ELECTRONIC DESIGN

SEAGOING ELECTRONICS

Highly specialized electronic devices—acoustic theodolites, thermal contour plotters, deep-sea seismographs, sound velocity meters—go to sea for oceanographic explorations.

An ELECTRONIC DESIGN Special Report
... page 40

COVER: Isotherms, the graphical representation of temperature distribution in the oceans, are strikingly shown by *ELECTRONIC DESIGN*'s artist. An integral measurement in the oceanographer's work, they are presented here as actually plotted according to depth and current. The cover keynotes this issue's Special Report, "Oceanography—High Tide for Design Ideas."

Selected Topics In This Issue

Sidelights of This Issue

Oceanography brings to mind the romantic world of mermaids and ghostly galleons, but the adventures encountered by *ED* Assistant Editor Manfred Meisels were strictly electronic in nature. Fresh from the briny, he reports on an up-to-the-minute science that is deeply involved in electronics and offering its own peculiar brand of engineering headaches. It's all in the Special Report, "Oceanography—High Tide for Design Ideas."

As befits their work, oceanographers are a rugged, independent, shirt-sleeved group of men. During their infrequent visits ashore they mostly snarl at the land-locked engineers who design the sea-going electronics. Oceanography is making rapid advances largely because of the measurement, communications, and data handling techniques possible through electronics. But it takes a special knack to design for the sea—a knack well worth acquiring, for the application areas for electronics instruments and systems in oceanography have barely been touched. Read about them in the first part of this special report beginning on page 40.

Reliability Is Possible

"A reasonable degree of reliability can be achieved now," says ED's Managing Editor, James A. Lippke in his editorial this issue.

He bases his remarks on two specific examples of successful reliability programs. First is the high reliability of Pioneer V's payload. Included in the payload were 8,500 total components, 2,500 of which were active elements, such as transistors and diodes.

A minimum estimate of the life of the payload was put at 43.8 days—over 1000 hours.

The telebit transmitter which has fewer parts was almost certain to be operative at least 216 days. These high reliabilities are the result of extensive, planned component testing.

Hoffman Electronics Corp., applying the AGREE reliability concept to the manufacture of TACAN equipment, has doubled and in some cases quadrupled the MTBF's of some units.

Whether or not we really get reliability depends on a few crucial steps that can be taken. Read Jim Lippke's comments on the subject, p. 53.

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Coming Next Issue

The eighth annual *ELECTRONIC DESIGN* Transistor Data Chart, containing specifications of all the latest types of transistors.

ELECTRONIC DESIGN

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New Military Specifications May Upset Designers

Next Round of Specifications Due From Military Will Cause Changes Throughout Electronics Industry

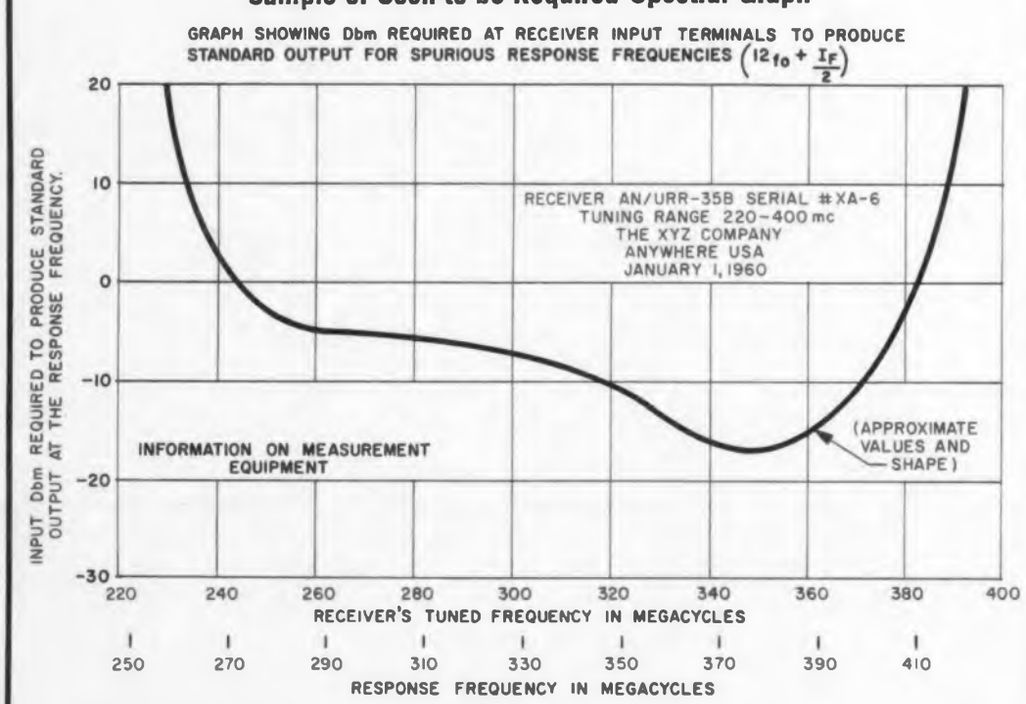
THE ARMY, Navy, and Air Force are preparing important changes in the specifications they write to procure electronic equipment. These changes may result in revised design practices throughout the industry, in the opinion of some military spokesmen. Most affected will be designers working in the areas of radio frequency interference, maintainability and reliability.

In RFI, the services are planning to require military contractors to submit a frequency response signature with each equipment they produce. Purpose: the elimination of components and circuitry that cause excessive RFI, and the more efficient use of the frequency spectrum.

In maintainability and reliability the goal is nothing less than defining by standard, meaningful numbers the maintenance required for, and the reliability of each device and system designed for the military.

In addition, changed specs will soon require modular construction and fault localizers for nearly all Navy equipment, and shipboard electronics gear will have to be designed for water cooling and for 400-v power supplies—the new Navy standard.

Sample of Soon-to-be-Required Spectral Graph



This sample frequency-response signature of a military receiver was prepared by a three-service committee to illustrate the requirements for data presentation of receiver interference characteristics. Now in preparation in Washington for issuance in about two months is a detailed standard for standard measurements of radio-frequency spectrum characteristics. After this standard is published, military contractors will be required to provide detailed graphs and tables similar to the sample above with each equipment they produce for the services. The goal is a catalog of interference signatures of every piece of military electronics equipment. Military spokesmen expect the standard measurement spec and the resulting library of interference data to have profound effects on the design of electronic equipment.

For first details of frequency measurement standard please turn to p 8.

Spectral Signatures Will Cut RFI

The three services have initiated programs aimed at procuring frequency response signatures of each piece of electronic equipment produced for the military. A standard spelling out requirements is expected to be published in about six weeks. The Department of Defense has made an emergency appropriation to support the program and is about to assign responsibilities to the individual services. Rough Navy estimates call for a complete catalog of signatures in a maximum of five years.

The signatures will be used to help find the components and equipments that contribute excessively to RFI. These troublemakers will then be field-changed or phased out, the Navy reports. The signatures will also help to establish meaningful standards for radiation characteristics. Current radiation specifications, according to a Navy spokesman, are written mainly to limits imposed by test equipment. To facilitate adequate radiation measurements test equipment capable of wideband, superhigh frequencies is being developed as part of the spectral signature program.

The data to be required of manufacturers will have to contain information on passive components as well as on active radiation sources. The services are just as interested in equipment that is excessively susceptible to RFI as they are to troublesome RFI sources.

At the Navy's Bureau of Ships, specialists in the frequency-response signature program expect

their work to lead to an enormous retrofit operation as the interfering components and equipments are found and replaced. BuShips engineers predict that many tubes and components will have greatly changed parameters in the future because of the program, and that magnetrons may be among the first components to go.

Another step toward interference control will be taken when a greatly revised and improved version of the Navy's interference specification is issued for comment in late July. The spec MIL-I-16910B, will call for broader frequency coverage, more realistic limits and more precise measurement techniques. It will be the first spec to reference the new standard on frequency spectrum measurements.

Maintainability Figures on the Way

In the Army, the Signal Corps, Ordnance, and Corps of Engineers are working on separate but related maintainability programs and have developed, under Signal Corps leadership, a method for measuring maintainability. The industry is evaluating the proposed technique through the Electronic Industries Association, which is coordinating members' comments now starting to come in. The EIA's M5.5 maintainability committee expects to present the industry's viewpoint on the proposal by October of this year. The result may be a Signal Corps specification on specifying maintainability.

A more ambitious project being pursued at the Signal Corps', Ft. Monmouth, N.J. center, is expected to result in a detailed maintainability index. An attempt is being made to assign weighted numbers to selected factors in maintenance so that as an equipment incorporates these factors the numbers corresponding to them can be added to get a relative figure of merit.

The Air Force has prepared a modification of its MIL-M-26512 specification, which requires a maintainability analysis to be made of equipment produced for that service. The National Security Industrial Association is now studying the proposed changes and is expected to have its comments on record shortly.

The specification was modified to clarify unclear language, which the industry found confusing after introduction of the specification last year.

A similar situation exists with MIL-D-9412C, an Air Force specification designed to spell out maintainability requirements of ground support equipment. The EIA is scheduled to submit members' comments to the Air Force on a proposed clarified version of the specification by the end of this month.

Both MIL M-26512 and MIL D-9412C need clarification, the Air Force believes, because they were written hurriedly in order to establish main-

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tainability requirements at the earliest possible date.

An Air Force maintainability index, similar to that of the Signal Corps, is expected to result from a study that has been conducted by Radio Corporation of America for about a year. RCA is collecting field data on the failure rate of Air Force equipment. Data collected so far has supported the Air Force's belief that failure rate is proportional to system complexity. The data will be used by RCA to construct a maintainability index in the form of a matrix chart. Preventative, Corrective, and Repair maintenance would be charted against high, medium, and low levels of maintenance skill required.

The Navy's Bureau of Ships is following the Air Force work in establishing a maintainability index. For some time BuShips has been using such an index for its mechanical equipment. BuShips is also trying to develop a technique for predicting the maintainability of shipboard electronic equipment. Research for this program is being conducted by International Telephone and Telegraph's Federal Electric Div.

Reliability Will Be Numbered

As with maintainability, the military services are driving to attach meaningful numbers to reliability. Being evaluated now is a proposed three-service specification, MIL R-26484A, which was written to spell out the reliability requirements of new subsystems and equipments designed for the military. The proposed spec is reported to be based on MIL Standard 441.

Massive efforts to establish reliability requirements are underway in connection with two other programs: the work of the Advisory Group on Reliability of Electronic Equipment (AGREE), and the work of the Ad Hoc Study Group on Parts Specification Management for Reliability.

The 1957 AGREE recommendations are now being tried out by what one industry spokesman calls "brute force." The military wants to find out what the AGREE program will cost in money and effort. The first equipments developed under the AGREE recommendations are now starting to come through. Hoffman Electronics Corp. is producing a TACAN system designed originally before the AGREE specs were available, RCA is producing a data link, and Spartan Electronics is making an instrument landing system under the AGREE recommendations. Some companies, however, are reported unwilling to promise to comply with some of the details of the recommendations in bidding on contracts. Although the Army has been directed to implement AGREE, the only equipment currently being produced under the program is destined for the Air Force.

The Navy, which reports that it has special problems in making sure that equipment is produced in time for hulls under construction, says it is modifying or going slowly in implementing AGREE. Navy maintenance specialists believe that the AGREE recommendations will be modified to avoid slowdowns and excess costs in producing electronics equipment.

The report of the Ad Hoc Study Group on Parts Specifications will be published in about six weeks and will probably be followed by a Dept. of Defense letter to all manufacturers, which will request implementation as soon as possible.

The report, which has been called the most advanced step taken in reliability in the U.S., is expected to result in installation throughout industry of elaborate testing facilities, an increased burden on government inspection services, increased cost of parts for equipment producers, greater first cost of equipment for the military, and, finally, lower maintenance costs and greater reliability of military and non-military electronic equipment.

Action on Modules and Fault Localizers

Among the planned changes in military specifications are some that will affect construction and maintenance design of equipment.

A revised version of the Navy's over-all electronics spec, MIL-E-16400, is scheduled to appear before the end of this month. This spec will strongly encourage the use of modular construction. At present, the Navy is requesting contractors to submit bids based on both conventional and for modular construction. The Navy's goal is eventual complete modular construction, the changed specification is a step in that direction. Manufacturers will find it extremely difficult to get waivers for conventional construction.

Another imminent change in this area is the switchover to compartment packaging of systems for shipboard installations. BuShips is initiating the installation of some radars in open racks in specially designed ship compartments as a test of the feasibility of this type of construction, which is favored by telephone systems designers.

Manufacturers who have been getting waivers permitting them not to bring out test points in the equipment they make for the Navy, will find such waivers much harder to get after the revised MIL-E-16400 is issued. The Navy's efforts in requiring test points is only one step toward the goal of eventual automatic fault location. The Specification board of BuShips is about to meet to consider recommendations for requiring incorporation of fault locating features in Navy equipment. BuShips engineers report that requirements in one form or another will shortly appear in Navy specifications for fault locating features. ■ ■

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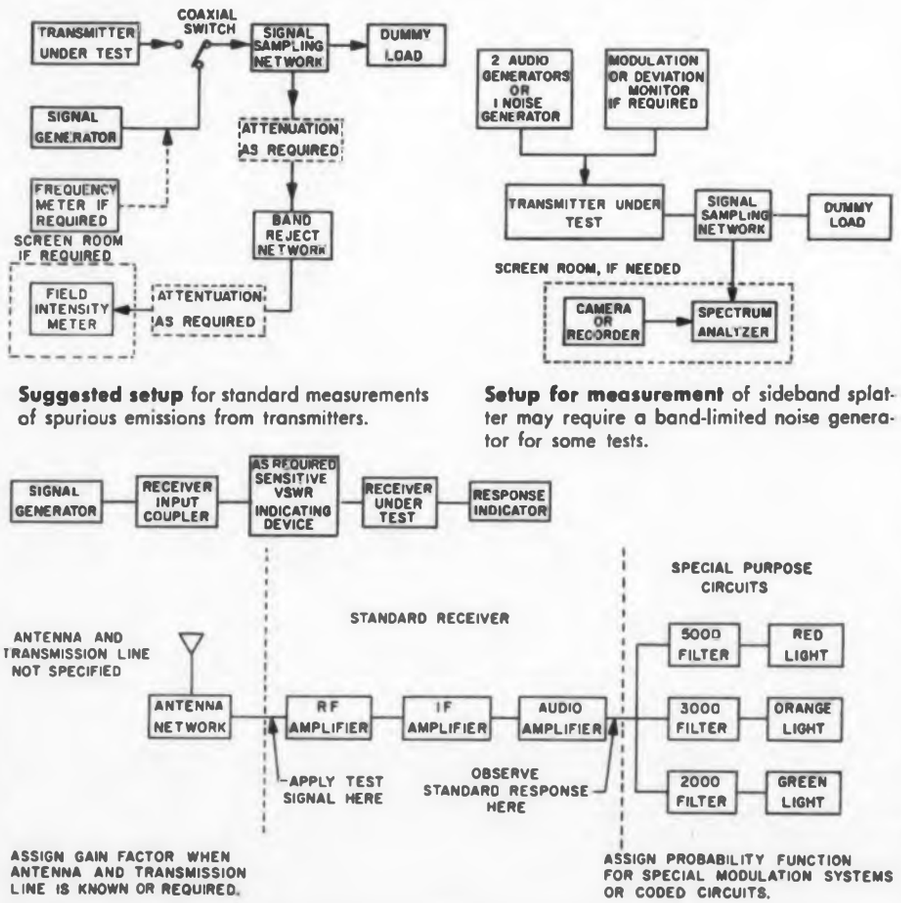
Exclusive Details of New Standard

THE standard described here was developed by the three services to procure detailed data on the frequency spectrum characteristics of equipment produced for the military; this information is considered basic to the entire military program of interference control. The standardized data will then be used to eliminate RFI-causing and RFI-prone equipment from the military electronics scene.

The standard, which is now awaiting editing and the assignment of a number, is scheduled for issuance in about six weeks. Following on its heels will be changes in specifications for military equipment. These changes will require that spectrum measurements be made in accordance with the standard; later, frequency response limits may be set for various types of military equipment.

Typical Setups for Standard Interference Measurements



Suggested setup for standard measurements of spurious emissions from transmitters.

Setup for measurement of sideband splatter may require a band-limited noise generator for some tests.

Sample setup shows where test points should be located for measuring standard response signal during receiver tests.

Over a period of several years a library of frequency-response signatures will grow and will be used to guide replacement and phase-out of troublesome equipment.

To implement the program, special test equipment is being developed. The Navy has just awarded a phase-type contract to Applied Research, Inc., Port Washington, N.Y., for a broad-band radio-frequency spectrograph that will give a visual indication of interference over a wide frequency range.

The instrument is expected to provide response signatures from 10 kc to 10 kmc in about one-seventieth the time required for similar results with standard frequency-by-frequency recording methods. The device is an outgrowth of a much simpler instrument reportedly used by Republic Aviation Corp.

Another device said to be in design will be able to take measurements to 100 kmc.

Following is an outline summary of the proposed standard, "Measurement of Radio-Frequency Spectrum Characteristics." The standard was written by the three services with the assistance of all other government agencies interested in interference control.

The Standard Summarized

The general spectrum characteristics measurements specified in the standard are: 1. RF output at equipment terminals, 2. Antenna-radiated rf output (to provide data on complete equipment), 3. Receiver susceptibility (to radiation other than at the operating frequency), and, 4. Environmental operational level (to determine the effects of the electromagnetic environment on equipment in terms of degradation and failure as the environment becomes more severe). The standard requires that measurements of the environmental operational level be made on systems and all related subsystems.

The section on general requirements specifies that equipment to be measured be set up so it approximates the intended operating electrical and physical figuration.

CIRCLE 9 ON READER-SERVICE CARD ➤

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- Equipment spectrum characteristics must be submitted on developmental, prototype and production equipments as specified.
- Transmitter measurements data must show intended frequency and spurious frequencies, signal levels at the various frequencies, and modulation envelope characteristics, as appropriate.
- Receiver data must show signal levels at all frequencies where a standard response can be produced.
- Data on radiated-output must show spatial distribution of power in a complete system to indicate its potential effect on the electromagnetic environment.

Introducing the detailed-requirements section of the standard are specifications for instrument accuracy. Frequency accuracy of signal generators must be within 1 per cent, calibration of the attenuator on the signal generator must be correct within 2 db, and where modulation is required, all quantities must generally be within 5 per cent.

Interference and field-strength meters must be calibrated as two-terminal voltmeters at all frequencies with an accuracy of 26 per cent (2 db) of the indicated value.

Transmitter sampling devices, if used, must have a maximum output to the measurement receiver of —27 dbm.

Transmitter, Receiver, and Radiation Data Measurements

Transmitter measurements require tests of power output, spurious and harmonic outputs, and sideband splatter. This data must be presented in tables of frequency and power output, in megacycles and decibels. Included must be tuning-band information and whether output is peak, quasi-peak, or average. Measurements of sideband-splatter must include photos of a spectrum analyzer presentation of generator tests.

Receiver measurements must include tests of sensitivity, susceptibility, and oscillator radiation. Data on sensitivity must be presented both as a graph (similar to the same on p 4 of this issue of *ED*) and in tabular form. Complete calibration and nomenclature of test gear used, lengths of all connecting cables and a copy of the calculations must be included. Data on susceptibility to spurious response must be given by family in terms of amplitude vs tuned frequency of the receiver and the signal generator frequency. Oscillator radiation data must be presented as transmitter data.

For measurements below 20 mc, the standard specifies that the measurement antenna must be a vertical rod or whip. For tests between 20 and 400 mc the antenna should be a half-wave dipole. Between 400- and 1,000-mc measurements must be

taken with a dipole and a corner reflector. The antenna for tests above 1,000 mc must be directive and have a beamwidth not more than 10 deg wide at the 3-db points at a wavelength of 6 cm. Side-lobe attenuation must be at least 40 db below the main beam.

The standard also includes specifications for three-dimensional radiation measurements. These may use either the elevated sphere technique or an instrumented aircraft. ■ ■

Lead Zirconate Titanate Isn't Necessarily 'PZT'

The news report on Branson Ultrasonic Corp.'s use of PZT ultrasonic transducers to boost cleaning efficiency (*ED*, May 25, p 26) contained an error which is all to prevalent among electronic design engineers.

The report erroneously used the expression "PZT" as a generic term for lead zirconate titanate. Actually, PZT is a registered trade name for a particular lead zirconate titanate composition, the patent for which is owned by Clevite Electronic Components Div. of Clevite Corp.

The ceramic that Branson used with such success was indeed Clevite's PZT. But the material with which Narda Ultrasonics Corp. had difficulty was another company's composition of lead zirconate titanate.

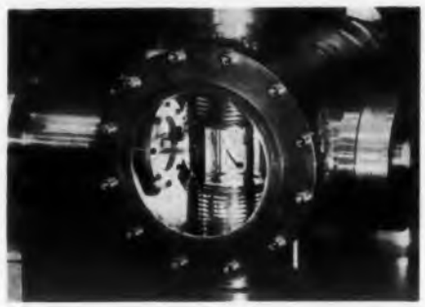
Engineers at NTC Meeting See No PCM-PDM Controversy

There is no real controversy between pulse-code modulation and pulse-duration code techniques. Each has its own uses in telemetry, according to a consensus of engineering opinion at the National Telemetering Conference in Santa Monica, Calif.

PCM was given for the first time a session of its own and little of the expected controversy arose among attending engineers. It was generally agreed that PCM was useful in achieving accurate, quasi-static data.

A workshop session revealed the need for R&D in several areas. Under the chairmanship of Frederic C. Lahn of the Boeing Airplane Co., the engineers called for increased work in frequency response, underwater telemetering, and new measurement areas.

Speakers predicted that the greatest advances over the next decade would be made in the field of high-temperature measurement. Some workshop members voiced the fear that the government deadline of 1970 for shifting from VHF to the new frequencies for telemetry would not give them ample time to develop and install a microwave system comparable to VHF systems.



The chamber in which photodetachment and crossed-beam experiments are conducted. Ions enter from the left and interact either with electrons traveling vertically or with photons coming in through front window.

NBS Stepping Up Research In Hot Gases and Plasmas

A SPECIAL program to unify and accelerate research on hot gases has been established by the National Bureau of Standards.

The work includes many long-standing bureau programs, such as investigations of ionospheric and solar phenomena, research on atomic properties and high-temperature gases, and studies of

The discharge of this exploding wire generates cylindrical shock waves. The waves are being studied in plasma and astrophysic research conducted at the Boulder, Colo., laboratories of NBS.

Technician inserts a filter in the path of a photon beam that is to interact with negative ions in the lighted chamber at left. This equipment has been designed by the National Bureau of Standards for the continuation of studies basic to plasma physics. It may be used in crossed ion-electron-beam experiments as well as in photodetachment work.

radio-wave propagation in plasmas. By integrating its activities in these areas, the bureau hopes to stimulate work in the specialized fields of very-high-temperature physics and laboratory astrophysics.

A long-range experimental and theoretical program has been planned. The program, which includes work at NBS laboratories in Washington, D.C., and Boulder, Colo., is expected to provide the necessary measurement standards, basic data, theoretical guidance, and interpretative techniques for determining the relevant properties of hot gases.

In Washington, studies are being conducted in high-temperature measurements, statistical mechanics, and thermodynamics—all part of the bureau's effort to characterize plasmas accurately. Other activities include atomic-energy investigations, studies of transition probabilities, and work on collision cross sections. Work in these areas is expected ultimately to provide the atomic properties needed to predict the behavior of hot gases.

At the Boulder facility, microwave diagnostic techniques are being developed to provide a physical understanding of plasma configurations. Theoretical work on the physics of stellar and planetary atmospheres, expected to provide convenient and important examples of non-local thermodynamic equilibrium high-temperature gases, is also being done at Boulder. ■ ■

New Space Craft Will Land Seismometer on Moon

'Ranger' Is Attitude-Stabilized, Maneuverable, Self-Programing; Seismometers Being Tested Will Withstand 5,000-G Impact Shock

A SECOND GENERATION space vehicle—fully attitude stabilized, maneuverable and self programing—is being designed to carry the payload in the recently announced U.S. project to land a seismometer on the moon.

The space craft is the Ranger, under design at Jet Propulsion Laboratory, Pasadena, Calif. It is intended also as the basic vehicle for a number of advanced space probes, including flights to Mars and Venus.

Ranger is to be equipped with a steerable parabolic antenna, stabilizing jets and a hydrazine-fueled rocket engine for mid-course guidance. Four photoelectric sun sensors will orient the vehicle for maximum illumination of its solar cells. A photoelectric earth sensor will control vehicle attitude and steer the antenna to keep it aimed toward earth. Rate gyros will provide for full, three-axis stabilization. An omnidirectional antenna is also to be carried in the vehicle to maintain communication during the rapid maneuvering associated with mid-course guidance.

The two solar panels on Ranger contain a total of 8,640 Hoffman silicon cells and will deliver 190 w to the vehicle's storage batteries. These will power the guidance and control equipment aboard as well as the communications system. Two 960-mc transmitters, one for each antenna, are to be on board. The parabolic antenna will be driven by a 3-w unit using a relatively wide band form of modulation yet to be selected.

New Instruments Planned

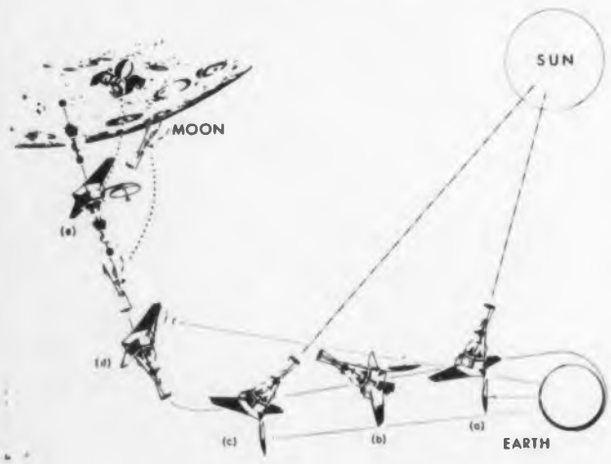
A variety of new devices are planned for the instrument payload. These include:

- Rubidium vapor magnetometer, to measure absolute magnetism to an accuracy of 0.01 gamma.
- Lyman-alpha telescopes, to examine the nature of hydrogen clouds surrounding the earth.
- Friction experiment to determine the behavior of various lubricants in space. Spinning, spring-loaded disks will be used here.
- A broad array of radiation and particle detectors, including electrostatic, ion chamber, Geiger tube, solid-state and multiple-coincidence types. Among these may well be prototypes for sensors to be used in a satellite system now being planned to detect nuclear tests in space.

Ranger will extend some 12 ft along its major axis and weigh about 800 lb. For lunar shots, planned by the National Aeronautics and Space Agency, the vehicle will be carried aloft by the Atlas-Agena-B combination; interplanetary flights will require the higher-thrust Atlas Centaur.

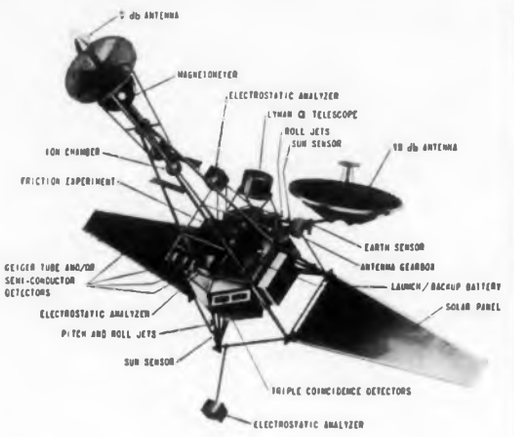
The lunar-impact flight is expected to blast off sometime in 1962. Previous to that however, a number of Ranger flights will be aimed to go past the moon and thence into solar orbit.

In the lunar-impact flight, most of the instruments listed will be replaced by a 300-lb, mushroom-shaped, detachable capsule containing a seismometer, impact accelerometer, temperature-measuring equipment and telemetry gear. The



Flight plan for Ranger lunar shot. (a) Vehicle acquires earth and sun after separating from booster. (b) Mid-course guidance. (c) Sun and earth reacquired. (d) Vehicle turns to aim TV camera and seismic capsule at moon. (e) Capsule released and braked by retro-rockets. Ranger is destroyed on impact. Parabolic antenna is aimed at earth at all times except during mid-course guidance and after release of capsule.

Quartz seismometer being designed for later soft landings on moon is checked by Gary Latham, seismologist at the Lamont Geological Observatory. Closeup at right shows delicate construction of the instrument. Small ring in center is the seismic mass. Most of the components on the top deck are fabricated from quartz. Photoelectric pick-up is housed in the barrel.



Ranger spacecraft model illustrates the variety of instrumentation and electronic gear to be carried aloft by the most ambitious space vehicle now in design. A steerable parabolic antenna is planned, as are sun sensors that will orient the vehicle for maximum illumination of solar cells. A moon shot will carry seismometer capsule in place of most of the instruments shown here, but space probes will approximate the model.

actual instrument payload is about 50 pounds. The vehicle will carry a television camera to photograph the moon's surface. A 200-line scan is expected to yield a maximum resolution of about 10 ft. A gamma-ray spectrometer will also be on board to analyze lunar radioactivity.

Lunar Flight Plan

The following sequence is planned in flight:

- After separating from its booster, Ranger is tumbled by gas jets, so that the photocells can acquire the sun and orient the vehicle for maximum illumination of its solar panels. With the vehicle's long axis thus aimed at the sun, Ranger then rotates about that axis until the parabolic antenna is aimed at the earth.
- Some 12 to 17 hours after launching, a radio command reorients the vehicle for mid-course guidance and fires the rocket engine. This maneuver completed, Ranger's photocells reacquire the sun and earth again, as before.
- Forty hours later (about one hour away from impact) another ground command turns the vehicle, so that the camera and payload capsule point at the moon. TV transmission begins.
- A radar altimer in the vehicle commands separation of the capsule at about 100,000 ft above the moon. After separation, the capsule is spin-stabilized by gas jets, decelerated by a retrorocket, and then "despun" before impact by the extension of weights on wires. These maneuvers are programed by a timer within the capsule.

The calculated impact velocity is about 300 miles per hour, and the capsule's crushable

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structure is being designed to absorb a landing impact of 5,000 g's.

Telemetry from the capsule will be continuous at 960 mc with a power of several tens of milliwatts. Battery life will allow for two to three months of operation. The Aeronutronics Div. of Ford Motor Co., Newport Beach, Calif., is making the capsule under a $3.5 million contract.

Seismometer Design Progressing Rapidly

Design of the seismometer is well along. Both the Lamont Geological Observatory of Columbia University and the Seismology Laboratory of the California Institute of Technology have built and tested prototype units. A vertical component instrument having resonant frequency of about 1 cps on the moon is specified.

The Lamont version consists of a hollow, spring-suspended cylinder weighing about 2 lb, which carries a push-pull moving coil winding. Flux is supplied by an Alnico VI magnet within the cylinder, and it acts across a 3/8-in. air gap. The push-pull arrangement was selected to minimize spurious output resulting from side-to-side oscillation of the mass.

Late last month the unit was tested by dropping it (encased in a wood and plastic bomb) onto a concrete runway from a altitude of about 2,000 ft. Except for a cracked magnet, the device survived an impact of well over 5,000 g's. Ferrite magnets have fared better in drop tests and may

Models of Ranger and lunar-impact capsule (not to same scale) are discussed by their respective builders —Clifford I. Cummings (left) program director of the Jet Propulsion Laboratory, and Dr. Donald B. Duncan, general operations manager of space technology operations for the Aeronutronic Div. of Ford Motor Co.

Moon seismometer built by Lamont Geological Observatory disassembled after air drop tests. Magnet (foreground) cracked on impact, but the rest of the device withstood damage. Dark cylinder in center is the seismic mass and carries windings for a push-pull moving coil pickup.

be used in spite of their somewhat lower flux.

The accompanying electronic amplifier is fully transistorized. Its design is based on the 2N43A, which was selected for its combined properties of low noise, reliability and stability. Circuitry is push-pull throughout to reduce electrical noise further. The two windings of the moving coil pickup have an input impedance of 1,000 ohms each—again selected for lowest noise. The amplifier pass band is from 1/20 cps to 3 cps.

The Cal Tech seismometer is similar in concept to the Lamont instrument, but it employs a variable reluctance type pickup and an Alnico V magnet.

It is expected that "soft" landings on the moon will follow the initial attempt. Later flights will probably carry three seismometers and employ displacement-sensitive pickups—photoelectric or capacitative.

Miniature Seismometer Built of Quartz

One unusual approach is a quartz seismometer in development at Lamont. This instrument uses a seismic mass of only 30 grams and will have a resonant frequency of up to 1/15 cps on the moon. The instrument is built around a Lacoste-type zero-length spring suspension. The entire suspension, including springs, is fabricated of quartz to minimize inaccuracies resulting from the wide range of lunar temperatures. The instrument is so fragile that it will have to be frozen into a block of dry ice or other gas to protect it during even a comparatively soft landing. The ice will then be evaporated to free the mechanism. However, the propensity of quartz to absorb gases must be overcome for this scheme to succeed.

The quartz seismometer employs a photoelectric pickup in which an opaque vane is driven across the surface of a photocell in response to seismic disturbances. Light will probably be generated by nuclear-powered luminescent sources. The instrument also has magnetic damping. ■ ■

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Adaptive Space System

AN ADAPTIVE space guidance system, to achieve an orderly redundant system based on performance rather than predictions made by designers prior to actual space flight, was described at a session of the National Specialists Meeting on Guidance of Aerospace Vehicles in Boston.

