by recording studios, broadcasters and audiophiles. A feature of both the 5-position single channel and the 4-position, 2-channel stereophonic version is the unique Line-Aten Straight-line volume control. Input and output impedances are from 50 to 600Ω plus hi-Z. An illuminated VU meter is on each output line. UltrAudio Products, Dept. P-10, 7471 Melrose Ave., Los Angeles 46, Calif.

Circle 324 on Inquiry Card

TRANSDUCER

This general-purpose underwater transducer is now available.

The Clevite Oyster, is designed to operate at up to 60 psi water pressure over a range from 10 to 10 KC. Below resonance, its response is a constant −82 db, reference 1 v/microbar (−90 db into 60 ft. of coaxial cable). It is substantially nondirectional over its normal freq. range, and can be used as a transmitter or receiver. With 60 ft. of cable, it weighs 11 oz. with brass piston, 9 oz. with aluminum pistons. It is 1¾ x ½ in. Clevite Ordnance Div., Clevite Corp., 540 E. 105 St., Cleveland, Ohio.

Circle 323 on Inquiry Card

COAXIAL SWITCHES

75 db isolation over wide ranges in the VHF and UHF regions.

This 8000 series of high power coaxial switches incorporates a new concept in electro-mechanical switching, reducing contact wear to a minimum. Reliable capability is achieved by a direct bearing flush type mechanism. The SPDT switches are presently being made in both 1⅝ and 3⅛ in. coax. VSWR in these switches is low. The series is manually operated, but motor drives can be furnished. Bogart Mfg. Corp., 315 Seigel St., Brooklyn 6, N. Y.

Circle 325 on Inquiry Card

Another New High Order of Reliability!

El-Menco

*MYLAR-PAPER DIPPED CAPACITORS

TYPE MPD

ASSURE A LOW FAILURE RATE OF

Only 1 Failure in ~~7,168,000~~ 14,336,000 Unit-Hours for 0.1 MFD Capacitors*

Setting A New High Standard Of Performance!

Life tests have proved that El-Menco Mylar-Paper Dipped Capacitors — tested at 105°C with rated voltage applied — have yielded a failure rate of only 1 per 1,433,600 unit-hours for 1.0 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD El-Menco Mylar-Paper Dipped Capacitors will yield ONLY 1 FAILURE IN 14,336,000 UNIT-HOURS.

CAPACITANCE AND VOLTAGE CHART

- *Five case sizes in working voltages and ranges:*

200 WVDC —	.018 to .5 MFD
400 WVDC —	.0082 to .33 MFD
600 WVDC —	.0018 to .25 MFD
1000 WVDC —	.001 to .1 MFD
1600 WVDC —	.001 to .05 MFD

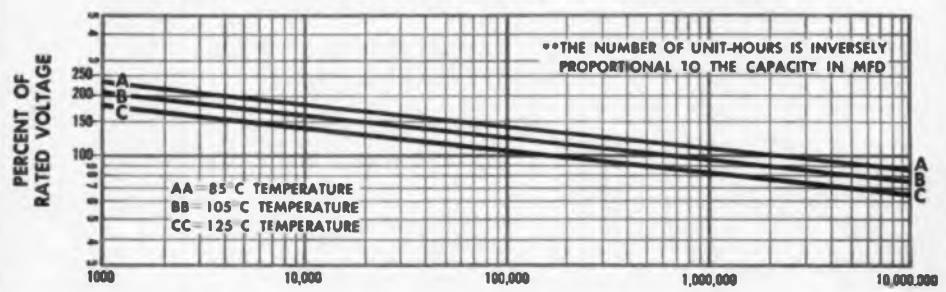
SPECIFICATIONS

- TOLERANCES: 10% and 20%. Closer tolerances available on request.
- INSULATION: Durez phenolic, epoxy vacuum impregnated.
- LEADS: No. 20 B & S (.032") annealed copper clad steel wire crimped leads for printed circuit application.
- DIELECTRIC STRENGTH: 2 or 2½ times rated voltage, depending upon working voltage.
- INSULATION RESISTANCE AT 25°C: For .05MFD or less, 100,000 megohms minimum. Greater than .05MFD, 5000 megohm-microfarads.
- INSULATION RESISTANCE AT 105°C: For .05MFD or less, 1400 megohms minimum. Greater than .05MFD, 70 megohm-microfarads.
- POWER FACTOR AT 25°C: 1.0% maximum at 1 KC

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

Write for Technical Brochure

MINIMUM LIFE EXPECTANCY FOR **1.0 MFD *MYLAR-PAPER DIPPED CAPACITORS AS A FUNCTION OF VOLTAGE & TEMPERATURE



*Registered Trade Mark of DuPont Co.

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC CONNECTICUT

• molded mica • mica trimmer • dipped mica • silvered mica films
• tubular paper • mylar-paper dipped • ceramic feed-thrus • ceramic discs

Circle 119 on Inquiry Card

New Products

1 KC CRYSTAL FILTER

Filter features high selectivity and high attenuation for missile use.

Insertion loss is 6.2 db. The input impedance is 500Ω and the output impedance is 500 KΩ. This filter meets Mil-C-3098 B vibration standards and applicable portion Mil-T-27 A. Spurious harmonics are more than 60 db down. Their complete line of filters range from 1 KC-30 MC. Burnell & Co., 10 Pelham Parkway, Pelham, New York.

Circle 294 on Inquiry Card

PULSE GENERATOR

Type III provides both output and pretrigger pulses.

The output pulses have an amplitude of ± 5 v. Duration is 2 nsec., min. and 100 nsec. max at low repetition rates, decreasing to 20 nsec. at 100 KC repetition rate. Risetime is less than 0.5 nsec. Repetition rate is continuously variable from 10 pps to 100 KC. The pretrigger pulses can be set to occur from 30 to 250 nsec. ahead of each output pulse. This time is variable from a front-panel control. The pretrigger pulses have an amplitude of 10 v., duration of 250 nsec. and half-amplitude risetime of 4 nsec. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 295 on Inquiry Card

New! Sylvania CT4251

First

Compact
Decade Counter Tube
in Dome-Shaped T-9 Bulb
with 10 Output Cathodes

Illustration compares size advantage of Sylvania CT4251 to type in T-11 outline

Sylvania introduces the new CT4251 . . . opening a dramatic new approach to the design of very compact, low-cost counting equipment in the 0-50KC frequency range.

Utilizing a new dome-shaped T-9 bulb evacuated from the base, Sylvania CT4251 offers significant reductions in seated height. CT4251 features 10 output cathodes, offering the versatility and advantages of tube types previously available only in the T-11 bulb. Examples: electrical information can be fed from all 10 cathodes, enabling preselection of a count from 0-9; the diameter of the ring of cathodes is identical with that of types in the T-11 outline, providing excellent visibility of readout information.

Sylvania CT4251 is the lowest cost *cold cathode Decade Counter Tube* available. Combining electrical and visual readout functions, it offers extensive economies in circuitry and associated components. Sockets, too, for its 13-pin circle are as much as one-half the cost of sockets normally required for T-11 types. In addition, this new 13-pin circle makes it possible for Sylvania CT4251 to be designed into equipment using transistorized and printed circuit techniques.

Tests to date of Sylvania CT4251 indicate superior quality performance even under stand-by operation for 500 hours.

Your Sylvania Sales Engineer will be pleased to tell you more. Contact him or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 194, 1100 Main St., Buffalo 9, N.Y.

Sylvania Type	Total Anode Current (mA)		Min. Anode Supply Voltage (Vdc)	Min. Double Pulse Amplitude (V)	Min. Double Pulse Width (μsec)
	Min.	Max.			
CT4251	0.65	0.8	400	−70	4

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Circle 123 on Inquiry Card

New Products

FREQUENCY CHANGER

The FCR 3P-300 operates 1, 2, or 3φ over a range of 45—2000 CPS.

The unit operates without moving parts and has an accuracy of ±1%. With an auxiliary frequency standard, accuracy can be increased to ±0.01%. Its dimensions are 21⅜ x 19½ x 15¾ in. Sorensen & Co., Inc., Richards Ave., So. Norwalk, Conn.

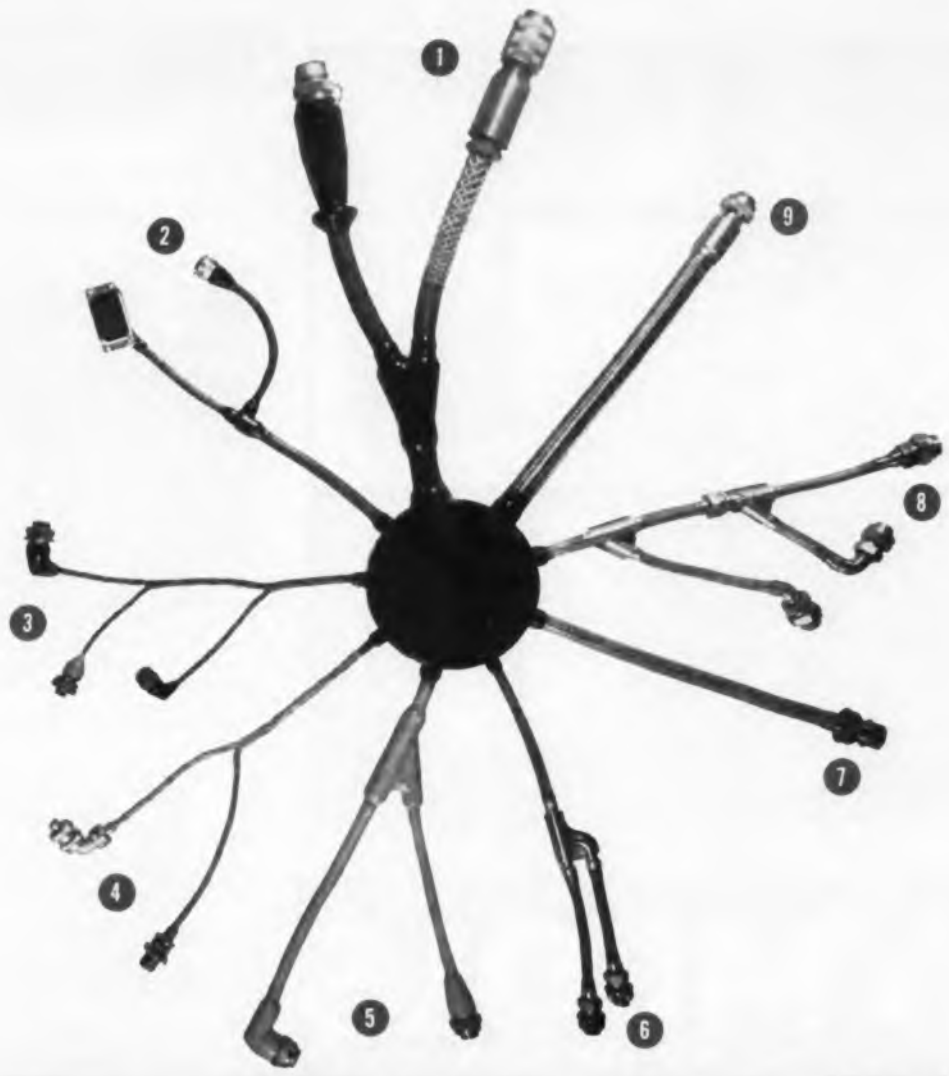
Circle 296 on Inquiry Card

SSB COMMUNICATIONS

SSB Transmitter Adapter operates from 1 to 50 MC.

This unit, Model SSB-58-1B, not only covers standard high freq. communications bands but also makes practical high efficiency Class C SSB operation, using the EER system for scatter transmission. Existing or brand new AM transmitters may be easily adapted to produce Peak Envelope Power of from 3 to 4 times their carrier rating for SSB operation. Kahn Research Laboratories, Inc., 81 S. Bergen Place, Freeport, L. I., N. Y.

Circle 297 on Inquiry Card



TYPICAL BENDIX® SPECIAL-PURPOSE CABLES THAT SOLVE CRITICAL ENVIRONMENTAL PROBLEMS

1. Heavy Duty—Ground Support Cable
2. Benseal® Missile Control Cable
3. Fabric Braided—Aircraft and Missile Control Cable
4. Metal Braid—Aircraft Nacelle Cable
5. High Temperature—Radiation Resistant Cable
6. High Temperature—Lightweight—Missile Cable
7. "Wet Wing" Aircraft Fuel Cell Cable
8. Rewirable—Jet Engine Control Cable
9. High Temperature—1500°F.—Thermocouple Cable

Bendix cables—products of over a quarter-century of design and manufacturing experience—are proving their complete reliability in a countless variety of applications involving critical environmental conditions.

BENDIX CABLES • BENDIX CONNECTORS

Designed together to work best together

For complete information, write:

Scintilla Division
SIDNEY, NEW YORK

The Bendix Corporation

Circle 77 on Inquiry Card

New Products

ULTRASONIC CLEANER

Low priced, 1 pt., cleaner has many applications.

The unit features a broad band freq. modulated circuit which eliminates the need for automatic tuning. The generator is rated at 30w average power—120w peak power output. Fused for 2a, the generator operates from 117v. 50/60 cps. The 1 pt. capacity cleaning tank features a working compartment measuring 3⅝ x 3⅝ x 3 in. Ultrasonic Industries, Ames Court, Engineers Hill, Plainview, L. I., N. Y.

Circle 308 on Inquiry Card

MINIATURE RELAY

Model DH-7B ac contactor is for aircraft and missile use.

The unit is a small 3PDT general purpose relay rated 50a at 115/208 v., 400 cps. Hermetically sealed in a can, it measures 2⅝ x 2⅞ in. Its weight is 12 oz. Specs call for the relay to operate in ambients of —65° to 120°C, 20g's to 2000 cps vibration, 0 to 80,000 ft. altitude. Unit is made to meet Mil-R-6106B. Other units are available with contact forms of SPST to 6PDT side stable or latching; current ratings of 5 to 50a and coil/contacts of any reasonable ac or dc voltage. The Hartman Electrical Mfg. Co., 175 N. Diamond St., Mansfield, Ohio.

Circle 309 on Inquiry Card

Flexibility and Refinement

APR-20 rectangular antenna pattern recorder

APR-30 polar antenna pattern recorder

...The reason most antenna pattern recorders come from S-A

It's the little things that make the difference. Little things, refinements, "extras," and top-notch workmanship all add up to preference for S-A instrumentation.

Things Like Plug-in Balancing Potentiometers...

Series P plug-in pen balancing potentiometers

Series P potentiometers are used in both rectangular and polar coordinate pattern recorders. By interchanging potentiometers together with the appropriate pen function amplifier, different responses—linear, square-root, and logarithmic—are obtained. Interchanging these new self-aligning potentiometers can be accomplished in less than thirty seconds. Stocking spare units cuts downtime. Of dust and dirt proof construction, Series P plug-in balancing potentiometers are offered with exchange pricing.

DC Amplifiers...

DCA-21 amplifier for dc input signals

Scientific-Atlanta's DCA-21 amplifier lets APR 20/30 recorders accept dc input signals. A narrow band amplifier preceded by an electromagnetic chopper, the sensitive DCA-21 has a linear dynamic range of 80 db. The unit is directly interchangeable with Series CBA-20 Crystal-Bolometer amplifiers.

Recorder Pen Programmers...

Up to five different pen writing codes can be selected by adding the Model RPP-1 Recorder Pen Programmer to an APR 20/30 installation. Compact, lightweight, and rack mounted, the programmer provides solid line, dot, dash, dash-dot, and space-dot-dot codes at an adjustable code rate of 30 to 90 cycles per minute.

Modification C, Chart Compression...

Modification C, which must be ordered at the time of recorder purchase, provides both standard and compressed cycle charts from a single APR 20 Rectangular pattern recorder. Standard chart cycle is 20 inches, compressed 8 inches. Compressed recordings are conveniently sized to fit standard 8½ x 11 notebooks and reports.

Chart Paper, Recording Pens, Ink, and Accessories...