Many of the toughest down-to-earth problems of getting into space were aired during the three-day conference, sponsored by the Institute of the Aeronautical Sciences. Solid critical discussion from the floor after many of the presentations indicated the magnitude of difficulties remaining before various planned lunar and interplanetary flights are possible.

Achieving adequate reliability in a two-year round-trip to a planet is one of the toughest problem areas, according to W. F. O'Neil, stability and control engineer, Douglas Aircraft Co., El Segundo, Calif.

Without redundancy he estimated that a simple system, containing about 20,000 lumped constant components each having reliability of about 1 failure per million operating hours, would have a mean time between failures of about 60 hours.

Even with redundant systems, each having an expected life much shorter than the trip time, it is unlikely that the mission could be accomplished without all systems failing.

Majority Circuits Reject Failures

To meet this problem Mr. O'Neil and co-author M. J. Abzug, stability and control group leader for the Douglas El Segundo Div., recommend an adaptive approach to redundancy.

In the proposed design each redundant system would be split into small sub-units, each containing perhaps ten components. Majority circuits are used to reject outputs of sub-units which fail.

Two major considerations of such a system are the reliability of the majority circuits and the minimizing of search time to eliminate faulty units.

A system combining some of the principles of the Random Adaptive Fault Locator described by W. R. Ashby in "Design For a Brain," (John Wiley and Sons, Inc., New York, 1952) and the Perceptron developed at Cornell Aeronautical Laboratory, Buffalo, N. Y., might meet these demands, Mr. O'Neil said.

Reliable majority circuits might be achieved by using time-shared redundant switching cir-

Described at IAS Meeting

cuits, using methods developed by Shannon to achieve the reliability level required.

Search time to locate faults might be minimized by successively subdividing the groups of sub-units into two parts, one containing the part which failed. The subdivision would be accomplished by equalizing the aggregate probabilities of failure within each of the two subgroups.

At the beginning of a space trip the system designer would assign probabilities of failure to each sub-unit. As a part fails during the trip this distribution of probabilities would be shifted by increasing the failure probability for that type of sub-unit while decreasing all other probabilities in such a manner as to keep a constant total probability.

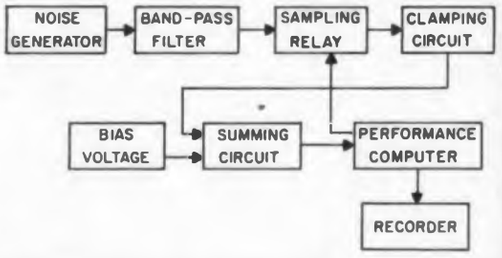
A multistage adaptive random parameter selector operating on this form of logic might be used to accomplish this goal.

Random Parameter Selector Built

An analog computer set-up was used by the Douglas researchers to illustrate the mechanization of a random parameter selector and to test their solution time probability predictions.

The output of the clamping circuit in the diagram represents a selected parameter. This output is summed with an operator-introduced bias voltage representing the external environment. The performance computer, which controls the sampling relay, consists of a relay with a controlled firing voltage.

If the summed voltages do not exceed the firing voltage, the parameter is acceptable and the



Random parameter selector model used by Douglas researchers to illustrate mechanization and to test prediction of solution time probabilities for various bias voltages. If the sum of the clamping circuit output, representing parameters, and the operator-introduced bias voltage do not exceed a set value, the parameter is accepted. If the voltage level is exceeded, the sampling relay is triggered and a new parameter is selected.

NEWS

relay does not fire. If the firing voltage is exceeded, however, the relay is triggered and a new parameter is called for by the sampling relay. This sampling process continues until an acceptable parameter is selected.

Initial tests of the selector indicate some discrepancy between predicted and actual numbers of trials on lower probability points, which is believed to be due to the limitations of the present computer set-up.

Satellite TV-Attitude Control System

A possible attitude control system for satellites using three TV cameras was described by P. A. Button, P. E. Mallory, and S. B. Boor of Radiation, Inc., Orlando, Fla. The system is based on the principle that the velocity of a TV camera moving parallel to the surface of the earth divided by the altitude of the camera, is equal to the velocity of the earth's image over the TV tube's photosensitive area divided by the focal length.

Area-correlation between stored and present TV images in a three-axis system—for roll, pitch and yaw—could be used to establish an accurate local vertical, according to the authors.

Control of the attitude of a space vehicle by means of an electrically suspended free reaction sphere was a possibility suggested by Ralph D. Ormsby, head, technical planning, Bendix Systems Div., Ann Arbor, Mich.

Tests of magnetic and air bearing suspension at Bendix have indicated that the electrical system is best, according to Mr. Ormsby, primarily because it is the only suspension method which does not generate retarding torques.

Mr. Ormsby said that Bendix has developed a unique low-power circuit which can generate electrical suspension forces large enough to operate in a satellite. He said that preliminary estimates of power requirements indicate that 5 w will suspend an 8-in. diam., 20-lb steel reaction sphere in a 0.01-g environment.

Midas II Malfunction Fails To Shake AF Confidence

Despite failure of the infrared-scanner telemetry link in the orbiting Midas II, the Air Force is confident that the satellite's instruments can distinguish between the fiery plumes of missiles and other heat sources on earth.

Midas II, designed as a forerunner of a chain of IR satellites that would detect enemy missile launchings anywhere in the world, was hurled

into space May 24 from Cape Canaveral, Fla.

Air Force sources indicate that the satellite's instruments might distinguish between missile and earthbound heat sources by taking advantage of the atmospheric absorption of radiation from incandescent CO_2 and water vapor in a missile exhaust.

When the missile is on the ground, almost all of this radiation is absorbed. As it rises to the upper fringes of the atmosphere, however, attenuation drops sharply and almost all radiation in the spectral bands being monitored can be received by the satellite's IR sensors.

Since peak radiation for very hot sources is centered on the near infrared region, about 1-3 microns, this seems the most likely choice for spotting a missile launching. An absorption band for both CO_2 and water vapor exists at about 2.6 to 2.9 microns, (*ED*, June 24, 1959, p 30), so that a detector sensitive at these wavelengths might be used.

Tests on Flares and Missiles Thwarted

Air Force plans to test the ability of Midas II to distinguish between ground flares at Edwards and Vandenberg Air Force Bases in California and actual missile shots were thwarted by the telemetry failure.

The satellite was orbited at about 300 miles. It was turned so that the nose pointed toward the ground when it reached orbit.

An initial Midas attempt failed when the satellite failed to orbit (*ED*, March 16, p. 4).

Radio Study Goes Underground

Deep in a mine shaft in the Mojave Desert, this experimental transmitting station is helping Space Electronics Corp., Glendale, Calif., study underground radio communication.

WASHINGTON REPORT

Ephraim Kahn

INEFFICIENCY AND WASTE in managing the military's electronics supplies has been charged by the General Accounting Office. This has resulted in "significant additional costs to the government," and the Defense Department is now making a study of the problem. It is scheduled to be completed in November. The GAO clearly would prefer a single-manager system for electronics instead of the "six independent organizations performing the same or similar stock management functions" that it finds today.

NEED FOR SCIENTIFIC PERSONNEL to work in the Air Research and Development Command is being assessed for the next 10 years. To the extent that it is thought necessary to make changes so as to make it easier to attract and keep competent scientists and engineers, the organization's personnel policies will be modified.

DEFENSE PRODUCTION ACT is being extended without change until June 30, 1962. The law gives basic authority for assigning materials priorities. It permits defense contractors to exchange technical information without running afoul of the antitrust laws. Provision is also made for government loans (and loan guaranties) to firms working on defense projects.

"OBJECTIVELY DETERMINED CRITERIA" for reliability will be incorporated into the Bureau of Naval Weapons' specifications for missiles and components. Proposals will be as specific as possible; reliability requirements will be "expressed in mean-time-between-failures or in other appropriate dimensions." In setting reliability standards—which are conceived of as an "inherent element" of production and engineering—demands will be expressed in a number of ways: (1) In quantitative terms, where objective determination and documentation are possible; (2) through reliability prediction techniques, with later confirmation by actual test; (3) by quantitative demonstration of attained reliability. The Navy will offer help to qualified firms in achieving desired reliability levels. Needless to say, reliability requirements will far exceed those of normal production.

LEVY OF LOCAL TAXES on government-owned production equipment would be permitted under a bill introduced by Rep. Chet Holifield (D, Calif.), chairman of the House Military Operations Subcommittee. Odds are against passage of the measure this year. It would cancel the local tax exemption (recently affirmed by the Supreme Court) that is given

to "industrial or commercial real property or equipment owned by the United States, but in the possession of private persons and being used in connection with businesses operated for a profit."

ELECTRONICS RESEARCH will continue to be shared by private firms and government facilities in just about the same proportion as today. The Director of Defense Research and Engineering, Dr. Herbert F. York, is having a survey made of government-owned research facilities. Limitations on personnel are likely to preclude any significant expansion of electronics research by the Defense Department itself. In fact, there is a feeling that the government's electronics manpower is spread rather thinly over a broad area. An upswing in electronics research projects probably would lead to additional contracts with private firms.

LESS VULNERABILITY TO INTERFERENCE is required by the Navy for its electronics systems. Chief of Naval Operations Admiral Arleigh Burke wants electronics systems that are both less susceptible to electronic countermeasures and to interference from other devices used by the Navy. As time goes on, the Navy will try to write into its electronics specifications increasingly tough requirements for resistance to interference.

POSSIBLE PATENT INFRINGEMENTS apparently will not impede the government when it wants to buy from foreign firms. The Comptroller General has ruled, following a protest from a U.S. firm, that as long as the price rules of the Buy American Act are observed, the low competitive bidder should be given the contract "regardless of a possible infringement claim." The government operates under a 1910 law which enables it to "obtain or use patented articles from any source by payment of reasonable compensation to the patentee." Furthermore, when the government weighs bids, it is not allowed to take into consideration the possible costs of litigating an infringement (or other) suit. Court action against the government "is the sole and exclusive remedy allowed" to the firm or person whose patent may have been infringed by another supplier.

PROGRESS PAYMENTS PROBLEMS apparently have been solved amicably. The Senate, after hearing Finance Committee Chairman Harry F. Byrd (D, Va.) object strenuously to the so-called 80-20 plan, voted to outlaw it. The House did not. When efforts were being made to iron out differences between the Senate and House versions, Secretary Gates intervened. He sent a memo noting that a sudden move like this would put a great administrative burden on the Pentagon. It was also made clear that the problem could be solved without new legislation at this time. The Congressmen, heeding Secretary Gates, deleted this proposed new provision. But they warned the military that this is an appropriate subject for lawmaking, and urged that "strict surveillance" be maintained over the high-cost self-financing of military contracts to which Sen. Byrd had taken exception.

NEWS

Doppler Radar Guiding Executive Aircraft

Doppler radar, with associated computers, is being used to guide executive aircraft.

Installation in two executive Grumman Gulfstreams of the RADAN 500 and TNC-50 track navigation computer was performed by PacAero Engineering Corp. of Santa Monica, Calif.

The RADAN navigation system, coupled to the flight director and the autopilot, provides both a pictorial display and automatic steering of the aircraft to a desired track. The Gulfstream aircraft have reportedly operated successfully with RADAN in transcontinental flights, both on autopilot and with direct control of the plans.

With the RADAN 500, aircraft can operate in poor weather conditions and along flight paths where there are no established airways. Another advantage is that pilots supplied with continuous ground-speed readings can more easily adjust to wind conditions.

CHANGES IN PRICES AND AVAILABILITY

DIFFUSED SILICON MESA TRANSISTOR, 2N706, has been reduced $9 in price by Fairchild Semiconductor Corp. of Mountain View, Calif. The price cut represents a drop from $24 to $15 in the 1-99 lots and from $16 to $10 in the 100-999 lots.

STORAGE TUBE, the Permachon, has been cut in price from $900 to $600 by the Westinghouse Electric Corp. of Youngswood, Pa.

GERMANIUM TUNNEL DIODES have been reduced in price by Philco Corp.'s Lansdale Div. Tunnel diodes introduced last March originally priced at $10 each, now cost $5 each. Unit price of a new series is also $5.

COUNTER TUBES used in timers, scaling devices, tabulating machines, nuclear and radar measuring equipment, and other advanced electronic equipment are under a new pricing structure at Sylvania Electric Products Inc., Williamsport, Pa. As an example, high-speed (100 kc) types have been reduced 23 to 34 per cent. Under the new structure, counter tubes can be obtained in quantities of 1 through 24 at original equipment prices with a full six-month guarantee.

CIRCLE 940 ON CAREER INQUIRY FORM, PAGE 221

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ME	☐	☐	☐	_____	Other_____	☐	☐	☐	_____
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- ☐ MICROWAVE AND ANTENNA DEVELOPMENT
- ☐ FLIGHT ANALYSIS
- ☐ INSTRUMENTATION
- ☐ RADAR SYSTEMS
- ☐ PUBLICATIONS ENGINEERING
- ☐ SYSTEMS TEST
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- ☐ MICRO & MOLECTRONICS
- ☐ SOLID STATE CIRCUIT DESIGN
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- ☐ SOLID STATE PHYSICS
- ☐ MAGNETICS
- ☐ OPTICS
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QUOTES IN THE NEWS

On the electronics industry:

"The electronic industry will pass the $10-billion mark in sales this year, making it the fifth largest manufacturing industry in the U.S. It is already pressing the aircraft industry in dollar volume and total employment . . . By 1965 we will rank right behind the automobile and steel industries . . . The air frame and electronic industries will become almost entirely integrated in the present decade . . . Unlike the automobile, steel and aircraft industries, however, electronics is an industry of small business establishments. While we have several giant corporations in our industry, actually it is made up of more than 4,000 small manufacturing companies, 60 per cent of which employ less than 100 people and 85 per cent of which employ less than 500 people."—*Harvey Riggs, president of International Electronic Research Corp. of Burbank, Calif.*

On Microminiaturization

"It is impossible at this time to predict with certainty which of the many approaches to miniaturization holds the most promise, but it seems quite certain that electronic systems to be built for years to come will incorporate components as we know them today, as well as all of the other techniques which have been or will be developed, in that combination which achieves the best balance between cost, reliability of operation and availability in mass production. It follows that I do not look for any revolutions in the electronics industry."—*Robert C. Sprague, Chairman of the Board and Treasurer of Sprague Electric Co., in an address which was given at a meeting of the National Federation of Financial Analysts Societies.*

On engineering education:

"Engineering faculties of our colleges and universities must not build for tomorrow, but must plan their curricula to prepare the student for the day after tomorrow . . . Scientists and engineers nowadays work side by side more than they did in the past and in some areas the old roles have been interchanged. The activities of the engineer now lead the activities of the scientist. This is particularly true in the space program."—*Dr. John P. Hagen, National Aeronautics and Space Administration, at an Industry Open House at Newark College of Engineering.*

◀ CIRCLE 940 ON CAREER INQUIRY FORM, PAGE 221

NEWS

Magnetic Recording Industry Defines Its Stereo Terms

The Magnetic Recording Industry Association has adopted standards for the terms "track" and "channel." The terms are now defined as:

Channel—A single complete electronic transmission path for sound; it must include one or more separate microphones, an amplifier and one or more loudspeakers.

Track—A path which contains reproducible information left on a medium by recording means energized from a single channel.

The action by the association grew out of the confusion caused by advertising describing "three-channel stereo." The new descriptions are expected to eliminate or correct misleading advertising practices.

Space Belt Records Body Data

Laboratory spacemen at the Boeing Space Medicine Section in Seattle are wearing instrument-laden belts during physiological experiments. The instruments shown include an electrocardiograph, phonocardiograph, respirometer, and electro-encephalograph. Designed primarily for laboratory work, the instruments are said to give results equal to those of standard-size equipment. They are packaged to operate from —40 to +110 F, with static acceleration up to 1 g and vibration up to 5 g and 500 cps.

Television Tape Recorder Developed for Mobile Use

A television tape recorder that occupies only 11 sq ft of floor space and weighs about 500 lb has been developed for mobile installations or studios where space is limited.

The recorder uses a modulator-demodulator unit with built-in crystals that preset carrier frequency and deviation. The developer, Ampex Corp. of Redwood City, Calif., also said the device has increased circuit stability and is immune from noise and tape drop-outs. The machine is said to show a 6-db improvement in signal-to-noise ratio over previous models.

Called model 1001-A, the recorder is a smaller version of a console model produced by Ampex. Both machines can be equipped with the Inter-Sync television signal synchronizer (*ED*, March 30, 1960), which replaces the recorder's drum servo and capstan signal generator and reportedly can mix pretaped sequences onto one composite tape without splicing.

Several recorders can be locked with the synchronizer, making possible electronic editing of television tape.

The rack mounting chassis uses the same connectors as the replaced parts. Once it is plugged in, only a few wire changes are necessary to put the recorder back in operation.

The company expects the Inter-Sync device to be included in the standard monochrome 1001-A recorder. This model will be priced at $48,400. Production is now under way with earliest availability estimated in July.

Electronic "Bridge" Checks 3,600 Circuits in New Jets

A steel bridge on wheels is used in production testing of the electronic and electrical systems in the F-105D jet fighter. The bridge is said to permit checking out 3,600 circuits in one-fourth the usual time.

Designed by Republic Aviation Corp.'s Manufacturing Engineering Div., the bridge is about two stories high, 15 ft wide, and 64 ft long.

It is rolled into position to span the fuselage at the final assembly area. The testing harnesses, which have more than 170 miles of wiring, are lowered from the overhang and connected to the system being checked out. Readings are then fed into a battery of automatic circuit analyzers built into the front section of the bridge.

The F-105D is an all-weather fighter-bomber employing 43 electrical systems and 18 electronic systems.

NEWS

Stacked, Sealed Used in Sylvania

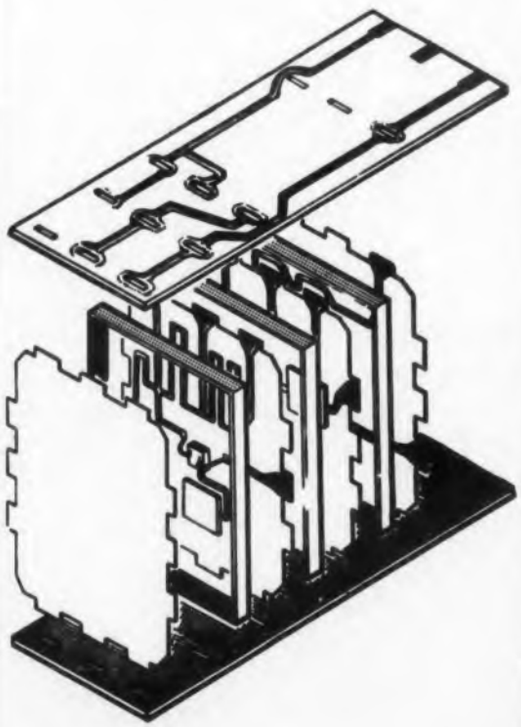
NEW stacked-wafer micromodule techniques have been developed by Sylvania Electric Products Co., Inc., under an independent research program.

Multi-component, hermetically sealed wafers are stacked one on top of the other and interconnected by printed circuit wafers. Each wafer, measuring less than one-half in. sq and about 10 mils thick, is capable of carrying a stage of circuitry.

Spacers used to separate stages are fused to the circuit wafers to provide sealing. Glass spacers are used, and wafers are about 96 per cent alumina ceramic.

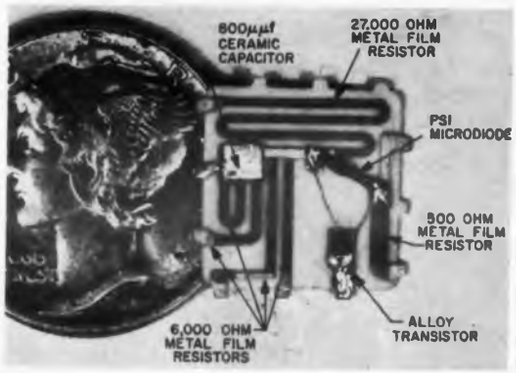
Individual modules are connected by a printed interwiring board, so that wires are not required.

A low frequency radio transmitter is being built to illustrate the potential of the concept for usable equipment. Special transistors have been



Interconnection techniques used in the Sylvania microminiature module circuits substitute silk-screened interwiring boards for wires. Each wafer, carrying a stage of circuitry, is fused to a spacer element providing a hermetic seal.

Wafer Stages Microcircuits



Many components can be placed on one wafer in the Sylvania microminiature module approach. Each ceramic wafer is a little less than one-half-in. square and about 1/100-in. thick.

produced for the transmitter, and inductance will be provided by wound toroidal cores.

The technique can be easily adapted to automated production, according to Sylvania. Present microcomponents and film deposited components can be used with the wafers, and future molecular electronic developments might also be adapted to the concept. ■ ■

Fall Instrument Conference Schedules Diversified Program

Arrangements are being completed for the Fall Instrument-Automation Conference and Exhibit of the Instrument Society of America, which will be held in New York City the week of Sept. 26-30.

Theme of the conference and exhibit will be "Progress Through Instrumentation." Papers and discussions at the conference sessions will cover subjects concerned with instrumentation in aeronautics, meteorology, the nuclear and underwater areas, and a complete range of industrial equipment.

A number of the exhibits will be those of the armed forces. These will feature various applications of instrumentation in the nation's defense program. The National Aeronautics and Space Administration is also preparing exhibits that deal with space exploration and satellites.

NEWS

Shipments of Components Hit All-Time High in 1959

More electronic components were shipped in 1959 than in any other year, according to the Electronic Div. of the Business and Defense Services Administration, Dept. of Commerce.

Also in 1959, the value of shipments of semiconductor components exceeded that of tubes for the first time, the BDSA said. Total output of components in 1959 was more than 30 per cent greater than 1958 output, partly as a result of a second-half rise of 12 per cent over output of the first half of 1959.

Component Shipments, Second-Half 1959, Estimated Quantity and Value

	Quantity (in thousands)	Value (in millions)
Power and Special Purpose Electron Tubes	5,591 222,249	127.3
Receiving Tubes		186.1
Television Picture Tubes	6,995	129.3
Semiconductor Devices	118,935	217.8
Capacitors	664,605	122.9
Complex Components[1]	18,342	5.9
Connectors	42,832	76.0
Quartz Crystals	2,480	7.0
Relays	11,808	83.6
Resistors	1,122,026	121.8
Transformers and Reactors	13,036	74.6

[1] Includes "Packaged Electronic Circuits," Packaged Assembly Circuits," "Couplates," printed circuit component wiring assemblies, etc.

The BDSA report was compiled from data covering about two thirds of the electronics industry.

The figures represent estimated total industry shipments rather than total shipments. Source of the basic figures was the semi-annual Joint Survey of Production Capabilities for Electronic Parts conducted by the Electronics Production Resources Agency of the Dept. of Defense and the Electronics Div., BDSA.

New EIA Committee to Link Makers of Computers, Components

A new group has been formed to tell components manufacturers what the manufacturers of computer systems want from them.

The group, called the Microminiature Electronic Components Subcommittee, will work within the organization of the Electronic Industries Association. For the present, components in modular form have been excluded from the group's consideration.

The subcommittee will make recommendations in these three areas of component design:

- The shape of components and the placement of leads to facilitate assembly of systems.
- Standards for components, particularly standards of endurance to environmental conditions.
- The transportation and handling of components.

The subcommittee is part of the Computer Requirements Committee of EIA's Industrial Electronics Panel.

More Radios Now Than Ever, Broadcasters' Report Says

Radio has experienced a phenomenal growth in the past decade, according to a special report by the National Association of Broadcasters. The report cities these figures:

- More than 155 million radio sets are now in use in the U.S. In 1950 this figure was 85 million.
- Over 15 million radio sets of all types were made in the U.S. last year, a 5 million increase over 1950's figure.

The use of transistors has played a large part in radio's swelling production, the report said. About 95 per cent of the portable radios produced last year were transistor radios—and portable radios accounted for 41 per cent of last year's total production.

A significant measure of radio's growth is the constantly increasing number of radio stations, NAB said. The report puts the number of am and fm stations on the air at 4,035, an increase of 228 in the past year. In the last decade, radio stations on the air have increased by almost 2,000. The growth of fm is a particularly bright part of this picture, according to NAB. In 1956, fm had 557 outlets; by the end of 1959, the authorized total had risen to 840. The number of grants in 1959 is said to have established a 10-year record, with fm station fall-outs also hitting a 10-year low.

Construction permits issued for am stations amounted to 101 in 1959. Applications were filed in 1959 for 675 additional am and fm stations.

NEWS

Race for 'Ultimate' Still Deadlocked,

NO outstanding "ultimate" in the way of a complete power system exists for present and near-future space vehicles, Dr. J. H. Fisher of Electro-Optical Systems, Inc., Pasadena, Calif., said at the Fourteenth Annual Power Sources Conference. When such important factors as reliability, cost, availability, over-all weight, hazard problems and growth potential are weighed, it becomes surprisingly evident that obvious advantages of one system are offset by attributes inherent with other schemes in the 5- to 30-kw range.

Photovoltaic cells with nickel-cadium batteries as storage devices, nuclear energy power sources requiring no storage aids, plus latest thermionic and thermo-electric arrangements were included in the evaluation.

300-W SNAP X Project Described

The nuclear-powered thermoelectric converter and reactor program, SNAP X, was described by Maj. George W. Ogburn of the U. S. Atomic Energy Commission. Designed for satellite operation, the 18-in. high, 32-in. diam assembly will deliver 300 w during periods ranging from 138 days (half-life for PO-210) or as long as 90 years (half-life for PU-238) depending on the reactor fuel selected. The total system weight is in the order of 300 lb with an additional 300-400 lb required for shielding to protect transistorized electronic equipment housed in the satellite. The temperature range of the thermoelectric elements will vary from $T_H = 1150$ F to $T_c = 800$ F. Cooling will be accomplished by conduction and radiation; no circulating water will be used.

Solar Cells Approach 15 Per Cent Efficiency

Silicon solar cells have been constructed in the laboratory with efficiencies in the order of 15 per cent, reported Dr. G. Rudenberg of Transitron Electronic Corp., Wakefield, Mass. He admitted that full-scale production was not to be expected in the near future. However, as pointed out by M. B. Prince of Hoffman Electronic Corp., 12 to 14 per cent efficiency is not uncommon in large area, production model cells.

Considerable effort has been placed on achieving similar results with gallium arsenide photovoltaic cells. Within the relatively short research time devoted to this study (compared to the time spent on silicon devices), efficiencies approaching 7 to 8 per cent have been realized, declared Paul Rappaport of RCA.

Power Source Expert Claims

Various types of fuel cell batteries were described including liquid cells, ion exchange and regenerative ion exchange schemes. However, the 1,200 engineers assembled in Atlantic City May 17-19 were cautioned that, while strides have been accomplished within the past year, additional efforts are still necessary before full-scale military and industry acceptance will be achieved.

Other Gains Revealed

Also revealed at the Signal Corps-sponsored Conference were gains attained in watt-hour capacity, low-temperature operation and recycling life for sealed secondary batteries. Longer storage life and low-temperature capabilities of primary cells were likewise announced.

The Proceedings of the Conference are scheduled for publication in October and can be ordered from the Power Sources Conference Committee, P.O. Box 891, Red Bank, N.J. The price of the Proceedings is $5.00. ■ ■

Gallium Phosphide Ingot

Scientists at Bell Telephone Laboratories, New York, inspect an ingot of gallium phosphide. Bell is developing methods of growing single crystals of a transparent semiconductor, gallium phosphide, and studying its properties. These studies will help in the basic understanding of high-energy-gap semiconductors. The material is transparent, making it possible to observe visually the differences which take place under varying conditions of doping and electron density.

Zinc-Oxide Fuel Cell Seen As Truck, Auto Power Source

A prototype fuel cell using zinc as the fuel and compressed oxygen as the oxidizer has been developed by the Electric Storage Battery Co., Exide Industrial Div., Philadelphia.

In the cell, zinc is oxidized in a potassium hydroxide electrolyte as oxygen is admitted under low pressure. The company predicts that such a cell will be able to keep an electric industrial truck going continuously in heavy-duty service for 16 to 24 hours before recharging is necessary.

The cell can be recharged electrically to restore its full power potential. This is said to eliminate any need to remove waste products, described as a serious problem in the practical development of other types of fuel cells.

To save time spent in recharging, another design can be used in which the zinc electrode can be removed and charged outside the cell, or replaced altogether. At this early stage of development, the company believes its zinc-oxygen cell will cost less to own and operate in industrial material-handling equipment than gas or propane power units. It is also thought that within a few years practical cells, capable of being mass produced, can be developed.

A prototype zinc-oxygen fuel cell is the power source for this racer. Tank in rear contains oxygen which is admitted under low pressure into the cell where power is produced by oxydizing zinc fuel in potassium hydroxide electrolyte. The cell will be developed first for electric industrial trucks. After testing, it might be adaptable to automobiles and trucks.

Emergency Highway Call System Uses Solar-Powered Batteries

An emergency highway calling system designed to aid stranded motorists has as its basic unit a 1-w solar-powered transmitter.

The transmitter, called the safety satellite, is

The solar-powered safety satellite transmitter for a highway emergency calling system is demonstrated by H. Leslie Hoffman, president of Hoffman Electronics Corp. By pressing any of four buttons—for police, ambulance, fire truck or service truck—a motorist can transmit a coded radio message summoning help.

housed in a 1-cu-ft metal box that can be mounted on a roadside pole. It draws its power from nickel cadmium batteries that are recharged by five silicon solar cells mounted on a 20-ft antenna. The battery pack powers 150 transmissions without recharging, according to the system's developer, Hoffman Electronics Corp. of Los Angeles.

To operate the transmitter, a motorist presses one of four buttons on the transmitter panel depending on the type of service he requires. There are buttons for fire, ambulance, police and service truck.

The message is transmitted by code in 1-1/2 sec, and the transmitting unit is then automatically turned off. The call can then be repeated or a new call for a different service can be made, it is said. The coded message is picked up at a central point by an fm receiver which feeds into a solid-state digital decoder. The receiver is said to display the message visually, pinpointing the location of the stranded motorist and indicating the service he requires. A printed record of the message is also provided.

According to the company, one receiver can monitor as many as 1,000 transmitters.

COMPUTER BRIEFS

COMPUTER TECHNOLOGY faces five big problems, according to C. C. Lasher, general manager of GE's Computer Dept. These are: understanding and development of applications, development of easier programing methods, standardization of both hardware and computer languages, and money for future basic research and development.

NEWS

Gravity Gradient Planned for

GRAVITY gradient meters appear to be gaining importance in the eyes of space-flight planners.

Several firms have started projects in this field, either under contract or as independent research programs. Instruments being developed will measure the differing gravitational forces at differing distances from the center of a gravity field.

Applications being considered for these instruments include:

- Continuous servo-positioning of a platform with respect to an elliptical orbit. This might be useful for properly orienting cameras or other sensors toward the earth or other body.
- Continuous determination of a local vertical so that the satellite itself might be oriented with respect to its orbit.
- Determination of various orbital parameters around a body other than the earth, where ground tracking is not available.
- Investigation of gravitational fields about bodies other than the earth to gain data valuable in aiming of later shots toward that body. A combination of radar measurements to the surface of the body would probably be combined with gravity gradient measurements in this case.

Uses Accelerometers, Not Gyros

Since difference accelerometers rather than gyro-type components are used with gravity gradient systems, the disadvantages of gyros would be eliminated. These include the cumulative errors caused by drift, the necessity for continuous op-

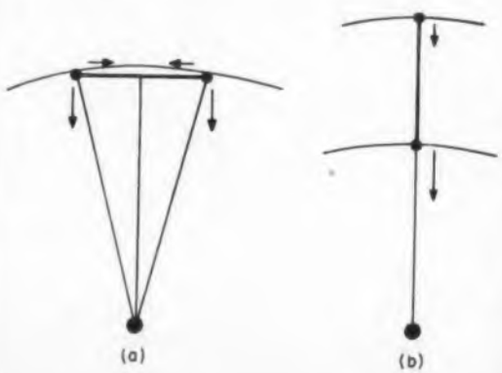


Fig. 1. (a) Two masses separated by a weightless rod are attracted toward the center of a gravitational field as shown, causing tension to be exerted on the rod. (b) When the masses are aligned radially toward the center of a gravitational field, there is a greater accelerating force exerted on the closest than on the farther mass, resulting in a stretching force on the rod.

Meters Space Flight

eration, and difficult calibration problems.

The use of gravity gradient systems, however, introduces new problems. Efforts of several companies are being directed at solving these problems because of the promise for these systems.

Among companies working in the field are Radio Corp. of America; Bell Aircraft Co.; North American Aviation, Inc.; Douglas Aircraft Co.; Martin Co.; American Bosch Arma Corp., Arma Div.; and Systems Corp. of America.

The principle of the gravity gradient meter is illustrated in Fig. 1. Two inertial masses are separated by what is assumed to be a weightless rod. When the rod is aligned perpendicular to gravitational equipotential surfaces, Fig. 1b, the accelerometer which is closest to the center of the field encounters a stronger gravitational attractive force than the farther accelerometer. This results in a force tending to stretch the rod.

When the rod is aligned perpendicular to the radial direction to the center of the gravitational field, Fig. 1a, the components of the force on the two masses combine to produce a tension in the rod.

The actual difference accelerometers being developed to produce these effects, and the instruments under development to sense the compression and tension forces, are classified.