Scientific-Atlanta offers its customers one-day service by stocking, for immediate delivery, a wide variety of chart paper, recording pens, and other recording necessities.

But above all, it's the engineering philosophy of a company run by antenna engineers for antenna engineers.

Call your nearby S-A engineering representative for more information on S-A pattern recorders and accessories. For complete technical information, please write to Box 44.

Crystal Bolometer Amplifiers...

High gain, low noise crystal-bolometer antenna

Sensitive, narrow-band Crystal-Bolometer amplifiers are miniaturized units designed for use as preamplifiers in S-A polar and rectangular pattern recorders. Five models, CBA-21 through CBA-25 are available. Features include bolometer burnout protection, low noise figure, triaxial signal ground return, up to 108 db gain, 80 db linear dynamic range, adjustable bandwidth (CBA-23), high rejection (CBA-24), variable center frequency (CBA-25).

SCIENTIFIC-ATLANTA, Inc.

2162 Piedmont Road, N.E. • Atlanta 9, Georgia
TRinity 5-7291

7

New Products

TANTALUM CAPACITORS

These tantalum slug, wet-electrolytic's have a ±10% tolerance.

Series TS tantalum slug capacitors have the distinguishing characteristics of tantalum wet-electrolytic capacitors —excellent stability, great capacitance per unit volume and efficient operation at temperature extremes. They have low leakage current and power factor. Ohmite Mfg. Co., 3655 Howard St., Skokie, Ill.

Circle 314 on Inquiry Card

HEAT SINKS

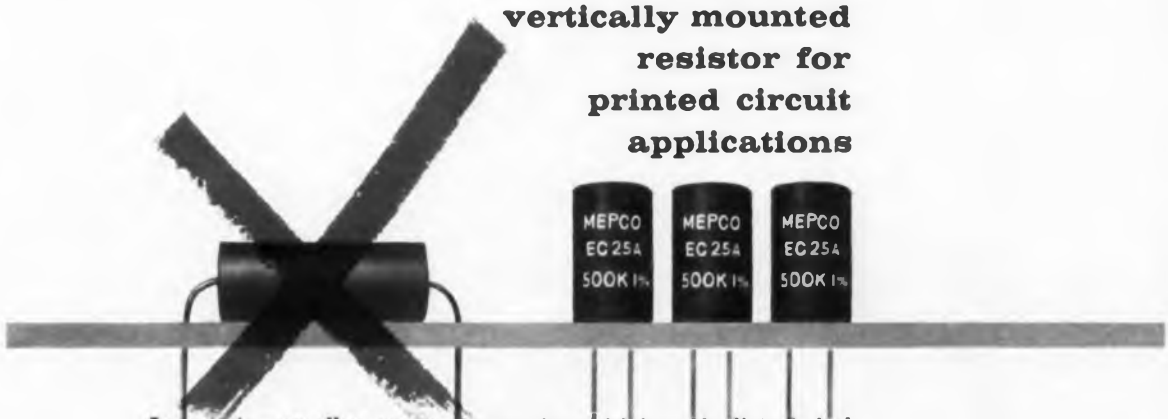
Positive cooling is provided by the staggered vertical "pickets."

The design of the displaced vertical "pickets" in a forced-air application, provides more air passageways and induced turbulence for increased efficiency and rapid carry-off of heat. The UP Series have conventional mounting hole patterns for power transistor and diode case sizes T03, T06, T08, T010, T015, D05, and others. IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 315 on Inquiry Card

NEW CARBON FILM RESISTORS

the first economical, space saving, vertically mounted resistor for printed circuit applications



Low cost — smaller space . . . two items high on the list of vital importance in solving today's tough design problems. MEPCO's new miniature ¼ W Carbon Film resistors were specifically designed to break the cost and space barrier in printed circuit applications.

Having both leads extending from one end and available in three different lead spacing arrangements, these Carbon Film Resistors for vertical mounting offer advantages never before available.

Write or call today for samples and literature.

SPECIFICATIONS

Power Rating	¼ W at 70°C derated to 0 at 150°C	**Length**	$1\frac{3}{64} \pm \frac{1}{64}$
		Diameter	$\frac{1}{4} \pm \frac{1}{64}$
Max. Voltage	300 volts	**Leads**	$1'' \pm \frac{1}{8}''$
Resistance Range	5 to 500 K	**Lead Spacing**	A .125 ±.005
Tolerance	±1%		B .156 ±.005
Temp. Coeff.	—200 PPM to 500 PPM		C .200 ±.005
Environmental Char.	MIL-R-10509C Char. B		

MEPCO

Manufacturers of Precision Resistors

MEPCO, INC.
Morristown, New Jersey

Circle 129 on Inquiry Card

New Products

STABLE OSCILLATOR

New packaged plug-in oscillator has stability of 1 part in 100 million.

This 1000 KC crystal oscillator is designed with transistorized circuitry for use in freq. counters or as a master oscillator in freq. control systems. This plug-in package is supplied with a high precision glass crystal. The oscillator can be custom-designed for other freq. in range 950 KC to 300° KC. Bliley Electric Co., Union Station Bldg., Erie, Pa.

Circle 300 on Inquiry Card

Y CIRCULATORS

Waveguide Y circulators have 20% bandwidth and 20 db isolation.

The new line of "20-20" circulators is for microwave reception and transmission applications. It is small and light without sacrificing performance. Specs for any frequency band within the 2.6-12.4 KMC range are: isolation, 20 db min.; bandwidth, 20% of center frequency; insertion loss, less than 0.5 db; VSWR, less than 1.2. Hughes Aircraft Co., Components Div., International Airport Sta., Los Angeles 45, Calif.

Circle 301 on Inquiry Card

Now these 5 modules put BEAM-X®
switch to work — Binary Decoders —
Low Cost Counters — Multiposition
Distributors — Transistorized Decade
Counters — Multiposition Scanners —
DC-114
TRANSISTORIZED DECADE COUNTER
DC-111
This is the lowest cost, transistorized decade counter available.
5 NEW MODULES PUT BEAM-X® SWITCH TO WORK
Burroughs Corporation
ELECTRONIC TUBE DIVISION
Plainfield, New Jersey

New Products

SILICON MESA TRANSISTORS

These low-current, high-gain units are for use at switching speeds.

The series, 2N1944, 2N1945 and 2N1946, features a typical gain-bandwidth product of 100 MC at f-20MC, with min. gain-bandwidth of 60 MC. Outstanding characteristics are found in the dc gain area with min. h_{FE}-150 at V_{CE}-2 v. and I_C-lma. At I_C-250 μa, h_{FE}-60 min. Max.h_{FE} under similar conditions is 450 and 250 respectively. The devices are constructed of float zoned silicon. Reliability is insured by adhering to the standards of mil-S-19500B. Industro Transistor Corp., 35-10 36th Ave., Long Island City 6, N. Y.

Circle 304 on Inquiry Card

ADJUSTABLE LUG

Adjustable lug is for oval core or flat type resistors.

The large flattened contact surface of this new adjustable lug, permits wider distribution of pressure over the wire. An additional feature is the immobility of the adjustable lug without first loosening the assembly screw, preventing damage to the exposed winding in movement. This type of adjustable lug construction on the Tru-Ohm Series OR style resistors permits precise adjustments without regard for shape or construction of unit. Tru-Ohm Products, 3426 W. Diversey Blvd., Chicago 47, Ill.

Circle 306 on Inquiry Card

PULSE GENERATOR

Lab unit has rechargeable battery pack for "in the field" operation.

The Model B-10 is a portab'e, completely transistorized, high speed pulse generator. The unit features a main output pulse which is continuously variable in repetition rate from 20 pps to 2 million pps or may be triggered from an external source at rates to 2 MC; delay (with respect to the synchronizing pulse output) continuously variable from 0 to 10,000 μsec; polarity, either positive or negative. Rutherford Electronics Co., 8944 Lindblade St., Culver City, Calif.

Circle 305 on Inquiry Card

DIFFERENTIAL AMPLIFIER

The TDA-875 has both differential and single-ended modes of operation.

This transistorized unit has high common mode rejection and input impedance plus solid state reliability. Mode selection is n.ade by means of a front panel control. Five fixed gains are also chosen by a front panel switch. The unit may be used as a wide-band, floating, single ended, potentiometric amplifier by switching out the magnetic dc isolator. Amplifier gain is not affected by load variations. Epsco-West, 240 E. Palais Rd., Anaheim, Calif.

Circle 307 on Inquiry Card

for lightning-fast indications with controllable retention

DU MONT DIRECT-VIEW STORAGE TUBES

DUMONT

ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

TUBE SALES DEPARTMENT

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

DU MONT INTERNATIONAL DIVISION, 515 MADISON AVENUE, NEW YORK 22, N.Y. CABLE: ALBEEDU

New Products . . . for the Electronic Industries

AUDIO CABLE

Double channel audio cable is for use with stereo equipment.

Multiplex, Code No. 17555 is constructed of two tinned copper stranded conductors with color coded insulation. Each conductor has a spirally wound shield that serves as the second conductor of each pair. The spirally wound shield is quickly and easily "pig-tailed" into the lead for the second conductor of the pair. Lenz Electric Mfg. Co., Dept. ES-2, 1751 No. Western Ave., Chicago 47, Ill.

Circle 319 on Inquiry Card

POLYSTYRENE CAPACITORS

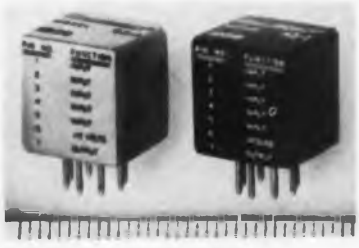
These capacitors meet Mil-C-19978, characteristic "P".

The Gen-Pro "20 Series" is hermetically sealed in metal cases with glass-to-metal end seals and provide high insulation resistance, greater than 1 x 10^5 megohms x mfd.; low dissipation factor less than 0.1% at 1 KC at 25°C.; negative temp. coefficient —120 ±30 ppm/°C.; temp. range —55°C. to +85°C.; low dielectric absorption less than 0.1%. General Products Corp., Union Springs, N. Y.

Circle 320 on Inquiry Card

COMPUTER GATES

These components are for use in digital computers.



The and/or gate and the or/and gate are only 0.35 cu. in. and have a freq. response from dc to 10 MC. They weigh 7.6 grams and operate over a temp. range of —55°C to +55°C. The standard 7-pin base design for both modules permits easy insertion for prototype work and programming. Modules are available color coded. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass.

Circle 321 on Inquiry Card

HATHAWAY DENVER announces its **DRIREED**

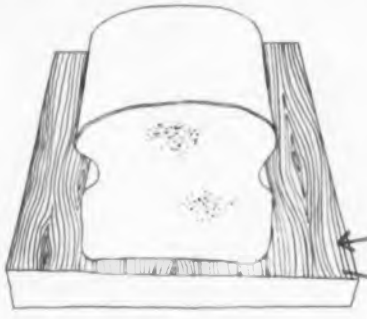
ELECTRONIC COMMUTATOR

THE PROBLEMS* in Electronic Commutation

Channel to Channel Cross-Talk • Relatively Low Open Circuit Resistance • High Closed Circuit Resistance • Inconsistent Transfer Gain • High Cost of Components

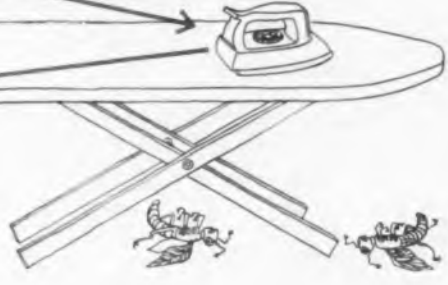
THE IDEA

An electronically driven multiple contact switch including a solid state commutating system and using dry reed switch contacts which move only 0.002" from open to closed.

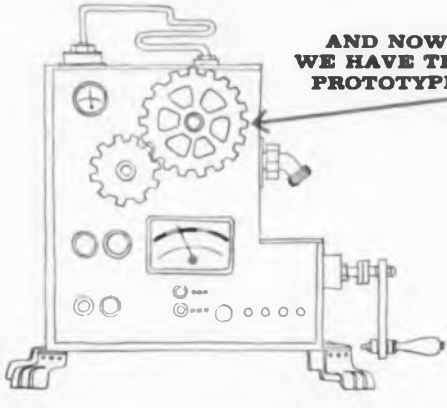


TO THE BREADBOARD

THE BUGS HAVE BEEN IRONED OUT



AND NOW WE HAVE THE PROTOTYPE



WE CAN CRANK IN . . .

the proper number of constants, number of contacts, etc., to suit . . .

FEATURES

- Utilizes ¾" hermetically sealed dry reed contacts
- Contact life **one billion** operations (at low current)
- Switches rates to 1,000 cps
- Solid state drive circuit
- Outstanding vibration and shock characteristics
- Complete isolation of contacts from power circuits
- Open circuit resistance greater than 3×10^{12} ohms
- Closed circuit resistance less than 100 milliohms
- Low cost

THE APPLICATIONS

- Telemetry
- Thermocouple scanning
- Computer inputs
- Strain gage scanning
- Transducer scanning
- PDM coding

Is yours among them?

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William A. Christian, Sales Manager

*All the advantages of transistor commutation with none of the disadvantages listed at the top

HATHAWAY DENVER

5806 East Jewell Avenue, Denver 22, Colo.

A division of **Hathaway Instruments, Inc.**

New Products

GLOVE BOXES

Modular units have several uses in the laboratory.

The interior dimensions of a unit are 36 x 42 x 23 in. A variety of interchangeable parts are available to modify the glove boxes for use as a controlled atmosphere enclosure; for radio-chemistry experimentations; or for bacteriology or virology applications. The enclosures are designed with removable end panels, so that 2 or more 3 ft. modular units can be attached together. Kewaunee Scientific Equipment, 4012 Logan St., Adrian, Mich.

Circle 298 on Inquiry Card

PLASTIC CLAMPS

These units are tough and economical.

They have high tensile strength and rigidity; good dielectric properties, even at high freq.; also resist solvents, grease, oil, and many common acids and chemicals. Seven sizes: 1/8, 3/16, 1/4, 5/16, 3/8, 7/16 and 1/2 in. dia. are available. All edges are round and smooth to give full protection against vibration, strain and pulling. They may be used as wire and cable clamp, wire strap, transformer lead clip, strain relief, tube holder, or pipe hanger. Holub Industries, Inc., 430 Elm St., Sycamore, Ill.

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Keep up to date—get the facts about the new products and equipment as they hit the market. ELECTRONIC INDUSTRIES' advertisers will be glad to send you complete literature giving specifications and data relating to those products advertised in this issue. To help you, the new product items, new literature and advertisements in this issue are numbered consecutively, from the front to the back of the book. The extra cards are for the use of your associates with whom you share your copy of ELECTRONIC INDUSTRIES.

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ALPHABETICAL LISTING OF

CIRCLE THE NUMBERS OPPOSITE THE NAMES OF THE

101 Acme Electric Corp.—Power supplies
[illegible] Allen-Bradley Company—Miniature composition resistors.
91 Allen-Bradley Company — Adjustable fixed resistors.
6 Alite Division of U. S. Stoneware—High-alumina hermetic seals and bushings.
[illegible] Alpha Wire Corporation — Electronic wire and cable product catalog
[illegible] American Bosch Arma Corporation—Aerospace telemetering system
3 American Optical Company—8-channel direct writing recorder.
[illegible] American Sterilizer—Flexible film laboratory dry box.
[illegible] AMP Incorporated—Solderless termination connectors.
[illegible] Ampex Instrumentation Products Company—Data recorders
[illegible] Amphenol-Borg Electronics Corporation, Borg Equipment Div.—Three, four and five-digit microdials.
[illegible] Amphenol-Borg Electronics Corporation, Amphenol Connector Div.—Mil-type connectors.
[illegible] Arco Electronics, Inc. — Distribution transformer.
116 Arco Electronics, Inc.—Elmenco capacitor distribution
[illegible] Arnold Magnetics Corporation—Magnetic amplifiers.

152 Associated Research, Inc.—High voltage testing equipment

[illegible] Beckman Instruments, Inc., Helipot Div.—Trimming potentiometers.
77 Bendix Corporation, The, Scintilla Div.—Special-purpose cables.
106 Bomac Laboratories, Inc.—4-5 MM balanced duplexers.
[illegible] Boonton Electronic Corporation—Capacitance bridges.
[illegible] Bourns, Inc., Trimpot Div.—Potentiometer trimmer.
[illegible] Bradley Semiconductor Corporation—Building block.
[illegible] Brady Company, W. H.—Printed circuit tapes and shapes.
[illegible] Bruno-New York Industries Corp.—Pig tailoring machine.
[illegible] Brush Instruments, Div. of Clevite Corp.—Multi-channel recording systems.
[illegible] Burroughs Corporation, Electronic Tube Div.—Switching tubes.
[illegible] Bussmann Mfg. Div., McGraw-Edison Co.—Fuses and fuseholders.

[illegible] Cambridge Thermionic Corporation—Ceramic coil forms
[illegible] Cannon Electric Company—Audio plugs

[illegible] Centralab, The Electronics Div. of Globe-Union, Inc.—Metallized ceramic tubes.
[illegible] Cinch Manufacturing Company—Noval tube sockets.
44 Clare & Company, C. P.—Relays.
140 Clevite Transistor Products—Semiconductor devices.
[illegible] Cleveland Container Company, The—Phenolic tubing.
[illegible] Columbus Process Company, Inc.—Multiplexing transformers.
[illegible] Connecticut Hard Rubber Co.—Silicone rubber conductive gasketing.
[illegible] Controls Company of America, Control Switch Div.—Precision switches.
4 Corning Glass Works—Tin oxide resistors.

[illegible] Dage Electric Company, Inc.—Precision hermetic seals.
[illegible] Dale Electronics, Inc.—Precision resistors.
[illegible] Davies Molding Company, Harry—Standard-plastic parts
[illegible] Daystrom, Incorporated, Potentiometer Div.—Trimming potentiometers.
[illegible] Delta Design, Inc.—Portable temperature chambers.
[illegible] Deutsch, Electronic Component Div.—Hermetic seals.
[illegible] Dit-Mco, Inc.—Automatic logic circuit test.
[illegible] Dorsett Electronics, Inc.—Modular packaged telemetry system
121 Dorsett Electronics, Inc.—Electronic organ kits.
[illegible] DuMont Laboratories, Allen B.—Direct-view storage tubes.

[illegible] EICO—Electronics catalog
[illegible] Eisler Engineering Company, Inc.—Welding machines and accessories
[illegible] Electrical Industries—Hermetic seals.
[illegible] Electro Motive Mfg. Co., Inc., The—Mylar-paper dipped capacitors
21 Engineered Electronics—Pulse width detection circuits.

[illegible] Fairchild Semiconductor Corporation—Epitaxial transistor.
12 Fenwal—Electronics—Thermistors
[illegible] Film Capacitors, Inc.—Power supplies
[illegible] Fresno County—Industrial sites.
[illegible] Fusite Corporation, The—Tri-glass for hermetic seals.

[illegible] General Electric, Power Tube Dept.—Harmonic filters.
[illegible] General Electric Company, Semiconductor Products Dept.—Germanium alloy transistors.
[illegible] General Instrument, Semiconductor Div.—Silicon mesa transistors.
[illegible] General Motors, Delco Radio Div.—Power transistors.
[illegible] General Motors, Delco Radio Div.—Power transistors.
141 General Products Corporation—Taper pin terminal boards.
[illegible] General Radio Company—1,000-Megacycle frequency standard.
49 Gertsch Products, Inc.—Complex ratio bridge.
111 Good-All Electric Mfg. Company—Mylar-case capacitors.
150 Grainger, Inc., W. W.—Motor distribution.
172 Graphic Systems—Visual control board
124 Gremar Manufacturing Company, Inc.—RF connectors.

[illegible] Hathaway Instruments, Inc., Hathaway Denver—Dry reed electronic commutator.
[illegible] Hewlett-Packard Company—Waveguide crystal detector mounts.
151 Howard Industries, Inc.—DC motors.
47 Hughes Aircraft Company, Microwave Tube Div.—S-Band traveling wave tubes.

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ADVERTISERS FROM WHOM YOU DESIRE FURTHER INFORMATION

Hughes Aircraft Company, Semiconductor Div.—Diodes, transistors and rectifiers.

IERC, International Electronic Research Corp.—Heat-dissipating electron tube shields.

Industrial Electronic Engineers, Inc.—Digital readout indicators.

Inland Motor Corporation of Virginia—Solid state 100-watt d-c amplifier.

International Rectifier Corporation—Superpower high voltage rectifiers.

International Resistance Company—Miniature precision power resistors.

International Resistance Company—Miniature precision power resistors.

PROFESSIONAL ENGINEERING OPPORTUNITIES

Circle number of company on card at right from whom you desire further information.

802 General Electric Company, LMED Div.
801 General Motors, AC Spark Plug Div.
803 Motorola, Inc., Personnel.
804 National Cash Register Company.

ITT Industrial Products Div.—Accelerometer calibrator.

Jennings Radio Mfg. Corporation—High voltage vacuum capacitors.

Johnson Company, E. F.—Nylon connectors.

Jones Division, Howard B.—Fanning strip.

Julie Research Laboratories, Inc.—DC standards laboratory.

Kemet Company, Div. of Union Carbide Corporation—75v Solid tantalum capacitor.

Keystone Carbon Company, Thermistor Div.—Disc type thermistors.

Kulka Electric Corporation—Military terminal boards.

Lavelle Aircraft Corporation—Aerospace components.

Lel, Inc.—Parametric telemetry preamplifier.

Lenz Electric Manufacturing Company—Double channel audio cable.

Lepel High Frequency Laboratories, Inc.—Dual purpose heating zone and crystal pulling fixtures.

McKinstry Metal Works, Inc.—Wiring boxes.

Measurements, A McGraw-Edison Div.—Standard frequency meter.

Mepco, Inc.—Carbon film resistors.

Metals & Controls, Inc., Div. of Texas Instruments, Incorporated—Silver electroplated strip.

Methode Manufacturing Corporation—Fork contacts.

Microtan Company, Inc.—Miniaturized transistor transformers.

Microwave Associates, Inc., Electron Tube and Device Div.—Coaxial switches.

Minneapolis-Honeywell Regulator Company—Precision meters.

Minnesota, Dept. of Business Development—Industrial Horizons Minnesota.

Minnesota Mining and Manufacturing Company, Irvington Div.—Heat reactive tubing and heat resistant tubing.

Minnesota Mining and Manufacturing Company, Magnetic Products Div.—Heavy duty instrumentation tape.

Minnesota Mining and Mfg. Co., Mincom Div.—Instrumentation recorder and reproducer.

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 221 of this issue.

Postcard valid 8 weeks only. After that use own letterhead describing item wanted. **APRIL 1961**

PROFESSIONAL ENGINEERING OPPORTUNITIES

Please send me further information on the engineering position I have circled below.

801	806	811	816	821
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803	808	813	818	823
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107	Non-Linear Systems, Inc.—Digital voltmeter.
12	Oak Manufacturing Company—Pushbutton switches.
48	Obmite Manufacturing Company—Tantalum slug capacitors.
115	Obmite Manufacturing Company—Capacitor calculator.
137	Panoramic Radio Products, Inc.—Spectrum analyzer.
73	Philco Corporation, Lansdale Div.—Switching transistors.
149	Polyphase Instrument Company—Band pass and low pass filters.
71	Potter Instrument Company, Inc.—High speed digital magnetic tape handler.
124	Power Designs, Inc.—Regulated DC power supply.
61	Princeton Electronics Corporation—Silicon diode.
97	Quan-Tech Laboratories—Transistor noise analyzer.
92	Radio Frequency Laboratories, Inc.—Gaussmeter.
78	Raytlad Tubes, Incorporated—Heat-shrinking encapsulating boot and transitions.
142	Rohn Manufacturing Company—Communication tower.
93	Rotron Manufacturing Company, Inc.—Cabinet cooling fans.
1	Sangamo Electric Company—One farad capacitor.
89	Sarkes Tarzian, Inc.—Silicon rectifiers.
127	Scientific-Atlanta, Inc.—Mast antenna pattern recorders.
64	Sealectro Corporation—Cable plug and jack.
135	Selectrons, Ltd.—Selective plating tool.
155	Sensitive Research Instrument Corporation—Fluxmeters.
136	Shallcross Manufacturing Company—Kelvin bridge.
84	Shockley Transistor, Unit of Clevite Transistor—4-layer "glass" diode.
145	Shure Brothers, Inc.—Communications microphone.
178	Sonotone Corp.—Electronic tubes.
104	Sperry Rand Corporation, Semiconductor Div.—Semiconductor devices.
79	Sprague Electric Company—Aluminum electrolytic capacitors.
76	Sprague Electric Company—Decade counters, precision toroidal inductors.
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46	Stackpole Carbon Company—Fixed composition resistors.
126	Stanpat Company—Drafting aids.
171	Stewart Engineering Corporation—Backward wave oscillators.
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72	Superior Tube Company—Cathode alloy.
128	Sylvania Electric Products, Inc., Electronic Tubes Div.—Decade counter tube.
109	Sylvania Electric Products, Inc., Semiconductor Div.—Epitaxial mesa transistors.
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54	Tektronix, Inc.—Dual-trace oscilloscope.
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110	Texas Instruments Incorporated, Semiconductor-Components Div.—Epitaxial transistors.
85	Transitron Electronics Corporation—Micro zener diodes.
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75	Ungar Electric Tools—Light weight soldering iron.
45	U. S. Components, Inc.—Miniature connectors.
115	Varflex Corporation—Synthetic tubing and sleeving.
69	Victoreen—Voltage regulator triode.
103	Waveline, Inc.—Waveguide directional couplers.
120	Western Rubber Company—Custom made rubber products.
88	Westinghouse Electric Corp., Semiconductor Dept.—Silicon rectifier stacks.

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IRC

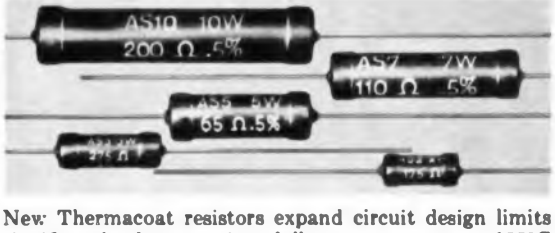
BOONE
DIVISION

International Resistance Co.

Close Tolerance
Power Wire Wound Resistors

New

350°C HOT SPOT—125°C AMBIENT
THERMACOAT® MINIATURE PRECISION POWER RESISTORS



New Thermacoat resistors expand circuit design limits significantly by carrying full power even at 125°C ambients. These resistors meet MIL Characteristic V (MIL-R-26C) with an allowable 350°C hot spot, well above the 250-275° customary for resistors of this type.

Thermacoat is the exclusive silicone formulation developed by IRC for its Type AS miniature power wire wound resistors. In addition to the high heat capabilities, Thermacoat is tough and smooth, with high dielectric strength.

Thermacoat resistors have all the other advantages you want—small size, close tolerance, welded connections and permanent markings.

New Thermacoat resistors are available now in sample and production lot quantities. Order them through the sales offices listed on the back cover.

Type AS Resistors | SPECIFICATIONS

Resistance Ranges: Minimum 0.1 ohm; maximum 20K to 175K ohms.

Power: 2, 3, 5, 7, 10-watt sizes, rated at 125° C ambient.

Tolerances: ±1% or ±3% commercial, ±5% MIL standard. Tolerances as close as ±0.05% depending on resistance.

Temperature Coefficient: Averages less than ±25 ppm/°C.

Intermittent duty operation: Higher than rated wattages permitted up to 350°C hot spot limit.

High-frequency applications: Ayrton-Perry non-inductive windings available. Minimum resistance values, 10Ω for ±1% and ±3% tolerance 1Ω for ±5% tolerance. Full details on request.

Terminal strength: Withstand pulls in excess of 10-pound MIL-R-26C requirement.

SPECIFICATIONS

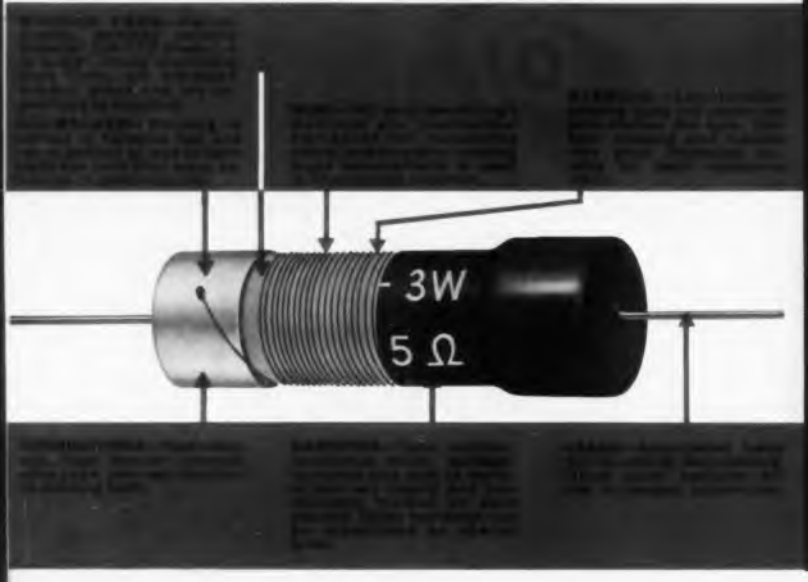
Dimensions:

TOLERANCES AVAILABLE

CONSTRUCTION FEATURES

THERMACOAT for 350°C hot spots, 125° C ambients.

IRC developed this modified silicone formulation especially for miniature power resistors. It cures at low temperatures, hence heat does not distort the windings nor affect temperature coefficients. THERMACOAT is tough and smooth, with high dielectric strength. Its unique ability to withstand 350°C hot spots brings new design latitude to your circuits.



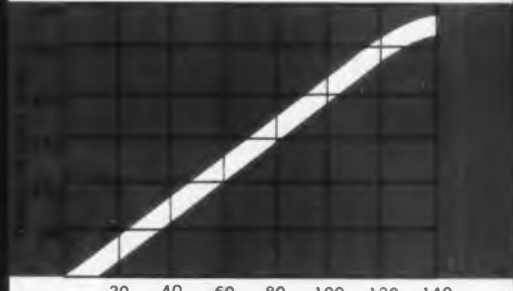
DERATING

125 170 215 260 305 350

AMBIENT TEMPERATURE °C

No derating to 125° C! All sizes of new Type AS miniature power wire wound resistors carry full wattage at high resistance values and high temperatures, because of Thermacoat.

TEMPERATURE RISE



20 40 60 80 100 120 140

PERCENT RATED LOAD (128° C ambient)

In free air, Thermacoat resistors do not reach 350°C hot spot limit, even at 140% of rated power.

IRC

BOONE DIVISION

International Resistance Co.
Post Office Box 393
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Amherst 4-8861

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Tele-Tech's ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • APRIL 1961

SYSTEMS—WISE . . .

By using COBOL, a standardized computer language, programming time has been cut nearly 30% at RCA's Electronic Systems Center, Wall St., N. Y. The company says that two representatives of one of the largest aircraft manufacturers were able to work with COBOL after a few days' training. One wrote a complete COBOL program within 5 days.

Prototype systems are being developed for measuring the temperatures at the surface of the Dyna-Soar manned space glider's skin panels and leading edges. Boeing awarded a contract for this work to Advanced Technology Laboratories, Mountain View, Calif.

POLARIS CONTROL

Lt. J. D. Shilling, D. Parsons, Lockheed Missiles & Space Division rep., and Chief Kurtz observe missile launching control panel during test aboard the U.S.S. Theodore Roosevelt. Sub carries a Polaris missile.