Need High-Sensitivity Instruments

Instruments must be sensitive enough to sense gravity gradients of about 10^{-10} g/ft at 36,000

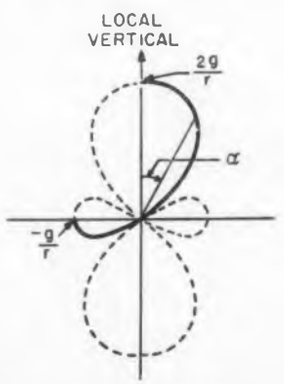


Fig. 2. Approximate plot of magnitude of the gravity gradient as a sensing instrument like the one in Fig. 1 is rotated about its center of gravity. Dark line represents rotation of the meter through the first quadrant. Horizontal components of the gravity gradient, due to curvature of equipotential surfaces result in the negative values as α approaches 90 deg.

miles from the earth. The gravity gradient at the surface of the earth is about 10^{-7} g/ft.

Instruments under development should be capable of achieving this sensitivity at accelerometer separations small enough to be useful with present satellite dimensions, according to Dr. Paul H. Savet, technical staff assistant to the chief engineer, Arma Div., American Bosch Arma Corp., Garden City, L.I., N.Y.

A representation of the magnitude of the gravity gradient as an instrument is rotated about its center of gravity is illustrated in Fig. 2. If the gravity difference between the two accelerometers is designated G, then: $G = (2g/r)\cos^2\alpha - (g/r)\sin^2\alpha + (d\theta/dt)^2$.

The θ term is used to compensate for a centrifugal force caused by the continuous positioning of the satellite so that its face is always toward the earth.

The magnitude does not remain in the first quadrant as the instrument is rotated through the first quadrant (dark line) because of a component of the gravitational force due to the curvature of equipotential surfaces. (See Fig. 1a.)

In most applications a three-axis system would be used, and some form of computation will be needed. A computer might be designed for use in the satellite, or data might be telemetered back to the earth for data reduction. ■ ■

RCA Computer Study Under Way For Army's Project PRESS

A computer study in connection with Project PRESS is under way by the Radio Corporation of America, Moorestown, N.J. Project PRESS is an experimental program to determine the efficiency of radar in the detection and identification of ballistic missile warheads.

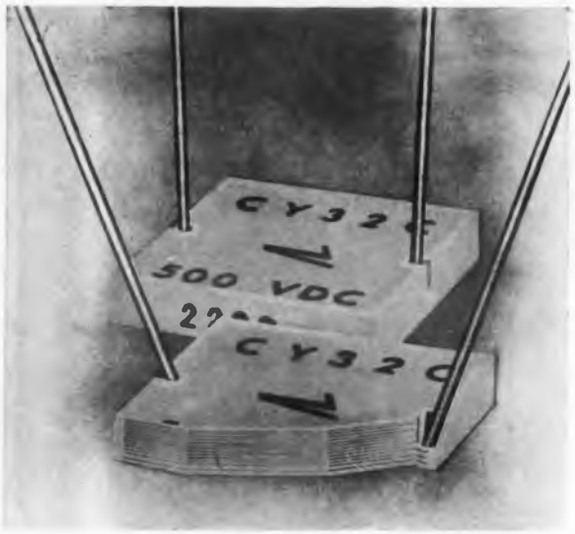
PRESS is the Pacific Range Electromagnetic Signature Study Facility. A project of the Advanced Research Projects Agency of the Department of Defense, it is under the supervision of the Army Rocket and Guided Missile Agency.

The primary objective of the computer study effort is design specification of a data-handling and computer complex which will assimilate and process all data acquired on PRESS.

Contractor officials said the $115,885 study contract may lead to a design which could yield positive identification of warheads early in their trajectories.

RCA is already at work on Target Resolution and Discrimination Experiments (TRADEX), also a part of PRESS. TRADEX, a long-range tracking radar, will yield a new order of data about the behavior of ICBM's.

...in any environment, silicones protect



Fluid Short-Stop Deflects Moisture

Employed in many airborne guidance, tracking, computing, and telemetering units, "Vitramon" Capacitors are porcelain-bodied to resist adverse conditions such as heat and humidity. But Vitramon engineers realized that only a small amount of condensation on the porcelain could cause leakage paths and lead-to-lead shorts. They solved the problem by dipping each capacitor in Dow Corning silicone fluid. The micro-thin coating is moisture-repellent . . . durable. The silicone surface "beads" water, preventing condensed moisture from forming a conductive film.

CIRCLE 801 ON READER-SERVICE CARD

This Resin Is As Good As Its Bond

The Osborne Electronic Corporation makes, among other things, specialty transformers for airborne electronic systems. Look hard and you'll see an Osborne unit in the Jupiter Ground Support Equipment control box on the facing page. At the center of each Osborne transformer is a coil bobbin which must have maximum mechanical and electrical strength in minimum thickness to allow maximum copper content in the core window area. Normal tolerance is ±.015. In addition, they must withstand temperatures from —65 C to over 200 C, be free of voids or pinholes. Osborne engineers have found the most economical way of producing top quality silicone-glass laminate coil bobbins of special sizes and shapes for their custom transformers is by winding glass tape on a mandrel, then saturating it with Dow Corning solventless resin applied by paint brush. Dow Corning resin cures with heat; no pressure needed. It provides the high physical strength to resist heavy wire winding pressure.

Silastic® Insulates Beyond The Call

This giant Klystron focusing coil, a product of Varian Associates, is destined for a vital role in space-age electronics. Designed for 5000 hours minimum life, it operates at 1650 watts input and is cooled by liquid heat-exchange. *Inlet* coolant temperature is 125° C!

Where does Silastic, the Dow Corning silicone rubber, fit in? It's over, under, and around every layer of the coil. A paste form of Silastic is coated on each successive winding and over the copper cooling coils as well. Dielectric strength, resiliency, and resistance to heat and moisture are essential. The coil must withstand water immersion tests, vibration tests, a shock test of 10 G's for 15 cycles of 11 micro-seconds each, and environmental testing which includes severe thermal cycling.

CIRCLE 803 ON READER-SERVICE CARD

CIRCLE 802 ON READER-SERVICE CARD

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CIRCLE 800, 801, 802, 803 ON READER-SERVICE CARD

Maker Claims Univac III Can Handle "3 R's" at Once

The solid-state Univac III, because of its ability to handle 27-bit words, will meet up to 85 per cent of business data-processing requirements, according to its developer, Remington Rand of New York City.

Reading, writing, and computing are said to be carried on simultaneously, with reading and writing rates put at 200,000 digits per sec. The capacity of the system's magnetic-core memories is given as 16,384 words; the system can be expanded to double this figure, the company says. Univac III will work with both punched cards and magnetic tape.

Rental fees for the system are expected to range from $15,000 to $30,000 per month, depending upon specific user requirements. Orders are now being taken for delivery in the fall of 1961.

Major Computer Center Established in Minneapolis

A computing center has been established at Control Data Corp.'s Minneapolis, Minn., home office. This center is reportedly the highest capacity operational commercial computing center in the U.S.

The principal computer in this permanent facility is one of Control Data's large-scale, solid-state digital computers, the 1604, with 32,768 48-bit words of high-speed magnetic-core storage.

The facility includes a complete battery of peripheral equipment, including two Control Data Model 1607 magnetic-tape systems comprising eight magnetic-tape transports, each capable of reading and writing 30,000 characters per second.

Technical Writing Groups Discuss Plans to Merge

A proposed merger of the Technical Writing Improvement Society and the Western Technical Writing Institute was discussed at a recent meeting in Pasadena, Calif. According to spokesmen, the new organization would be in a better position to help in industrial writing improvement efforts, particularly among engineers and other technically trained people.

In the discussions, the feeling was that a more concerted approach must be made to management to help train technical personnel in the modern techniques of scientific communication.

—Photo by Jan Halm

Oceanography—High Tide for Design Ideas

Electronics Assumes Major Role in Precision Measurement of the Sea; Imaginative Engineering Is Key to Underwater Instrumentation

Manfred Meisels
Assistant Editor

ELECTRONICS is going down to the sea in ships. Oceanography has graduated from sounding lines to sonar, with electronics extending the range and accuracy of measurement and giving access to entirely new areas of study.

Designers are assuming key roles in oceanography as evidenced by the variety of ingenious new electronic instruments to be lowered over the side this summer. These include:

- "Upside-down" sonar
- Acoustic theodolite
- Acoustic spectrograph
- Ocean-bottom seismograph
- Gravity meter for shipboard use
- Wave-powered electric generator

These instruments point up the accelerated pace of present-day oceanography and the varied opportunities for solid, imaginative electronic design. Backed by increasing government participation and funding, oceanography is gearing for the large-scale exploration of "inner space."

The 1961 Federal budget, now before Congress, allots $57 million for oceanography—a 50 per cent increase over 1960 and a 225 per cent increase over 1959. This money will go for direct support of oceanographic research in private and government laboratories, ship and facility construction, and pertinent military funds. Nongovernmental expenditures in oceanography run to an additional $10 to $15 million yearly. Of these totals, about 10 per cent goes for the development and procurement of electronic hardware. But because of the specialized nature of oceanographic electronics and the limited availability of ready-made equipment, less than half of this amount is finding its way directly to the electronic industry.

$1 Billion in 10 Years

Also up for congressional approval is a bill to implement a ten-year oceanographic program (TENOC). This program, resulting from a survey of the nation's oceanographic needs conducted by the National Academy of Sciences–National Research Council, calls for the doubling of government-supported R&D in private research centers by 1970 and for stepped-up construction of new research vessels and facilities. The total cost of this program over the 10-year period will approach $1 billion. About $100 million of this would be spent for electronic instruments and shipboard equipment.

Such figures are small in comparison to the billions going for missile and space programs and a number of people in Washington advocate even greater emphasis on oceanography. "It is suggested that oceanography might pay a greater return on our investment than certain more fashionable programs of equal magnitude," James H. Wakelin, Assistant Secretary of the Navy for R&D, told ELECTRONIC DESIGN.

Nevertheless, the "substantial and orderly" expansion of oceanography called for in the TENOC program will create major opportunities for the electronics industry. The instruments to be tested this summer are among the first results of the recently formed partnership between electronics and oceanography.

"Upside-Down" Sonar Tells Instrument Depth

"Upside-down" sonar employs conventional equipment and techniques, but with an ingenious twist. The sonar forms a part of a submerged, ship-towed instrument package and measures the depth of the package by pinging upwards. The time delay in the acoustic return from the water-air interface indicates depth and is transmitted back up the cable to the towing vessel. This technique eliminates ambiguities from multiple bottom returns which cannot be readily sorted out by a small, downward-pinging sonar.

Large shipboard sonars are primarily designed to measure bottom depth directly beneath the vessel and are in constant use for this purpose. They cannot thus be conveniently or effectively employed in monitoring the depth of instruments towed at some distance away from the ship. Reflections from the towing cable and the presence of scattering layers seriously hamper their use.

The "upside-down" sonar is in development at the Woods Hole Oceanographic Institute, Woods Hole, Mass., and will be used this summer with submerged current meters, temperature sensors, and other towed measuring devices.

New Device to Measure Current

Another Woods Hole innovation is the acoustic theodolite, which will provide a continuous vertical profile of ocean currents from the bottom to the surface in a particular location.

The theodolite consists of an acoustic pinger mounted in a 1.5-m square frame with a hydrophone in each corner. The frame is lowered to the bottom, after which the pinger is released and floats upward, transmitting all the while at a continuous rate. As the pinger rises, it is displaced by ocean currents; the difference in arrival time of the acoustic signal at each of the four hydrophones is a measure of the pinger's lateral displacement, and hence of the currents. The signals are recorded on a strip chart within the frame and the entire assembly is programmed to later release its ballast and rise to the surface where it can be recovered.

Acoustic Spectrograph Will Use Delay Lines

The acoustic spectrograph will provide a tool for study of the fine structure of acoustic transmission and reflection in the ocean. The spectrograph will receive and analyze white noise generated by electrical spark discharges, gas and chemical explosives, and powerful underwater gongs or "thumpers." One hundred adjustable band-pass filters spaced over a frequency range of 8 kc will separate the received acoustic signal into its component frequencies for analysis. Data will be shown on a 100-pen graphic recorder. In addition, delay lines in the instrument can be programmed to synthesize theoretically predicted acoustic behavior such as bottom-echo trains and other phenomena. The existence of such effects can thus be confirmed by the delay lines and logic circuits on a go, no-go basis.

The instrument will analyze the transmittive and reflective properties of marine life scattering layers and thermal layers in terms of their effects on particular acoustic frequencies. Ultimately, such studies could lead to the identification of marine life and physical properties of an ocean area entirely by acoustic means. Dr. J. B. Hersey of Woods Hole is developing the instrument.

Seismograph Employs Acoustic Telemetry

In an entirely different area of oceanography, The Lamont Geological Observatory of Columbia University at Palisades, N.Y., is readying an improved version of its ocean-bottom seismograph. An experimental unit lowered last fall proved to be extremely successful and a more sensitive instrument is going over the side this summer. The seismograph consists of a vertical component geophone (essentially a spring-suspended mass with a moving coil pickup) whose output frequency modulates a 12-kc acoustic telemetry carrier. The instrument rests on the ocean bottom and can detect seismic waves generated by deliberate explosions as well as natural earthquakes. Information from both these sources will be collected in use.

Batteries provide for about four days of continuous operation and the instrument is not recoverable; the presence of a cable would generate

Washington Calls for Creative Design in Seagoing Instruments

The Broad Applications for Electronics

The person who comes closest to filling the role of an oceanographic "czar" in government is James H. Wakelin Jr., Assistant Secretary of the Navy for R & D, and chairman of the Interagency Committee on Oceanography of the Federal Council for Science and Technology. Here, Secretary Wakelin spells out for ELECTRONIC DESIGN readers the electronic instrumentation requirements of oceanography.

"One of the critical areas in oceanography is the dearth of sophisticated scientific instrumentation for use at sea and in the laboratory. Oceanographic instrumentation has not evolved rapidly because of the small number of people and ships that have been involved.

"Any expansion of effort in this field must include a broad program of instrument development. In this area, the electronics industry can play a major part. The precision depth finders, salinometers and navigation devices are only indications of the variety of the shipboard equipment that is needed. Instruments capable of continuously recording multiple parameters at depths in the oceans even as sensors in missiles record atmospheric data are needed.

"In addition there is a need to develop instrumentation for buoys to measure, record, and transmit scientific data automatically and continuously for long periods of time. These data must be collected in a manner amenable to machine handling because of the large volumes involved. New devices such as deep-diving research vehicles require their own instrumentation peculiar to the environment in which they must operate. Laboratory and shipboard test equipments with high degrees of precision and reliability must be developed."

The Specific Hardware Requirements

"We must encourage more creative instrumentation for oceanographic research and support the individual worker who comes up with a really promising idea on instrumentation or technique." Such are the recommendations of the National Academy of Sciences-National Research Council committee in its report on U.S. oceanographic needs.

The report is also quite specific on electronic hardware requirements. The following instruments are thought to "merit particular attention."

- **Permanent and expendable oceanographic instruments for aircraft.**
- **Deep torpedoes to make measurements at a specified depth, near the bottom, or to follow a given course, isotherm, or isohaline, and record how other variables change along that surface.**
- **Samplers and sensitive instruments to measure the radioactivity at all ocean depths.**
- **Accurate, powerful, and reliable acoustic telemetering devices.**
- **Stable platforms for gravity meters or precision weighing devices.**
- **Direct density measuring devices.**
- **Cameras and underwater television.**
- **Seismic equipment.**
- **Turbulence measuring devices.**
- **Acoustic equipment for biological research.**
- **Precision salinometers.**
- **Precision echo sounders.**
- **Towed temperature recorders.**
- **Magnetometers.**
- **Smaller items such as standardized water-tight connectors.**

Electronic Measuring Instruments for Oceanography

Measurement	Present Methods	Methods In Development	Proposed Methods	Design Requirements and Problems
Ship position	Celestial navigation Loran A,B,C SINS	Satellite navigation	Sonar bench marks Ocean-bottom topography	Accurate, low-cost equipment giving world-wide coverage. 300 ft. accuracy wanted
Buoy position and travel history	Radar and sonar tracking Radar and sonar beacons	Radar and sonar transponders	Inertial navigators Loran transponders	Electrical power sources Standardized telemetry equipment Efficient, high-pressure transducers and hydrophones
Bottom depth, topography and sub-structure	Sonar SOFAR	Multiple sonar arrays Ocean-bottom seismograph		
Instrument depth	Sonar Sonar beacons	Sonar transponders "Upside-down" sonar		Multiple bottom echoes Temperature and scattering layers
Water and sub-bottom temperature	Thermistor chain Thermocouples Wire-wound resistance thermometers Airborne bolometer Airborne bathythermograph Thermal contour plotter	Towed thermal follower FOIF ("Diving Duck")	Guided torpedoes	Repeatability and accuracy (0.01 deg C) Low time constant Thermistors not uniform in response
Current	Mechanical current meters "Swallow" buoys Drifting buoys Geoelectro-kinetograph Dye and fluorescent tracers	Acoustic theodolite Hot wire meters	Radioactive tracers	All methods are relatively inaccurate and inconvenient. Want fine details to less than 10 per cent error
Density	Swallow buoy Inference from other measurements	Vibrating reeds and forks Index of refraction	Beta particle counter	New devices must be built from scratch. Instruments must not be sensitive to gravity or acceleration.
Salinity	Laboratory analysis of samples	In situ analyzers using conductivity, inductance or capacitance effects.		
Gravity	Pendulums in submarines Gyro-compensated ship-board meters	Meters on stable platforms		1 year life for platform gyros 1 minute angular error. Low cost ($25,000.)
Magnetism	Flux gate magnetometer Search coil magnetometer Nuclear precession magnetometer	Rubidium vapor magnetometer		Convenient data handling Absolute measurements
Wave motion, direction, and turbulence	Wire probes (resistance and capacitance bridges) Stereo photography	"Splashnik" accelerometer		Wide range devices Turbulence measuring instruments Wave direction indicators Must withstand prolonged use in severe environment

spurious noise. Ultimately, a ballast-releasing, self-rising feature will be included, especially with the more elaborate three-component instruments now being planned. These instruments are expected to be a useful adjunct to acoustic methods in the study of sub-bottom geology.

Gyro-Stabilized Gravity Meter

A shipboard-mounted gravity meter is also being readied at Lamont. Heretofore, gravity measurements at sea could be performed only in deeply submerged submarines. These constitute reasonably stable platforms on which pendulums are used to measure gravity. The new instrument consists of a two-axis, gyro-stabilized platform which carries a spring-loaded mass for direct measurement of gravity. The entire assembly is expected to be accurate to one part in 10^6 of earth's gravity.

Power from the Sea

A possible answer to the chronic power shortage for weather buoys and other floating instrument systems may be provided by a wave-powered buoy developed by the Stratos Div. of Fairchild Aviation, Manhattan Beach, Calif., and being tested at Woods Hole.

Two large paddles projecting from the side of the buoy are driven up and down by the waves much like the crank of a railway hand-car. The paddles develop hydraulic pressure which is stored in an accumulator and bled off to turn an electric generator. The buoy is expected to develop up to 1 kw continuously in a 6-in. sea. However, the buoy is a rather outsized affair (a cylinder 12 ft high and 4 ft across). Much smaller units giving proportionately less power will probably be designed if the prototype does well.

These new devices are only an example of how electronics is proving useful and necessary in oceanography. Classical measurements, such as ocean temperature, current and density all require a variety of modern electronic gear and can pose unusual problems in electronic design. Present methods, new developments and design problems in each area of measurement are outlined.

In Situ Devices Wanted

The sampling techniques generally used in oceanography are giving way to continuous-reading, *in situ* (in the medium) instruments. Fast response, usually less than a second, is preferred for convenient observation of fine structures of current, temperature, etc. Instruments should have extremely low power demand and long-term stability in their operating environment. Wherever possible, components (and es-

Official U.S. Navy Photograph

"Splashnik" wave-measuring accelerometer goes over the side. Accelerometer output is telemetered to survey ship. Entire assembly, including balsa wood raft, costs about $150.

pecially transducers) should be well insulated and insensitive to pressure so as to facilitate the design of free-flooding instruments. Capacitors and carbon resistors are particularly troublesome in this respect. Transistors should be filled with silicone oil to resist high pressures.

Precise Navigation a "Must"

Any measurement unaccompanied by position is useless. The ship, the buoy and the submerged instrument package must be precisely located in position for the data to be of any use to oceanographers. Ideally, accuracies on the order of 300 ft are desired. These can possibly be obtained with Loran-C, but there is no Loran in the South Pacific, the Arctic regions and elsewhere. Also, Loran receivers are expensive in terms of oceanographic budgets. Ships Inertial Navigation System (SINS) is still an unknown quantity.

Oceanographers look forward to the early development of navigation satellites such as the system heralded by the recent launching of the Navy's "Transit" vehicle. Here again, accuracy may prove expensive.

A more distant but more economical solution, and one that might be of use to all ocean-going ships, is the establishment of sonar "bench marks" on the ocean bottom. Such beacons, arranged in clusters of three or more at precisely determined locations could be used by any ship equipped with a depth sounder. Initially, reflectors consisting of air-filled barrels or the like could serve the purpose, but more sophisticated systems would employ coded beepers or transponders. Approximately 60 clusters laid out from a known shore reference and zeroed in position

SEAGOING ELECTRONICS

with SOFAR (Sound Fixing and Ranging) could serve the entire North Atlantic.

Each cluster might have a range of perhaps 3 or 4 miles. The system could provide a check on SINS and prove otherwise useful in submarine navigation. Long-lived nuclear-powered sources now in development would be employed.

Accurate navigation will also result from our increasing knowledge of ocean-bottom topography. Ships will be able to navigate by bottom features much as a pilot uses landmarks. Sonar beacons could then be limited to certain areas not having a distinctive topography.

Transponders Needed for Buoys

Buoy and instrument positions along line-of-sight distances are determined with high accuracy by radar and sonar tracking and by radar and sonar beacons. Transponder beacons would be much preferred as longer operating life could be realized from the limited power supply that can be fitted into a small instrument package.

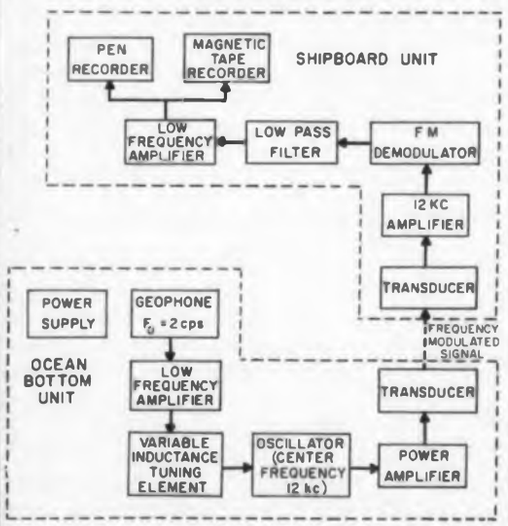
Woods Hole estimates that it could immediately use at least 50 low-power radar transpon-

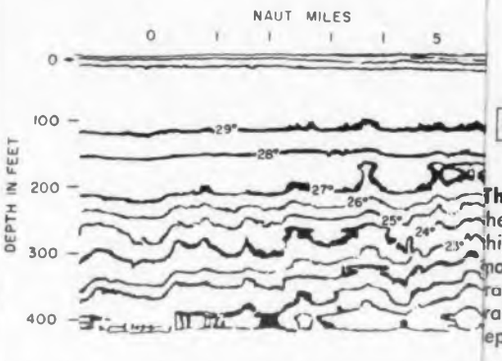
Ocean-bottom seismograph, developed by Lamont Geological Observatory, gets its first test (above). Acoustic telemetry package is strapped to trash barrel containing batteries. Seismograph itself is suspended from the can. At right, Chuck Hubbard, Lamont engineer, tests improved version to be used this summer. Metal cylinder on lab bench is moving coil geophone. Magnetostrictive pinger sings away merrily in oil drum behind Hubbard. Operating scheme is shown in block diagram.

ders. Requirements are for 1 w of power at X band. Coding is not necessary and cost should be in the neighborhood of $300.

Robert Waldron, electronic engineer at Woods Hole, foresees wide commercial application for radar transponding buoys as markers for harbors, navigation channels and commercial fishing grounds. Radar beacons are already being put to such uses, particularly in England, but are not transponders and hence not entirely suited to the purpose.

Over-the-horizon tracking of buoys rules out sonar and radar. Here, oceanographers must re-





sort to conventional radio triangulation, whic is not sufficiently accurate. Mr. Waldron ha considered mounting Loran transponders on su buoys, but is stymied for lack of a transpondi frequency acceptable to the FCC.

Cheap Inertial Navigators?

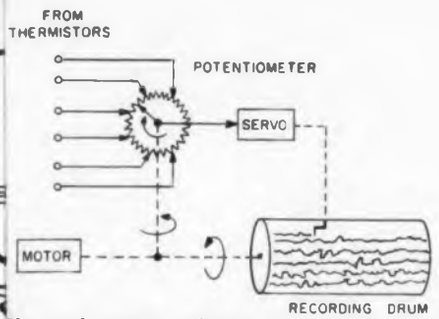
One suggestion making the rounds calls f equipping buoys with telemetering inertial nav gators. Opinion here is sharply divided. Son oceanographers believe that a "cheap and dirt system using non-gyroscopic accelerometers c achieve the required accuracy and long-term st bility. Others feel that nothing short of a SIN type arrangement would suffice. At any rate, one has yet given any prolonged thought to t actual design of an inertial buoy navigator. Su a system, if successful, would have the bon feature of simultaneously measuring wave heigh —an accurate instrument for this purpose is mu in demand by oceanographers.

Convair, San Diego, has recently begun a stu program encompassing all aspects of buoy desig This program may ultimately lead to a standa buoy system with plug-in units for telemet sonar, radar, power, etc. An organized syste approach to buoy and instrument design wou be of great value in oceanography, though so scientists object that their particular instrume needs cannot be boiled down to plug-in systen

0.01 C Temperature Measurements Needed

Temperature measurements at sea run gamut from the water-air interface to sub-bott sediment layers. Accordingly, a wide range instruments has been developed—each suited a particular aspect of temperature measureme

Accuracy is the key requirement; very min temperature differences can have profound fects on ocean currents and weather. A 0.1 temperature rise could play havoc with the po ice caps. Oceanographers would like to meas



Thermal contour plotter automatically records isotherms in the ocean. Potentiometer scans voltages from ship-towed thermistor chain while the servo actuates marking pen at preset voltage intervals to give isotherm traces on recording drum. Typical record is also illustrated. The plotter can distinguish and record isotherms separated by as little as 0.05 C.

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temperature to within 0.001 C. This is hardly practical outside the laboratory, but as Dr. William Richardson of Woods Hole puts it, "If we can't measure to 0.01 C, we might as well not bother going out." This accuracy is now being approached in the field, but requires great care in calibration of equipment.

Thermistors, wire-wound resistance thermometers and thermocouples are in general use, but each is beset by inherent disadvantages. Thermistors require painstaking calibration, wire-wound thermometers have a very slow time constant, and thermocouple reference junctions must be kept at a constant, known temperature.

There is also a need for instruments having fast time constants, preferably less than 1 sec, to enable faster and more sensitive measurement. Surface temperatures are measured directly by immersed sensors such as thermocouples, or by airborne infrared bolometers. The latter method gives wide coverage and high accuracy, but is rather poor in navigational accuracy. For deeper temperature profiles with better positional accuracy, air dropped, telemetering bathythermographs are occasionally used. These are throw-away instruments much like sonobuoys. Temperature is measured by a thermistor lowered at a known rate and data is telemetered either to the airplane or a nearby survey ship.

More frequently, towed or buoy-mounted thermistor chains are used to observe deep, vertical temperature profiles. Data may be telemetered either acoustically or by radio. As many as 25 thermistors are carried on a chain and measurements can be made conveniently down to about 000 ft.

ntour Plotter Speeds Data Processing

Reduction of data from thermistor chains has been greatly speeded by an automatic thermal

contour plotter recently developed by Dr. Richardson at Woods Hole. The device records isotherms at intervals down to 0.05 C and does away with laborious hand processing of thermistor measurements.

Each thermistor is connected to a separate lead of a multi-tap potentiometer. The potentiometer winding thus carries a voltage gradient analogous to the temperature gradient along the thermistor chain. A continuously rotating potentiometer arm, synchronized with a recording drum, transfers the gradient to a servo system. The servo is designed to briefly actuate a marking pen on the drum at any given number of predetermined voltages. Since these voltages are proportional to ocean temperature, the result is a presentation of isotherms plotted against depth and ships' travel.

The thermistor-chain method is also applied to measurement of sub-bottom temperature gradients. Here, the thermistors are fastened to the outside of the coring plunger and measure temperatures simultaneously with coring.

Continuous vertical temperatures can also be measured by "Diving Duck" buoys which sink to the bottom, release their ballast, and return to the surface. Thermistor output can be telemetered or stored internally. The Clearing Div. of U.S. Industries is designing a complete line of "Diving Duck" or FOIF (Free Oceanographic Instrument Float) for temperature, pressure and other measurements.

Temperature Followers in Development

Still another recently developed method of observing thermal contours employs a towed thermal follower. This device, built by the Naval Electronics Laboratory, San Diego, consists of a towed temperature sensing unit and a servo control. A thermistor is balanced in a bridge with a resistance corresponding to a desired isotherm temperature. When unbalanced, the bridge fires a thyratron to control the towing winch, thus "locking" the follower onto a desired isotherm. Several of these units have been used simultaneously to detect internal waves.

This principle could be extended to similarly guide a free vehicle, such as a torpedo, along an isotherm. Clearing Div. of U.S. Industries is considering developments along these lines.

Current Measurements a Problem

A really accurate, convenient system for measuring ocean currents has yet to be devised. Rotor-driven current meters of various types now in use do not reveal detailed current structure and are insensitive to very slow currents. Neutral-density or "Swallow" buoys, designed to float at a given depth, are something of an improvement. However, they must carry sonar beacons for tracking and an entire ship must be employed in chasing down a string of buoys.

Various colored and fluorescent dyes are often used to "tag" water for current measurement. Instruments have been developed to detect these chemicals by their emission and absorption spectra, but the whole system is not very convenient for deep-sea work. The use of radioactive isotopes has been proposed and may prove feasible. However, underwater radiation detectors must be made available before this method can be introduced.

Still another basis for design of a current meter is the use of an electrically heated wire. Its temperature would vary in relation to the heat removed by water flow.

An interesting device for current measurement, now in disfavor because of its relatively poor accuracy, is the geoelectrokinetograph (GEK). This device measures the voltage induced in a moving body of water by the earth's magnetic field. Electrodes have been placed at each end of the Key West-Havana telephone cable to measure the gross flow of the Gulf Stream by this method. Russian oceanographers continue to rely on the GEK for current measurements.

Deep-sea sound velocimeter. Business end (right) incorporates a reflective, folded sound path. The velocimeter operates on the "sing-around" principle. Arrival of a sound pulse at the receiver triggers another pulse at the transmitter. Repetition frequency is thus indicative of sound velocity.

Densitometers Are Tricky

Oceanographers are still looking for a good, *in situ* density measuring instrument. Swallow buoys measure density incidental to their function as current-tracking buoys, but density is like a hitchhiker tagging along with ocean current measurements. Observation of minute structures is out of the question.

Density can be inferred from temperature, pressure, and sound velocity measurements. However, a direct method is preferable, both for convenience and as a check on other measurements. Instruments should be accurate to one part in 10^6 with measurements unaffected by gravity or acceleration.

Densitometers now in development make use of effects related to density rather than measuring this property directly. This is probably the most practical line of approach for field instruments.

Hollow reeds and tuning forks, filled with water, have been considered. Their resonant frequency is dependent on the density of the water inside. Accuracies to one part in 10^5 have been

Nuclear precession magnetometer takes a dry run in the woods behind the Lamont Geological Observatory. Device consists of a water-filled cylinder surrounded by energizing and sensing coils.

achieved experimentally, but to build such devices is extremely difficult and they are to some extent sensitive to gravity and acceleration.

Index of refraction, which varies with density, has also been tried for *in situ* measurement. Still another method involves a submersible beta-particle source and counter. Such devices tend to work well in the laboratory, but achieving satisfactory operation at sea is another matter.

Millions for Gravity Meters

Sea gravimeters are probably the most expensive electronic headache in oceanography. The only commercially available unit costs approximately $250,000, and is not altogether satisfactory to oceanographers. This device employs gyros to sense angular ship motion and generates appropriate corrections to the gravity as measured by a hull-mounted sensor.

An alternate approach being developed at the Lamont observatory is to mount the gravity sensor directly onto a gyro-stabilized platform.

In either instance the sensor is a spring suspended mass designed so as not to bottom, oscillate, or rotate under the influence of ship motion. This represents a substantial design achievement; measurements can be made to one part in 10^6 of the earth's gravity against a background noise of up to 0.5 g due to ship surge, heave, and vibration. The Lamont gravimeter employs a sensor developed by Askania of Germany.

Stable platform type units are thought to offer greater possibilities for improvement and cost reduction than gyro-compensated meters. In both types, however, gyros constitute the major cost problem. Accurate gyros developed for missile use are expensive not only in first cost but also in terms of expected operating life. Available gyros offering accuracies down to 0.5 min of arc cost as much as $20,000 and are rated for 5,000 hours of operation. This is extremely long by

SEAGOING ELECTRONICS

missile standards but still means an operating cost of $4 per hour. With two gyros per system, daily operating costs are almost $200—20 per cent of a typical survey ship's daily budget.

Oceanographers would snap up a stable platform type of gravimeter selling in the $25,000 range. "The manufacturer could sell 10 of them on announcement day," commented one scientist.

Nuclear Precession Magnetometer in Use at Sea

Measurement of the earth's magnetic field is relatively straightforward and presents little difficulty to oceanographers. Improvements being made generally involve simpler or more convenient equipment rather than greater sensitivity or accuracy. Flux gate and search-coil magnetometers are in wide use.

A relatively new entry is a nuclear precession magnetometer adapted for oceanographic use by the Lamont Geological Observatory. This instrument measures a voltage developed by the precession of hydrogen proton spin axes due to the earth's magnetic field. The device can be towed up to 700 ft behind the ship without the need for preamplifiers in the towed vehicle. Data are recorded onto a punched paper tape by a specially designed analog-to-digital converter.

The nuclear precession magnetometer is accurate to about 1 part in 50,000 of earth magnetism. Though higher accuracies can be had with flux gate instruments, Lamont prefers the nuclear precession type because of its relatively simple construction and because it measures absolute rather than relative quantities.

A more accurate absolute magnetometer is the rubidium vapor type. This device measures the effect of a magnetic field upon the emission and absorption spectra of rubidium vapor. It is still a laboratory instrument and has yet to be adapted for use at sea.

New Sound Velocity Meter Is Extremely Accurate

In situ measurement of sound velocity has been greatly simplified by the recent development of an ultrasonic velocimeter. This device uses the "sing-around" principle in which the liquid under test forms an acoustic delay line. A transducer at each end of the line maintains signal circulation. The repetition rate of the signal is thus a measure of sound velocity in the line.

In actual practice, the instrument transmits a 10-cycle burst of 2.6-mc noise down a 21-cm folded path. When received at the other end, the signal triggers a second burst, and so on. Pulse repetition rate varies between 6.8 and 7.6 kc.

The velocimeter is designed for use down to 36,000 ft. Accuracy is within 1 ft per second and drifts as low as 50 parts per million in 24 hours have been achieved. The folded path not only shrinks instrument size but reduces inaccuracies due to motion of the liquid or of the meter.

The velocimeter was designed by Martin Greenspan and Carroll Tschiegg of the National Bureau of Standards.

"Splashnik" Measures Waves

Wave motions have been classically measured by resistive or capacitative immersion probes. These are unsuited for deep water work as they must be supported by a vertically fixed reference platform or tower.

A recently developed instrument to circumvent this problem is the raft-mounted, telemetering accelerometer. Dubbed "Splashnik," the device consists of a simple, spring-restrained accelerometer mass with moving-coil pickup and an fm telemetry system. Splashnik is strictly a throw-away instrument; its cost is about $70 and it carries batteries for no more than 3 to 4 hrs of operation. Telemetry is at least 190 mc, giving about a 10-mile range.

Wave frequency down to 1 cps is measured by the accelerometer. Data are recorded on magnetic tape and speeded up to audio frequencies for analysis.

Splashnik is used for measuring waves up to about 15 feet high; beyond that higher waves tend to interrupt line-of-sight transmission. The instrument was developed at the David Taylor Model Basin and is being used by the New York University Dept. of Oceanography.

Oceanographers require a single precise instrument capable of measuring waves over the entire range from capillary waves to 60-footers. Instruments for the study of turbulence within waves and of wave direction are also needed. The latter can now be determined only through stereo photographs.

NYU is also studying the over-all problem of energy transfer from wind and sunlight to the ocean. Very sensitive, wide range anemometers would be useful here as would broad spectrum (from low IR to high UV) pyrometer cells. ■ ■

The second part of this article, to appear in the July 6th issue of ELECTRONIC DESIGN, *will consider the design of electronic systems for oceanography. Requirements for telemetry, data processing, shipboard equipment and weather-buoy systems will be discussed. These areas offer design problems as challenging as any in the instrumentation field and present an opportunity for large-scale participation by industry.*

(Advertisement)

NEW PRODUCT

Versatile Crimped Connector For Miniature Coax Cable

A highly versatile crimp-type snap-locked modular HYFEN® connector for miniature coaxial cable has been introduced by the Omaton Division of the Burndy Corporation, Norwalk, Connect. This modular HYFEN offers the facility of simple removal of individual snap-locked contacts or gang disconnect.

Both inner and outer contacts are crimped to the conductors, simplifying a previously complicated and difficult process. In addition this process eliminates many of the parts formerly used, and also eliminates any heat in the connection process. The result is a reliable coax connection, easily and quickly installed.

The new plug-and-receptacle unit will presently connect RG195U and #24 shielded miniature coax cable. Connectors for other sizes of miniature coax will be available soon.

Connector frames, of die-cast anodized aluminum, accommodate three, five, or eight inserts snapped in from either front or back. Inserts for coax cable, of glass-filled diallyl phthalate, accommodate up to 21 contacts. A plug or receptacle insert may hold male or female contacts, or they may be intermixed. Coax cable inserts and standard wire inserts (35 contacts) may be mounted in the same frame.

Contacts can be crimped to cable ends either before or after the harness is in place. Engaging and disengaging forces of low magnitude make it easy to insert, remove, and replace contacts and inserts individually for flexibility and economy in circuit changes and checks.

Burndy Corporation, Norwalk, Connect.

CIRCLE 45 ON READER-SERVICE CARD

EDITORIAL

Reliability—It's Now Up to the Policy Makers

A reasonable degree of reliability can be achieved. Pioneer V despite that faulty diode and apparent battery leak proves it. Hoffman Electronics Corp. has reached new heights in reliability in its TACAN airborne electronic equipment. The recent report of the Ad Hoc Study group on Parts Specifications and Management for Reliability (see *ED*, June 8, p 78) shows how it can be done.

It is now up to the policy makers in industry and government to cash in on the reliability that is currently technically possible.

To be sure, engineers have nowhere reached the ultimate in their ability to produce a more reliable part, but just how far they do get depends, again, on policy decisions by management.

If government and industry want to make reliability more than a topic for speech making—and the speeches are getting a little stale after six years—they can act:

The government can, based on the Ad Hoc Study report:

1. Establish the Advisory Group on Management of Electronic Parts Specifications. Action must come from Supply and Logistics and Research and Engineering offices of the Department of Defense.

2. Adopt practices for ensuring procurement of reliable equipment. Action must come from the individual services. They can specify desired quantitative levels of reliability.

Industry can, according to the Ad Hoc Study report:

1. Incorporate the features recommended in its purchase documents. Action must come from engineering managers.

2. Cooperate in implementing recommendations. Action must come from engineers and management. More than token lip service is needed.

The gentlemen of Ad Hoc Study group have done an outstanding job. They recommend that the proposed procedures be implemented in about 12 months. The report is now available from the Superintendent of Documents.* To use the words of E. J. Nucci, of the Department of Defense, "We don't have to wait until all of the ducks are lined up to get reliability." Our policy makers must act now.

James G. Kippin

*Ask for Parts Specification Management For Reliability dated May 1960, No. PSMR1, Vols. 1 and 2. U. S. Government Printing Office, Washington 25. D. C.

Tunnel Diode Relaxation Oscillators

Although a tunnel diode relaxation oscillator output is not a true flat-topped rect-angular pulse, the small amount of tilt (5 to 10 per cent) is not critical in many applications. The inherent simplicity and stability of the circuit plus the accuracy possible in predicting performance make it worthwhile to consider for pulse applications. Design information plus experimental verification of astable, monostable and bistable relaxation oscillators are presented.

Dr. C. M. Barrack
M. C. Watkins
Aircraft Armaments, Inc.
Cockeysville, Md.

FREQUENCY stability in the order of 0.1 per cent for a 10 per cent variation in supply voltage or 50 per cent change in operating temperature is possible with tunnel-diode delay-line-controlled relaxation oscillators. By proper choice of dc operating condition, astable, monostable or bistable operation can be selected. Circuitry is remarkably simple, requiring only a diode plus a resistor-inductor series combination. Frequency may be varied by changing the supply voltage or value of R or L.

Astable Relaxation Oscillator Circuit

The basic relaxation oscillator circuit utilizing a tunnel diode and an inductor is shown in Fig. 1a. The dc load line for this circuit is shown constructed on the characteristic curve of the diode in Fig. 1b. For an astable relaxation oscillator, it is required that the circuit dc load line intersect the diode characteristic curve in the negative resistance region as shown.[1]

Assume initially that there is no current flow through the inductor. When voltage is applied to the circuit, the current through the diode and inductor will begin to increase exponentially, as in Fig. 1c toward a value, I_a, determined by the total resistance in the circuit and the B supply voltage. The voltage across the diode increases as shown in Fig. 1d until a voltage E_1 is attained. The diode operating point then "jumps" to the voltage E_2.[2] Since E_2 is greater than the supply voltage E_a, the circuit operating point must change toward lower values of diode current and voltage along the diode characteristic. When the current has decreased to a value I_1, the diode voltage again "jumps" to a new value, E_4. The voltage across the diode now begins to increase again toward E_1. This completes the period of the relaxation oscillation.

In general, the time required for the voltage across the diode to change from E_4 to E_1, is not the same as the time required for the diode voltage to change from E_2 to E_3. The two periods can be readily computed from a knowledge of the voltages E_1, E_2, E_3, E_4, and E_a and the values of L, R, and R_d, where R_d is the incremental resistance of the diode. If it is assumed that $R \ll R_n$ where R_n is the absolute value of the diode negative resistance, the period t_1 is given by

$$t_1 = \frac{L}{R_d} \ln \frac{E_a - E_4}{E_a - E_1} \qquad (1)$$

Dr. Carroll Barrack (l) and Melvin Watkins (r) have been involved for some time with the application of tunnel diodes to pulse circuitry. Impressed by the circuit simplification possibilities, they investigated means to generate multivibrator-type waveforms. Results of their work demonstrate the excellent stability plus simplicity which is possible with tunnel diode configurations.

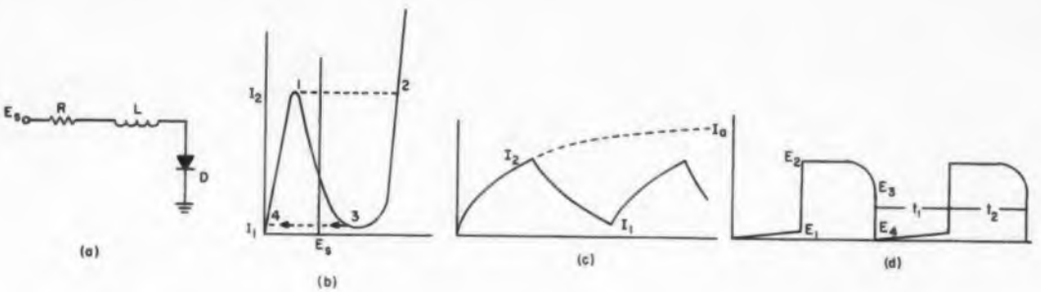


Fig. 1. For astable operation of the relaxation oscillator shown in (a), the dc load line must intersect the diode characteristic curve in the negative resistance region as shown in (b). As current rises exponentially (c) through the diode and inductor, the diode operating point shifts (d) from E_1 to E_2; as the current then decreases to I_1, the diode voltage swings from E_3 to E_4.

R_d = average incremental diode resistance in region between E_4 and E_1

$$t_2 = \frac{L}{R_d} \ln \frac{E_s - E_2}{E_s - E_3} \quad (2)$$

R_d = average incremental diode resistance between E_2 and E_3

If the resistance in the circuit is not small compared to R_n then Eqs. 1 and 2 must be modified as follows:

$$t_1 = \frac{L}{R_T} \ln \frac{E - E_4}{E - E_1} \quad (1a)$$

$$t_2 = \frac{L}{R_T} \ln \frac{E - E_2}{E - E_3} \quad (2a)$$

where
$R_T = R + R_d$

and $$E = E_s \frac{R_n}{R_n - R} - (E_1 + I_p R_n) \frac{R}{R_n - R} \quad (3)$$

E is the voltage at which the circuit dc load line intersects the negative resistance region of the diode characteristics. The value of E can perhaps best be found by graphical techniques since the value of R_n varies appreciably. If the load line intercept is in the linear region of the diode characteristics, Eq. 3 allows fairly accurate calculation of E. However, if the intercept is in the curved portion of the characteristic, large errors can exist since the proper value of R_n is then extremely difficult to determine.

Experimental Results Agree With Calculated Values

The characteristic curve of the GE ZJ-56 tunnel diode is shown in Fig. 2. From this curve the value of R_d in the $E_1 - E_4$ voltage region is seen to be fairly constant at approximately 42 ohms. In the $E_3 - E_2$ voltage region the value of R_d changes from about 18 ohms to over one thousand ohms. A good average value for R_d of about 200 ohms appears to be satisfactory. For the negative resistance of the diode, a value of —170 ohms is fairly accurate for current greater than 0.2 or 0.3 ma. For lower current, the value of negative resistance increases at a rapid rate.

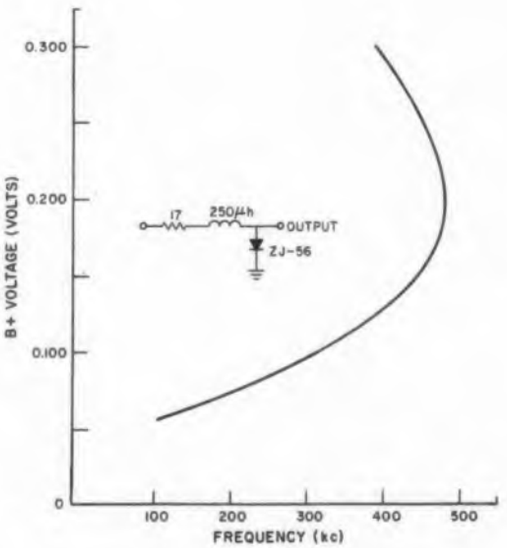


Fig. 3. Frequency vs supply voltage curve for a tunnel diode relaxation oscillator. Comparison between measured (•) and calculated (Δ) values of oscillator frequency indicates that reasonable accuracy in prediction can be expected.

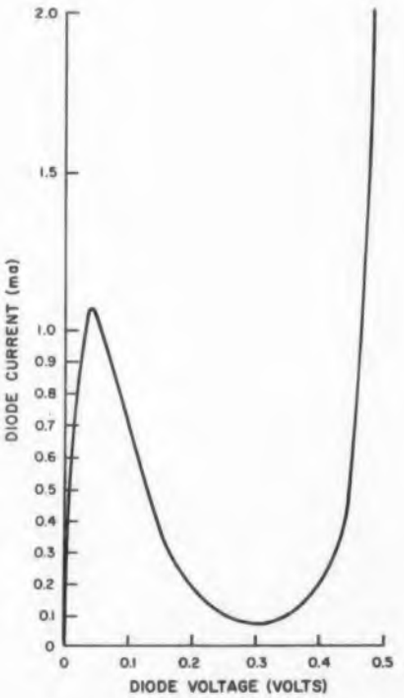


Fig. 2. *V-I* characteristics for the GE ZJ-56 tunnel diode.

Using the above values of diode resistance, the performance of a relaxation oscillator was calculated and compared with experimentally determined values. In Fig. 3 is shown the individual measured and calculated values of oscillator frequency for the circuit configuration shown. It is clear from these curves that it is possible to predict the value of the frequency of oscillation for the relaxation oscillator to a fair degree of accuracy. The curve in Fig. 3 indicates that over a portion of the curve, the oscillator frequency can be varied almost linearly over about a 2:1 range. If a fairly stable oscillator is desired, operation with a B+ of about 0.2 v will result in a configuration which will be relatively insensitive to any B supply variations.

Delay Line for Improved Oscillator Stability

A further increase in oscillator stability can be achieved by using a shorted delay line instead of

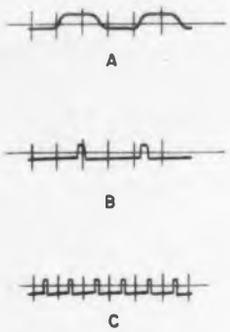


Fig. 4. Waveforms for delay line controlled astable relaxation oscillator. Delay line times are (a) 0.1 μsec (b) 0.4 μsec and (c) 2.0 μsec; different time scales are shown for each trace.

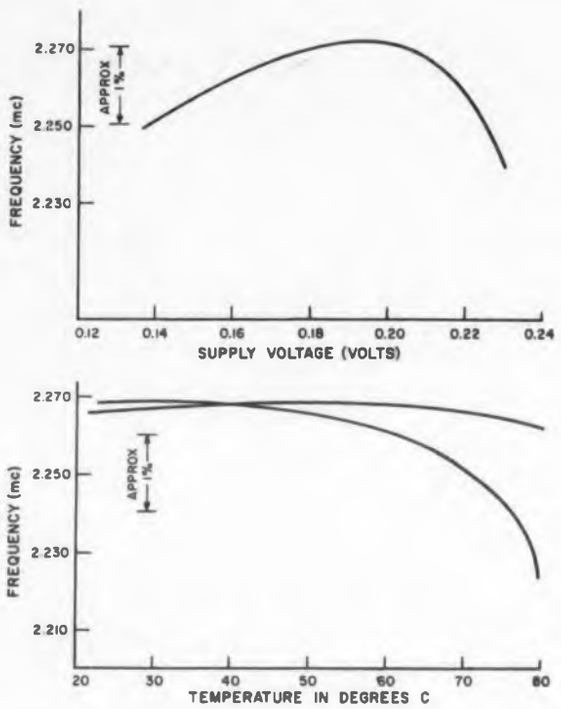
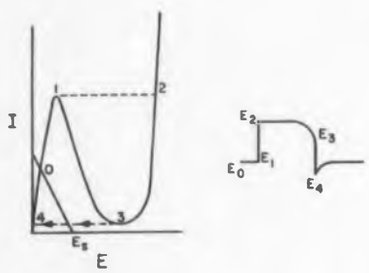


Fig. 5. A 50-per-cent change in supply voltage results in a frequency change of only one per cent in a delay line controlled oscillator (a). As shown in (b), frequency is maintained within one per cent for almost 60 C variation in operating temperature.



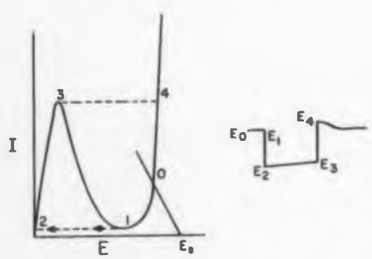


Fig. 6. With the diode biased below the peak of the diode characteristic (a), a positive trigger of sufficient amplitude drives the device to the path traced by 1-2-3-4-0. Biasing above the peak (b) necessitates the application of a negative pulse to initiate operation.

an inductor in the basic circuit of Fig. 1a. The waveforms resulting when different lengths of delay line are used are shown in Fig. 4. The rise time of the waveforms shown in Fig. 4 is about 30 nanosec. This is actually the rise time of the oscilloscope used to observe this waveform. When viewed on a Tektronix 517 oscilloscope the observed rise time was about 10-20 nano-sec.

The effect of supply voltage on the oscillator controlled by a 0.1-μsec delay line is shown in Fig. 5a where a 50-per-cent change in supply voltage (from 0.14 v to 0.21 v) is seen to result in a frequency change of less than one per cent. The effect of temperature on this oscillator is shown in Fig. 5b. When only the tunnel diode is heated, the frequency changes by only 0.1 per cent for almost a 60-C change in temperature. The change is much greater when the delay line is also heated therefore indicating a large delay line temperature coefficient.

Monostable Oscillator Operation

The basic relaxation oscillator circuit shown in Fig. 1a is changed from an astable configuration to a monostable circuit when the dc load line is made to intersect the diode characteristic at one point in either of the positive resistance regions. When the intersection point is in the region below the peak of the characteristic, the circuit is sensitive to only positive pulses, generating a positive pulse for each applied positive trigger. When biased in the positive resistance region above the valley point of the characteristic, a negative trigger pulse is required to start the oscillation. A negative output pulse results as the circuit completes its cycle. The duration of these pulses can be calculated from expressions similar to Eqs. 2a and 2b. If a delay line is used in the circuit, the resulting pulse is equal to twice the nominal delay of the line.

Fig. 6 shows the action of the monostable circuit. In Fig. 6a the diode is biased below the peak of the diode characteristic. A positive trigger of amplitude sufficient to drive the diode to point *1* on the curve is required to trigger the circuit. When this occurs, the operating point traces the path shown *1-2-3-4-0*. This results in the waveform shown. If the circuit is initially biased to E_4 instead of E_0, the negative overshoot in the waveform can be eliminated.

If the diode is biased above the valley point of the curve, the circuit-operating point follows the path shown in Fig. 6b. A negative trigger of amplitude sufficient to drive the diode-operating point from E_0 to E_1 will initiate the cycle. The waveform which results is seen to have a large positive overshoot. If the initial point is at E_4 instead of E_0 this overshoot can also be eliminated. If precise width pulses are to be generated, a delay line can also be used here in order to stabilize periods.

Bistable Operation

Bistable operation of the tunnel diode can be achieved simply by choosing a value of load resistor which causes the dc load line to intersect the diode characteristic at three points, two of which are in the positive resistance regions of the characteristic. This is shown in Fig. 7. If the circuit is initially at stable operating point *1*, a positive trigger pulse will switch the operating point to *3*. A second positive pulse will not affect the circuit. However, a negative trigger pulse will now switch the circuit operating point back to *1*. Hence, for bistable operation, a series of pulses alternating in polarity is required for circuit operation.

Since, in most instances, operation is desired with a series of pulses of one polarity the circuit of Fig. 7 must be modified in some manner. One way of accomplishing triggering from single polarity pulses, if the pulses are not too narrow, is to pass the trigger pulses through a differentiating circuit. If the positive and negative pulses are not too widely separated, it has been found that the simple bistable circuit will function properly. For very narrow pulses, this type of operation proves difficult. By use of pulse steering techniques, the circuit of Fig. 8 overcomes this difficulty and, in addition, provides for more reliable operation, since in the differentiating method, false operation is possible if the width of the original trigger pulse varies.

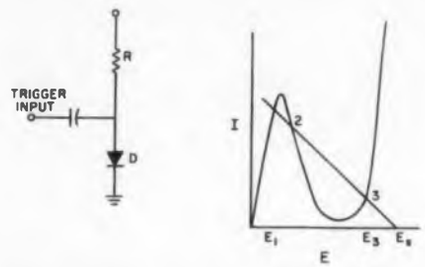


Fig. 7. Bistable operation is obtained by selecting a load resistance such that the dc load line intersects the *E-I* curve at three points, two of which are in the positive resistance region.

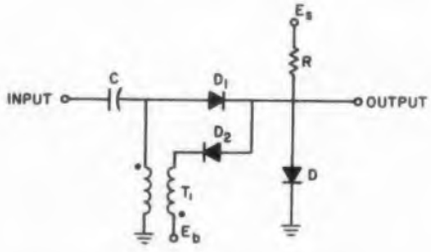


Fig. 8. By the use of pulse steering techniques, bistable oscillator operation can be made more reliable due to elimination of false operation resulting from input trigger pulse width variations.

The tunnel diode shown in Fig. 8 is biased in the same manner as the tunnel diode in Fig. 7. Assume the tunnel diode D is operating at point *1*. Diode D_1 is a conventional germanium diode and is slightly reversed biased by the tunnel-diode voltage E_1. Diode D_2 is also a germanium diode and is reversed biased by the voltage E_b, $E_3 > E_b > E_1$. A positive pulse is applied through capacitor C to the circuit. The amplitude of the pulse is sufficient to overcome the few millivolts back bias on D_1 and cause D_1 to conduct, thereby causing the tunnel diode to shift its operating point to E_3. The amplitude of the trigger pulse must be less than E_b if the negative pulse appearing at D_2 is not to be applied to the tunnel diode. When the tunnel diode operating point is at E_3, diode D_2 is now slightly forward biased, and diode D_1 is now appreciably biased. A positive trigger applied to the circuit is blocked by D_1 but is converted into a negative trigger by T_1 and passed by diode D_2. This negative trigger changes the tunnel diode operating point back to E_1. ■ ■

References

1. Lo, et al, "Transistor Electronics," Prentice Hall, 1955, pp 353-357.

2. Stoker, "Nonlinear Vibrations," Interscience, 1950, pp 94-96.

Solving Thermistor Problems . . . . Without Nomographs

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Nomographs are great time-savers in working with thermistors. But what if no nomograph is available for a particular problem? Design engineer Cummings presents the answer with a few equations and with a graphical method that applies universally.

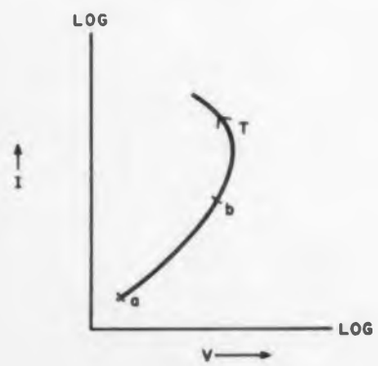

Fig. 1. Log plot of thermistor's voltage-current characteristic for increasing temperature shows the useful portion of the curve, *a-b*.

THERMISTORS are very useful to cancel out the temperature sensitivity of a measuring circuit. In order to be effective, however, the right combination of thermistor and series-shunt resistors must be selected.

In solving a thermistor problem of this type, engineers have come to depend heavily on nomographs. This causes little trouble, except when there is no nomograph available for the temperature range and resistance values involved. In other cases, the size, scale in slope of the available nomograph, makes it almost unreadable. Unless the design engineer can become independent of nomographs, he may flounder in these situations which are fairly common.

Solving thermistor problems directly from the few simple equations presented here should cause little hardship for the engineer. The freedom from nomographs it brings is well worth the little practice needed to develop a facility with the method.

Thermistor Characteristic Fitted To Circuit Requirement By Series-Shunt Resistors

A typical thermistor voltage-current characteristic for increasing temperature is illustrated in Fig. 1. The portion of this curve between *a* and *b* is approximated by the equation

$$\frac{1}{v}\, e^{B/T} = \text{constant},$$

where

B = a constant of the thermistor material expressed in deg Kelvin
T = absolute temperature in deg Kelvin

This characteristic can be altered to conform to a desired curve, usually determined in experiment, by selection of the proper series and parallel resistors. The basic resistance-temperature characteristic r of a thermistor is represented by curve *a*, Fig. 2. When a series fixed resistor, r_2 is added, the characteristic becomes that represented by curve *b*. On the other hand, addition of a shunt

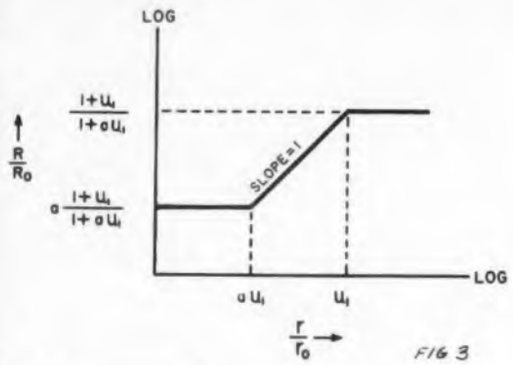

Fig. 3. Asymptotic plot of Eq. 5 showing break points and unity slope section.

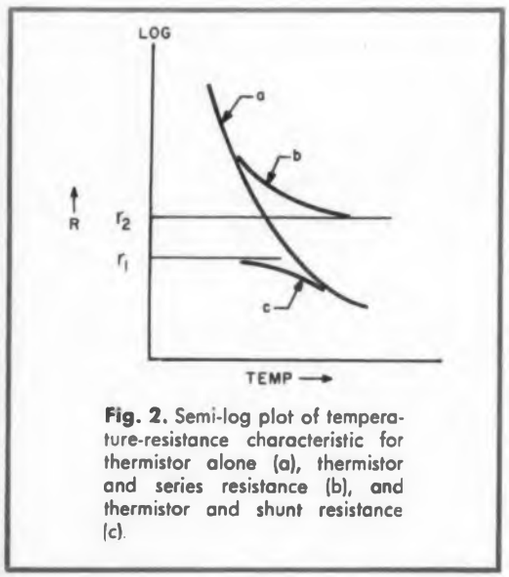

Fig. 2. Semi-log plot of temperature-resistance characteristic for thermistor alone (a), thermistor and series resistance (b), and thermistor and shunt resistance (c).

fixed resistor, R_1 yields the characteristic c. A series plus a shunt arrangement will produce a curve lying somewhere between these two extremes, and represents the usual case.

Normalized Resistance Values Are Plotted, Asymptotes Drawn

The series-shunt combination R can be represented by the expression

$$R = r_2 + r \parallel r_1 \tag{2}$$

To determine r, r_1 and r_2, the first step is to normalize R and r with respect to their values for the temperature at which thermistor manufacturers specify the thermistor's value. This is usually 25 C. Thus

$$\frac{R}{R_{25}} = \frac{r_2 + r \parallel r_1}{r_2 + r_{25} \parallel r_1} \tag{3}$$

This equation can be transformed to more useful forms by expounding the expressions $R \parallel R$, and

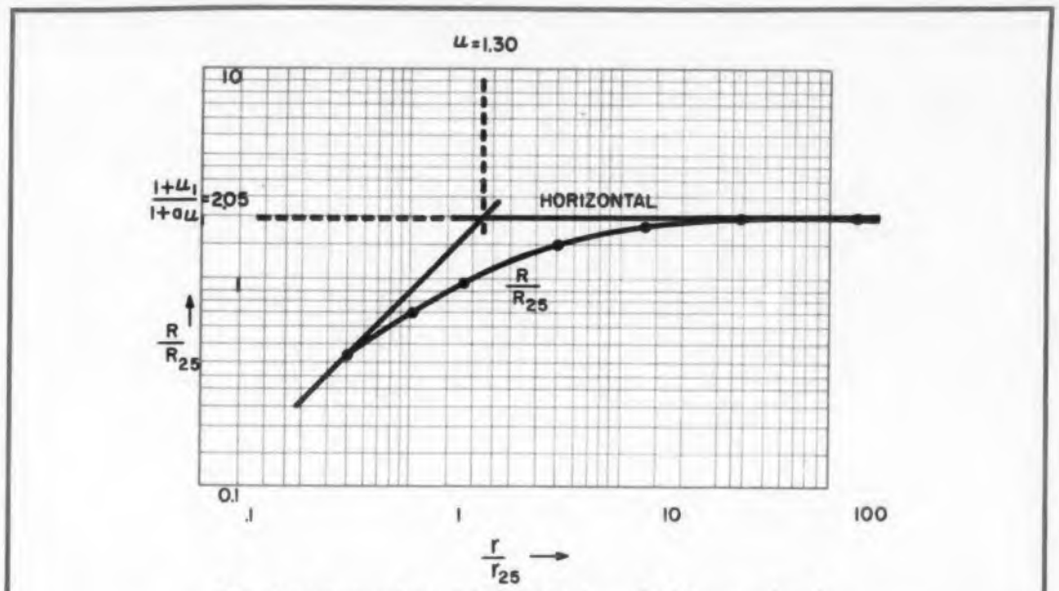

Fig. 4. Experimentally determined values of R/R_{25} are plotted against r/r_{25} on log paper, and the asymptotes are constructed visually.

$R_{25} \parallel r_1$, dividing numerator and denominator by $(R_{25})^2$, and

Letting $$\frac{r_1}{R_{25}} = U_1, \tag{4a}$$

$$\frac{r_2}{r_{25}} = U_2 \text{ and} \tag{4b}$$

$$\frac{U_2}{U_1 + U_2} = a, \tag{4c}$$

where a is a number between 0 and 1.

Expression 4c can be solved for U_2

$$u_2 = \frac{a\,u}{1 - a} \tag{4d}$$

Eq. 3 now becomes

$$\frac{R}{R_{25}} = \left(\frac{1 + u_1}{1 + au_1}\right)\left(\frac{\frac{r}{r_{25}} + au_1}{\frac{r}{r_{25}} + u}\right) \tag{5}$$

Then for three conditions of r/r_{25}, we have the expressions

$$\frac{r}{r_e} < au_1 \qquad \frac{R}{R_e} = a\,\frac{1 + u_1}{1 + au_1}$$

$$au_1 < \frac{r}{r_e} < u_1 \qquad \frac{R}{R_e} = \frac{1 + u_1}{1 + au_1}\,\frac{\frac{r}{r_e}}{u_1}$$

$$\frac{r}{r_e} > u_1 \qquad \frac{R}{R_e} = \frac{1 + u_1}{1 + au_1}$$

This is an asymptotic plot with break-points at au_1, and u_1. It is illustrated in Fig. 3. The slope for Eq. 6b is unity.

Using An Asymptotic Plot and These Equations, The Required Thermistor and Resistor Values Can Be Determined

To illustrate the use of the asymptotic plot and the six equations, consider an actual case where a feedback loop in an aircraft fuel indicating system had to be compensated for temperature. The known or derived quantities are listed in Table 1.

Table 1. Values of Thermistor Compensating Network – r_2 is Fixed

Temp.	A r/r_{25} (Given)	B R (Experimental)	C R/R_{25} (Normalized)	D R/R_{25} (Actual)
—60	75.00	200 K	2.00	2.02
—40	21.70	195 K	1.95	1.95
—20	7.40	180 K	1.80	1.77
0	2.82	150 K	1.50	1.47
25	1.00	100 K	1.00	1.00
40	0.57	70 K	0.70	0.75
60	0.29	47 K	0.47	0.53

Column A (r/r_{25}) are manufacturer's values for an available thermistor, supplied with the component. Column B (R) is the value of resistance needed to temperature-compensate the circuit. This is determined experimentally, using a temperature chamber and a decade box. Column C

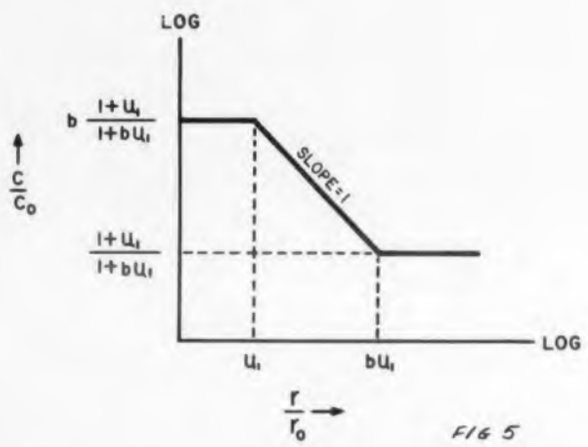

Fig. 5. Asymptotic plot of Eq. 14, showing break points and minus unity slope section.