EIA has set up a new program for compiling data on industrial electronic equipment. Marketing data will be included on testing and measuring equipment, computing and processing equipment, control and processing equipment, communications and navigational aids, and miscellaneous equipment including medical electronics, etc.

Scientists at Lockheed are working out an automatic timetable system for charting flight paths in space for low-thrust rockets. The project will develop tables of information on speeds, heading, payload flight times, booster rockets, and available low-thrust rocket engines. Data will be used (in a computer) to select the best time and route for making any space flight to the moon and near planets.

New telemetry system (experimental) developed by GE's MSVD is expected to be able to beam signals through space about three times as far as any telemetry system yet flown. System is one of a family of communications systems called Synchrolink. Synchrolink is a digital system classified as Pulse Code Modulation with Phase Shift Keying (PCM/PS).

The Navy now has a hand-held camera designed to collect evidence of intrusion by Russian vessels probing American radar installations and snooping at missile firing activities. No ordinary camera, it can get evidence during dawn light, is simple enough to be operated without formal training, rugged enough to withstand rough handling. The KE-28A (Spotter) is being made by Chicago Aerial Industries, Inc.

← Circle 163 on Inquiry Card

A new technique provides intense bursts of positive ions lasting no longer than one-billionth part of a second. It will be used for studying atomic events such as the interactions of neutrons with nuclei. The system, Pilac (Pulsed Ion Linear Accelerator), made by High Voltage Engineering Corp. uses a 3,000,000 v. Van de Graaff positive ion accelerator equipped with a pre-acceleration pulsing system and a post-acceleration "time compression" magnet.

A computing system combining a digital computer and a differential analyzer is being built to study flight characteristics of the new triplesonic B-70 before it ever leaves the ground. Packard Bell Computer Corp is building the system. It will include a PB 250 digital computer and a TRICE digital differential analyzer.

A small, lightweight, high frequency transceiver system for airborne applications requiring high power and long-range communications is being made by Hughes Aircraft's Communications Div. The HC-101 weighs about 150 lbs. and provides 1000 w. of transmitting power for single sideband and AM compatible voice communications.

An electronic system for measuring body functions of space men and high-altitude pilots has been introduced by Gulton Industries. The equipment continuously measures fourteen body functions and reports readings to a ground station.

The National Science Foundation has awarded Columbia Univ. a grant for a study to determine the cause of noise at frequencies well below radio channels. "(Noise) Phenomena below the radio frequencies have been studied very little," says Columbia's Dr. Heirtzler, "The effect of lightning is evident down to frequencies as low as one cycle per second.

ELECTRONIC ANALYZER

Automatic electronic analyzer predicts operational readiness of ICBM's or other complex weapons systems. Called D-PAT, it uses a digital computer with test program procedures stored on a magnetic memory drum. Hughes Aircraft Co. engineer completes simulated diagnostic check. Arrow indicates bad component.

DC restoration has been left out of today's sets in the price struggle. It can be put back by adding just three parts—a silicon diode, resistor, and capacitor.

For Better TV Pictures . . .

A Simple, Inexpensive DC Restorer

By OLIVER K. ALLEN

International Rectifier Corp.
El Segundo, Calif.

THE dc restorer, poorly understood by many engineers, is essential for optimum performance in TV receivers.

Without dc restoration, the tonal values of the picture vary up and down scale. They are dependent solely on the proportion of light and dark areas, and without fixed relationship to the true value of the original subject.

Many design engineers are inclined to think of picture quality only in terms of contrast, frequency response, focus, vertical and horizontal linearity, freedom from interference, and many other obvious considerations. They forget the function and importance of controlling dc levels.

A thorough and convincing analysis of the problem was recently presented by R. J. Nissen[1]. Here we outline the desirability of incorporating dc restoration in TV receivers, and explain the reasons for its disappearance from present designs.

Intrigued by Nissen's[1] article, we conducted some experiments to observe the effects of dc restoration. Using two receivers, one with a dc restorer and the other without, first-hand proof was obtained of its desirability.

Convinced of the benefits to be derived from resurrecting the technique, we then compared a large number of schematic diagrams of recently produced TV receivers. Only a very few sets currently use dc restoration. Most of these are higher priced sets of limited sale. Aside from the dc restoration feature, there was one difference immediately apparent in these sets. This was the presence of additional video amplifier stages, and the method of presenting the picture information to the cathode ray tube in those sets having dc restoration.

Understanding DC Restorer

Basically, those with dc restoration all used a circuit similar to the simplified one shown in Fig. 1. Here picture information is fed as positive signals to the control grid of the picture tube, and brightness control is applied to the cathode. As seen in Fig. 1, the diode rectifier provides restoration by clamping the negative sync and blanking pulses to ground. This establishes a fixed reference level by which, since a fixed relationship exists between these pulses and the

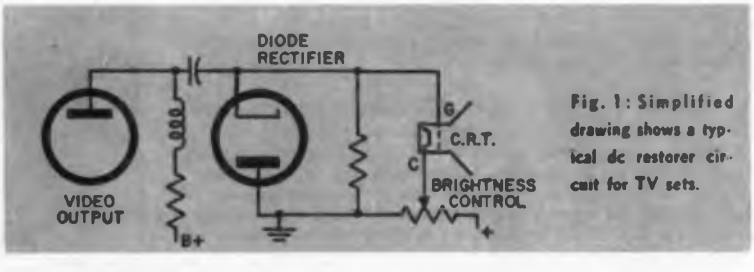


Fig. 1: Simplified drawing shows a typical dc restorer circuit for TV sets.

1. R. J. Nissen, "The Case for D-C Restoration," *Electronic Industries*, p. 186, January 1960.

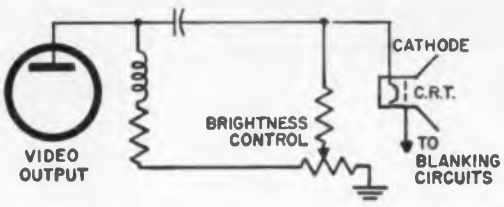


Fig. 2: Typical circuit used in today's TV sets which do not have a dc restorer.

black picture information, a true reference point is established for the tonal values throughout the picture.

If the function of the dc restorer is not clearly understood, it will help to examine Fig. 1 without the diode rectifier and to consider the problem of reproducing a picture with high fidelity. A picture, like sound, has amplitude variations known as contrasts. Likewise, it also has varying frequency and waveform components pertaining to detail and form. One component of the picture, however, has no direct counterpart in the reproduction of sound. This is the absolute level or the brightness of each tone value in the picture material.

Without the diode, the circuit of Fig. 1 will function as an ac coupled amplifier. The signal voltages from the video amplifier will arrange themselves, according to their areas, around the normal, no-signal voltage applied to the grid so that an equal power is applied both positive and negative.

This method can and does function perfectly if the tonal values are evenly distributed in the entire picture. But often the scene transmitted does not have this uniform distribution, and the voltages (by so neatly arranging themselves) then reproduce the picture in degraded tones which are much lighter or darker than is desired for good picture fidelity.

Now, re-examine Fig. 1 with the diode in place. It can be seen that its clamping action forces all the tones to distribute themselves as positive signals according to their voltage amplitudes, and to maintain a constant relation to the tonal values of the original scene. This certainly yields a picture with higher fidelity.

Adding a Diode

In most cases, where dc restoration is absent but grid modulation of the picture tube is used, the addition of a simple diode in the above manner is sufficient to provide adequate dc restoration. Recommended for this purpose is International Rectifier Corporation's silicon diode 1N1711.

In other cases, however, the problem is not this simple. The schematics which we examined indicated that probably 90% of the receiver models produced in the past several years, and possibly 95-98% of the receivers actually sold, used a circuit similar to that of Fig. 2. Here, the picture information is fed to the picture tube cathode, and mixed with the dc voltage from the brightness control.

This was probably done to effect a cost saving, using higher gain tubes and circuits in the video amplifier to eliminate one stage of amplification. Note that in this case, the polarity of the signal is reversed, with the sync and blanking pulses positive and the picture information negative. In applying dc restoration here, a difficulty arises since no convenient low impedance point of suitable potential exists for diode clamping, and, of course, the cathode voltage varies with every setting of the brightness control, making a varying reference voltage necessary.

A Simple Modification

It was decided, therefore, to develop a circuit which would be simple, inexpensive, and adaptable to most TV receivers. Keeping in mind the difficulties involved in modifying printed or etched circuits found in many sets, it seemed advisable to avoid breaking into any part of an existing circuit.

The circuit of Fig. 3 was chosen and tested since it is easily added to most existing sets, requires only two connections to the existing circuit, and in all pertinent respects duplicates the important functions of the conventional dc restorer.

The component parts used are relatively inexpensive and are available from most electronic parts distributors. The diode was chosen for low capacitance, high reverse resistance, good temperature stability, and the ability to withstand any voltage condition encountered during warmup and operation of the set.

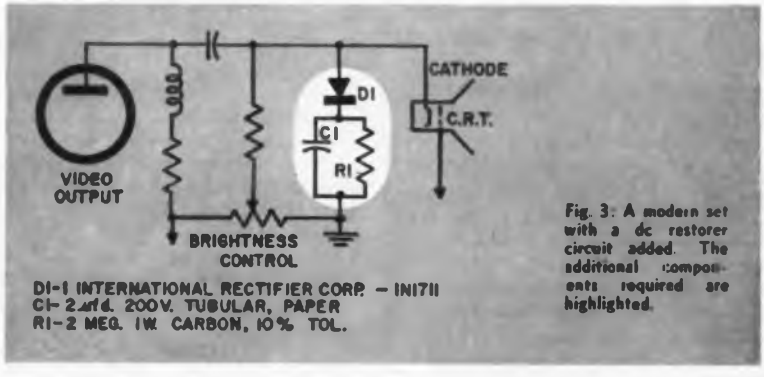


Fig. 3: A modern set with a dc restorer circuit added. The additional components required are highlighted.

In operation, the diode conducts on sync and blanking pulses, thereby charging the 2 mfd. capacitor to a voltage somewhat above the no-signal potential of the cathode. The R-C circuit has a long time constant. It allows the diode to clamp the positive pulses, just as the diode in a conventional dc restorer clamps the negative pulses to the grid. Connection of this circuit necessitates a change in the setting of the brightness control. But in most cases the new setting is well within the normal range of the controls.

A wide-band dc oscilloscope was

DC Restorer

used to examine the performance of the video coupling circuit of a typical modern receiver. There was a very apparent drift in dc level with the circuit provided by the factory. The modified circuit of Fig. 3 was then added. With values of components adjusted for optimum results, as indicated by oscilloscope observation, the performance was good.

The final, acid test, then, was to view the resultant pictures both with and without the new restorer circuit. The improved stability of the pictures tonal values with the added circuit was quite apparent. The previous tendency for tonal values to shift abruptly up or down scale when a dark or light element was added to the scene had disappeared. The whole result seemed more natural to the viewers. The improvement was most noticeable where the natural distribution of tones in the picture was unbalanced, as in low-key moonlight scenes so popular in westerns and who-dun-its.

Another improvement was the reduction of fatigue to the viewer. Just as listener fatigue is minimized when distortion is reduced in the reproduction of music, so was fatigue lessened here by the reduction in distortion of tonal values.

The circuit described has since been installed in several receivers of different makes and models with equally gratifying results.

Careful examination of a receiver circuit should be made, however, before attempting this conversion. It is possible that some of the ingenious circuits devised by the designers might be upset by this addition. Broadcast engineers try to offset the lack of dc restoration in most modern sets by maintaining balanced proportions of light and dark subject matter in the transmitted scenes. Hence, not all programs will be noticeably affected by this circuit improvement.

Proposals For Space Communications Filed

Seventeen organizations have filed proposals with the FCC in their inquiry into the problems of space communications. While most parties agree that a single system is best, emphasis has shifted from the question of sharing frequency space to such issues as: "stationary" satellite systems vs a lower-altitude, multi-satellite operation.

Some Views

AT & T says the delay of 6/10 sec. in a round trip telephone conversation via a stationary satellite would make this type of system unsatisfactory.

RCA and Lockheed (part of a three-company study group which included General Telephone and Electronics Corp.) are in favor of a synchronous system.

General Electric Co. presented a plan for a "low-altitude" or 2000 to 6000 mi. orbiting, 10 satellite system. It would use less frequency space than AT & T's low altitude system. GE also said that sharing with terrestrial point-to-point operations would be necessary. AT & T emphasized that this space would have to come from other than common carrier bands.

EIA's position was that exclusive allocation is unnecessary and urged mandatory hearings on all applications for space communications ground stations.

Hughes Aircraft suggested a means for getting a stationary system into operation quickly.

Other Space Actions

NASA has briefed the Senate Aeronautical & Space Sciences Committee on its program, and the Office of Civil & Defense Mobilization issued policy guidelines for considering Government agencies' requests for space frequencies — said much more information is needed before definite policies can be laid down. NASA also extended the bid deadline for satellite system bids.

The FCC laid plans for a preliminary or exploratory study of legal and financial aspects and procedures of fostering development of a space system.

Frequencies

AT & T said they are convinced that frequencies will be in the 1000-10,000 MC range—says that tests in the 10,000-16,000 MC range have proven these frequencies unsatisfactory. They say that bandwidths would be about 250 MC for a two-way communications system.

The company calculates 1980 requirements between the U. S. and Europe at about 3000 message telephone circuits, 500 private line voice grade circuits, and 6 two-way TV channels; the rest of the world would need about 7000 message telephone circuits, 1500 voice grade private line circuits, and about 10 two-way TV channels.

GE has proposed that the U. S. should pursue, on its own initiative and on a cooperative basis, experiments with other interested countries using temporary frequency assignments to develop the technical and operational information necessary as a basis for the allocation of frequencies on a permanent basis.

COMMUNICATIONS CENTER

New Defense National Communications Control center is the "heart" of the Communications Control Complex. It will monitor and control the long-haul, non-tactical communications facilities of all services. Philco Corp. was prime contractor for the project.

Civilian Space Use Seen

"Profitable use of space is feasible and private industry must plan its commercial space enterprises now," says Robert E. Gross, Board Chairman at Lockheed Aircraft Corp.

Lockheed has been studying the problem jointly with two communications companies. Study involves how to do the work, how to finance it, and how to operate the completed installations.

He proposes the formation of an industrial team of companies to enter the commercial satellite field. They would develop the complex ground support equipment, launching pads, block houses, data processing devices, a quality assurance organization, develop the satellites, place them in orbit, and maintain and replenish them in space.

ESG GYROSCOPE

Technician attaches a high-voltage lead to Minneapolis - Honeywell's electrically suspended gyroscope. The gyro's spherical rotor is suspended in electric fields. Units on sides are optical pickoffs which provide info on the gyro's orientation. Gyro will be used with Polaris system.

EMI Color TV Cameras To U. S.

Hayes, Middlesex — EMI Electronics, Ltd., has received orders for 15 color TV cameras, 250 monochrome cameras and other electronic equipment from its American distributor, Fairbanks, Morse & Co., West Hartford, Conn.

Receiver Designed Around Molecular Electronics

A radio receiver whose main working parts are molecular electronic functional blocks has been designed by Westinghouse engineers. It has been demonstrated at the Electronics Technology Laboratory of the Air Force's Wright Air Development Div.

The experimental unit was designed to test the feasibility of building military electronic systems with molecular electronic building blocks. Its main parts are six silicon functional electronic blocks about the size of a dime, and about one-quarter as thick. Each block performs some function required for radio reception such as amplification, detection, etc. The receiver tunes in all stations across the standard broadcast band.

The company's original Air Force contract in molecular electronics was in April, 1959. They announced functional electronic blocks which could perform eight different functions in Nov. 1960. This broadcast receiver was an independent experiment by the company as a practical example in integrating these blocks into a more complex system.