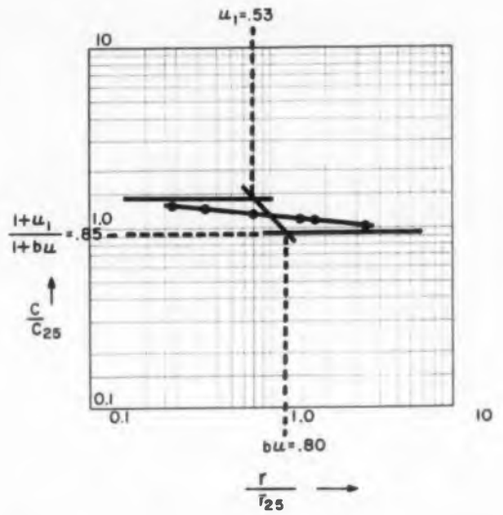

Fig. 6. Experimentally determined values of C/C_{25} are plotted against r/r_{25} on log paper, and asymptotes are again constructed visually.

(R/R_{25}) is simply column B normalized with respect to the value at 25 C, which is 100 K, in this case. Column D is the first attempt to match actual network to the characteristic values in Column C. The method of constructing the network to possess this characteristic will now be explained.

Determined Values of R/R_{25} Plotted vs r/r_{25}; Asymptotes Drawn In

These values in column C are plotted against the values in column A, on log paper, Fig. 4. The asymptotes are constructed visually. The upper one is drawn horizontally slightly above the highest point of the curve. The sloping straight line is constructed through the lowest value on the R/R_{25} curve, with a slope of one. From these two straight lines, the values needed to determine r_1 and r_2 can be determined. Thus from Fig. 4,

$u_1 = 1.30$ (on the abcissa), and

$$\frac{1+u_1}{1+au_1} = 2.05 \text{ (on the ordinate)}$$

Then solving,

$$au_1 = 0.122 \text{ and}$$

$$a = 0.0916$$

From Eq. 4d,

$$u_2 = 0.135$$

Eq. 5 now yields the value R/R_{25} for each temperature point:

$$\frac{R}{R_{25}} = 2.05\,\frac{\frac{r}{r_{25}} + 0.122}{\frac{r}{r_{25}} + 0.130}$$

These results are plotted in Column D of Table 1. From the expression

$$\frac{r_{25}}{R_{25}} = \left(\frac{1}{u_1+u_2}\right)\left(\frac{1+u_1}{1+au_1}\right)$$

with all right-hand quantities known, the ratio r_{25}/R_{25} can be calculated to be

$$\frac{r_{25}}{R_{25}} = 1.43$$

That is, $r_{25} = 1.43 \times R_{25}$. Since R_{25} was determined in experiment, $r_{25} = 1.43\,(100\text{ K}) = 1.43\text{ K}$.

The values of the r, r_1, and r_2 can now be determined. From Eq. 8,

$r_{25} = 143$ K, for the thermistor at 25 C.

From Eq. 4a,

$r_1 = 186$ K for the fixed shunt resistor.

Finally, from Eq. 4b,

$r_2 = 19.3$ K for the fixed series resistor. These are the values of two resistors and the thermistor which, when wired into the circuit, will closely approximate the curve in Fig. 4.

Method Can Also Be Applied to Solve Cases where r_2 Is Not Fixed

A more difficult case occurs when r_2 is no longer fixed, but is a copper winding of some electromagnetic device. It is required that the total resistance R remain constant. Again normalize and let

$$r_2 = c$$

$$\frac{r_{25}}{c_{25}} = u_{25}$$

$$\frac{r_1}{r_{25}} = u_1$$

Then

$$\frac{R}{R_{25}} = \frac{c + r \parallel c_1}{c_{25} + r_{25} \parallel r_1} = 1$$

Divide the numerator and the denominator by $c_{25}\,r_{25}$. This yields

$$\frac{c}{c_{25}} = \left(\frac{1+u_1-u_{25}\,u_1^2}{1+u_1}\right)\left(\frac{\frac{r}{r_{25}} + u_1\,\frac{1+u_1+u_{25}\,u_1}{1+u_1-u_{25}\,u_1^2}}{\frac{r}{r_{25}} + u_1}\right)$$

Let

$$b = \frac{1+u_1+u_{25}\,u_1}{1+u_1-u_{25}\,u_1^2}$$

where b is a number between one and infinity. Solving for u_{25}

$$u_{25} = \left(\frac{b-1}{u_1}\right)\left(\frac{1+u_1}{1+bu_1}\right)$$

Again

$$\frac{c}{c_{25}} = \left(\frac{1+u_1}{1+bu_1}\right)\left(\frac{\frac{r}{r_{25}}+bu_1}{\frac{r}{r_{25}}+u_1}\right)$$

This asympotic plot, with breakpoints at u_1 and bu_1, is illustrated in Fig. 5.

Temperature-Compensating A Magamp Winding

As an example, temperature-compensate the copper control winding of a magamp, given the following first four columns of Table 2.

Table 2. Values of Thermistor Compensating Network — r_2 = magamp winding

Temp	r/r_{25} (Given)	c (Experimental)	c/c_{25} (Normalized)	c/c_{25} (Actual)
5 C	2.25	38.72	0.92	0.93
20	1.23	41.18	0.98	0.99
25	1.00	42.00	1.00	1.00
40	0.57	44.46	1.06	1.06
60	0.29	47.74	1.14	1.13
75	0.19	50.00	1.19	1.17

The asymptotic plot is illustrated in Fig. 6. Thus from the plot

$$u_1 = 0.53$$

$$bu_1 = 0.80$$

$$\frac{1+u_1}{1+bu_1} = 0.85$$

Eq. 14 becomes

$$\frac{c}{c_{25}} = 0.85\left(\frac{\frac{r}{r_{25}}+0.80}{\frac{r}{r_{25}}+0.53}\right)$$

Values of Eq. 15 are given in the last column of Table 2. Also

$$b = \frac{bu_1}{u_1} = \frac{0.80}{0.53}$$

Then from
Eq. 9b, $r_{25} = 34.5$ ohms.
From Eq. 9c, $r_1 = 18.3$ ohms.
Finally, from Eq. 10, $R = R_{25} = 54.0$ ohms. ■ ■

Practical Guide to Choosing Blowers For Cooling Electronic Equipment

John W. Bolt
American-Standard Industrial Div.
Detroit, Mich.

"Cooling electronic equipment is not an exact science," says John Bolt, "but much of the guess-work can be taken out of it." In this practical guide to selecting blowers, Mr. Bolt shows how.

THOUGH there is no direct theoretical solution to the problem of cooling electronic equipment, there are very useful rules of thumb. Combined with scientific theory, they can help keep a cooling system "inside the ball park" and can guide the designer when he is writing specifications or making cost analyses.

Cooling electronic equipment is often regarded as a necessary evil. In some cases, a chassis is completely designed with little or no thought given to the blower which must go with it. In such situations, the blower is often forced into the category of specialty items because space limitations preclude the use of standard air movers. Naturally, the designer pays a premium for "specials."

Early Planning Cuts Costs, Boosts Cooling Efficiency

If the designer considers cooling at the initial design stage, he can generally cut costs and boost cooling efficiency. Since the space left for a blower can influence the selection of blower types, early consideration of basic blower shapes makes it possible to optimize the dimensions for the most suitable standard design.

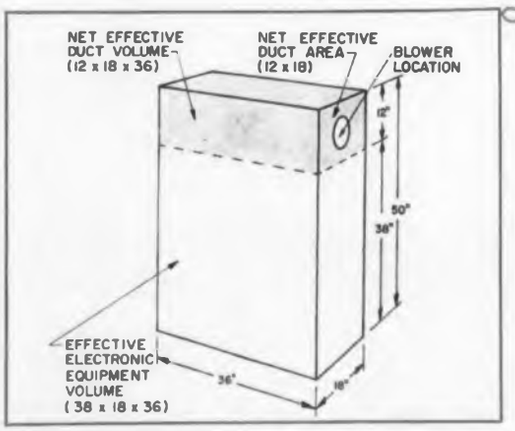

Fig. 1. Sketch shows how to determine net effective duct area which blower must feed.

Air Flow and Cabinet Volume Determine Blower Capacity

The scramble for compactness should not blind the engineer to the need for air circulation. The blower capacity depends on the required velocity of air flow and on the net average duct area of the cabinet.

In a conventional draw-through, forced-convection design, in which air is drawn into the cabinet, across components, and out the opposite side, the cabinet becomes, in effect, a duct.

The required air velocity and the net effective duct area determine the required blower capacity. Charts 1 and 2 will help determine the specific blower requirements in terms of cubic feet of air per minute and static pressure.

How to Determine Effective Duct Area

Fig. 1 shows how to establish the net effective duct area for a hypothetical electronic-equipment cabinet. It is assumed that the cabinet has dimensions of 18 x 36 x 50 in., resulting in a volume of 32,400 cu in. The total effective volume required for the electronic equipment and mounting components is determined (in this hypothetical case) to be 24,624 cu in.

Dividing this volume by the bottom area (18 x 36 in.) gives a net height of 38 in. for the elec-

Chart 1. Equivalent Diameter of Rectangular Duct

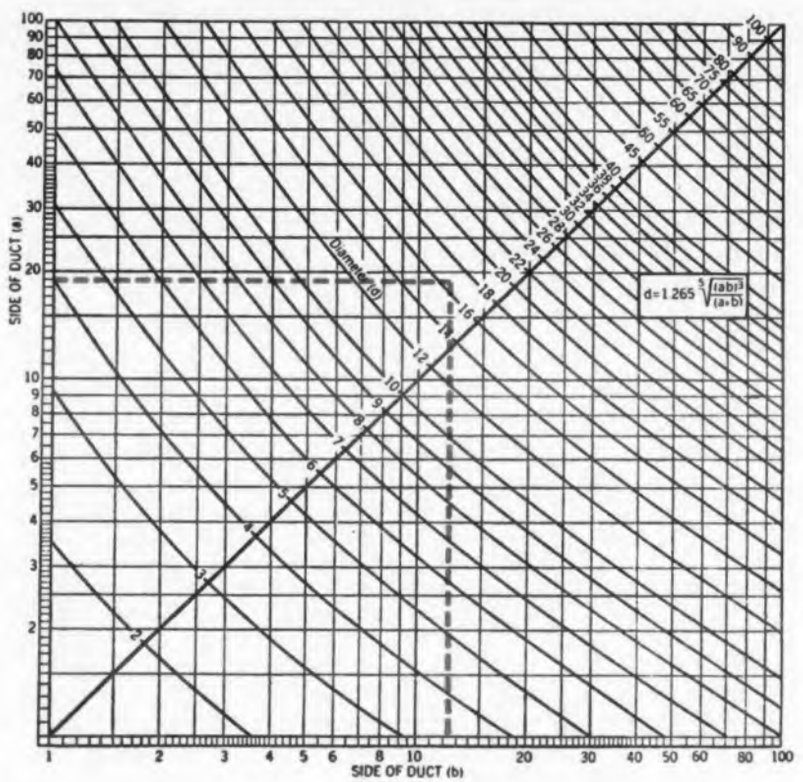

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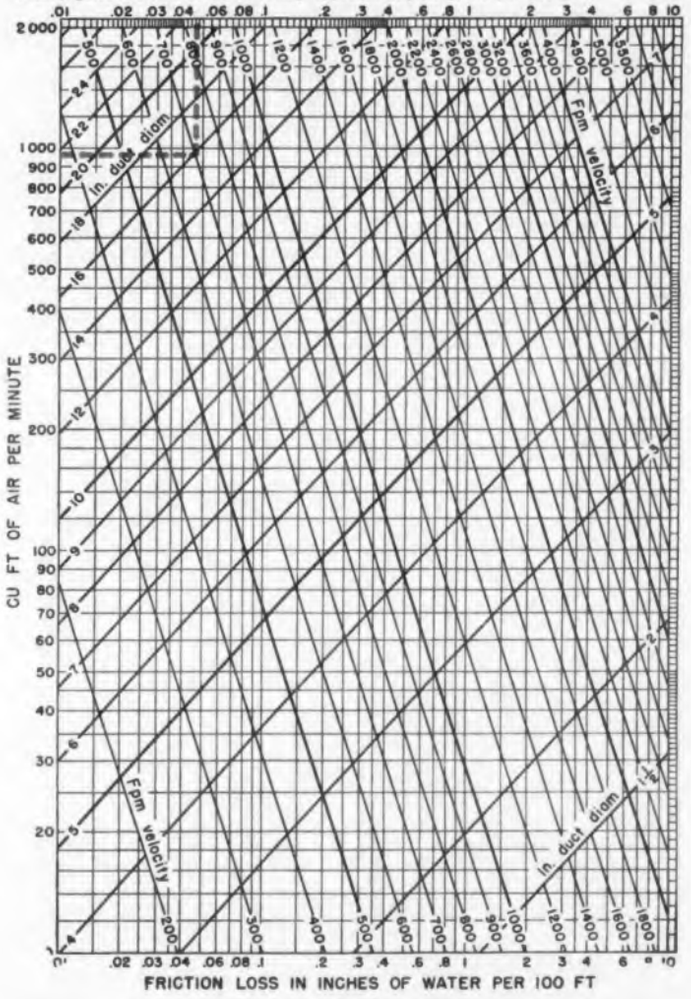
Chart 2. Blower Capacity and Static Pressure*

*Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft.



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tronic equipment. Subtracting 38 in. from the total cabinet height leaves 12 in. for the net effective duct height. The net effective duct area, then, is 12 x 18 in.

Chart Gives Blower Capacity For Round Duct

Since Chart 2 (to determine blower capacity and static pressure) requires an expression of duct area in terms of diameter of an equivalent round duct, it is necessary to use Chart 1 to determine the equivalent diameter. On Chart 1, a vertical line from $b = 12$ in. intersects a horizontal through $a = 18$ in. right at the curve representing a 16-in. diameter.

Once the required air velocity is known, Chart 2 can be used to find anticipated static pressure and required blower capacity. Air velocity is a function of the heat-transfer requirements. It depends on the heat generated by the electronic components, the net effective duct area, the temperature and density of the incoming air, and the maximum allowable equipment temperature.

There are several techniques for determining the required air velocity. An excellent one may be found in "Weight Flow Nomograms for High-Altitude Air Cooling" (*ED*, Oct. 15, 1957).

If, for our example, the required air velocity is determined to be 700 fpm, the intersection of 700 fpm with the 16-in. duct diameter on Chart 2 gives blower capacity requirements of 975 cfm at 0.046-in. water gage static pressure.

The engineer should avoid static pressures which call for oversized blowers. Larger-than-necessary blowers cost more to buy and more to operate. The static-pressure requirements are easily reduced by increasing open cabinet space.

Prototype Testing Avoids Headaches Later

Since these procedures give a ball-park blower specification, it is strongly recommended that prototype blowers be tested as installed in a production cabinet, complete with equipment before final purchase contracts are awarded.

The shape and location of equipment within the cabinet frequently play tricks with the flow of air through the cabinet. Such flow patterns cannot be predicted by mechanical, electrical, or thermodynamic formulas, nor by reference to past experience with cabinets of "similar" construction and configuration.

A slight change in size, position or power characteristics of just a few tubes, relays or resistors, can often completely alter the ventilation requirements in a given cabinet.

Off-the-Shelf Blowers Are Best . . . Even With Modifications

When the engineer designs around a production blower, he can often test this installation with an off-the-shelf item that fits precisely. This can involve a minimum investment.

Fig. 2. Duplex centrifugal blower uses common motor to drive two fan wheels.

Fig. 4. Typical compact propeller fan can be used for supply or exhaust air.

Fig. 5. Single-stage vaneaxial blower, designed to MIL specs, has all parts made of aluminum except mounting bracket and screen guard.

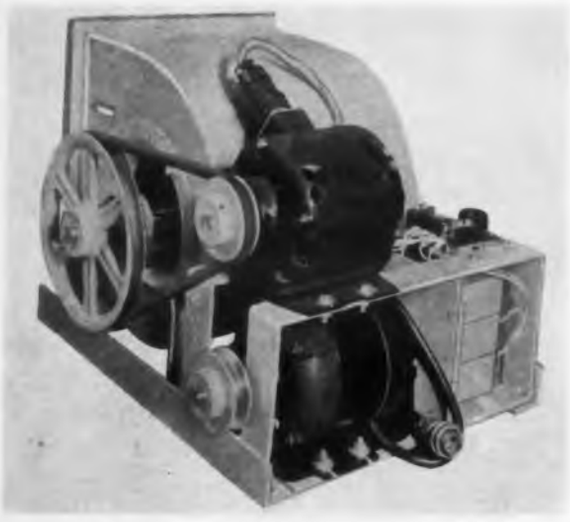


Fig. 3. This single-stage, belt-driven, centrifugal blower has a "piggy-back" motor arrangement as a safety feature. Normally operated with a high-speed ac motor, it uses a dc motor in case of ac power failure.

Fig. 6. Low-volume, high-speed tubeaxial blower, often used for cooling oscilloscopes.

Fig. 7. Highly efficient, compact, mixed-flow blower has not yet been classified as a basic type for cooling electronic equipment.

It is often necessary, however, to specify a non-standard blower to meet space, volume, or static-pressure requirements. In such cases, it need not be essential to go to the expense of a custom-built prototype blower for testing. More often than not, one can use off-the-shelf blowers which may not have the exact dimensions called for in the design specifications. It can be externally mounted and ducted to the cabinet.

Though short of perfection, this gives an acceptable cut-and-try device to test the accuracy of the calculated requirements without the high cost of a special prototype.

Choice of Blower Hinges on Five Factors

Once the required blower capacity has been determined, selection of the best blower for the job depends on five factors:

1. Static pressure
2. Cost
3. Size
4. Noise level
5. Type of air flow

The final selection will be a compromise.

Determining the static pressure is rather simple with the aid of Charts 1, 2, and 3 (for higher velocities and larger duct diameters).

Four Basic Blowers For Forced Convection

There are four basic blower types available for forced-convection cooling of electronic equipment:

1. Centrifugal
2. Propeller
3. Vaneaxial
4. Tubeaxial

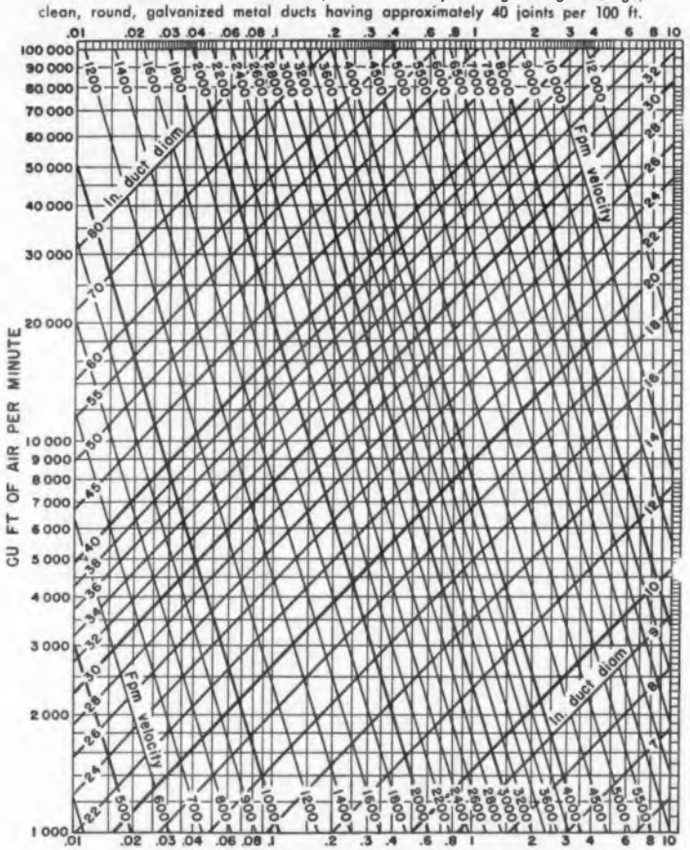
In addition, there is the mixed-flow blower, a recent development which is really too new to be included as a basic type. This unit combines the characteristics of centrifugal and vaneaxial types. Its unique feature is its continually rising static-pressure curve over the range from free delivery to no delivery.

The mixed-flow blower promises to be an ideal fan for electronic cooling. Performance of the production unit compares favorably with that of a vaneaxial type designed for equivalent duty though it is somewhat less expensive.

Each blower type has certain general characteristics that provide advantages and disadvantages in a given installation. Briefly, the general characteristics are as follows:

Chart 3. Blower Capacity and Static Pressure For Large Air Velocities and Large Ducts*

*Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft.



(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft.)

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Centrifugal. (Figs. 2 and 3).

1. Normally used where static pressures vary from 1/8 to 10 in. of water with single-stage blower. With multi-stage blower, static pressure can be as great as 30 in. of water.
2. Used where 90-deg change in air-flow direction is desirable.
3. Most quiet type in higher static-pressure ranges.
4. Ranks third in quietness in lower static-pressure ranges.
5. Duty for duty, it ranks second in cost.
6. Duty for duty, it is the largest type.
7. Can be made in duplex arrangement using a common drive motor to provide double the air delivery at the same static pressure.

Propeller. (Fig. 4).

1. Used where static pressures vary from free delivery to 3/4 in. of water.
2. Straight-through air flow.
3. Not applicable to higher pressures.
4. Most quiet for lower static pressures.
5. Duty for duty, it is least expensive.
6. Duty for duty, it is smallest.

Vaneaxial. (Fig. 5).

1. Used where pressures vary from 1/8 to 5 in. of water with single-stage blower. With two-stage blower, static pressure can be as great as 15 in. of water.
2. Straight-through air flow.
3. Noisier than centrifugal in higher and lower pressure ranges.
4. Duty for duty, it is most expensive.
5. Duty for duty, it is third in compactness.

Tubeaxial. (Fig. 6).

1. Used where pressures range from 1/8 to 2 in. of water.
2. Straight-through air flow.
3. Not applicable to higher pressure ranges.
4. Next to propeller type in quietness in lower pressure ranges.
5. Duty for duty, it is third in cost.
6. Duty for duty, it is second largest.

Ready-Reference Table of Blower Properties

Blower Characteristics					
Blower Type / Static pressure range / Noise (lower s.p. range) / Noise (upper s.p. range) / Cost / Size					
Centrifugal	1	3	1	2	5
Propeller	5	1	N	1	1
Vaneaxial	3	4	2	5	3
Tubeaxial	4	2	N	3	4
Mixed-Flow*	2	5	3	4	2

*Based on data for one blower size only. Key: *1* represents the broadest static pressure range, lowest noise, and, duty for duty, the lowest cost and smallest size. *5* represents the reverse. *N* = not applicable.

Mixed Flow. (Fig. 7).
(Characteristics listed are based on data for one size only.)

1. Good for use with pressures from 1/8 to about 9 in. of water at 11,000 rpm.
2. Straight-through air flow, though air is mixed within blower casing.
3. Noisy in lower pressure ranges.
4. Noisier than vaneaxial for higher pressures.
5. Duty for duty, it is less expensive than vaneaxial type.
6. Duty for duty, it is second in compactness.

The table shows these characteristics correlated for ready reference. The importance of each factor will vary from installation to installation.

If cost is all-important, for example, the electronics designer will want to use a propeller type if possible. This means that static pressures must be low because propeller-blowers are not recommended for pressures above 3/4 in. of water.

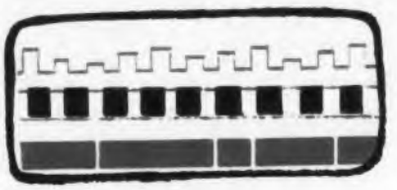
Had the duct size and air-velocity requirements in the sample calculation been 4 in. and 1400 cfm, a propeller fan could not have been used. The 0.92-in. pressure developed would have been too high.

Other Factors Contribute to Choice

There are many other factors that influence blower selection. Among these are rotational speeds, harmonics, power factors and blower materials. Also, there is often a supplementary blower and duct system needed for cooling hot spots and mass concentrations.

The charts and table in this article will give a reasonably accurate approximation of blower needs for initial design analysis and cost estimation. It should be borne in mind, though, that a certain amount of cut-and-try may still be necessary before a final selection can be made. ■ ■

Part 2



Pulse Code Modulation Terminal And Repeater Methods

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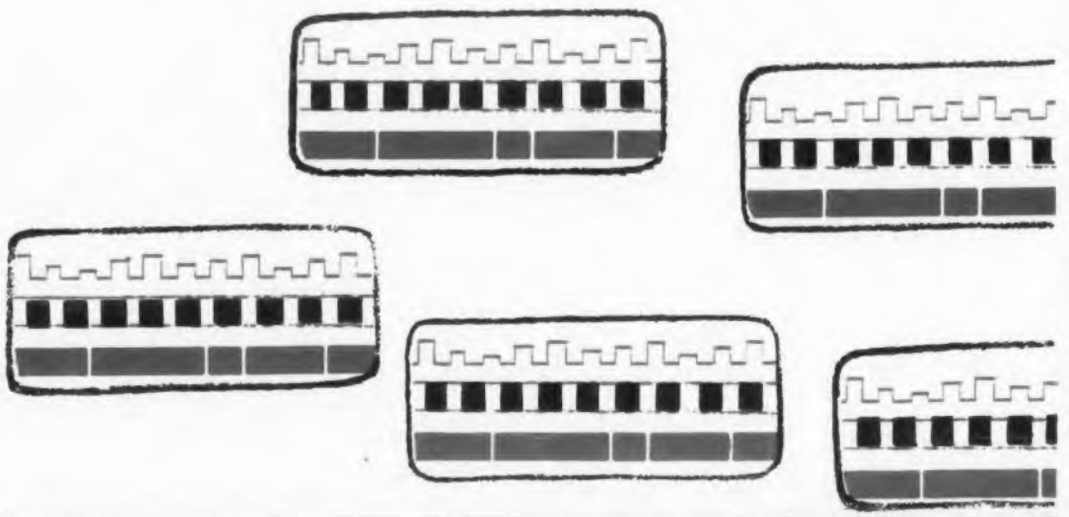
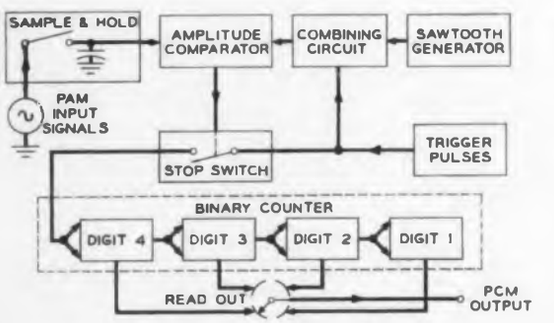
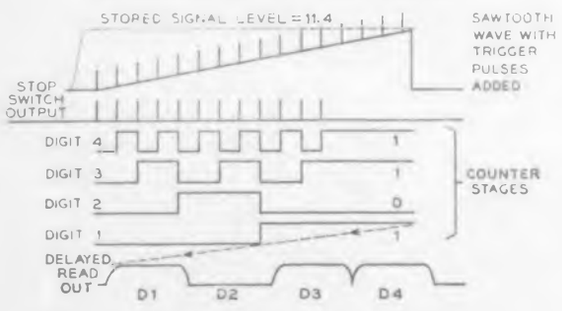
Choosing the best method of coding is important in the design of a pulse-code modulation system. In the second part of this series on PCM, three coding methods are described in detail. Part 1 appeared in ED. June 8, p. 52.





(a) LEVEL-AT-A-TIME CODER DIAGRAM



(b) LEVEL-AT-A-TIME CODER WAVEFORMS

Fig. 9. Block diagram of a four-digit level-at-a-time coder (a), and (b) its waveforms.

THREE COMMON methods of encoding an analog signal into combinations of pulses and spaces are:

- Level-at-a-time
- Digit-at-a-time
- Character-at-a-time

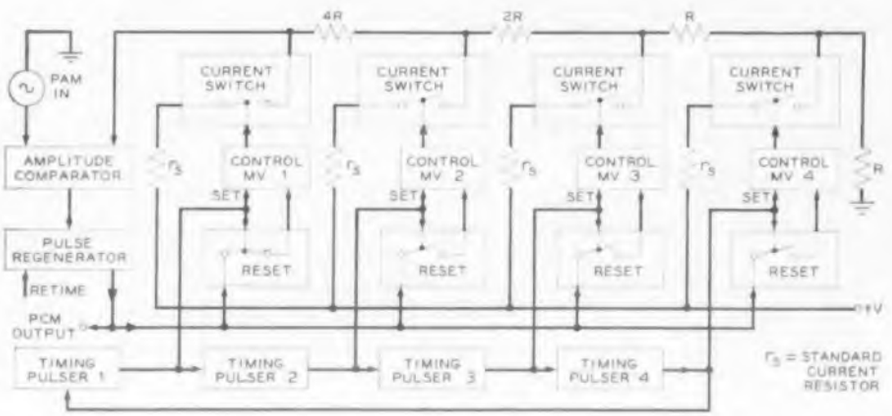
How PCM encoders are classified into one of these methods depends upon the way they arrive at the decision as to what combination of pulses and spaces to send out. Each of these coding methods will be discussed in detail.

Level-at-a-Time Coders

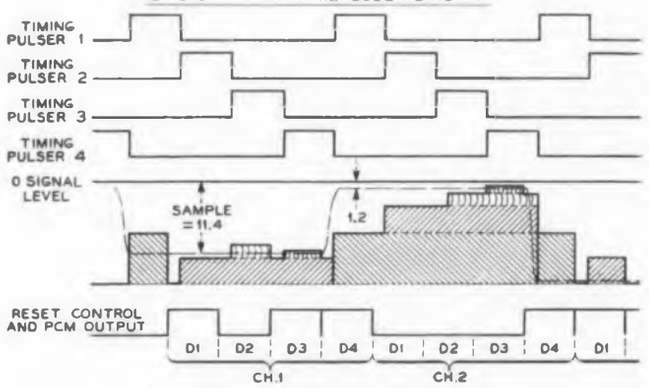
Level-at-a-time coders are organized in such a manner that the input signal to be coded is compared, in turn, with each of the possible amplitude levels. The decision circuit is asked the question, "Is this the level?" When the answer is "no," the next level is introduced and the question is asked again. When that level is generated which corresponds to the input signal, the decision circuit responds with a "yes," by generating a pulse or some other response which causes the code corresponding to that level to be read out for transmission. A seven-digit coder of this type must make 128 decisions for each sample. Because so many decisions are required this is relatively a slow process.[8,9]

One of several possible methods of instrumenting such a coder is shown in simplified block-diagram form in Fig. 9. The four digit coder must make a maximum of 16 decisions. Input signal magnitude is sampled and stored on a capacitor until the code has been determined. This stored signal is applied to one input of an amplitude comparator which is some form of decision circuit such as a Schmitt trigger. The other input is a sawtooth wave with trigger pulses superimposed as shown in Fig. 9b.

Each of the superimposed pulses tries in turn to trigger the amplitude comparator. When the sawtooth builds up to the signal magnitude, the amplitude comparator is triggered and it puts out a pulse which stops the four stage binary counter by opening the switch between the trigger pulse generator and the binary counter input. This stops the counter at a count corresponding to the magnitude of the input signal. After the counter is



(a) DIGIT-AT-A-TIME CODER DIAGRAM



(b) DIGIT-AT-A-TIME CODER WAVEFORMS

Fig. 10. Parts of a digit-at-a-time coder (a) with its wave-forms (b).

stopped, the stages can be scanned one after the other as indicated. Once the PCM digits are read out, the counter is reset to zero and the process is repeated on the next channel sample. The pulses can be read out in any desired order.

Suppose, for purposes of comparison of the coder types, that a 12-channel, seven-digit system is assumed with a sampling frequency of 8000 cps. Each channel must be coded once every $1/8000$ sec $= 125$ μsec. Apportioning this interval to the 12 channels allows 10.4 μsec per channel and 1.5 μsec per digit. Even when the entire 10.4 μsec interval is used for the 128 decisions, only 0.08 μsec is allowed per decision. Practically two at least such units are operated alternately in order to permit the full time to be used with the following interval used for readout.

Self compandors may be built into this unit readily, by changing the shape of the linear sawtooth to that of the desired compression characteristic. A single sine wave cycle added to the sawtooth will give a good characteristic.

A decoder generates the same type of linear sawtooth or compressed characteristic. The sawtooth amplitude is sampled when the receiving counter matches the incoming code group.

Digit-at-a-Time Coders

Digit-at-a-time coders are organized so that only a single decision must be made for each digit. They have been compared to an abbreviated game of "Twenty Questions" where only n questions are permitted.[10] The total signal range is first divided into two parts by introducing a reference value corresponding to the weighted value of the most significant digit, and asking the question, "Is the signal in the upper half?" When the answer is "yes," a pulse is sent out. When it is "no," a space is sent.

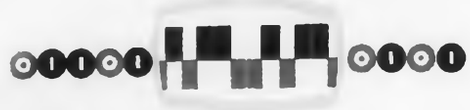
That half containing the signal magnitude is then selected and this range is also split in half by providing a comparison with the weighted value of the second digit and asking the question, "Is the signal in the upper half (of what is left)?" Again a pulse is sent for a "yes" answer and a space for a "no" answer. This establishes that quarter of the total range in which the signal lies. The selected quarter of the range is then divided in half again by repeating the question using the weighted value of the third digit for comparison. This process is repeated until the smallest digit has been determined.