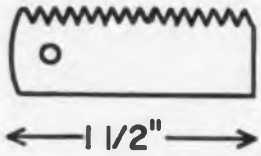
CUES for Broadcasters

A Spring for Presto Turntables

E. FARBER, Ch. Eng.

WNEX, Macon, Ga.

If the flat spring holding the Shift Detent Ball in a Presto Turntable T-68 or similar model breaks, a quick, easy and permanent repair can be made by



A broken hacksaw blade makes a good detent spring in Presto changers.

breaking a thin hacksaw blade to 1½ in. Place 1½ in. in a vise and bend until it breaks. The hole at the end of the hacksaw blade will fit the screw. Our replacement has been working fine for 12 months.

Control Room Telephone Relay

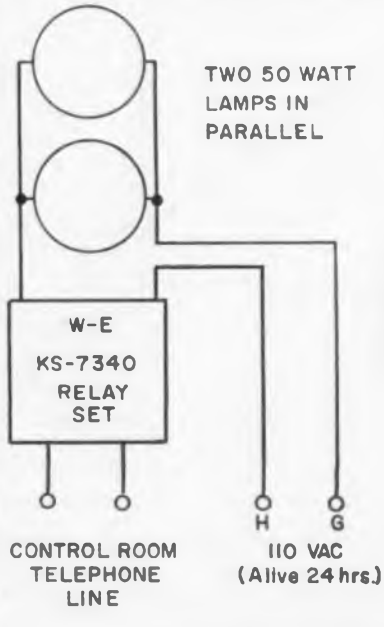
LAWRENCE L. PRADO, JR., C. E.

WPEP, Taunton, Mass.

Perhaps some broadcasters are not aware that they may obtain a signaling relay from their local telephone company. Designated as Western Electric Relay Set KS-7340, the telephone company will install this unit across an incoming telephone line.

While several uses are possible, the most desirable will perhaps be for the Control Room telephone as shown in the drawing. Prior to the installation of this relay our incoming calls in the Control Room were indicated by a rather weak neon flashing lamp. Unless the board operator was looking at the lamp, he never knew if the telephone was ringing! After miss-

(*Continued on page* 208)



A bright signal light to indicate a ringing telephone is a necessity in studios. Two lamps are used to overcome bulb burnout.

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WASHINGTON News Letter

DEFENSE PLANNING — The electronics industry through its Electronic Industries Association engaged in a significant conference during mid-March. The conference was on its role in the national defense posture and in the space satellite communications field. The address of Army Secretary Elvis J. Stahr, Jr., first since his appointment by President Kennedy, launched the conference with a presentation of "Planning for Limited War Requirements." A leading figure in military research, Lt. Gen. Bernard A. Schriever, chief of the Air Force Research and Development Command, was the other major speaker dealing with the role of electronics in space.

EIA SEMINARS—One seminar at the conference was on the problems of small electronics manufacturers. It covered liabilities of components suppliers in the event of a missile accident, the effect of electronic imports on small manufacturers, and definition of small electronic companies on the basis of employment. C. J. Harrison, Rixon Electronics senior vice president, and Western Electric Co. general attorney Frank L. Dewey were panelists.

SPACE SATELLITES—At the space satellite communications seminar, Dr. William L. Firestone, Motorola Communications engineering director, and Dr. Samuel G. Lutz, Hughes Aircraft senior staff scientist were the speakers. Industry panel members at the seminar on limited war were Lt. Gen. C. S. Irvine, Avco vice president; Dr. Philip Carlson, Lockheed Aircraft senior research scientist; Northrop's Nor-Air Division advance systems director W. E. Gasich; John F. Greco of Hughes Aircraft Co., and A. Atley Peterson of Sperry-Rand.

NEW FCC CHAIRMAN—The largest audience at any similar Commission occasion witnessed the induction of the new FCC Chairman Newton N. Minow. Outgoing Chairman Frederick Ford for the first time in Commission history invited every FCC employee to the ceremony. Supreme Court Justice Douglas administered the oath and disclosed that 22 years ago he had expected to become Chairman of the FCC.

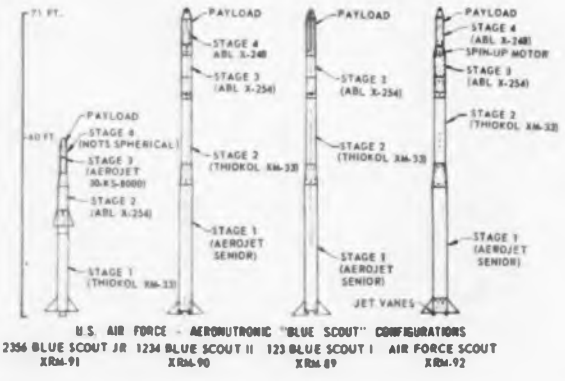
ALL-CHANNEL TV SETS—In order to stimulate the growth of educational television, outgoing FCC Commissioner Ford disclosed to the Senate Interstate Commerce Committee that the Commission has drafted a bill prohibiting interstate sale of TV sets which don't meet its proposed all-channel standards. By bringing in greater use of UHF TV channels, Commissioner Ford contended that forced acceptance of all-channel sets would greatly encourage the spread of educational television. Commissioner Rosel H. Hyde at the hearing also endorsed Senate Committee Chairman Magnuson's plan for a $51,000,000 appropriation to enable the states to purchase educational TV station equipment.

National Press Building
Washington 4

ROLAND C. DAVIES

Blue Scout 11

U. S. Air Force's Blue Scout 11 will reach an altitude of 1575 statute miles. Built by Ford Motor Co.'s Aeronautronic Div., the vehicles are assembled from existing solid-propellant rocket engines. Three and four stage combinations are used with each vehicle tailored to the individual launch-test requirements.



U.S. AIR FORCE - AERONUTRONIC "BLUE SCOUT" CONFIGURATIONS

2356 BLUE SCOUT JR XRM-91 | 1234 BLUE SCOUT II XRM-90 | 123 BLUE SCOUT I XRM-89 | AIR FORCE SCOUT XRM-92

XRM-90 BLUE SCOUT II

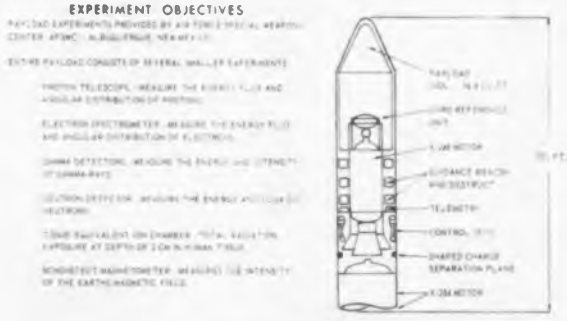


Fig. 1 shows the four configurations used in the Blue Scout program. Fig. 2 shows the experiment objectives of Blue Scout 11 and a cutaway of the payload carrier recently successfully launched from Cape Canaveral.

Linear Accelerator

(*Continued from page* 115)

of radium were available, the cost would be prohibitive. However, radiation from the Linac is much more penetrating than from either radium or the artificial radioisotope Cobalt 60.

The X-ray head. Electrons traveling at nearly the speed of light are bent 90° by magnetic lenses and focused on a gold target. A source of X-rays only one millimeter in dia. and more powerful than 70,000 curies of radium may be produced.

(*Continued from page* 204)

ing several important calls on our 'beeper phone' due to the operator not seeing the neon lamp, several relays were tried. But we never had much success until the W-E Relay Set was obtained.

While a single 100-watt, rough service type lamp will provide lengthy service, two 50-watt, regular type lamps in parallel will provide an added safety feature of indicating when one lamp is defective. With 100-watts of illumination, the operator's attention is attracted, even if he has his back to the lamps.

The 110 vac lamp circuit should be wired into a continuously 'hot' circuit to provide indication, even when all the Control Room equipment is turned-off after regular broadcasting hours.

Equipment Cooling

George F. Province

KRMO, Monett, Mo.

As equipment maintenance experience progresses through the process of time, it becomes obvious that one of our most insistent enemies is nothing more than the ever present factor of heat.

Heat will eventually reduce the efficiency of any component and may consist of a rapid shortening of life to a very slow, but nevertheless fatal effect on performance.

Not being a believer in "convection" cooling and coupled with "operator lag" in the opening of strategic doors and/or windows when excessive temperatures are reached, we have provided forced air cooling whenever possible.

Naturally, the first item of concern is the transmitter. Some do not have this feature but should be so provided at the earliest moment. To cool without adequate filtering will result in an accelerated dust build-up, so don't sell this feature short. It is a must.

There is a large number of companies making blowers and filters, one being McLean Engineering Labs of Princeton, New Jersey. They feature a wide variety of items, specifically for our applications. For approximately $60.00 you may obtain a blower/filter assembly with ball bearings that will do an excellent job of cooling with a minimum of attention. Either "throw-away" or "permanent-washable" filtering is optional. Surplus availability of this item so far is not known.

Being short of money and surplus-minded, we located a small blower-filter assembly through Lectronic Research Labs, 715 Arch St., Philadelphia 6, Pa. This unit, designated as stock item #B-115, costs $18.50 and consists of two blowers on one 5½ x 11 in. panel. Each blower unit extends 8 in. deep and has two 4-in. blades as well as a spirally wound "screen" type filter. The filter may be either oiled or coated with a water soluble adhesive to form the so-called permanent type filter. The adhesive is available in a pint sized spray can through McLean, as part number S-1083 at $1.00

(*Continued on page* 210)

$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate will be paid for material used.

(*Continued from page* 208)

per. The adhesive constitutes a cleaner handling filter versus oil.

Both blowers may be used in tandem to provide approximately 200cfm, or split up at 100cfm each for two cabinets. We split them and mounted each on a standard 5¼ x 19 in. panel. They were mounted to one extreme side of said panel to leave space for the mounting of any item within the dimensions left. In our case, this was a 6vdc power supply.

Using the old panel as a guide, scribe the blower opening and four mounting screw holes *on the panel side that it will be mounted on.* Carefully cut out the opening, and dress it with a half round file. After blower mounting, we used rubber cement to seal the slight slit area between the panel and blower housing. The filter element should then slide in very easily.

This assembly was mounted at or near the bottom of the rack cabinet. If your cabinet is vented on its lower to middle portion, these must be closed to provide complete pressurization with exhaust to and out the top only.

These little blowers have proven quite effective and are quiet in operation. They require approximately 0.038 ampere running and lend themselves adaptable to simple thermostatic control if you so desire. Although they feature sleeve bearings, the provision of two oil tubes per motor makes lubrication simple. Vacuum cleaning of our filters is performed weekly at a minimum and more often when conditions warrant it.

AUTOMATED POST OFFICE—International Telephone and Telegraph Corp. has requested immediate public hearings by the House Treasury-Post Office subcommittee to answer criticisms that its automated post office in Providence, R. I. (Project Turnkey), was not working properly. The company said, "we are astounded by the inaccuracies of the statement about Project Turnkey made by Rep. J. Vaughan Gary (D-Va.), chairman of the . . . Committee." ITT said that Turnkey was not supposed to be "fully automatic" but that it is automated. They pointed out that the fact that no career employee of the Providence Post Office would lose his job because of Turnkey, was continually reiterated. Said ITT "Turnkey was designed to serve as a postal laboratory and is capable right now of fulfilling that function should experimental equipment be supplied by the Post Office Department for test."

MINIMUM WAGES—The Electronic Industries Association has appealed for Congressional support of legislation to establish a single government policy on minimum wages by making the national minimum set down under the Fair Labor Standards Act applicable to firms subject to the Walsh-Healey Public Contracts Act. They cited, "inconsistency and duplication" in the government's minimum wage policies. The Walsh-Healey law, which empowers the Secretary of Labor to make wage determinations for certain industries, has "outlived its usefulness," said EIA President, L. Berkley Davis.

Polycarbonate Resins

(*Continued from page* 123)

a circuit board being inserted into card guides already mounted in a machine.

Card Covers

Polycarbonate card covers are used as dust and air barriers. The ribbed design gives excellent toughness with a wall thickness of only 60 mils. Self-extinguishing properties are important here.

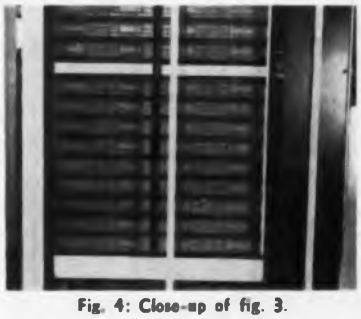
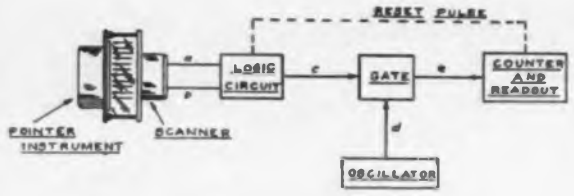
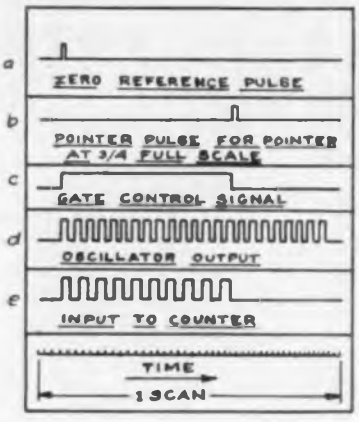


Fig. 4: Close-up of fig. 3.

Fig. 2 shows a card cover as it is molded; Fig. 3 illustrates the actual machine application; and Fig. 4 is a closer view of the machine shown in Fig. 3.

Block diagram with illustrating waveforms.





Digital Converter

(*Continued from page* 106)

units; a scanner which attaches with adapters to the instruments to be "read," and an electronic unit for the electronic circuitry and digital display.

The scanner translates the angular position of the pointer relative to a zero or reference position into a pulse time interval. It uses a momentary contactor and a photoelectric pickoff to generate a pair of pulses, the interval between which is proportional to pointer displacement. The displacement is alternately sensed and registered on the display.

The time interval between pulse pairs may be quantized as desired for readouts in units appropriate to the measurement. Scanning frequency may be as high as 10 scans per sec. The scanner (photoelectric) imposes no mechanical load on the pointer.

As the pickoff unit passes the pointer, a second pulse is developed as at (b) in the chart. The output of the logic circuit produces a gate control signal (c) representing the interval between pulses. The oscillator freqency (d), is chosen in accordance with the resolution and full scale reading desired. The gate circuit produces the pulse train (e), which is fed to the electronic counter and registered by the readout.

Macleod Instrument Corp., 4250 N.W. 10th Ave., Fort Lauderdale, Fla., makes the device.

* * *

News of Mfrs' Representatives

REPRESENTATIVES WANTED

Electronic Connector Manufacturer seeks sales representatives in (1) Washington and Oregon; (2) Northern California; and (3) Chicago. Manufacturer is located in the Midwest. (Box 3-1, Editor, Electronic Industries.)

LEL, Inc., Copiague, L. I., N. Y., has appointed the following representatives: **Measurement Equipment Co., Inc.**, N. Reading, Mass., to cover New England, and **Fryco**, Scottsdale, Ariz. to cover Arizona.

Silicon Transistor Corp., Carle Place, N. Y., has appointed two representative firms. They are **Maury Farber Associates, Inc.**, Buffalo, N. Y. for upstate New York; and **N. R. Schultz and Co.**, Seattle, Wash., for the Pacific Northwest territory.

The **Luscombe Engineering Co.**, Pasadena, Calif., has been appointed manufacturers' representative in California for International Resistance Co.'s Control Components Div., Phila., Pa.

The Birtcher Corp.'s Industrial Div., Monterey Park, Calif., has announced the appointment of **Zack Electronics**, Palo Alto, Calif., to represent them in Northern California.

Manson Laboratories, Inc., Stamford, Conn., has appointed **Bonn Associates, Inc.**, Metuchen, N. J. to cover Metropolitan New York, eastern Pennsylvania, Delaware and northern Maryland and the **Tiby Co.**, Cleveland, Ohio, to cover Ohio, Michigan and western Pennsylvania.

Bressler Associates, Union City, N. J., has been appointed as representatives for Burnell & Co., to cover the greater metropolitan New York and New Jersey areas.

Awards

The Electronic Representatives Assoc., presented four special awards for "Excellence in Sales Management" at its 1961 Convention Banquet. Awards and winners were: Distributor Division Award, **Robert G. Beebe of Antenna Specialists Co.**, Cleveland, Ohio; Industrial Components Award, **Edward Bachorik**, Vice President of Sales, **Allied Control Co., Inc.**, New York, N. Y.; Instrument Division Award, **Marvin I. Steinberg**, Vice President and Sales Manager of **Sensitive Research Instrument Corp.**, New Rochelle, N. Y.; and Audio Division Award, **Gordon J. Gow**, Vice President and Sales Manager, **McIntoch Laboratories, Inc.**, Binghamton, N. Y.

Borg Equipment Div., Amphenol-Borg Electronics Corp., Broadview, Ill., has appointed two representatives: **George L. Herrick Co.**, Cleveland, Ohio, to cover the state of Ohio; and the **S. F. Foster Co.**, Fayetteville, N. Y., to cover up-state New York.

Consolidated Electrodynamics Corp., Pasadena, Calif., has appointed 3 Eastern manufacturing representatives: **Eltron Engineering Sales, Inc.**, Newtonville, Mass. in the New England area; **Sunday-O'Brien**, Haddonfield, N. J., in the Philadelphia area; and **Bernard White and Co.**, Baltimore, Md., in the Washington-Baltimore area.

New Officers

At the January meeting of the Mid-Lantic Chapter of the Electronic Representatives' Association, new officers were installed: President, **Dave Humes**; Vice President, **Harry Estersohn**; Secretary, **Martin Friedman**; Treasurer, **Harold Blumenstein.**

(l-r) H. Blumenstein, H. Estersohn, J. Farie (outgoing President), D. Humes, M. Friedman, and G. Scarborough (Exec. Sec.)

Markite Corp. New York City, has named the firm of **Wasson & Gallagher**, Oak Park, Ill. as representatives in northern Illinois, eastern Iowa and southern Wisconsin.

Wallson Associates, Inc., Elizabeth, N. J., have appointed **L&M Associates**, Saddle Brook, N. J. as their representatives.

Electronic Tube Corp., Phila., Pa., has announced the appointment of **James L. Highsmith & Co.**, Charlotte, N. C., as southern sales representative covering the areas of Virginia, West Virginia, North & South Carolina, Georgia, Alabama and Tennessee.

Clevite Transistor, Waltham, Mass., has appointed the **Samuel N. Stroum Co., Inc.**, Seattle, Wash., to cover Washington, Oregon, Idaho and Montana.

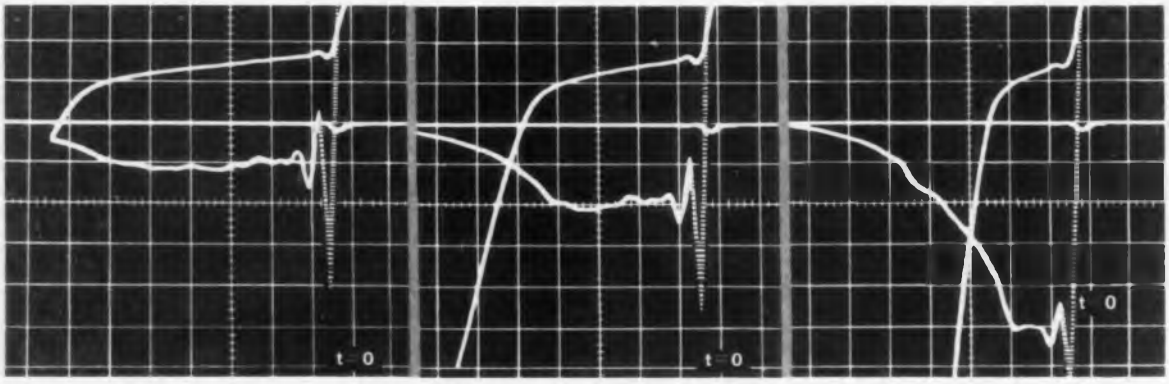


Figure 1 —1ma., 10nsec., 185mv./div.

The usefulness of diode stored charge measurements

by DAVID E. HUMEZ
Technical Advisor to the Manager of Operations
Clevite Transistor, Waltham, Mass.

Because driving signals usually are of fixed amplitude and duration in a given circuit, it would be desirable to express the transient behavior of diodes in terms of the charge which must be removed during switching. It would be even more desirable if a simple method of measuring stored charge under a given set of circuit conditions could predict the diode behavior under different conditions.

Measurements of the charge represented by the product of reverse current (I_r) and the time (t_r) required for the diode junction voltage to drop to zero have been disappointing. For the same forward current (and therefore the same total stored charge) the charge measured varies widely with changes in the reverse current. Table 1 lists a series of measurements on a single, moderately-fast, diode. Note particularly that the measurement made from 10ma. to 18ma. shows a smaller ratio of t_r to τ, the effective total charge lifetime, than all the other measurements and yet does not show a maximum normalized value of t_rI_r. Very small values of t_r/τ do not give more understandable results.

Table 1

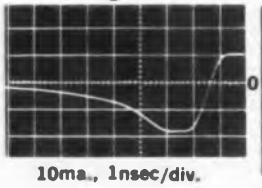
I_f ma	I_r ma	t_r nsec	t_rI_r $\mu\mu$coul	τ nsec	τI_f $\mu\mu$coul
5	2	18	36	31.7	158.5
20	2.0	42	84	33.2	664.0
20	1.0	62	62	31.6	632.0
20	0.5	86	43	33.8	676.0
20	0.1	134	13.4	34.0	680.0
10	18	3.1	55.8	33	330.0
20	1.0	73	73	37.2	
20	2.0	48	96	33.6	
20	5.0	26	130	31.6	

The use of the popular expression $Q = \tau I_r (e^{t_r/\tau} - 1)$ at all, and particularly when $t_r << \tau$, gives rise to large errors because the derivation of the expression makes use of a fundamentally false assumption: viz., that at the time, t_r, the charge contained in the diode will have dropped to zero. Both theory and measurement show that the fraction of the total charge removed during this time is never larger than about one fourth, that it varies widely with the ratio of I_f/I_r and that it reaches a maximum at I_f/I_r of approximately 1.5 corresponding to $t_r/\tau = 0.35$ approximately.

The current and voltage traces displayed in figure 1 illustrate the variation in the fraction of charge removed during the time, t_r. The diode behavior shown is that of the diode of Table 1. The last three lines of Table 1 were derived from the photographs, whereas the first five lines were obtained with different equipment. Experimental difficulties in achieving simultaneous traces of current and voltage have given rise to small errors.

A general solution of the diffusion equation for a diode whose base is thick compared to a diffusion length (W > L) yields the expression, $\text{erf}\sqrt{t_r/\tau} = I_f/(I_f + I_r)$. By the use of this simple expression, values of τ and τI_f (the total stored charge) have been calculated in the last two columns of Table 1. For a wide range of values for I_f/I_r, remarkably uniform values of τ result. From the value of τ can be calculated t_r for any value of I_f/I_r. Assuming a value of τ = 33 nsec t_r was calculated for $I_f/I_r = 0.55$. The result predicts that the constant current phase of recovery should be over in 3.1 nsec. Figure 2 illustrates this same diode performing under these conditions. The diode is being switched from 10ma forward to 3 volts and approximately 100 ohms external loop impedance. Note that with such a low voltage and loop impedance the voltage drop across the diode itself is not negligible. The reverse current is not 3/100 amperes but rather .018 approximately. Also at this speed the rise time of the generator and CRO are important. It is, none the less, encouraging that a measurement made at 134 nsec and an I_f/I_r of 200 to 1 should predict so well the behavior at 3.1 nsec and an I_f/I_r of 1 to 1.8.

Figure 2



10ma., 1nsec/div.

Table 2

I_f ma	I_r ma	t_{r1} nsec	t_{r2} nsec
20	2.0	42	140
10	1.0	42	200
5	0.5	42	260
2	0.2	42	330
1	0.1	40	380

Table 2 illustrates a simple test for the condition W > L. The diode yielding the results listed as t_{r1} satisfies the condition, the other diode does not.

Stored charge measurements can, then, be made at conveniently long times for a large group of moderately to very fast diodes intended for use in the low nanosecond range. A single set of test conditions could well be adopted as standard for a very wide range of end use conditions.

Detailed information on this subject is available. When writing please ask for Applications Bulletin 3.

← Circle 140 on Inquiry Card

News of Mfrs' Representatives

Associated Research, Inc., Chicago, Ill., has appointed the **J. E. Redmond Supply Co.**, Phoenix, Ariz., as engineering field representative for the state of Arizona.

Polyphase Instrument Co., Bridgeport, Pa., has announced the appointment of four representatives. They are: **W. B. Pray Sales**, Wellesley, Mass., as their New England representative; **Cartwright & Bean** to cover Florida, Georgia, South Carolina, North Carolina, Tennessee, Alabama, Mississippi and Louisiana; **James J. Backer Co.**, Seattle, Wash., for Washington, Oregon, Idaho, Montana, Alaska, and the territory of British Columbia; and **Avtronics, Inc.**, Inglewood, Calif., for Southern California and the State of Arizona.

'Rep of the Year'

The **Irv Brown Co., Inc.**, Brooklyn, N. Y., has been voted Representative of the Year, for the second consecutive time by the New York Chapter of the National Electronic Distributors Assoc. Runners up were **Jerry Kirschbaum Co.**, Hewlett, N. Y. and **Arthur M. Harris, Inc.**, Flushing, N. Y.

(l-r): H. Brown, I. Brown, receiving Award Plaque from P. Wilk (Chairman of the NEDA Chapter's Award Committee), S. Haas (Member of the Awards Committee of NEDA), A. M. Harris and J. Kirschbaum—runners-up

ERA Convention

During the Electronic Representatives Association's 2nd Annual Convention in California, **Wally Shulan** was elected President for 1961; **Larry Harriss** elected Chairman of the Board; **Grant Shaffer** elected Secretary; **Harry Halinton** re-elected Treasurer and **William C. Weber Jr.** re-elected Executive Director. Three District Vice Presidents were also chosen: **Kenneth E. Hughes** (Eastern District); **R. Edward Stemm** (Central District) and **J. Robert Natoli** (Western District). Four ERA Trade Divisions also elected new Chairmen: **Norman Marshank**, (Audio Div.); **Grady Duckett**, (Distributor Div.); **Walter Roth**, (Industrial Components Div.) and **Frank Waterfall**, (Instrument Div.).

"EUREKA" IS HARDLY THE WORD FOR IT, ARCHIMEDES!

"Astounding" is more like it, because we use your principle to buoy the "heart" of our precision gyroscopic instruments. Floatation eliminates frictional forces on pivots and thereby reduces drift rates. Consequently, we are able to develop precise gyros and pendulous accelerometers for missile guidance and ship navigation.

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Of special importance to career-oriented scientists and engineers is the fact that Light Military's approach to thin film circuitry and microelectronic module development is *both* research *and* application oriented.

Simultaneous with basic and applied research studies are equally intense engineering efforts to *practicalize* new concepts and apply them early in the cycle to advance development and design programs now underway in airborne, missile and satellite communications; guidance and digital data processing systems.

If your experience is in any of the above areas, and you want to move forward rapidly as a member of one of our growing research or development groups, we invite your early inquiry.

For immediate consideration, write in strictest confidence to Mr. R. Bach, Dept. 24-MD

* Enlargement of Double Nor Circuit includes 2 transistors, 2 Zener diodes, 4 diodes, 2 capacitors, 4 resistors. Photo retouched for reproduction

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Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers · Development Engineers · Administrative Engineers · Engineering Writers
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Reliability Held Key To Component Firm's Success

"High reliability, already measured in the thousandths of a percentage digit, is almost certain to become also the fine line between future success or failure of electronic component firms," says Warren B. Hayes, Thompson Ramo Wooldridge executive.

Firms which make effective use of marketing techniques based on the reliability yardstick will succeed he told a meeting of the American Marketing Association. Those who don't will probably fall victim to failure, merger, acquisition or cessation.

The competitive position of companies who do establish themselves as suppliers of high reliability components will be greatly enhanced in every phase of the market, and the companies who fall short of this accomplishment will be competitively damaged. He saw these attritional competitive forces inducing a greater consolidation of the components industry as the number of active and important companies is reduced by failures, mergers, acquisitions, and cessations.

Computers Analyze Census Data For City Planning

Four Remington Rand Univac 1105 computers are culling millions of bits and pieces of information from the recent U. S. Census. This information will be processed by another Remington Rand Computer system to pinpoint sociological trends, changing economic currents, shifts in population between urban areas, from farms to cities, and from cities to suburbs. It is expected to help in planning future American cities.

The study, being made by S. J. Tesauro & Co., Detroit, will pinpoint areas where economic growth is soundest, weakest, most dynamic, or too sluggish. Tables could lead to refinements in defining and measuring markets for goods and services.

Company Competition Important In Technological Race With Russia—Cook

"Although in the public mind, the United States is in a race with Russia for technological superiority, the meaningful race—the one that determines the pay-off in international superiority—is the competitive race among the organizations that design, develop and build aerospace products," says General Orval R. Cook (Ret.), President of Aerospace Industries Association of America, Inc.

He gave equal importance to the Government's role in pushing ahead the technical frontier and holding down the costs of progress in an address before the Institute of the Aerospace Sciences in Dallas, Tex. He said that much of the problem in costly, untimely decisions, is a "bureaucratic protective mechanism," conceived as a result of the present atmosphere in which mistakes are singled out with gasps of horror and magnified out of proportion. "While repetitive mistakes cannot be condoned, honest mistakes in the ultimate analysis are less harmful than the tardy decision brought about as a result of the fear of unjustified criticism that can in turn breed catastrophic errors."

He also warned the industry against "over-engineering." He said the ability of industry to keep costs under control and provide a product of high reliability will determine success far sooner than will numbers of engineers . . . sheer numbers of engineers on a project are an invitation to over-engineer.

EDISON AWARD WINNERS

L. Berkley Davis, GE Vice President, presents trophies to John T. Chambers (center) and Ralph E. Thomas, joint winners of the 9th annual Edison Radio Amateur Award. The award is given for "outstanding public service."

RCA's EDP Consolidates At Cherry Hill Plant

Most of the administrative and home office personnel of the RCA Electronic Data Processing Div. have been consolidated at company facilities in Cherry Hill, New Jersey. Only a product planning group, now at Pennsauken, N. J., remains to be transferred.

New Microwave Tube Plant

Hughes Aircraft Company's microwave tube division is adding a 35,000 ft² building adjacent to its headquarters in Los Angeles. The building will handle increasing production and development requirements of the microwave division.