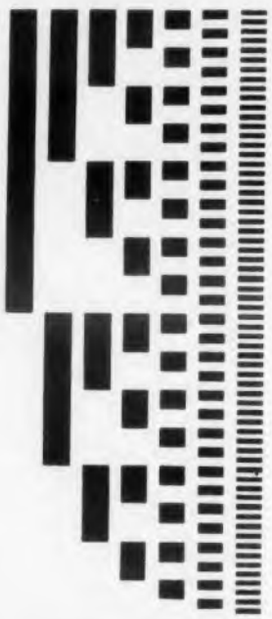
The illustrative coder shown in Fig. 10a is only one of a large number of this class which have been proposed.[11-15] A chain of monostable multivibrators, timing pulsers *1* through *4*, is used to dictate which digit is being coded. These multivibrators produce a sequence of four pulses each one digit interval long, Fig. 10b. When timing Pulser *1* turns on, it triggers the digit *1* control *MV* to the on state. Bistable multivibrators are used for control. This closes current switch *1* (two diodes) thus permitting a standard current of say 10 ma to flow through the binary weighted resistance network. At the same time all of the other current switches which might have been closed are opened. The standard current flowing through the binary network to ground produces a voltage step at one input to the amplitude comparator equal to one-half the peak-to-peak signal range.

Suppose $R = 100$ ohms then $4R + 2R + R + R = 8R = 800$ ohms. A half height step of 8 v results from a current of 10 ma. Probably a larger R would be used in practice.

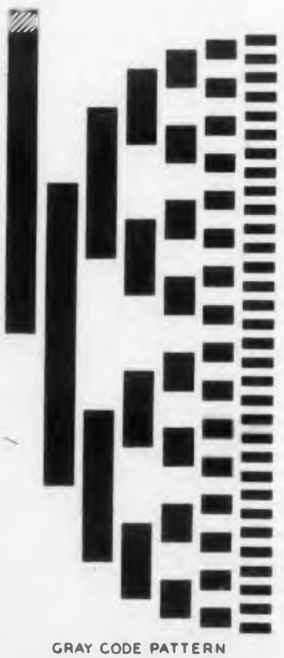
When the voltage across the network exceeds the signal amplitude at the other input of the amplitude comparator, the comparator makes a decision that a pulse should be sent out for digit *1*. Because this decision pulse might be somewhat erratic as to time and shape, a pulse regenerator is used to standardize the signal before transmission. The pulse serves a second purpose. It is fed back through reset switch *1* to turn control *MV 1* off thus opening the current switch and removing the 8-v step. When the voltage across the network is less than the input signal, a space is sent and current switch *1* remains closed for the duration of the coding sequence.

Timing pulser *2* then turns on causing control *MV 2* to turn on and switch the standard current (10 ma) through the network resistors, $2R + R + R = 4R$ to ground. The resulting 4-v step appears at the input of the amplitude comparator by itself if the digit *1* current switch was opened. It adds to the 8-v step to produce a 12-v step when current switch *1* was left closed. Once again the amplitude comparator makes its decision sending out a pulse if the network voltage is





NATURAL BINARY CODE



GRAY CODE PATTERN
(WITH EXTENDED DIGIT 1)

Fig. 11. Gray-code pattern used in beam coder-tubes compared with the natural binary code pattern.

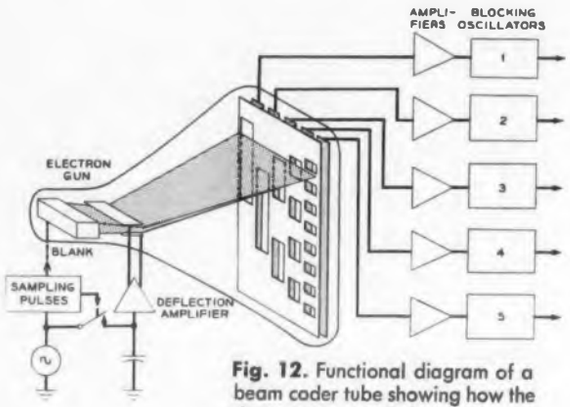


Fig. 12. Functional diagram of a beam coder tube showing how the Gray-code pattern is used.

greater than the stored signal and a space if it is less. When a pulse is sent, it also resets control *MV 2* thus opening the switch and removing the 4-v step.

This sequence of two operations establishes the quarter range with which the signal lies. A similar procedure is followed by switching in each of the following current sources in turn. The final 1-v step is 1/16 of the peak-to-peak range. Note that this successive approximation process has adjusted the network voltage so that the level set by the closure of the switches just does not exceed the signal. At the decoder it is necessary only to cause the corresponding switches to be closed for a similar network in order to produce the quantized output signal.

This type of coder can be arranged so that substantially all of the digit interval is available for decision. Therefore, about 1.5 μsec are available per decision for the twelve-channel example. The digits are transmitted as produced; therefore no read-out time or scanning operation need be provided.

Self-companding may be provided in a number of ways. One way uses feedback to change the standard currents in accordance with the network voltages,[15] using a low ratio of standard current resistor to network impedance,[13] or switching in logarithmic attenuators instead of currents or voltages.[14]

Character-at-a-Time Coder

Character-at-a-time coders employ some form of indexing technique which permits the entire code character associated with a given level range to be determined at once. Each of the digits is uniquely determined by the indexing operation. The individual digits are independent of one another. The decisions can be made simultaneously, so this is the fastest type of coder. Such coders employ, in a sense, a cipher table in which the input signal establishes the position in the table to be examined. Because the digits are independent of one another, the 2^n combinations which are in the cipher table need not be arranged in any logical order.

As a practical matter, however, the Gray code pattern of Fig. 11 is usually used. This code, which was designed by Gray,[16] for use in beam coder tubes, is widely used in both linear and circular position indicators because only one digit at a time is changed in moving from one level to the adjacent level. A functional diagram of a beam tube coder of this type is shown in Fig. 12.

The signals to be coded are first stored on a capacitor by closing the sampling switch briefly at the beginning of each coding interval. The stored signal magnitude is then amplified, and the resulting signal is used to deflect the beam of the coder tube.[17,18]

A rectangular slit gun structure is used in this tube to produce a ribbon beam of electrons which are focused on a Gray code aperture plate near the end of the tube. When a section of the beam passes through a hole in the aperture plate, the current is picked up by one of the collector wires. One wire is stretched behind each digit column.

The individual collector currents are amplified, and the resulting signals are used to trigger the blocking oscillators. These are the independent decision circuits for this particular coder. Normally they have no problem making a decision because the sections of the beam either pass cleanly through a hole to produce a pulse, or hit solid metal so that no current gets through and a space is produced. When a section of a beam rests on an aperture edge, however, only partial current will get through to be amplified.

The blocking oscillator is called on to decide whether the current was less than half the normal peak so that a space should be produced. With the Gray code only one such doubtful decision has to be made at any level, and even if it is made incorrectly, the error produced would be less than one step. The coder tube beam is normally blanked during the time the stored sample is being changed. This chops up the output signals; so that ac coupled amplifiers can be used.

With this type of coder, substantially the entire channel interval is available in which to make the simultaneous decisions and no feedback or other logic operation is called for. A seven-digit coder of this type operating at a 10-mc sampling rate has been used to transmit television signals.[19] Although this rate is sufficient for 1250 voice frequency channels, the problem of gathering together this many PAM samples with adequate crosstalk margin is so difficult that multiplexing and coding smaller groups is more practical. The

large group multiplexing operation should be carried out when the signals are in binary form, thus permitting signal regeneration.

A tube with a conventional pencil beam can be used when only a few dozen channels are to be coded. A single collector is used for the entire aperture plate. The pencil beam is swept or stepped horizontally across the plate to produce each of the digits in turn from a single amplifier and blocking oscillator.

Even though the read-out is sequential, this is still a character-at-a-time coder because the code is defined by the vertical position of the beam. Wave coders use a separate decision circuit for each digit so that a full channel interval is made available for each decision. These are really digit-at-a-time coders in which operations are propagated down a group of serial circuits instead of fed back around a common circuit.

Once the signals are encoded by any method, it is the job of the regenerative repeater to see that the combinations of pulses and spaces are delivered correctly to their destination.

Part 3, the concluding part of this series, will discuss regenerative repeaters.

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digital communications (continuation of a series)

Digital Techniques in Industrial Radio Communications Systems

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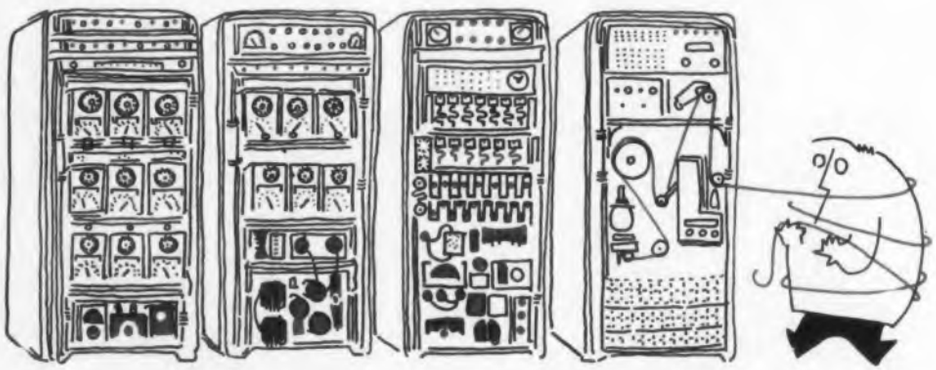
Author Ted Saltzberg takes up in this part some of the more unique and complex systems in use. Part 1 of this two-part article, which appeared in ED, June 8, p 62, discussed basic principles of digital devices and one of the less complex applications.



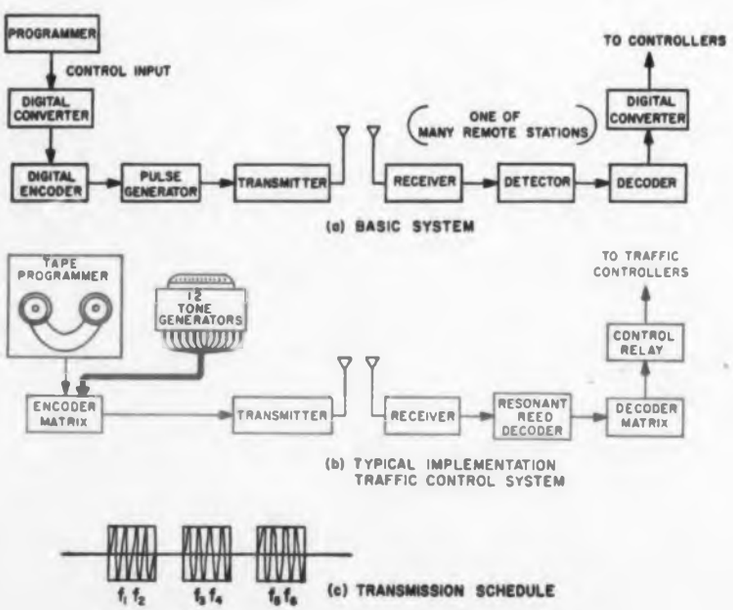


Fig. 1. Block diagram of a one-way traffic control system showing the basic system *(a)*, implementation of the basic system to a traffic control system *(b)*, and the transmission schedule *(c)*.

Part 2

SIMPLE digital systems will not perform all of the functions required in complex processes. As automatic machinery and computers find more applications in industry, the need for direct communication between these devices increases. Design of this complex equipment offers many interesting challenges to engineers.

One Way Traffic Control

Many unique ideas have already been utilized in some of the operating systems. For example, a traffic control system designed to control pretimed intersection controllers from one central point is an excellent example of the use of radio-digital techniques in a remote control application. A major system installation is now operating in Washington, D.C.

The essential elements of a one-way remote control system are shown in Fig. 1. The control input dictates the control action to be taken, and is normally provided by a programing device which may be either manually or automatically operated. The digital converter translates all the input from programing devices employed to a common compatible code.

The digital encoder initiates the generation of the proper coded signals by the pulse generator. At the remote point the coded transmissions are recovered by the pulse detectors and decoded by the digital decoder. Another digital converter relates the state of the decoder to the function to be controlled and initiates the control function.

This traffic control system operates in the 952- to 960-mc band. The radio receiver used in the remote installation is fully transistorized.

To insure reliable operation under the most extreme propagation conditions and to eliminate the possibility of falseing, a coding system is used, based upon transmission of multiple tones of long duration. To initiate a function change at the in-

tersection controller, six separate and distinct audio tones are transmitted in sequence. The duration of each pair is about 1 sec, with a 0.1 sec space between pairs. Thus the total transmission time is slightly greater than 3 sec. The first two pairs of tones designate the address of the intersection being called, and the last pair designates the function to be selected. Twelve distinct tone frequencies are employed, all in the audio band from 300 to 1000 cps. The present system services over 1000 intersections and 36 distinct functions at each intersection.

Remote control of the system is accomplished from a central control point, Fig. 2. An endless loop of punched paper tape, about 1000 ft long, contains a full year's program, including special programs for holidays and special events. The tape is divided into program blocks. Each block includes a time frame which corresponds to the time at which the remote function is to be activated, and a function frame which contains the coding corresponding to the address of the intersection and the function to be controlled. At the time corresponding to the time frame, the function frame is read. As a direct consequence, an encoder matrix is energized which selects six of the outputs of twelve tone oscillators in the proper sequence to generate the pattern corresponding to the desired address and function.

A unique type of pulse detector is employed in the intersection unit. An extremely high-Q, resonant reed relay, with Q in excess of 100, is used as a tone detector. The reed vibrates readily when a signal of the resonant frequency is applied. The amplitude builds up quickly and reaches the point where a small contact wire on the reed touches a contact screw. This intermittently closes a circuit which charges a capacitor.

The charged capacitors supply inputs to a matrix which actuates the proper function relay at the station called.

Status Reporting

Another type of traffic control system employs radio to perform a status reporting function, Fig. 3. The system is essentially a feedback system in which the volume and flow of traffic is sensed and reported to a central processing computer, which in turn determines the sequencing and timing of the signals at the intersections, resulting in expedited traffic control. Both analog and digital computers are being used in current systems to process the sensed traffic volume data, and both analog and digital techniques are employed to convey the control signals to the intersection controllers via radio or wire line.

The sensors employed to detect the traffic may be a variety of devices: radar detectors, infrared detectors, pressure treadles, and pneumatic tubes stretched across the roadway. In general, the rate

Fig. 2. Base station for the one-way traffic control system.

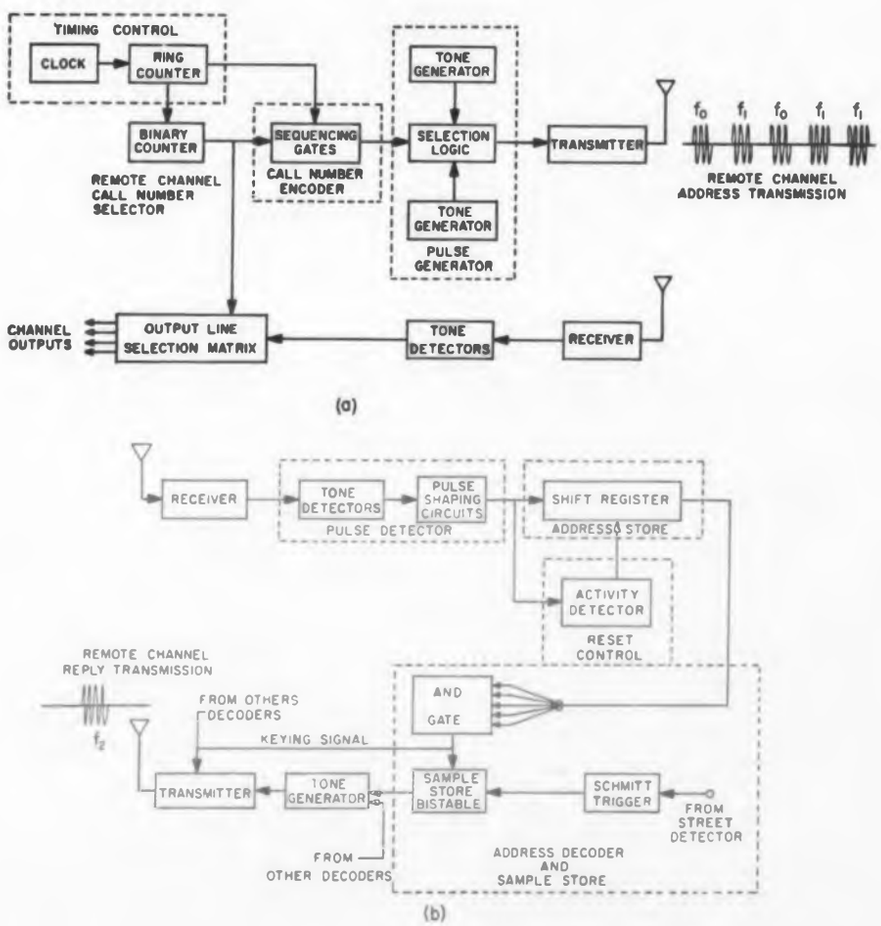


Fig. 3. Traffic control system incorporating status reporting. Base station diagram *(a)* and remote station *(b)*.

at which the detectors are actuated does not exceed one per and one-half per sec.

Two basic ways are available for transmitting this signal to the central processing location: wire line and radio. In a system where a large number of detectors are employed and the distances from the detectors to the central control point are great, radio is most economical.

The radio interconnect system is shown in Fig. 4. It is essentially a time division multiplex system. Each detector location in the system is interrogated at a rate of 1-1/2 sec. A storage element at each location holds the traffic sample until interrogated, whereupon the local transmitter is keyed on and the state of the store is transmitted, then the store is cleared to await the next sample.

System Easily Expanded

The present system is capable of handling 32 remote samplers. A remote station can accommodate the total number of sampler inputs or any part thereof. The only limitation is that the total number of inputs into all remote stations does not exceed 32. The system is easily expanded in multiples of two.

This system operates in the 960-mc band in a simplex mode of operation, which means that all the remote stations and the master station radio equipment share the same operation frequency. Each sampler at each remote station is addressed upon interrogation by the transmission of a unique serial stream of 5 tone bursts. Two frequencies are used, one frequency denotes a "one" value and the other a "zero" value. Since there are 32 combinations of tone bursts, 32 remote points can be interrogated. The pulse transmission rate employed in addressing the remote stations is about 166 pulses per second.

A block diagram of the central station is shown in Fig. 3a. The development of the sequential groups of pulses which correspond to the address of the sampler to be interrogated is accomplished by means of an encoder, which consists of a binary counter, a ring counter, and a group of logic circuits.

The binary counter contains the number corresponding to the address of the remote sampler to be interrogated. The status of the counter is serialized by the ring counter and fed into the pulse modulator. The modulator consists of two tone oscillators which are gated on and off in accordance with the binary counters output to produce the desired sequence of five pulses.

The binary counter also energizes a matrix which couples one of the 32 output lines to the master station receiver. The remote station interrogated will respond with a tone burst when it contains a sample. The tone burst is detected and the resulting pulse is routed to the correct output line. The binary counter is stepped to the next number. The interrogation cycle is then repeated.

The local station block diagram is shown in Fig. 3b. The output of the local station receiver is fed to a pulse detector which converts the tone bursts to dc pulses. These pulses are coupled to a decoder, consisting of a five-stage shift register, which stores the received pulse train until all five pulses have been received. The output of each of the five decoder stages is fed to a decoding module. One such module is associated with each sampler.

The module tests, through logic circuits, whether the decoder contains its address, and, if it does, initiates the readout of a storage bistable, also contained in the module, whose state is dictated by whether a sample has been detected or not during the previous interrogation cycle. If a sample has been stored, the remote station responses with a tone burst.

A resetting device, labeled activity-detector, a part of the control circuitry, resets the decoder to its initial state when no pulse activity appears at the output of the detectors for a prescribed length of time. In this application the activity detector would be adjusted to reset the decoder when a period of inactivity equivalent to one pulse period occurs. Thus the decoder would be reset during the time the local station store is being read out.

Data Gathering

The most general radio communication system employing digital techniques is typified by a radio interrogation system assembled for monitoring an atomic energy test installation area. With the exception of the radio equipment the system is fully transistorized. The system is capable of controlling and monitoring remote functions, gathering and logging the data from a large number of remote radiation and weather measuring stations. While designed for use with radio, the system is compatible with any communication equipment providing a 3000 cps bandwidth. It has the capability of addressing in excess of 1000 individual points. At present 400 of these addresses are assigned to radiation and weather-measuring instruments, the remaining 600 being available for manually initiated supervisory control functions.

Upon interrogation by the master station, the remote station responds with the data of the selected channel. Normally the response will consist of a stream of pulses which will be equivalent to three binary coded decimal digits. The system is capable of handling the direct pulse outputs of Geiger-Mueller radiation detectors and scintillation counters, or the analog output of an ionization chamber. Alarm provisions are included to detect abnormal radiation alarm conditions. The

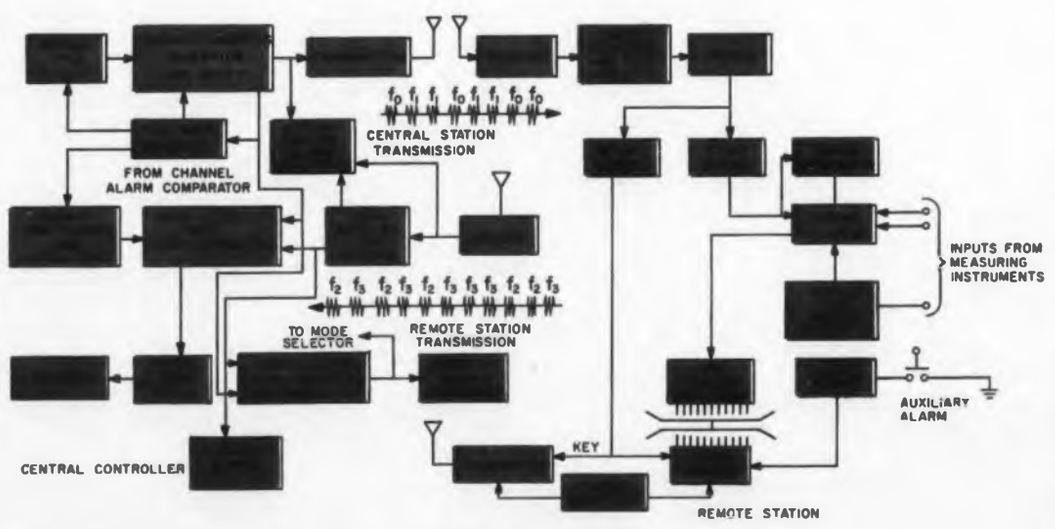


Fig. 4. Block diagram of a complex data gathering system showing the central controller and a typical remote station.

reported data is read out by a typewriter and stored in a punched paper tape.

Readout Equipment Limits Speed

The present system interrogation rate is several hundred data channels in two minutes. Much greater rates are practical with this system. The present rate limitation is due to the inability of the readout equipment to handle the data faster.

The interrogation and response procedure is accomplished in the following manner. Fig. 4 shows a simplified system diagram. Several modes of operation are provided: continuous, selected lesser rates, and manual interrogation.

Channel Checked Every Two Minutes

A sequence of tone bursts is developed at the master station. These correspond to the binary coded decimal equivalent of the call number assigned to a particular channel. This signal frequency modulates the master transmitter and is transmitted to all remote stations. A waiting period elapses, during which the stored data of the selected channel is transmitted, and during which the master station transmits an unmodulated carrier. Upon completion of the waiting period, the next channel in order is interrogated. In continuous mode each channel is interrogated once every two minutes. In each of the selected lesser calling rate modes, all of the channels are called in a period of several minutes. However, the time between each complete group of calls is selected by the operator, up to a period of eight hours.

In practice each transmitted channel call number performs two functions: (1) it initiates the storage of the data associated with the channel to be read out at a later time (2) it initiates the response of the selected channel. Thus at each remote station a decoder determines whether the tone sequence received from the master station corresponds to a radiation detector stored call or the respond call number of the selected channel.

When the decoder recognizes a channel store call, an electronic gate is opened coupling the radiation-detection instrument to a storage circuit for a period 30 sec. During this time the master station continues to transmit channel calls and to receive responses for other channels.

When the remote station decoder recognizes a channel report call number, it keys its associated transmitter. It also initiates a coding process which converts the radiation count, stored in a multiple decade scaler, into an equivalent sequence of tone bursts which in turn modulate the transmitter. At the master station these tone bursts are detected and stored for further processing. The information is retained in storage until it has been read into a paper-tape punch and an automatic typewriter, whereupon it is cleared to await the response of the next selected channel. ■ ■

X-Y Switch Board Speeds Programing, Testing And Breadboarding

THE Sealectoboard, a circuit-switching and component-interposition device, allows instantaneous set-up or programing of circuitry logic between X and Y axes of terminations, without the use of patch-cords. It also allows interposition of diodes and other miniature electronic components between any X and Y termination.

Made by Sealectro Corp. (610 Fayette Ave., Mamaroneck, N. Y.) the board consists of two separate layers of formed, silver-plated, beryllium-copper contacts mounted on plastic boards at right angles and separated by spacers. The two planes of contacts are connected in an X and Y axis configuration to outside circuitry; they may

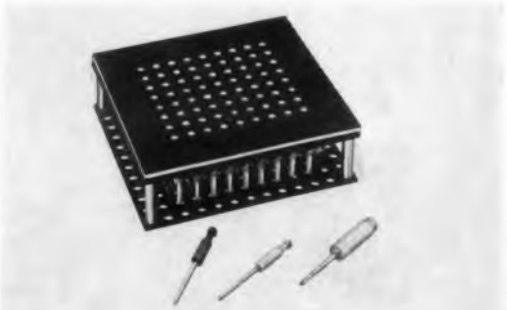


Fig. 1. Sealectoboards are available in any size. Plug-ins are based on 0.25 x 0.25 modules. Shorting plugs and component plugs are available in all EIA colors.

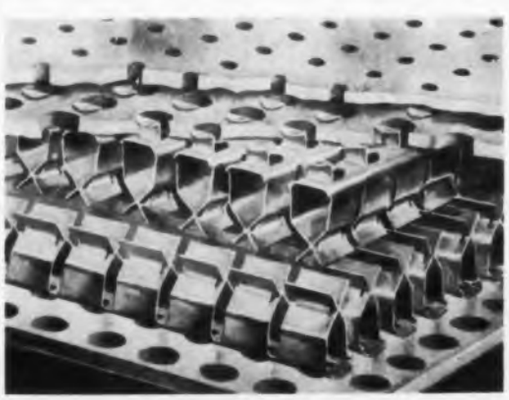


Fig. 2. The boards incorporate two planes of continuous contact strips running at 90 deg to each other, and insulated between planes and between strips.

be connected at any point by the insertion of a shorting plug, eliminating the need for dual pins and patching cord.

Plugs that accommodate such components as diodes are also available. These plugs make contact with the bottom plane contacts, and through an insulated lead, bring the circuit up through the components and return it down through the plug to the upper plane of contacts—thus interconnecting the component between the selected X and Y axes terminations. Component plugs and shorting plugs are interchangeable.

For special requirements, contact strips are available in gold or rhodium-silver plating. Handles or knobs of diode or shorting plugs are available in all EIA colors, permitting color-programing or recording of circuit logic.

The Sealectoboard is available in any size; it can also be had in three-plane models for interconnecting three circuits or three connection components. These plug-ins are based on 0.25 x 0.25 modules.

The boards are rated for a maximum voltage of 500 v dc; they have a maximum flashover rating at sea level, between planes, of 5,000 v. The maximum rated voltage between adjacent strips is 3,500 v dc. Contact resistance is 5 milliohms; maximum current capacity is 5 amp.

Prices on the boards range from 17 to 21 cents per hole, depending on quantity; there is an additional charge for custom requirements. The diode plug is priced at 58 to 86 cents per unit (less diodes), depending on quantity. And the shorting pins are priced between 14 and 20 cents, depending on quantity. Delivery is four to six weeks.

Some typical applications are: analog and digital computers, data processing equipment, automatic testing equipment, telemetry, instrumentation, and automatic telephone communication systems.

For more information turn to the Reader Service Card and circle number 250.

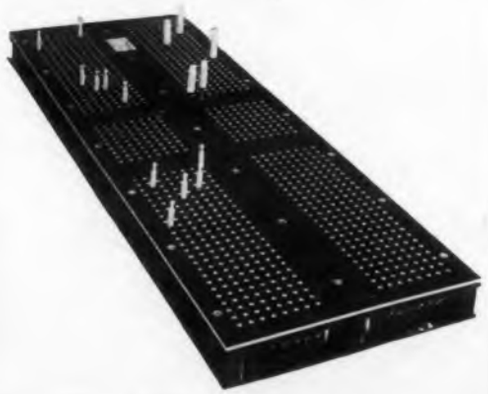


Fig. 3. The shorting plug interconnects upper and lower strip at the desired X-Y intersection. Component plugs permit connecting desired component between the upper and lower socket strip at the desired point.

New Transponders Plus Conventional Transducers Provide Digital Signals

FIRST steps toward truly digital transducers were made with the introduction of two new kinds of low-level transponders no bigger than a cubic inch; they eliminate the need for low-level amplifiers, multiplexers and voltage-to-digital converters. The transponders convert information from conventional thermocouples, strain gages and other transducers into high-level digital signals. Error is reduced; reliability, increased.

Announced at the 7th Region IRE Show in Seattle on May 24 by Electro-Logic Corp. (515 Boccaccio Ave., Venice, Calif.), the new units promise drastic reductions in the cost of telemetering systems. According to Dave Van Mindeno, the company's manager of Applications Engineering, a system with 30 input analog channels, 30 channels of manual preset high-low alarm circuitry and control, 10 channels of digital quick-look presentation and all necessary electronics could be installed for $35,000 instead of the $100,000 or $150,000 it costs now.

Both kinds of transponders are fundamentally magnetic switching devices biased by the transducer voltage. They are driven to saturation on receipt of an external pulse or pulses. The output pulse duration, or pulse train—depending on the kind of transducer—is proportional to the differential between the transducer voltage and saturation.

The TR1 series of transponders have pulse duration outputs for use with a digitizer. In this application, the low-level (order of 15 mv full scale) transducer output is transformed directly into a change in the length of the transponder's output pulse; and, by gating a high frequency crystal-controlled clock to the pulse width, a digital number is generated as a function of the input analog voltage.

In operation, a transponder is connected directly to each transducer. No input amplifiers are needed. By performing the conversion to pulse width, data acquisition is accomplished at the transponder. According to Mr. Van Mindeno, standard techniques using amplifiers, commutators and analog to digital converters require the processing of analog voltages in raw form by the three different elements. The inherent inaccuracies of each device are added together. With the TR1 series, the output is in pulse width form and can be handled from there by standard digital techniques. High-low limit comparison alarms can be set up economically and easily by simple one-level gating with the known limit.

Called a μ-Con by the firm, the TR2 series of transponders accept low-level signals from thermocouples or strain gages and, when interrogated by a strain of high-frequency pulses, release a number of pulses in proportion to the low-level input. (See Fig. 1) Input signals can be as low as 15 mv full scale, the repetition rate of the pulses in the interrogation train can be up to 70,000 pps, and the μ-Con unit can be interrogated up to 20 times a second (depending on pulse rates).

There is a residual number of pulses when the μ-Con's input level is zero. This number, says Mr. Van Mindeno, bears roughly a one-to-five relation to the number of pulses represented by full scale. In the example of Fig. 1, with 512 pulses in the full train, there would be 64 pulses in the residual. An accuracy and repeatability of one part in 448—about 0.2 per cent—would therefore be achieved.

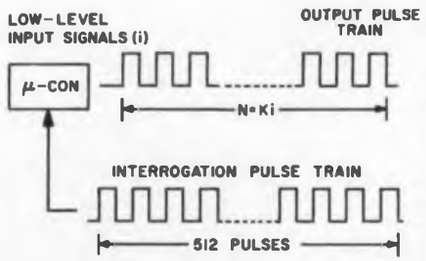


Fig. 1. Output from μ-Con transponder is a string of pulses up to 512 in number (in this example), representing output of transducer. By pre-calibration, number of pulses can be engineering terms for simple readout—290 pulses for 290 F, etc.

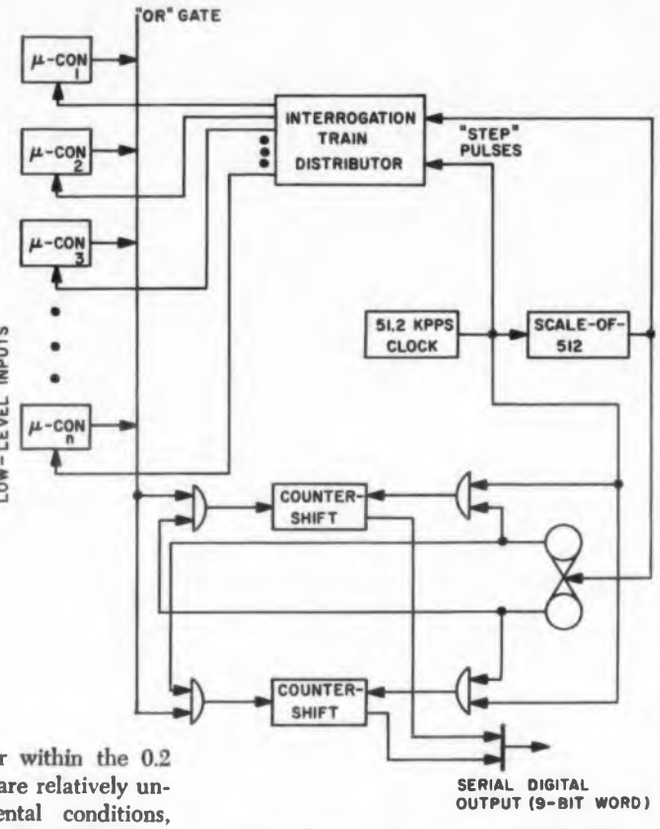


Fig. 2. Micro-Con system of low-level data acquisition uses two shift registers: one is accumulating while the other is clearing. If a computer clock is used instead of the external clock shown, direct computer entry without buffering is possible. Transponders can be interrogated in any order by the interrogation train distributor if suitable circuitry is incorporated.

Micro-Cons are linear within the 0.2 per cent resolution and are relatively unaffected by environmental conditions, says Mr. Van Mindeno. He adds, "they have very high inherent noise rejection—about 80 db—but the usual care must be exercised to avoid single-ended pickup. Essentially current-operated devices, these Micro-Cons are sensitive to changes in the resistance of the input circuits and applied voltage."

By suitable pre-calibration, both the TR1 and μ-Con transponder can provide output data directly in engineering units —deg F or C, psi, etc. In the TR1 series, this is done by varying the pulse duration; in the μ-Con, by varying the number of output pulses from the unit. Constants can be so proportioned that a thermocouple measuring a temperature of 310 F would cause the release of 310 pulses in the output train. If the temperature changed to 290 F, there would be 290 pulses in the output.

Used in a system, the individual μ-Con units are each connected to a low-level transducer. As in Fig. 2, the 51,200 pps clock, Scale-of-512, and the Interrogation Train Distributor function to gate successive burst of 512 pulses to each μ-Con in turn. Since only one μ-Con is interrogated at a time; all others remaining inactive, there is no possibility of crosstalk or interference; the output of all μ-Cons can be routed to subsequent equipment through a simple buffer OR gate.

Sequential pulse trains—with the number of pulses in each train representing different measurements—from the OR gate are alternately gated to one of two counter-shift registers. While one counter-shift is accumulating the pulses from one μ-Con, the other is having its previously accumulated count shifted out on the serial digital output pulse line.

In Fig. 2, 100 inputs would be scanned once each second; if 50 inputs were used, scanning time would be 0.5 sec, and so on. With reasonably good packaging practices, all the logical equipment (except the μ-Cons) and power supplies could be put in 200 cu in. and would weigh about 10 lb.

Many variations of the system of Fig. 2 are possible. If time were taken between samplings to perform the "shift out" operation, the equipment could be reduced in size and weight—one of the shift registers could go. The scanning speed, of course, would be reduced.

For further information on these digital transponders, turn to the Reader Service card and circle number 251.

NEW PRODUCTS

Covering all new products that might generally be specified by an electronics engineer engaged in the design of original equipment.

Microwave Triodes Weigh 1/6 Oz 255

Weighing 1/6 oz, both these microwave triodes are of metal-ceramic construction, with the metal gold-flashed to minimize rf losses. The GL-7391 is designed for Class C service and the GL-7644, for front-end radar service. They have identical outer dimensions, 1 in. long. In typical performance as an oscillator, operating at 5400 mc, the GL-7391 produces 65 mw. Operating in a bandwidth of 7.5 mc, the GL-7644 has a gain of 18.5 db and a noise figure of 4.3 db under matched conditions at 450 mc.

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

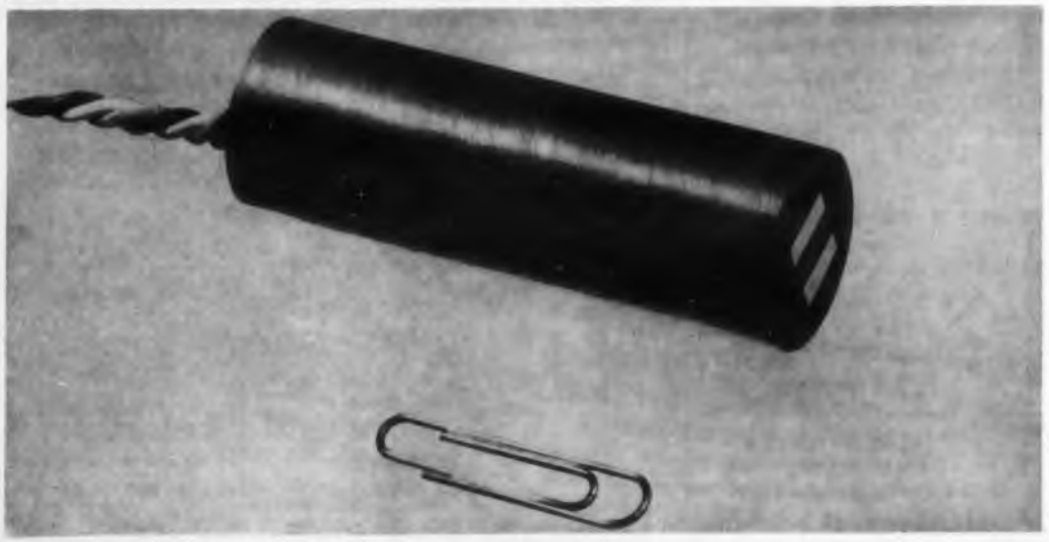
Price & Availability: *Both are available in production quantities; OEM price for GL-7391 is $55; OEM price for GL-6299 is $49.50.*

Switching Transistor's Turn On Time Is 40 Nsec 258

Type 2N706A, silicon mesa switching transistor is an npn unit designed for saturated circuitry and can be used in aircraft and missile circuits. Guaranteed specifications are: dc beta range, 20 to 60; charge storage time constant, 25 nsec max; output capacity, 6 to 5 pf; turn on time, 40 nsec max; turn off time, 75 nsec max: minimum BV_{CEO} of 15 v at a sustaining current of 10 ma; max $I_{CER(rbe=100\ K)}$ of 10 μamp at 20 ▼ V_{CE}.

Texas Instruments Inc., Dept. ED, P.O. Box 312, Dallas 21, Tex.

Price & Availability: *Available in production quantities; $15.70 each for 1 to 99, $10.45 each for 100 to 999. For the 2N753: $18.50 each for 1 to 99, $12.35 each for 100 to 999.*

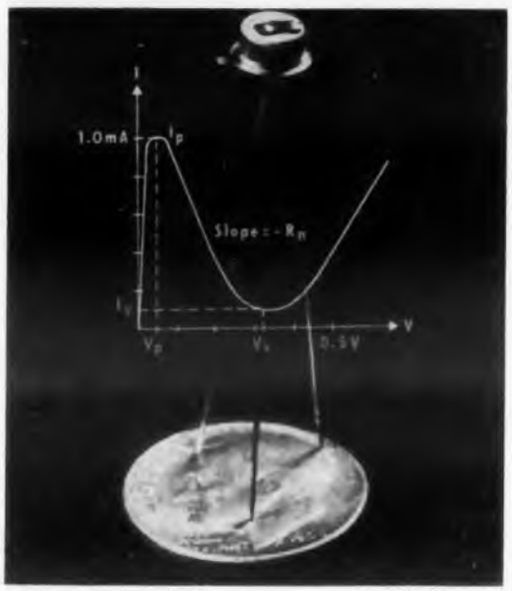


Proximity Switch's Life Span In Millions Of Cycles 257

Having a life span that is rated in millions of cycles, this proximity switch is designed for control of automatic machines. The switch has one moving part, which is opened or closed by the breaking of a magnetic field. No direct contact is necessary for the operation of the switch. It measures 2.5 in. long and less than 1 in. in diameter. The switch may be installed inside machine beds to control travel of the machine back and forth or buried within a punch press die to stop the press whenever it is loaded incorrectly.

Tann Corp., Dept. ED, Detroit, Mich.

Price & Availability: *In volume production by September; $17.50 per unit.*



Tunnel Diodes Designed For Low-Level Switching 256

Designed for low-level switching and small signal applications such as in special counting circuitry, these tunnel diodes are hermetically sealed, germanium units. Peak point current is controlled to provide a peak to valley ratio of 8 to 1. The peak voltage is 55 mv and the valley voltage is 320 mv. Series inductance is 1 mμh and series resistance is 1 ohm. Measured frequency of oscillation is over 1,500 mc.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

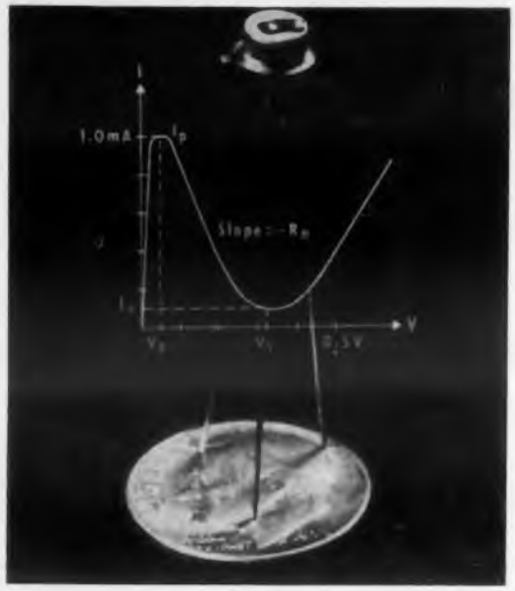
Price & Availability: *Immediate delivery $5.00 per unit in limited quantities.*

Magnet Wire's Insulation Permits Many Applications 259

Called Poly-Thermaleze, this Class A through F magnet wire is claimed to have physical, thermal, electrical, and chemical properties equal to or better than any of the organic film wires now available for coils, motors, and transformers other than oil filled. It is available in a complete range of grades and sizes of rounds, squares, and rectangular wire. It is rated for service at 155 C and its insulation resistance after being in boiling water for 10 min is 500,000 meg. The wire is compatible with varnishes, impregnants and encapsulants.

Phelps Dodge Copper Products Corp., Inca Mfg. Div., Dept. ED, Fort Wayne, Ind.

Price & Availability: *Available immediately from stock; priced the same as Formvar.*



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Phelps Dodge Copper Products Corp., Inca Mfg. Div., Dept. ED, Fort Wayne, Ind.

Price & Availability: *Available immediately from stock; priced the same as Formvar.*

rhodium-iridium/iridium thermocouple is for applications in vacuum or inert atmospheres, also in oxidizing atmospheres, at temperatures up to 3,600 F. The tungsten-rhenium thermocouple, for applications other than oxidizing atmospheres, can be used in temperatures as high as 4,000 F.

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Dept. ED, Wayne & Windrim Avenues, Philadelphia 44, Pa.

Price & Availability: *The rhodium-iridium/iridium is priced at $145.25 for the first 12 in. and $66.50 for each additional 6 in. The tungsten-rhenium is $49.90 for first 12 in. and $10.05 for each additional 6 in. Delivery time is 6 to 8 weeks.*

Environmental Chamber 356

Temperature range is —125 to +400 F

Model WF-12-125+400 environmental chamber is for research and development of dendritic semiconductor materials and other applications requiring precise and accurate temperature control. Adjustable temperature range is —125 to +400 F. A 90-lb load of components is lowered from +355 F to —85 F in 29 min; reverse cycle is the same. Dimensions are 44 x 24 x 19 in. and capacity is 12 cu ft.

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

Gauss Meter 354

Accuracy is 0.5%

This portable gauss meter uses a 6-in. mirror scale, taut band suspension, millivoltmeter. The accuracy of the indicating instrument is within 0.5% and the accuracy of the meter relative to a given master field is ±1%. The instrument has eight overlapping ranges. Indium-arsenide and indium-arsenide-phosphide probes are available for transversal and axial field measurements.

GRH Halltest Co., Dept. ED, 155 S. Morgan Blvd., Valparaiso, Ind.

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Immediate Eastern service at factory prices! Our staff gives you prompt delivery from a large selection of Cannon Plugs!

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CIRCLE 853 ON READER-SERVICE CARD

NEW FROM CANNON

KQ/KR MINIATURE PLUG A new miniature plug designed to meet the severe requirements of today's and future missiles and aircraft. Also adaptable for general purpose applications, these new plugs fill an important industry need. The KQ/KR features a single receptacle which will accept either of two quick coupling devices—a push-pull or a bayonet-lock mating device—and is fully tested for high-altitude performance. Integral construction features crimp-type, probe-proof contacts; monobloc insert-grommet assembly; polarization by multiple keyways.

CIRCLE 854 ON READER-SERVICE CARD

CRIMPEE COAXIAL PLUGS A completely solderless RF coaxial plug using a simplified crimping method for high-speed assembly. Fits many applications, such as mobile communications equipment, ham radio sets, and television master antenna distribution systems. This new CRIMPEE mates with the standard UHF Series of RF receptacles, and is available for five coaxial cables; RG-8/U, 9/U, 11/U, 58/U, and 59/U. An inexpensive crimping tool is provided for quick and easy assembly of the plug to its cable.

CIRCLE 855 ON READER-SERVICE CARD

CANNON/TUCHEL PLUGS Micro-miniature plugs incorporating a completely new operating principle. Electrical contact is made by pushing the pin into a claw-like socket. Contact reliability is increased by means of several springs of diminishing diameter and overlapping each other. This new Cannon/Tuchel construction insures a greater mechanical grip of interlocking parts, provides automatic cleaning of contacts, and increases electrical effectiveness even in the smallest space. These micro-miniature plugs are designed especially for aircraft, portable instrumentation, and other miniature electronic equipment.

CIRCLE 856 ON READER-SERVICE CARD

VIBRATION PROOF CANNON PLUGS

Reliability for Industry • Aircraft • Space Vehicles Cannon's full line of vibration-proof plugs are engineered to meet the most stringent demands of industry, missiles, and aircraft. If you have a problem in vibration, let us provide the answer. From umbilical plugs to the most versatile subminiatures... for any ground or airborne use, Cannon vibration-proof plugs surpass what is expected of them. Another reason why you should always consult the first name in plugs...why you should consult Cannon for all your plug requirements. For information on these or other Cannon products write to:

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 857 ON READER-SERVICE CARD

CANNON PLUGS

NEW PRODUCTS

Side-Mounted Relays 406

Are dpdt type

Type EC side-mounted relays are dpdt type and hermetically sealed. They stand acceleration to 100 g, vibration to 25 g, and mechanical shock to 125 g along all three major axes. The ambient temperature range is −65 to +125 C. Packaged to mount to the circuit board, they have an over-all height of 0.4 in. or less. Life is 100,000 operations at 28 v dc, at 2 amp, non-inductive. On dry cells they provide 10,000,000 operations.

Telecomputing Corp., Dept. ED, 12838 Saticoy St., N. Hollywood, Calif.

Ceramic Tooling Material 569

Stands temperatures to 3000 F

Suited for applications at temperatures to 3000 F, type S-2 ceramic tooling is easily molded using a slip casting technique in plastic molds. The material can be used in brazing and welding fixtures, hot forming dies, sintering boats, and diffusion boats. It can also serve as an encapsulent for rf heating coils and resistance heating elements.

Duramic Products, Inc., Dept. ED, 426 Commercial Ave., Palisades Park, N.J.

Price: A sample kit, including 10 lb of S-2 powder and 1 gal of plastic molding compound, is priced at $27.50.

Solder and Flux Kit 405

For experimental use

For experimental pre-production jobs, the R&D kit consists of 16 kinds of soldering chemicals, 11 kinds of flux-filled and solid wire solders, and 3 foil solders for making preforms. Included are fluxes that meet MIL-F-14256A.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N.J.

Price & Availability: $24 ea; from stock.

CIRCLE 58 ON READER-SERVICE CARD

Channel Analyzer 355

Has automatic programing

Model 20613 channel analyzer has pre-selected automatic programing, a magnetic-tape auxiliary memory, a 600- to 2500-v power supply, a single pushbutton manual operation, and six modes of readout. Any of 12 separate operations, such as accumulate, display, and complement, can be pre-programed on an easily operated programing patchboard.

Radiation Counter Laboratories, Inc., Dept. ED, 5121 W. Grove, Skokie, Ill.

Snap-Action Switch 351

Has bifurcated gold contacts

For use in data processing, radar and radio circuits, this miniature snap-action switch has bifurcated gold contacts. Used in dry circuits, these contacts offer low resistance and good reliability characteristics. The bifurcated contacts move with a wiping action to clean the surfaces with every cycle. Electrical rating of the spdt switch is 5 amp at 30 v dc. Weight is 0.006 lb, operating force is 3 to 5 oz, and dimensions are 1/4 x 1/2 x 3/4 in.

Micro Switch, Dept. ED, Chicago & Spring Sts., Freeport, Ill.

Price & Availability: *$4.75 ea. Small orders are available from stock. Large orders require up to six weeks for delivery.*

Pressure Controller 576

For industrial and military use

Model 57B pressure controller, for industrial and military use, has a 3-kc, 2-w oscillator to supply the pressure transducer with the necessary high-frequency carrier voltage. A meter-amplifier and meter monitor the line pressure or set point. Range on standard units is 0 to 200 psi; other ranges can be furnished.

Micro Gee Products, Inc., Dept. ED, P.O. Box 1005, 6319 W. Slauson Ave., Culver City, Calif.

Price & Availability: *Price is $2150 ea. Delivery time is 30 days.*

CIRCLE 59 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Control

Dynamic range is over 60 d

Type S-14 servo control has a trol accuracy of less than 3% tion in controlled level for sy resonances up to 50 db. Dyn range is over 60 db. The rea time is less than five cycles for a correction of 10-db gain reduc It is suitable for use in vibr testing.

Ling-Altec Electronics, Inc., I ED, 1515 S. Manchester, Anal Calif.

Tape Joining Equipment

Requires no heat or adhesive

This polyester film and tape ing equipment requires no preparation, external heat, or a sives. High-frequency mecha vibration creates heat only at joint interface. The process is a cable to audio and video tape, puter tape, and packaging film sheets. The equipment can be with materials 6 mils thick. power supply operates from 1 ac or from nickel-cadmium batt

International Ultrasonics, Dept. ED, 1697 Elizabeth Rahway, N.J.
Price: From $600 to $900.

Decade Amplifier

Range is 1 cps to 3 mc

Model 140-B decade amp has a response from 1 cps to a 40-v output, and a 10-meg impedance. It also has a low level, low output impedance, self-contained power supply t electronically-regulated. Gain 10, 100 and about 700 can be sw selected. The unit is suitable fo in vibration studies. It is ava as a chassis unit, in a cabinet, a rack panel.

H. H. Scott, Inc., Instrument Dept. ED, 111 Powder Mill Maynard, Mass.
Price: $99.50 to $105.

licator Lights 573

With wire-wrap terminals

ll Tec-Light neon or incandes- indicators are furnished with -wrap terminals. The lights are ished with permanent or re- eable lamps and in standard transistor driven types.

ransistor Electronics Corp., Dept. 3357 Republic Ave., Minneapo- 6, Minn.

***ilability:** Delivery time is three ks.*

lvanometers 400

lave 14-karat gold suspension

hese galvanometers have 14- t gold suspension for stability accuracy. A sensitivity of 0.5 μa mm is possible in bar and core gnet models. Coil resistances of to 1000 ohms are standard. Fif- n units are included in the stand- line. Special light-beam units h a sensitivity of 0.04 μa per mm also be furnished.

Winslow Co., Dept. ED, 701 Le- h Ave., Union, N.J.

essure-Sensitive 579 ipe

Is 0.006 in. thick

or use from −100 to +400 F, Temp-R-Tape pressure-sensitive e is 0.006 in. thick. Made of lon and having a high dielectric ength, tape is for use in color- ing in electrical applications.

The Connecticut Hard Rubber Dept. ED, 407 East St., New ven 9, Conn.

***ice & Availability:** For immediate livery, the tape is priced at $5.22 18-yd roll, 1/4 in. wide.*

CIRCLE 61 ON READER-SERVICE CARD

NEW PRODUCTS

Random Noise Generator 364

Has "pseudo-rms" metering circuit

Model 811-B random noise generator has uniform output and a "pseudo-rms" metering circuit which reads identically on sine waves and white noise. It provides an output of at least 2.5 v rms on all ranges, and response is from 2 cps to 1.5 mc. A meter input jack enables its meter to be used for measuring other signals. It is available as a chassis unit, in a cabinet, or on a 19 x 5-1/4 in. rack panel.

H. H. Scott, Inc., Investment Div., Dept. ED, 111 Powder Mill Road, Maynard, Mass.

Price & Availability: *Prices from $195 to $205.*

Storage Tube 360

Has 2.75-in. diameter

Type K1938 direct view storage tube is 2-3/4 in. in diameter. Over-all maximum length is 9-11/16 in. from the face to extremity of the 14-pin low-leakage type base. Writing speed is as high as 100,000 ips and resolution is 50 lines per in. It has a storage time of 2 min, erase time of 50 msec, and brightness level of 3,000 ft-L at 8 kv.

Allen B. Du Mont Labs., Inc., Electronic Tube Div., Dept. ED, 750 Bloomfield Ave., Clifton, N. J.

Price & Availability: *Price is $1,725 ea for sample orders. Quantity orders negotiated, price under $1,000. Can be delivered 8 weeks after receipt of order.*

Chopper and Transformer 376

For commercial test and control applications

Model C-1800 chopper and input/output transformer is specifically designed for commercial test and control applications such as dc amplifiers, comparators, null indicators, and servo systems where signals as low as 1 mv must be identified. This component combination can be used as a null indicator, modulator, or demodulator. Coil voltage is 6.3 v ±10% rms; contact circuit is spdt and base fits standard octal socket. Life in excess of 2,500 hr can be expected in most applications. The associated series A-1500 transformers are of a 4-winding, 8-terminal balanced design to permit step up or step down application with series or parallel impedance combinations.

James Electronics Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

Price & Availability: *Chopper is priced at $11.95, transformer at $5.75. Both units available from stock or firm's industrial distributors.*

Tape Reader 403

Reads up to 60 lines per sec

For reading out information stored on perforated paper, plastic, or metallic tapes, model 100 tape reader is for line-by-line reading at speeds to 60 lines per sec. A motor containing a printed-circuit armature can be started and stopped several hundred times a second. The tape reader has only one moving part. Its dimensions are 10-3/4 x 8-3/4 x 9 in.

Photocircuits Corp., Dept. ED, 31 Sea Cliff Ave., Glen Cove, N. Y.

NEW PRODUCTS

Solderless Terminal Blocks 397

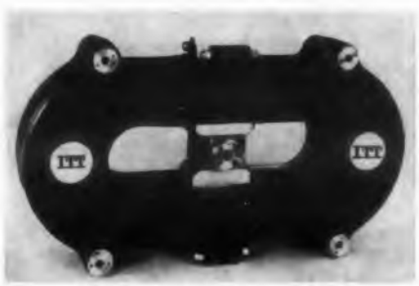
For taper pin terminals

Series 100-53 solderless terminal blocks have molded-in, taper pin receptacles for protection from shock and vibration. The receptacles are reamed to accommodate standard AMP-53 taper pin wiring terminals. Any combination of feed-through individual or shorting circuitry can be furnished.

Precision Connectors, Inc., Dept. ED, P. O. Box 96, Mineola, L.I., N.Y.

Magnetron 396

Range is 34,400 to 35,400 mc

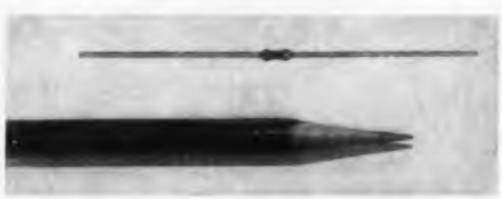


This magnetron tube is a fixed frequency oscillator operating in the 34,400-to-35,400-mc range. For use in radar and other electronic systems, the unit has a peak, pulsed output of 100 kw and a maximum average power of 40 w. The anode and cathode stem structures are forced-air cooled.

ITT Components Div., Dept. ED, 100 Kingsland Road, Clifton, N. J.

Carbon Film Resistor 404

Rated at 0.1 w at 125 C



This precision, carbon-film resistor is rated at 0.1 w at 125 C. Maximum rated voltage is 250 v

and the resistance range is 10 ohms to 300 K. Dimensions are 0.25 in. in length and 0.093 in. in diameter. The unit has a high temperature impact and a moisture resistant coating. No. 22 leads and silver-plated compression caps are used. It is for applications where good protection against mechanical abuse must be provided for and is available with an extra molded-plastic jacket.

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

Availability: *Delivery time is 16 days after receipt of order.*

Overpressure Transducers 392

Withstand 1500 psi

This series of pressure transducers, ranging from 0 to 25 up to 0 to 300 psi, is designed to stand 1,500 psi without shift or damage. The sensor design needs no auxiliary cut-off valving equipment. The units are for control, telemetry, and propulsion pressure measurement systems. Model 101, shown, measures 2.75 x 3 in. and is suited for differential pressure measurement applications involving the introduction of high pressures to the sensor and the instrument case.

White Avionics Corp., Dept. ED, Terminal Road, Plainview, L. I.

Price & Availability: *Delivery is in 8 to 10 weeks.*

Shaft-Position Encoder 358

Speed is up to 2000 rpm

Type 82 add-subtract Rotopulser performs a range of bidirectional measuring and control functions such as machine tool positioning, welder electrode positioning, and coil-winding. The unit converts mechanical motion into electrical pulses at up to 1200 counts per rotation. Speed range is 0 to 2000 rpm. Remote operation is possible up to 100 ft from control equipment. The unit measures 3.5 in. in diameter and 2 in. long. It weighs 20 oz.

Dynapar Corp., Dept. ED, 7312 N. Ridgeway Ave., Skokie, Ill.

Price & Availability: *Price is $725 to $975 ea; delivery is in 15 to 30 days.*

NEW PRODUCTS

DC Power Supply 571

Output is 12 kv at 1 ma

Model PS-12-S miniature power supply, designed to operate at 114 v ac at 60 or 400 cps, 1 ma continuous current, provides an output of 12 kv at 1 ma. Ripple is 0.75% at rated current and regulation from no load to full load is 7%. Output voltage is variable from zero to rated output, by varying the input voltage. Selenium rectifiers are used. Dimensions are 3-3/4 x 4-9/16 x 6-1/2 in.

Film Capacitors, Inc., Dept. ED, 3400 Park Ave., New York 52, N.Y.

Lamp Annunciators 574

For industrial use

These industrial lamp annunciators detect and indicate, visually and audibly, any abnormal condition or change in status. From the information received, they can start up or shut down machinery, feed information to data-logging or other control equipment, and, finally, reset themselves. They have plug-in circuits that can be easily removed and changed for different operations. Dimensions vary from 1 x 3 x 1-1/2 in. to 2 x 2 x 3 in.

Edwards Co., Inc., Dept. ED, Norwalk, Conn.

Silicon Varactor Diodes 566

For microwave use

These high-cut-off, silicon varactor diodes are for low-noise parametric amplifier receiver applications and other uses at microwave frequencies through 10,000 mc. Type 4296 is specified as 120 kmc min and type 4298, 150 kmc min. Both are housed in a fixed-polarity ceramic cartridge. In parametric amplifier applications noise is under 2 db at 3000 mc. Stray capacitance is about 0.4 pf and series lead inductance is about 3×10^{-9} h.

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

Availability: *Delivery time is about 20 days.*

◀CIRCLE 69 ON READER-SERVICE CARD
CIRCLE 912 ON CAREER INQUIRY FORM, PAGE 221▶

Expanding the Frontiers of Space Technology

in GROUND SUPPORT EQUIPMENT

FLIGHT TEST CHECKOUT
– Lockheed engineers monitor automatic checkout equipment in final check of test missiles prior to shipment to Cape Canaveral or Vandenberg AFB for development flights.

Ground support equipment development at Lockheed Missiles and Space Division has encompassed an unusually broad area, ranging from the problems involved in the unique water environment of the Navy POLARIS FBM to the more conventional land-launched missiles and satellites.

Thus, the Division is involved in the design, development and operation of shipping, handling, assembly, checkout, erection and launch control units and systems in all their mechanical, electrical and electronic aspects.

Electrical and electronic equipment designed by the Division includes items tailor-made to checkout missile subsystems before flight; the major portion of electrical equipment used at the launch pad; the complex equipment needed to receive and record telemetry flight data; and such mechanical ground handling equipment as fuel handling and transfer units, transporter erectors, handling dollies and trailers, mobile servicing and handling units, and rolling stations. One such special digital comparator system checkout known as ACRE/Flight Test, developed by Lockheed, saves from 10 to 15 thousand man hours in final checkout of each missile, allowing complete checkout in approximately one-fourth the time needed by other methods.

Excellent opportunities are available at Lockheed in this rapidly growing field for personnel experienced in mechanical, electrical and electronic design; packaging; instrumentation; digital computer programming and analysis; modification and checkout; ground handling equipment; controls and communication; circuitry; prototype fabrication; test; and air conditioning.

If you are experienced in one of the above areas, or in related work, we invite your inquiry. Write: Research and Development Staff, Dept. F-21, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIF. • CAPE CANAVERAL, FLA. • ALAMOGORDO, N.M. • HAWAII

POLARIS CONTAINER TRANSPORT
– Specially designed carrier for Navy-Lockheed POLARIS missile and container, can quickly, efficiently transport missile over smooth or rough terrain. Container is fitted with shock absorbers and controlled for temperature, pressure and humidity.

NEW PRODUCTS

RF Voltage Calibrator 389

Has a 1% accuracy to 10 mc

For use with rf signal generators and vacuum tube voltmeters, the Megavolter rf voltage calibrator obtains readings of 1% accuracy to 10 mc, 2% to 50 mc, and 3% to 200 mc. It measures from 1 mv to 1 v rms over the frequency range of 1 kc to 200 mc. The input impedance is 50 ohms, constant.

Kay Electric Co., Dept. ED, M ple Ave., Pine Brook, N. J.

Availability: *Units will be furnished from stock by September 1960.*

Power Supplies 395

Three models offered

Model 1000 supply, for use with photomultiplier tubes, Geiger tubes, and experimental devices, provides 500 to 3700 v dc. The unit is line-regulated to 0.1% and weighs 4 lb. Model 2000 has a 0.1% line regulated output of 105 to 125 v. Model 3000 supply is rated at 20 ma, 360 v. Ripple is 4 mv. This unit is for small amplifiers, photocells, voltage reference tubes, and silicon diodes. All models have a secondary winding that is insulated for 6000 v.

Electronic Lights, Dept. ED, 1713 N. Ashland, Chicago 22, Ill.

Availability: *45-day delivery time.*

High Voltage Connectors 359

Ratings to 300 kv

Gases, oils, and vapors can't penetrate fluormetic hi-voltage connectors even when cycled

repeatedly over a temperature range from —100 F to +400 F under 100 psig. They have good corona, arc and osmic resistance, and operate under a humidity of 100%.

The Joclin Manufacturing Co., Lufbery Ave., Wallingford, Conn.

Price & Availability: *Price depends upon design. All units made to customer specs. Can be delivered 30 to 45 days after order received.*

Micro-Microammeter 372

Accuracy is 2% of full scale

Model 415 micro-microammeter incorporates high-speed circuitry for rocket and satellite experimentation. It can be used for current measurements in ion chambers, photo-multipliers, gas chromatography, and mass spectrometry. A speed response of less than 600 msec to 90% of final value at 10^{-12} amp is possible where external circuit capacity is 50 pf. Accuracy is 2% of full scale on 10^{-3} through 10^{-8} amp ranges, and ±3% of full scale on 3×10^{-9} through 10^{-12} amp ranges. Zero suppression, up to 100 full scales, permits full scale display of 1% variations of a signal. It is capable of detecting current of approximately 1×10^{-14} amp, has a zero drift of less than 2% full scale per day, and supplies 1 v at 1 ma.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

Price & Availability: *Price is $750 fob Cleveland.*

Strain-Gage Plotter 398

Scans and records 20 channels per sec

Model 221 strain-gage plotter scans and records 20 channels per sec and plots in multiples of 96 channels. It automatically plots individual graphs for each channel while the test is in process. There are three zero positions per channel, separate range selectors, and separate gage-factor selectors. The unit can be used for plotting on pressure vessels, rocket engine casings, and other structures. Switching is by means of heavy-duty, large contact, rotary, multi-deck switches.

Gilmore Industries, Inc., Dept. ED, 13015 Woodland Ave., Cleveland 20, Ohio.

Availability: *Units are made on order and have a delivery time of 150 days.*

NEW PRODUCTS

Multi-Deck Thumbwheel Switch 367

Rotary type

Series TMBD-P-10 multi-deck 8-, 10-, or 12-position thumbwheel switches are available with 2, 3, or 4 XXXP or epoxy printed-circuit modules. These consist of any combination of binary and digital rotary thumbwheel switches all annually operated by a single 1/4-in. thumbwheel. Contacts are precious metal alloy and mounting frames, corrosion-protected aluminum. One number at a time is exposed through bezel opening.

Chicago Dynamic Industries, Inc., Precision Products Div., Dept. ED, 1725 Diversey Blvd., Chicago 14, Ill.