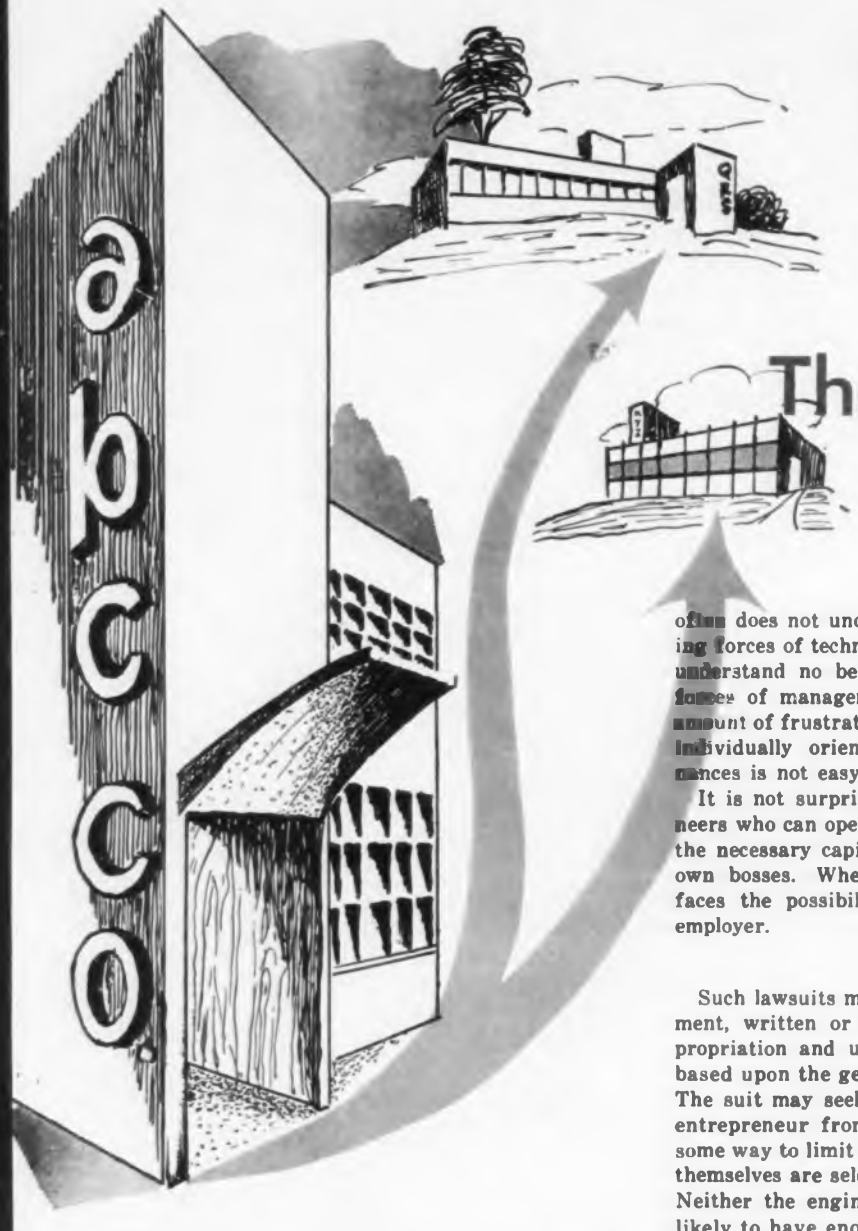
FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 195.

Wins Award for Atom Technique

Dr. George Pheler, professor of solid state physics, Univ. of California at La Jolla, has been awarded the 1960 American Physical Society prize ($2,500). He developed a method of examining the structure and behavior of atoms in semiconductor materials.

His development is called the electron-nuclear double resonance technique. It is expected to lead to more efficient and varied uses of semiconductors.

By ELTON T. BARRETT,
President
Trak Electronics Company, Inc.
Wilton, Connecticut



The Problem

FORMER employees starting their own companies is nothing new. It has been an American tradition since Colonial times. What is new is the frequency with which they are forming in the electronic industry.

Employer-Employee Problems

The electronic field has had a sustained growth providing a ready foothold for new companies. The Government has been the largest purchaser of electronic systems. Under its procurement policies a relatively few individuals control the spending of large amounts of money. In many electronic areas, relatively small capital is required to start a new company. Another factor is the inability of management to communicate with their own technical personnel. Management often does not understand the objectives and motivating forces of technical personnel. The technical people understand no better the objectives and motivating forces of management. Both groups suffer an equal amount of frustration. Communication between groups individually oriented toward science, sales, and finances is not easy.

It is not surprising, therefore, that top level engineers who can operate successful enterprises and have the necessary capital frequently elect to become their own bosses. When an engineer takes this step, he faces the possibility of legal action by his former employer.

Legal Action

Such lawsuits may be based on a contractual agreement, written or unwritten, upon the improper appropriation and use of trade secrets. They may be based upon the general theory of unfair competition. The suit may seek to recover damages, to enjoin the entrepreneur from carrying on the business or in some way to limit his business activities. Damages in themselves are seldom a significant motivating factor. Neither the engineer nor the new company itself is likely to have enough money to make it profitable to sue. More often, perhaps, the former employer fears real harm to his business and primarily seeks an injunction to prevent such loss. He may have spent substantial sums of money on a particular development program. Then he finds, when the project has reached the point where he is anticipating financial return, his experts who have been paid to do the development are starting a new business to capitalize of it. The former employer may charge unlawful use of trade secrets or make the more general charge of unfair competition.

What is the Law?

The engineer starting a new company could avoid these suits if the laws relating to the situation were clearly established. Unfortunately, this area of law

What rights does a firm have when employees leave and form their own company?
What rights do the employees have?
Lawsuits are flying back and forth in the courts, trying to establish precedents.
But to sue, or not to sue,
seems a brutal basis for solving the problem.
This medium-sized electronics firm has its own, unique answer.

E. T. Barrett

# of Splinter Companies

is still evolving in the courts and an increasing number of different situations are being held to come within the doctrine of unfair competition. The many suits under way in the electronics industry will cause significant additions to the body of laws now existing.

About all that can be said with certainty is that in the absence of any contractual arrangements to the contrary, an employee has the right to quit and start his own company. It is said that he has the right to use the general information and knowledge he has acquired, as these are the tools of his trade. The never-never land between general information or public knowledge and trade secrets is indeed difficult to define.

There are legal restrictions on using customer names, mailing lists, established routes, etc. Electronic companies supplying the Government frequently regard it as part of the job of the engineer to establish close personal relationships with certain engineers working for the Government. The freedom of the civilian engineer to compete with his former employer by making use of these relationships is subject to unclear limitations. A particular situation may be further complicated if a departing engineer takes a number of other employees with him to the new venture.

The Courts

The court will look at all of the relevant factors in arriving at a decision. Only a slight alteration of the facts might cause the same or another court to arrive at the opposite decision.

Unfortunately, neither employee nor employer is certain just what his rights are. If an employer, for any reason, wants to sue a former employee who has started a new business, he can find plausible legal grounds. Some of the suits being fought today may have as one objective to serve as a deterrent to other engineers who may be thinking of striking out for themselves. Such suits do not produce exclusively beneficial results for the employer. Even when the employer files to prevent significant losses which would be caused by the newcomer, the suits may be misinterpreted by his remaining engineers.

What To Do

The employer is in an unenviable position when faced with a loss by the actions of former employees which might be prevented by legal action. To prosecute is a lengthy affair, it is expensive, it is a distraction from the positive aspects of his business, and the unsettled state of the law makes victory uncertain. Also, remaining engineers, even those with no intention of starting a business, frequently have strong opinions about the inviolable right of an employee to start his own business. The indirect losses caused by lowering of morale and motivating forces and even the gradual loss of highly talented technical personnel may far exceed losses that would be caused by the new competition.

Such considerations cause many companies with ample legal justification to forego suits. Some companies, which formerly ignored such situations, are pressing such suits wherever possible, perhaps because their previous failure to act has led to a steadily increasing number of cleavages. Even the many legal actions now on file seem to have had no significant effect on the number of splinter companies being formed.

Why Form a New Company

Trak Electronics Co. is convinced a better solution can be found than merely deciding to sue or not to sue. First, why does an engineer want to start a new business. Money is certainly one reason, but frequently it is not the primary motivation. The possibility of financial return, though, and the possibility

Splinter Companies *(Concluded)*

of the lower tax rate of long term gain are attractive. He may be motivated in part by frustration and a feeling of being hemmed in by management decisions. There is also the prestige of being the operating head of a separate company. In a general sense many engineers have an inherent urge to create that may be satisfied by building physical apparatus or by establishing a successful new enterprise.

This does not mean that every engineer wants to be the head of a company. Many good engineers have a strong dislike for administrative responsibility. They do not like to deal with problems so intangible that they cannot be represented with numbers or situations where decisions must be made even though the available data is insufficient to permit logical analysis. Some feel they cannot undertake to learn about sales, financing, company organization, personnel problems, etc., without sacrificing their professional ability or standing. Most engineers realize fully that the hard work, worry, and primary responsibility inherent in starting a new company comprise an ulcer-forming combination. There is also risk; not only the financial risk but the risk of failure under circumstances where the responsibility cannot be shared with others.

Faced with the actual possibility of running his own show, it is more than likely the engineer will decide against it. Some will want to take the chance, but have an obvious lack of qualifications. Some have the desire and appear to have the necessary abilities. What should the company do about these? Trak Electronics has adopted the policy of helping them get into business.

A Better Solution

If an engineer can find financial backing, it must be because such investments have a good possibility of producing substantial financial returns. If such an investment is wise for a purely financial investor it is perhaps a good way for this company to use some of its money.

The plan worked out at Trak is flexible but in general works something like this: An engineering employee evidences a desire to head a new company. Consideration is then given to whether his former work record demonstrates that he is capable of successfully starting a new enterprise.

In reaching an opinion, necessarily largely on a subjective basis, these questions are considered: (1) has he demonstrated the ability to organize the work to complete his jobs within the scheduled time and funds? (2) Is he customer-oriented? That is, does he really understand the necessity for giving the customer what he wants? Does he have a record of selling himself and the company to the customers he meets? (Does he have the physical energy and drive necessary to overcome the obstacles facing any new business? (4) Does he have the elusive quality of "good judgment"?

His knowledge of details of financing, advertising, organization, etc., are considered of less importance. These he will learn, partly from our teaching, but mostly the "hard way."

Having arrived at a decision to establish a new company, the engineer and Trak managers work closely in selecting a field of endeavor. Here the company can be helpful in avoiding costly mistakes. Each proposed field is reviewed against a set of criteria. Sometimes outside experts or consultants are brought in or, an outside organization is engaged to make market surveys. Having agreed upon the field and prepared a

We believe that there are two basic requirements in forming a successful new company. One obvious one is a marketable product. The second one, which may be less obvious, is sufficient operating capital to enable the new company to become an expert in that product. The formation of TRAK Microwave Corporation was founded on these two basic tenets. We believe that whatever success we may enjoy will be a direct result of having been given the opportunity to do the engineering on our initial product line in the home plant where we were free from the mundane worries of obtaining sufficient immediate business to pay the rent. It was also of great value to have the complete facilities of the home organization, both for engineering advice and technical facilities including test equipment and all other services.

Two principals of Trak Microwave, G. James McCulloch (left and Charles Beaty, are shown in front of their headquarters.

Being basically engineers, one of the more important aspects of the pre-organization planning was the administrative and financial training available to us from top management of the parent firm. Not to be ignored was the tremendous advantage of being able to use the registered trademark of the home plant in the new corporation name, thus clearing the major hurdle of recognition with the customer.

We also feel that it would be unsound to attempt to hide the fact that we are a subsidiary because this information enables us to offer the complete product facilities of the home plant in order to obtain contracts which we are obviously too small to handle from either a financial or a facility point of view.

We believe that it would have been impossible for us to have accomplished our present situation without the financial help and business guidance available from our parent firm.

G. James McCulloch
Trak Microwave Corp.
Tampa, Florida

written definition in functional terms, consideration is then given to the design of the specific products which will represent the initial endeavor of the new company. The engineer who is going to start the new company may then undertake the necessary development work while he continues as an employee of Trak, or the new company may be established before any development is undertaken.

A new corporation is formed and the stock ownership is shared between Trak and the engineer or engineers who are going to take responsibility for the new corporation. Trak receives long-term options to repurchase the stock on a basis that will provide a substantial estate for the participants if the company is successful. Additional funds to get the company started are loaned by Trak or arranged for through other sources.

That is the general plan, but the obvious question at this point is "How well does it work?" We don't know. It will be a long time before enough results are in to form a useful evaluation.

At the present time Trak participates in the ownership of three other companies: Krystinel Corporation, Port Chester, New York, manufacturers of ferrites: Tucor, Inc., Norwalk, Connecticut, manufacturers of microwave tubes, and Trak Microwave Corporation, Tampa, Florida, manufacturers of cavity oscillators. These three companies were established on plans differing from each other and the present plans were evolved from our experiences in establishing these companies. The newest corporation, Trak Microwave Corporation, started operations in Tampa on October 1, 1960, and is operated by James McCulloch and Charles Beaty, both formerly engineers at Trak Electronics.

VOICE COMPRESSER

Technician checks Hughes Aircraft's "vocoder" which compresses voice by ignoring redundant sounds. This narrows the bend width enabling a tenfold increase in channel capacity. Electronic tone generators reconstruct the speed at the receiving end.

High Density Recording System For Computers

The Potter Instrument Co. has developed a new High Density Recording System, capable of recording magnetically on a reel of 1-in. tape approximately 11 times the amount of digital data that can be recorded by the most widely used conventional computer tape systems.

The data transfer rates are as high as 360,000 alpha-numeric characters per second, via 16 parallel recording channels on one-inch tape. Packing densities are up to 1500 bits per inch.

The system eliminates restrictions formerly imposed on some computers by limitations of conventional peripheral tape handling equipment. This will permit many of the new generation of computer systems to operate closer to, or at, their true speed capabilities.

Potter has made the information channels self-clocking—no separate clock channel is needed—and multi-channel data can be read out in true parallel form, despite inter-channel time displacement.

The technique employed in the Potter system is so reliable that, in a recent test of 40 hours continuous operation, less than two seconds of re-read time were required to recover data lost through transient error. During this test no permanent loss of information occurred. More than 20,000 passes over any portion of the tape can be made without losing information, or significantly increasing dropout rate.

Components of demonstration model of High Density Recording System include (l. to r.) test oscilloscope; Potter solid-state, high-speed central control unit; computer simulator; and Potter 9061I High-Speed Digital Tape Handler.

ITT Appoints European Exec

New York—Marc (cq) A. de Ferranti has been appointed President of ITT Europe, Inc. His headquarters will be in Brussels, Belgium. He will direct the expansion of ITT's manufacturing, sales, service, and telecommunications operations throughout Europe, Africa, and the Middle East.

(F101, AIR FORCE PHOTO)

National*

RESEARCH & DEVELOPMENT

New growth in Military and Commercial Lines creates opportunities at Dayton, Ohio, for the following personnel:

TEST EQUIPMENT ENGINEERS: A B.S.E.E. degree plus at least 2 years' experience in the design of airborne, ground, or special test equipment. Applicant must be familiar with analog or digital circuit design, as applied to worst case design conditions. Must be capable of assuming project responsibility and carrying project through to completion.

MECHANICAL ENGINEERS: A B.S.M.E. degree plus at least 2 years' experience in the design and development of electro-mechanical or electronic assemblies and equipments. Applicant must be familiar with methods of shock mounting and packaging of airborne and ground support equipment.

CIRCUIT DESIGN ENGINEERS: A B.S.E.E. degree plus 2 to 5 years' experience in the design and development of solid state digital circuitry. Applicant should have experience in circuit design for reliable operation under worst case conditions. Background in airborne and ground support test equipment desired.

LOGIC DESIGN ENGINEERS: A B.S.E.E. degree plus 2 to 5 years' experience in the field of logical design of airborne electronic equipment. Must have a good background in system logic design.

DIGITAL COMMUNICATIONS ENGINEERS: At least a B.S.E.E. degree plus 4 to 6 years' experience airborne and ground base digital communications. Must be familiar with the many facets of digital communications including encoding and decoding techniques. Background in RF, IF, and digital circuits desirable.

Direct all replies to:
Thomas F. Wade, Technical Placement G 9-2
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THE NATIONAL CASH REGISTER COMPANY, *DAYTON 9, OHIO*

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Industry News

Robert S. Schenck has been appointed Sales Manager for Electronic Devices Inc., New Rochelle, N. Y.

Frederick B. Simmons has been promoted to New England District Manager for Raytheon Co.'s Distributor Products Div., Westwood, Mass.

Frank A. Smith has been appointed General Sales Manager of the Neff Instrument Corp., Duarte, Calif.

M. W. Townsend, Vice President of Administration of Handy & Harman, New York, N. Y., has been elected to the newly-created post of Executive Vice President of the precious metals firm.

M. W. Townsend

J. Bleeksma

Jan Bleeksma has been appointed Vice President in Charge of Manufacturing of Amperex Electronic Corp., Hicksville, L. I., N. Y. Mr. Bleeksma was formerly Plant Manager.

Glen McDaniel, Vice President and General Counsel of Litton Industries, has been named Sr. Vice President of the Corporation.

Frederick M. Hoar has been named Director of Advertising and Public Relations for the Univac Div., Sperry Rand Corp., New York.

The Hughes Aircraft Co. has announced the appointments of **James E. Davenport**, Northeastern District Manager, Microwave Tube Div.; **William J. Gagnon** as National Sales Manager, Semiconductor Div.; **Herbert S. Evander** as Sales Manager for Transistors, rectifiers and special Devices; **Max F. Selby** as Manager of Personnel and Services, Industrial Systems Div.; and **Jack D. Wilson** as Manufacturing Manager for the Santa Barbara Research Center, subsidiary of Hughes Aircraft Co.

Kerby H. Fisk, Board Chairman and Chief Executive Officer of Allied Chemical Corp., has been elected a Director of Minneapolis - Honeywell Regulator Co., Minneapolis, Minn.

Curtis A. Haines has been appointed Vice President—Product and Facilities Planning of Sylvania Electronic Systems, Div. of Sylvania Electric Products Inc., Waltham, Mass.

John Lienhard has been appointed Vice President of International Standard Electric Corp. and General Manager of the Export Dept., International Telephone and Telegraph Corp., New York, N. Y.

Narda Ultrasonics, Inc., has announced the appointments of **Arthur H. Smith**, Vice President of Midwest Technical Development Corp., as Chairman of the Board of Directors; **Alfred C. Werner, Jr.**, as Director of Marketing; and **John A. Thoren** as Narda's Controller.

Walter H. Powell has been elected to the Board of Directors of International Resistance Co., Phila., Pa.

D. C. Arnold has been named Vice President-Sales for the Alpha Corp., systems management subsidiary of Collins Radio Co., Richardson, Tex.

Edwin L. Davis—appointed Sales Manager for Industrial and Military Products of General Electric's Receiving Tube Dept., Owensboro, Ky.

Horace R. Potter has been elected President of the Reeves-Hoffman Division of Dynamics Corporation of America.

H. R. Potter

J. R. Zacharias

Dr. Jerrold R. Zacharias, has been elected to the Board of Directors of the Sprague Electric Co., North Adams, Mass.

M. Gaius (Gus) Wike has been named Distributor Sales Manager of Tru-Ohm Products, Div. of Model Eng. & Mfg., Inc., Chicago, Ill.

Erwin Tomash has been elected Vice President of Ampex Corp. and Manager, Ampex Computer Products Co., Culver City, Calif.

E. C. Titcomb has been named Sales Manager of the Erie Pacific Div., Erie Resistor Corp., Hawthorne, Calif., for the company's line of digital counter timers and control systems.

Wiley V. Conover has been named Director of Sales for Autonetics, Div. of North American Aviation, Inc., Downey, Calif.

Oren Weir has been named Controller of Magnetic Controls Co. of Minneapolis, Minn.

William Rympalski has been appointed General Manager of Telemetal Products, Inc., a subsidiary of Polarad Electronics Corp., Brooklyn, N. Y.

Richard J. Looney has been named Sales Manager, Antenna Dept. Boeing Airplane Co., Seattle, Wash.

John L. Wilson has been appointed Manager of the Filament-Wound, Reinforced Plastic Parts Div., Taylor Fibre Co., Norristown, Pa.

Industro Transistor Corp., New York, N. Y., has announced the following appointments: **Ira R. Becker**, President; **Charles A. Tepper**, Vice Chairman of the Board; and **Marcus Gish** named Controller, Assistant Secretary and Treasurer.

Kenneth F. Petersen has been named General Sales Manager of Dage Div., Thompson Ramo Wooldridge Inc., Michigan City, Ind.

Max Lehrer has been appointed Director, Defense Business Development, Defense Electronics Products, Radio Corp. of America.

Arch Warden, President of Xcelite, Inc., Orchard Park, N. Y., has been elected a member of the executive committee of Service Tools Institute.

Lewis C. Pape has been named Director of Marketing of the Industrial Products Dept., Service Div., Packard Bell Electronics, Los Angeles, Calif.

Marvin Sachar has been promoted to the position of Credit Manager for the Allen B. DuMont Laboratories Divs. of Fairchild Camera and Instrument Corp., Clifton, N. J.

Paul Heilman has been named Commercial Products Manager of Reflectone Electronics, Inc., Stamford, Conn.

John H. McGinnis, has been appointed to the position of Marketing Manager, Sonic Energy Products Group, Pioneer-Central Div. of the Bendix Corp., Davenport, Iowa.

Electron Technology, Inc., Kearny, N. J., has announced the appointment of 3 new Vice Presidents: **Charles L. Baxter**, Director of Marketing; **John Hartmann**, Director of Engineering; and **Robert E. Rutherford, Sr.**, Director of Research and Development.

Z. W. Pique has been named Vice President, Marketing for Stratham Instruments, Inc., Los Angeles, Calif.

Edward S. Ruth, Director of Engineering for The Gamewell Co., Newton, Mass., has been appointed to the Board of Governors of the National Electrical Manufacturers Assoc. for a one year term.

Wendell B. Barnes, a New York investment banker, has been elected to the Board of Directors of Servo Corp. of America, Hicksville, N. Y.

Harry Zimmerman has been named Sales Manager, "RD" Instruments of The Hickock Electrical Instrument Co., Cleveland, Ohio.

L. A. Bassett has been promoted to the position of Manager of Transistor Sales for General Electric Co.'s Semiconductor Products Dept.

James P. Seitz has been named Executive Vice President of Nothelfer Winding Laboratories, Inc., Trenton, N. J. Mr. Seitz will be in charge of sales, research, engineering and production.

J. P. Seitz

Dr. M. A. Xavier

Dr. Miguel A. Xavier was elected Vice President of Century Electronics & Instruments, Inc., Tulsa, Okla., at a recent Board of Directors Meeting. He was formerly Chief Engineer.

Linton von Beroldingen has been named Manager of Public Information for Lockheed Missiles and Space Div., Sunnyvale, Calif.

JFD Electronics Corp., Brooklyn, N. Y., has announced the following sales appointments: **William Bellenkes**, Western; **George Kase**, Eastern; **Fred L. Strauss**, metropolitan New York area; **"Sarge" Barkett**, North Central; **John Neenan**, New England; and **David Taub**, Distributor Sales Supervisor.

The Palo Alto Engineering Co., (PAECO) a subsidiary of the Hewlett-Packard Co. has announced the following appointments: **John C. Beckett**, President and General Manager; **Roy A. Melin**, Vice-President and Production Manager; **Nick J. Mardesich**, Secretary-Treasurer; and **Rodger Earley**, Assistant Secretary.

Ellis G. Slack has been appointed Assistant to the President of Gulton Industries, Inc., Metuchen, N. J.

Personals

LeRoy H. Carson has been appointed Chief Engineer of the Transformer Div., Supreme Transformer Co., Oxford Electric Corp., Chicago, Ill.

Shockley Transistor, unit of Clevite Transistor, Palo Alto, Calif., has announced the appointment of **T. E. Veltfort** as Chief Electronics Engineer and **Jacob Ever** and **John V. Publicover** as Process Engineers.

John H. Phelps has been appointed Manager of Application Engineering for the General Electric Co.'s Semiconductor Products Dept., Liverpool, N. Y.

John H. Phelps

C. M. Aker

C. M. Aker has been elected Vice President - Engineering of International Telephone and Telegraph Corp., Industrial Products Div., San Fernando, Calif.

William O. Thompson has been named Chief Industrial Engineer for C. P. Clare & Co., Chicago, Ill.

R. S. Bowditch has been named Chief Engineer of the Electronics Div., Stratham Instruments, Inc., Los Angeles, Calif.

Dr. T. J. Bulat has been named Manager of Sonic Engineering by the Pioneer-Central Div. of the Bendix Corp., Davenport, Iowa.

Daniel P. Ross has been promoted to Sr. Engineering Specialist in the Tapco Group Research Dept. of Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

Hamish T. Law has been named Microwave Engineering Manager for Westinghouse's Electronic Tube Div., Elmira, N. Y.

Douglass C. Harvey has been appointed Associate Director of Research and Engineering for Eastman Kodak Co.'s Apparatus and Optical Div., Rochester, N. Y.

Louis E. Hart has been appointed Manager of Manufacturing Engineering, Electronics and Ordnance Div. of Avco., Evendale, Ohio.

William J. Monahan has been appointed to the post of Chemical Engineer for Silicon Transistor Corp., Carle Place, N. Y.

Cinch Mfg. Co., Chicago, Ill., has announced the appointments of **Roy Witte**, as Vice President in Charge of Research & Development and **Philip Martsolf, Jr.**, as Chief Engineer of Manufacturing.

Microwave Associates, Inc., Burlington, Mass., has appointed: **Dr. Kenneth Mortenson** to head the Active Solid-State Microwave Devices Group; **Dr. Marion E. Hines** to head the Research Group on parametric amplifier; and **Robert W. Terry** as Director of Engineering.

J. P. Smith, Jr., has been named a Sr. Engineer at Ortho Filter Corp., a division of Ortho Industries, Inc., Paterson, N. J.

Paul Harris has been appointed Staff Engineer at Clarostat Mfg. Co., Dover, N. H.

Indiana General Corp., Valparaiso, Ind., has announced that Vice President **Christopher L. Snyder** has been put in charge of all Corporate engineering activities and **Frank S. Greenwald** will head the newly formed Product Development Group.

Harold W. Schaefer has been named Vice President-Director of Engineering for the Consumer Products Div. of Philco Corp., Phila., Pa.

Stuart M. Hauser has been appointed Chief Engineer at Electro-Optical Instruments, Inc., Pasadena, Calif.

Stuart M. Hauser

Dr. Choh-Yi Ang

Dr. Choh-Yi Ang has been appointed Manager of Telecomputing Corp.'s newly organized Physics Research Laboratory.

David B. Young has been appointed Military Applications Engineer for GE's Ordnance Dept. in Washington, D. C.

Dr. Harold V. Hance has joined the Systems Research Center of Lockheed Electronics Co., Plainfield, N. J., as both Associate Director of the Center and Sr. Scientist.

Joseph DiGiacomo has been appointed Project Engineer of American Machine & Foundry Co.'s International Group., New York, N. Y.

John H. Gallichotte has been appointed Chief Engineer at Wave Particle Corp., Div. of Ramage & Miller, Inc. Richmond, Calif.

Radio Corp. of America, New York, N. Y., announces that **R. K. Lockhart** has been designated Manager, Development Engineering for U. S. Navy ultra high-speed computer project and **Harold Morris** appointed Engineering Manager for the RCA computer systems plant at Palm Beach Gardens, Fla.

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By Ye. I. Tenyakov. 60-11972. July 1960. 10 pages. Price $.50. Translation of Izvestiya Vysshikh Uchebnykh Zavedeniy. Elektromekhanika USSR. 1960.

On a New Method of Solving Electrostatic Problems and Editorial Comments

By E. L. Burshteyn, et al. 60-21766. May 1960. 7 pages. Price $.50. Translation of Radiotekhnika USSR, 1959.

Relation of Paramagnetic Absorptiton to Susceptibility

By S. A. Al'tshuler. 60-21769. May 1960. 6 pages. Price $.50. Translation of Zhurnal Eksperimental 'noy i Teoreticheskoy Fiziki USSR, 1950.

Measurement of Attenuation of Distributor Feeder Lines for Wire Broadcasting By the Signal Accumulation Method

By I. A. Shamshin and V. A. Nyurenberg. 60-31353. July 1960. 9 pages. Price $.50. Translation of Vestnik Svyazi USSR. 1960.

New Direct Fototelegraph Equipment

By S. I. Klykov, et al. 60-31352. July 1960. 11 pages. Price $.50. Translation of Vestnik Svyazi USSR, 1960.

Television; Radio-Relay Television Lines with R-600 Equipment and the Country's First Color Stereoscopic Television Installation

By G. A. Greybo and G. I. Gomer. 60-41213. August 1960. 24 pages. Price $.75. Translation of Vestnik Svyazi USSR. 1960.

The Use of Silica Gel in Cable Work

By T. V. Abramova. 60-31354. July 1960. 5 pages. Price $.50. Translation of Vestnik Svyazi USSR. 1960.

A Video Tape Recorder

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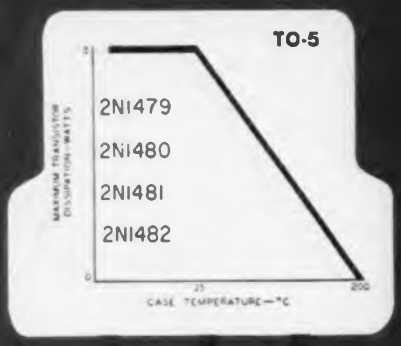

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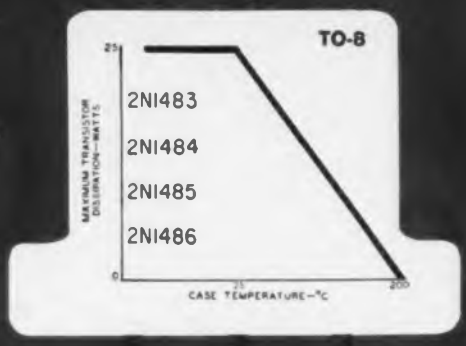

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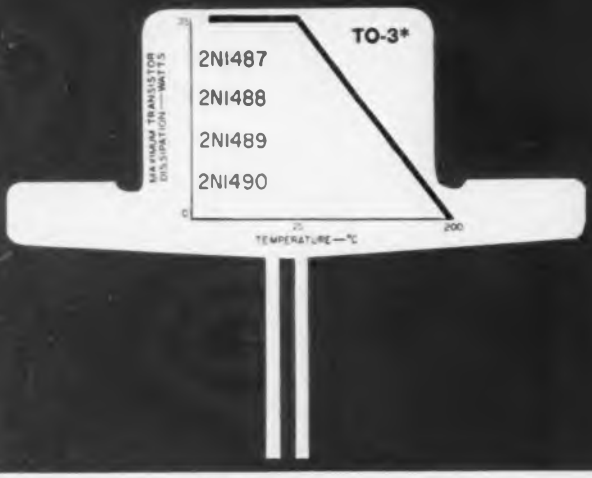

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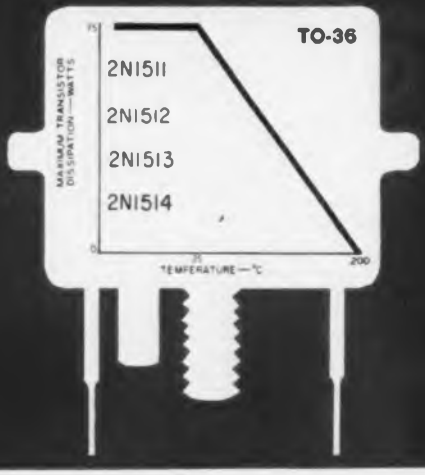

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COLLECTOR TO BASE VOLTS	60V	100V	60V	100V	60V	100V
COLLECTOR-TO-EMITTER VOLTS With base open (sustaining voltage)	40V	55V	40V	55V	40V	55V
with emitter-to-base reverse biased (V_{EB} = 1.5 volts)	60V	100V	60V	100V	60V	100V
EMITTER-TO-BASE VOLTS	12V	12V	12V	12V	10V	10V
COLLECTOR CURRENT (Amps.)	1.5a	1.5a	3a	3a	6a	6a
EMITTER CURRENT (Amps.)	1.75a	1.75a	—3.5a	—3.5a	—8a	—8a
BASE CURRENT (Amps.)	1a	1a	1.5	1.5a	3a	3a
TRANSISTOR DISSIPATION (Watts) At case temperature of 25°C	5w	5w	25w	25w	75w	75w
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