Price & Availability: *Available immediately on standard types; 60 days on lighted types.*

Portable Test Chamber 362

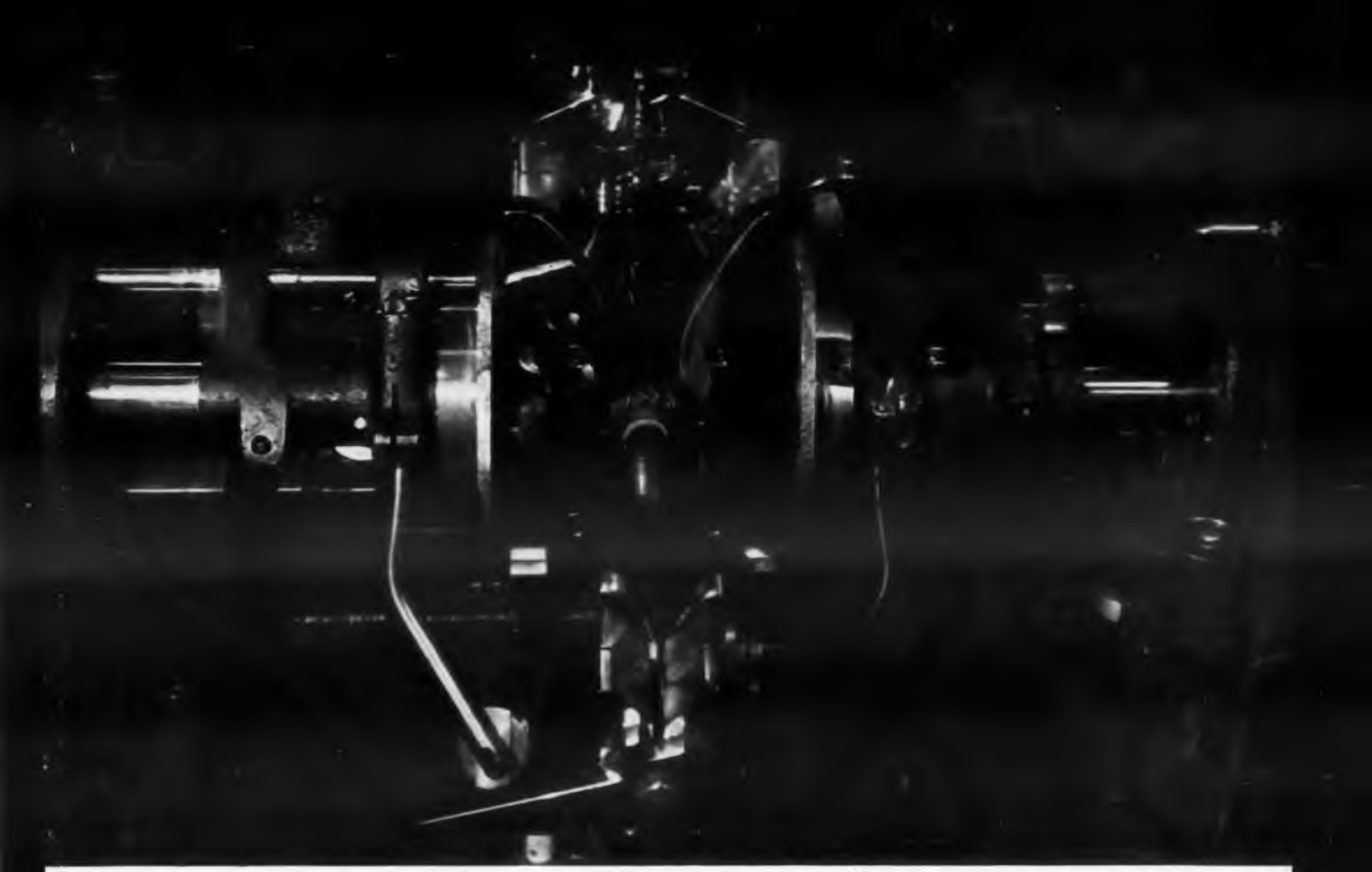
Range is —100 F to +500 F

Model 7000A precision test chamber, which accommodates rack-mounted electronic equipment, has prolonged temperature runs with stability to within 0.5 F over the range of —100 F to +500 F. The unit has an internal test volume of 19-1/2 x 11 x 15 in. It can be preset for automatic hot-cold cycling at alternate temperature levels.

Delta Design, Inc., Dept. ED, 7460 Girard Ave., La Jolla, Calif.

Price & Availability: *Price is $1125 each. Delivery seven days after receipt of order.*

CIRCLE 76 ON READER-SERVICE CARD



For more details on Anaconda Nylac's unique combination of useful characteristics, please turn the page—

When you must wind fast, tight, and meet high temperatures, too,

SPECIFY NYLAC SOLDERABLE MAGNET WIRE

The faster you wind and the tighter your space factor—the more you should consider the advantages offered you by Anaconda Nylac Magnet Wire.

For Nylac is Anaconda Analac with a tough, Nylon film outer covering. The Nylon provides outstanding slipperiness and abrasion resistance—these tight-winding characteristics enable you to make compact, easily shaped, uniform coils.

Yet Nylac incorporates many features of Analac. For example, it gives you easy, fast solderability without stripping. It also has excellent moisture resistance.

In addition, Nylac offers you high dielectric strength, high thermoplastic flow temperatures, excellent flexibility, resistance to hot varnishes and potting compounds. *And—it meets all 130°C (AIEE Class B) requirements.*

So by combining Nylon, an old and industry-accepted insulation, with a newer but thoroughly proven film covering—*Analac*—Anaconda's *Nylac* is a new solderable Class B Magnet Wire especially designed to overcome the strains of today's high-speed winding equipment and tight space factors.

The next time you face these and other winding problems, contact your nearest Anaconda Wire & Cable Sales Office. Our technical staff and Research and Development Laboratory facilities are available to give you every assistance possible. See the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.

6U263

Ask the man from

ANACONDA®

about

NYLAC MAGNET WIRE

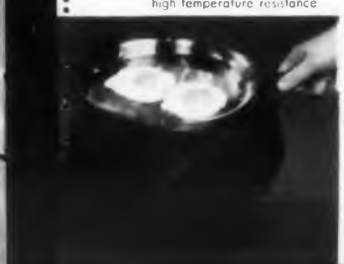
ANATHERM 155°C (AIEE Class F) high temperature resistance

EPOXY 130°C (AIEE Class B) superior compatibility

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

FORMVAR 105°C (AIEE Class A) proven dependability

ANALAC 105°C (AIEE Class A) solderable magnet wire



Important Facts about NYLAC MAGNET WIRE

Anaconda® Nylac film-coated magnet wire has a Nylon enamel outer surface over a film of Anaconda Analac (polyurethane) insulation. Nylac is a solderable wire that meets 130°C (AIEE Class B) thermal test requirements. It has outstanding windability and varnishability for severe process conditions, and exhibits excellent heat shock characteristics.

TECHNICAL PROPERTIES

ELECTRICAL PROPERTIES

Nylac has high dielectric strength. It has excellent electrical properties for all applications except high "Q" coils where dissipation factor should be as low as possible.

DIELECTRIC STRENGTH

Moisture environment of sample	Volts per mil of insulation
Dry	3580
Room Conditions	2560
Six hours at 100% relative humidity at 100°F	1310

DIELECTRIC CONSTANT AND DISSIPATION FACTOR

(Measured with capacitance bridge)

Frequency Cycles Per Second	Dielectric Constant		% Dissipation Factor	
	35°C	100°C	25°C	100°C
10^2	3.5	10.7	2.4	11.4
10^3	3.4	8.9	2.2	21
10^4	3.5	6.2	2.8	18
10^5	3.3	4.8	2.8	6

MECHANICAL PROPERTIES

Nylac is a strong flexible insulation. It adheres well to the conductor. Nylac wire survives severe abrasion, stretch and flexing in high-speed, high-tension winding operations due to the tough Nylon overcoat. The wire will take short radius corner bends without cracking.

CHEMICAL PROPERTIES

Nylac has outstanding resistance to chemical attack. It will withstand 24 hours' immersion at room temperature in solvents including naphtha, Xylol, ethyl alcohol, chlorothene, methanol, and in 5% sulfuric acid and 1% potassium hydroxide.

THERMAL PROPERTIES

THERMAL STABILITY

Nylac meets the 130°C (AIEE Class B) requirement. Graph 1 indicates 20,000 hours' life at 135°C for unvarnished samples. Varnished sample data, available on request, indicates over 30,000 hours at 130°C.

Nylac is not recommended for use where severe thermal overloads may be encountered.

NYLAC MAGNET WIRE UNVARNISHED AIEE 57 TEST

HEAT SHOCK
1 HR. AT 155°C

Prestretch	Mandrel Diameter (Multiple of Wire Diam.) 1x	3x	5x	10x
0%	pass	pass	pass	pass
10%	pass	pass	pass	pass
15%	pass	pass	pass	pass
20%	pass	pass	pass	pass
25%	pass	pass	pass	pass

Thermoplastic flow temperature

265°C using 5°C per minute rate of rise

SOLDERABILITY

Nylac wires solder without pre-stripping at practical solder temperatures.

Wire Size	Time-Seconds	Solder Temperature	Sample
15—18	15	360°C	Twisted
19—25	10	360°C	Pair
26—30	4	360°C	Wrap on
31—46	4	360°C	20 gage mandrel

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

ANACONDA WIRE & CABLE COMPANY
25 Broadway, New York 4, N. Y. ED

I am interested in learning more about the excellent properties of Nylac Magnet Wire. Please send me your new technical booklet DM5928.

NAME & TITLE .....

COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

Fused-Quartz Foam 683

For use at 2500 F

Designated Eccofoam Q, this low-loss, low-dielectric, fused-quartz foam is for use at 2500 F. It is essentially pure silicon dioxide and weighs about 12 lb per cu ft. At microwave frequencies, the dielectric constant is 1.2 and the dissipation factor is below 0.001. The material is particularly useful in microwave devices such as windows, radomes, and antennas. It is supplied in blocks 10 x 15 in. with thicknesses of 1, 2, and 3 in.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Cold-Cathode Register Tube 386

End-view type

The Digitron GR 10H cold-cathode register tube is an end-view type unit. It operates on 250 ac or dc and takes less space than conventional tubes.

Baird-Atomic, Inc., Dept. ED, 33 University Road, Cambridge 38, Mass.

Price & Availability: *Production quantities can be supplied after June 15. Price is $23 ea when ordered in quantities of 1 to 24 and $20 ea, in quantities of 25 to 99.*

Ultrasonic Cleaners 635

For a variety of applications

Ranging from units equipped to clean minute parts to those for large industrial installations, these ultrasonic cleaners may be used singly or unitized for specific manufacturing or maintenance procedures. Applications include removal of foreign matter from semiconductors, crystals, vacuum tubes, printed-circuit elements, and electronic assemblies.

C & E Marshall Co., Dept. ED, 1445 W. Jackson Blvd., Chicago 7, Ill.

Price & Availability: *Units that are in stock range from $100 to $1170 in price. Custom designed units can also be furnished.*

◀ CIRCLE 76 ON READER-SERVICE CARD

NEW PRODUCTS

Power Supply 442

For instrumentation, telemetering, and recording

For instrumentation, telemetering, and recording systems, this 5-w power supply comes in three models having outputs of 5, 10, and 15 v dc. Input is standard airborne 115 v at 400 cps. Dual magnetic regulation consists of a flux oscillator and a magnetic amplifier regulator. Requirements of MIL-E-5272A are met.

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

Price & Availability: *$392 ea when ordered in quantities of one to four; from stock for three-week delivery.*

Magnet Wire 623

Film-insulated

This 50-gage single-enamel film-insulated magnet wire is designed for use in subminiature relays, missiles, rockets, computers, and synchro motors. A one-pound spool holds 335,000 ft of wire.

Viking Wire Co., Inc., Dept. ED, Danbury, Conn.

AC Dielectric Test Sets 453

Are rated at up to 10,000 v

The Hywatt Hypots include eight models of portable ac dielectric testers with outputs ranging from 1500 v ac at 0.5 kva to 10,000 v ac at 1 kva, continuous duty ratings. Intermittent ratings are about twice the continuous ratings. Uses are de-

termining insulation breakdown in equipment such as power circuits, motors, generators, transformers, and capacitors. Operation is from 115 v ac at 50 or 60 cps, single phase.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price & Availability: *Units are built to customer specs. Price is from $535 ea.*

Carrier Amplifiers 590

Provides an excitation signal of 6.5 v rms

Model 688 carrier amplifier provides an ac excitation to transducers, such as linear or rotary: variable differential transformers and strain-gage bridges, which require an excitation signal of 6.5 v rms at 5 kc. The unit also amplifies, demodulates, and measures the output signal from the transducer. It can be adapted for use with specific pressure, position, rotational strain-gage, flow, and other transducers.

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

Price & Availability: *$625 fob Waltham; 45 days after receipt of order.*

Coaxial Trimmer Capacitors 378

Are rated at 3000 wvdc

The ME series coaxial, trimmer capacitors with insulating washers are rated at 3000 wvdc. The units have low stray capacitance and good linearity. They are precalibrated to any value within their range to ±0.5% and operate from −55 to +125 C. The units are of bonded, one-piece construction and are suitable for commercial, industrial, and military uses.

Marstan Electronics Corp., Dept. ED, 204 Babylon Turnpike, Roosevelt, L.I., N.Y.

Price & Availability: *$1.25 to $8.45; from stock to two weeks.*

NEW PRODUCTS

Data Transmission System 368

For multiplexing up to seven channels

The data transmission system, consisting of a transmitter and a receiver, is for multiplexing up to seven channels of three-wire synchro data for fm transmission over long distances. The system is suited for continuous transmission from remote radars of azimuth, elevation, and range data in aircraft, missile tracking, and acquisition applications. Construction is modular.

Feedback Controls, Inc., Dept. ED, 8 Erie Drive, Natick, Mass.

Reference Diodes 508

Are rated at 0.5 w

This series of 0.5-w, temperature-compensated reference diodes provides a stable 9-v reference source. Designated types 1N935 through 1N939, the units operate from −65 to +175 C with stability limits as low as ±0.0005% per deg C. They measure about 1/3 x 1/10 in. and are suited for use in such devices as digital voltmeters, oscillators, frequency meters, analog-to-digital converters, and power supplies. The hermetically-sealed, glass package meets MIL-E-1 and MIL-S-19500.

Motorola Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Gyro Tester 518

Simulates azimuth, roll, and pitch

This gyro test table is designed to simulate azimuth, roll, and pitch motion with each axis operating independently. Sinusoidal motion, variable amplitude, and variable cycles are provided for each axis. The table is offered with one of these ranges: ±20 deg amplitude on either side of center at 0.1 to 10 cycles per min; ±10 deg amplitude on either side of center at 0.5 to 60 cycles per min; and ±2 deg amplitude on either side of center at 3 to 300 cycles per min. The

Now pick the instrument that exactly meets your needs and order by model number!

MODEL 840
DC Volts/DC Ratios

MODEL 848
DC Volts/Ratio With Electrical Outputs

MODEL 841
DC Volts/DC Ratios/Resistance

MODEL 849
DC Volts/DC Ratios/Resistance With Electrical Outputs

MODEL 842
DC Volts/DC Ratios/AC Volts

MODEL 850
DC Volts/DC Ratios/AC Volts With Electrical Outputs

MODEL 843
DC Volts/DC Ratio/AC Volts/Resistance

MODEL 851
DC Volts/DC Ratio/AC Volts/Resistance With Electrical Outputs

MODEL 844
DC Volts/Ratio/DC Pre-Amplifier

MODEL 852
DC Volts/Ratio/DC Pre Amplifier With Electrical Outputs

MODEL 845
DC Volts/Ratio/Resistance/DC Pre-Amplifier

MODEL 853
DC Volts/Ratio/Resistance/DC Pre Amplifier With Electrical Output

MODEL 846
DC Volts/Ratio/AC Volts/DC Pre Amplifier

MODEL 854
DC Volts/Ratio/AC Volts/DC Pre-Amplifier With Electrical Outputs

MODEL 847
DC Volts/Ratio/AC Volts/Resistance/Pre-Amplifier

MODEL 855
DC Volts/Ratio/AC Volts/Resistance Pre Amplifier With Electrical Outputs

Many variations of these basic models including AC ratiometers, milliohmmeters, microvoltmeters and specialized measuring instruments tailored to individual systems requirements are available in the same physical configurations.

Ask your [E-I] sales office or representative for complete information.

Faster conversion times, higher input impedance, greater accuracies, plus all of the other specifications you wanted in a digital multimeter!

DC VOLTAGE SPECIFICATIONS: Apply to all instruments incorporating the pre-amplifier

Range:	±.00001 to .09999; .0001 to .9999; 1.000 to 9.999; 10.00 to 99.99; 100.0 to 999.9 v
Accuracy:	0.02% ±1 digit for 10 microvolt range of .00001 to .09999 v; 0.01% ±1 digit from .0001 to 999.9 v
Input Impedance:	1000 megohms up to 9.999 v; 11 megohms up to 999.9 v
Average Reading Time:	50 milliseconds
Operating Ambient Temperature:	0-50°C
Maximum Source Impedance:	5 K ohms on 10 microvolt range only; noncritical all other
Automatic Features:	Ranging, polarity

DC VOLTAGE SPECIFICATIONS: Apply to all instruments except those incorporating the pre-amplifier

Range:	±.0001 to ±.9999; ±1.000 to ±9.999; ±10.00 to ±99.99; ±100.0 to ±999.9 v
Accuracy:	0.01% ±1 digit
Input Impedance:	1000 megohms to ±9.999 v; 11 megohms to ±999.9 v
Average Reading Time:	50 milliseconds
Max. Balance Time:	200 milliseconds
Operating Ambient Temperature:	0-50°C
Automatic Features:	Ranging, polarity

DC RATIO SPECIFICATIONS: Apply to all instruments measuring DC ratios

Range:	.0000 to .9999*
Accuracy:	±1 digit
Input Impedance:	1000 megohms
Average Reading Time:	50 milliseconds
Max. Balance Time:	100 milliseconds
Reference Voltage:	10 volts ±10% (nominal)
Reference Input Impedance:	1000 megohms
Operating Ambient Temperature:	0-50°C

*With properly chosen reference supply, ratios of up to 100 times unity may be measured.

AC VOLTAGE SPECIFICATIONS: Apply to all instruments measuring AC voltages

Range:	.0000 to .9999 VAC; 1.000 to 9.999 VAC; 10.00 to 99.99 VAC; 100.0 to 999.9 VAC
Accuracy:	0.1% and two digits
Frequency Response:	30 cps to 10,000 cps
Input Impedance:	1 megohm shunted by 30 mmfd up to 9.999 VAC; 10 megohms shunted by 30 mmfd up to 999.9 VAC
Average Reading Time:	2 secs. low freq.; ½ sec. high freq. (400 cps and up)
Operating Ambient Temperature:	0-50°C
Automatic Features:	Ranging

RESISTANCE SPECIFICATIONS: Apply to all instruments measuring resistances

Range:	000.1 ohms to 999.9 ohms; 1000. ohms to 9999. ohms; 10.00 K ohms to 99.99 K ohms; 100.00 K ohms to 999.9 K ohms
Accuracy:	0.01% ±1 digit to 99.99 K ohms; 0.03% ±1 digit to 999.9 K ohms
Average Balance Time:	200 milliseconds
Operating Ambient Temperature:	0-50°C
Automatic Features:	Ranging (decimal point placement)

ELECTRICAL OUTPUT SPECIFICATIONS: Apply to all instruments incorporating electrical outputs

• Both 2-4-2-1 Binary Coded Decimal and 10 Line Coded Decimal are provided

table handles a 10-lb load and re
quires 115 v ac.

Royal Industries, Inc., Vard Div.
Dept. ED, 3850 Wilshire Blvd., Lo
Angeles, Calif.

*Availability: Units are made o
order and can be delivered 15
days after receipt of order.*

Gallium-Arsenide Varactor Diode 522

Cut-off frequency is 60 kmc at −2 v

Type XD500 gallium-arsenide diffused-junction varactor diode has a cut-off frequency of 60 kmc at −2 v and 110 kmc or greater at breakdown voltage. Encased in a reversible-polarity, double-ended, ceramic microwave package, the unit has a junction capacitance of 0.1 to 1 pf at zero bias, a Q-factor of 30 at 2 kmc and at −2 v, and a Q-factor of 45 at 2 kmc and at −6 v. Gallium arsenide offers high mobility at room temperature and reduction in noise.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

***Price & Availability:** Price is $433. Sample quantities can be furnished immediately.*

Transistor Tester 520

Accuracy is 0.5%

The SATT semiautomatic transistor tester is able to perform 30 to 60 tests per second and has an accuracy of 0.5%. It automatically measures significant parameters and compares the results against specifications for the individual types of transistors. All measurements are made with the transistor in a single-test position. The transistors are sorted in order of priority, depending on response, for audio, rf, or switching applications. The instrument can be modified for testing resistors, capacitors, diodes, tubes, printed cards, and subassemblies. The unit is furnished with 10 programing boards.

Monitor Systems, Inc., Dept. ED, Fort Washington Industrial Park, Fort Washington, Pa.

***Price & Availability:** Basic price is $22,500; delivery time is 120 days.*

◀ CIRCLE 82 ON READER-SERVICE CARD

HIGH PRECISION, SUBMINIATURE POTENTIOMETERS FOR MISSILES AND AIRCRAFT...

FOR EXTREME PRECISION IN MINUTE PACKAGE... single-turn potentiometers are available that provide maximum reliability and precision in units from 25% to 40% smaller than competitive models... the world's smallest ten-turn pot is also available in this line.

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Series 319 gangable potentiometers

Series 341 multi-turn high precision potentiometers

Model 304 subminiature single-turn potentiometer

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PACIFIC DIVISION

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MINIATURE WIRE-WOUND GANGABLE POTS (Model 319) solve many complex phasing, reliability, space and linearity problems. Each ganged section is ⅞" x ¼" high and is ganged without clamping rings for exceptional stability. By means of an exterior access opening, each wiper is independently adjustable through 360°. Maximum reliability is ensured by a rugged plastic body, even step linearity, fine resolution, low noise characteristics and long life over a range of 100 ohms to 200K.

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For complete specs on these extraordinary units, contact our Representative in your area, or write for Data File ED-1119-1.

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CIRCLE 83 ON READER-SERVICE CARD

◀ CIRCLE 84 ON READER-SERVICE CARD

NEW PRODUCTS

Pressure Transducers 607

Temperature stability is 0.01% per deg F

Type R pressure transducers, using Ni-Span-C Bourdon tubes as the sensing element, provide temperature stability of 0.01% per deg from —65 to +350 F. Multiplication of movement without pivots or linkage provides 1% linearity and hysteresis as low as 0.5% for the 100 psi range. Vibration tolerance is 1% for 10 g at 2000 cps and acceleration causes a 1% max shift at 50 g. Power rating is 0.7 w at 70 C. Pressure range of the seven models offered is from 0 to 100 psig up to 0 to 5000 psig. Weight is 3.5; units are suited for missile and aircraft applications.

International Resistance Co., Control Components Div., 401 N. Broad St., Philadelphia 8, Pa.
Price & Availability: *$175 ea for quantity orders. Delivery is in three to four weeks.*

Vane Axial Blower 449

Delivers 220 cfm of air

Operating on 115 v at 60 cps, type GR vane axial blower delivers 220 cfm of air at 1.75 in. of water static pressure and 3.5 cfm at 0 in. back pressure. Maximum current of free air delivery is 1.8 amp. Speed is 8000 rpm. The unit weighs about 4.5 lb and measures 4-3/4 in. in diameter and is 6-3/8 in. long. Housed in a black anodized aluminum enclosure, the blower can meet Mil specs.

Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.
Availability: *Units are made on order and can be delivered in 90 days.*

NEW PRODUCTS

Precision Thermostat 476

Opens or closes on temperature rise

Designed for electronic heating or cooling applications, the Klixon 4286 low-differential, precision thermostat opens or closes on temperature rise. It is for use as a control device in guided missiles, aircraft control, computers, and crystal ovens. Continuous temperature exposure limits are −65 to +270 F; the temperature setting range is 0 to 250 F. Approximate weight is 3.5 g.

Texas Instruments Inc., Metals and Controls Div., Dept. ED, 34 Forest St., Attleboro, Mass. *Price & Availability: Price is $4.25 ea when 100 to 249 units are ordered. Delivery is in two to three weeks.*

Pulse Generator 628

For laboratory, commercial, or military systems

This fully transistorized, programed pulse generator can be used in laboratory equipment or in commercial or military digital systems. Typical uses are in computer development, data handling systems, simulation of radar and sonar range targets, delaying scope sweeps, and system programing. Able to generate accurate delay pulses and gating waveforms with pre-selected periods and pulse bursts, the unit allows for selection of number of pulses in any sequence.

Universal Data Systems, Inc., Dept. ED, Valley Stream, L.I., N.Y.

Traveling-Wave Tube 554

For X-band use

Model 206 10-kw traveling-wave tube, operating from an input of less than 500 mw, is for use over the frequency range of 8.4 to 9.4 kmc.

The magnetic focusing and rf slow-wave structure are integral, permitting a high-current density beam to be focused with magnets weighing 2.5 lb. The tube is small and lightweight and stands extreme shock and vibration.

Watkins-Johnson Co., Dept. ED, 3333 Willview Ave., Stanford Industrial Park, Palo Alto, Calif.

Price & Availability: *Price is $14,850 ea or $11,450 ea for orders of two to five. Delivery time is 60 days.*

Power Supply 556

Provides 10 to 32 v at 0 to 15 amp

Type SCRT 32-15-1 transistorized power supply delivers an output of 10 to 32 v dc at 0 to 15 amp with both sides floating with respect to ground. Regulation is provided by silicon rectifiers. Dynamic response is less than 100 mv transient spike for 100 μsec for a ±2% step change in load current and less than ±1 v transient spike for 0.1 msec for a step load change from 15 to 0 amp. Ripple is less than 1 mv rms.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mt. Vernon, N.Y.

Price & Availability: *$650 ea; from stock.*

Power Supply 608

Delivers 0 to 36 v at 0 to 15 amp

This power supply delivers 0 to 36 v dc at 0 to 15 amp. Regulation is 0.1% or 3 mv, stability is 0.1% or 6 mv, and ripple is less than 1 mv rms. Temperature coefficient is less than 0.05% per deg C. Recovery time is 50 μsec. Required input is 105 to 125 v ac at 60 cps. The transistorized unit measures 8-3/4 x 19 x 13-7/8 in.

Kepco Inc., Dept. ED, 131-38 Sanford Ave., Flushing 55, N.Y.

Price & Availability: *Price is $825 for the unmetered model. $30 more for the metered model. Delivery time is 60 days.*

NEW PRODUCTS

Scaler and Timer 443

Provide staircase outputs

Consisting of the N-803 crystal-controlled timer and the N-276 scaler, this scaler-timer provides preset counts in 15 settings of 10 to 500,000 counts and preset time in 15 settings of 1 to 50,000 sec. Both the scaler and timer have staircase outputs for operation of a digital printer. A binary-coded decimal 1-2-2-4 output can also be provided. The scaler and timer can be used independently.

Hamner Electronics Co., Inc., Dept. ED, Princeton, N.J.

Availability: *From stock.*

Thermal Switch 603

Responds to tip temperature

Called the Tip-Stat, this thermal switch responds to tip temperature rather than to shell temperature. Typical applications are in aircraft generators where the device serves to actuate a control when the windings reach a dangerously high temperature. It operates from −20 to +550 F and employs a spring-loaded inner cartridge. Reaction time is less than 0.5 sec and temperature differential is 1 to 2 F. Repeatability is ±1 F. It weighs 0.9 oz and is rated at 1.5 amp at 28 v dc and 115 v ac, resistive load.

Control Products, Inc., Dept. ED, 306 Sussex St., Harrison, N.J.

Price & Availability: *$37.50 ea; delivery time is 8 to 10 weeks.*

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CIRCLE 70 ON READER-SERVICE CARD

NUMBER 5—RELIABILITY SERIES

Bourns Trimpot®
Puts the Proof in Humidity-Proof

Plunging a potentiometer into near-boiling water is just one of the ways Bourns puts the proof in humidity-proof. Every Trimpot unit made takes this 60-second bath with the water simmering at 90°C. Air expanded by the heat creates four pounds of pressure inside the potentiometer—enough to cause bubbles—if it leaks. Only if the unit is completely leak-free does it pass the test.

Bourns humidity proofing starts at the beginning—with original design and selection of materials. The plastic chosen for Trimpot cases, for example, displays the unusual properties of high insulation resistance and extremely low moisture absorption.

Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot does more than "resist" moisture; it keeps moisture out.

For more information about the industry's largest selection of humidity-proof adjustment potentiometers—wirewound and carbon in a variety of sizes, power ratings, operating temperatures, etc.—write for new Trimpot summary brochure and list of stocking distributors.

Exclusive manufacturers of Trimpot®, Trimit®, and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

CIRCLE 71 ON READER-SERVICE CARD

NEW PRODUCTS

Arc Resistance Tester 445

Provides 15 kv at 60 ma

Model 8540 arc resistance tester provides 15 kv at 60 ma ac for testing the ability of solid electrical insulating materials to resist the action of an arc in accord with ASTM Spec D-495 and Federal Spec LP406B. The bench-type instrument is suited for laboratory and production quality control applications. Voltage control is continuously variable from 0 to 15,000 v.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price & Availability: *Price is $2250. Units are built to customer requirements.*

Coaxial Circulators 582

For operation at 1400 mc

Designed to operate at 1400 mc, model X-101A broadband, three-port circulator has better than 15 db isolation from 1200 to 1500 mc and a peak isolation in excess of 20 db. Ratios of isolation to insertion loss are high over better than 10% bandwidths in the range of 1 to 2 kmc. From 1200 to 1500 mc the insertion loss is 1 db; at band center it is typically 0.5 to 0.6 db. The unit can be provided with an electromagnet for applications requiring a switchable unit.

Melabs, Dept. ED, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Availability: *Delivery time is 30 to 45 days.*

Thermocouple Cable 552

This multiple-conductor extension-wire cable for all thermocouple calibrations has a polyvinyl-over-polyvinyl insulation. Temperature limit is 221 F. The cable is made in 16 and 20-gage wire in 4 to 48 pairs twisted with a variable pitch.

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Dept. ED, Wayne & Windrim Avenues, Philadelphia 44, Pa.

Epoxy Adhesive 553

Meta-Bond 321 can be applied to metals, ceramic, glass, cement, and all other stable temperature materials. It is 100% epoxy and has excellent electrical insulation properties.

Metachem Resins Corp., Dept. ED, 530 Wellington Ave., Cranston 10, R. I.

Transistor Outline Template 555

No. 319 has cut-outs for 27 sizes of transistors, using registered designating numbers, sizes, and specs. The template measures 9-1/2 x 5-1/2 in.

Rapidesign, Inc., Dept. ED, P.O. Box 429, Burbank, Calif.
Price: *$3 ea.*

Soldering Kit 676

The kit includes four jars of paste solders, each with a different type of flux. Fluxes range from neutral rosin to highly-activated rosin. Each paste solder is 60% tin and 40% lead solder alloy.

Fusion Engineering, Dept. ED, 17921 Roseland Ave., Cleveland 12, Ohio.
Price & Availability: *$15 ea; from stock.*

Crystal Can Relay 559

For use in a printed-circuit socket, this 4-pole relay can operate in ambient temperatures to 125 C and meets Mil specs for shock and vibration. Design is compact.

Branson Corp., Dept. ED, 41 S. Jefferson Road, Whippany, N.J.

Hot and Cold Air Blower 557

Model E-1 blows air at room temperature or at 170 F. Velocity of air is 11,500 cfm. The unit removes moisture and dust from electronic parts.

Ace-Sycamore, Inc., Dept. ED, 448 De Kalb Ave., Sycamore, Ill.
Price: *$87.50 ea.*

Sulfur-Copper Alloy 558

Amsulf has high machinability and conductivity. It is suited for switches and electrical components, soldering iron tips, and electrical connectors.

American Metal Climax, Inc., AMCO Div., Dept. ED, Rockefeller Center, New York 20, N.Y.

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A new "teaching machine," specifically designed to meet the needs of complex modern industrial and military programs has been developed by Western Design, Division of U. S. Industries, Inc., Goleta, California. Called the "Tutor," the new automated device housed in an EMCOR Sloped-Front Console Cabinet ensures active participation by the student, while simultaneously grading his work and timing his performance. The use of an EMCOR Modular Enclosure in housing the nerve center of the "Tutor" presents a compact and centralized control center. Human engineering features of the Modular Cabinet design bring all equipment within easy reach and sight of the operator. The flexible, versatile and structural capabilities of over 600 basic frames of the EMCOR MODULAR ENCLOSURE SYSTEM solve the daily packaging problems of industrial and military design engineers.

Condensed Version of catalog 106 available upon request

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Originators of the Modular Enclosure System

Ingersoll PRODUCTS DIVISION
BORG-WARNER CORPORATION
630 Congdon Avenue Elgin, Illinois

CIRCLE 94 ON READER-SERVICE CARD

NEW PRODUCTS

RF Transistor Test Set 560

For both npn and pnp transistors

For measuring rf parameters of both npn and pnp transistors, model 1802 test set provides direct readings of the alpha cut-off frequency and gain bandwidth product for junction transistors up to 50 mc. It also provides direct readings of the RC product and the collector output capacity. The instrument is line-operated and needs no auxiliary equipment.

Dynatran Electronics Corp., Dept. ED, 178 Herricks Road, Mineola, N.Y.

Zone Melting Apparatus 634

For zone refining and leveling

Model Z-83 zone melting apparatus, for zone refining and leveling, is offered in 3- or 5-ft bed sizes. It can be used with inert atmospheres or connected to a pump for vacuum operation. Speeds are variable from 0.1 to 18 in. per hr. Return is 2 in. per sec. The carriage can be set from 1 to 28 in.

MRC Manufacturing Corp., Dept. ED, 47 Buena Vista Ave., Yonkers, N.Y.

Price & Availability: *$2575 ea; 15-day delivery.*

Corona Test System 549

Detects and measures corona

This complete system for detection and measurement of corona detects and displays on an oscilloscope any trace of corona, whether caused by voids within an insulating structure, insufficient clearances, or other defects in material or completed assemblies. The detector is a high-

gain, wide-band amplifier which feeds a high-sensitivity oscilloscope. A corona meter is optional.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price & Availability: *Price ranges from $2995 to $3645 ea for one to five-unit orders. The units are made on order only.*

Electronic Counters 589

Measure 10 cps to 1.2 mc

Types 523CR and 523DR electronic counters directly measure frequencies from 10 cps to 1.2 mc, time intervals from 1 μsec to 10^6 sec, and periods from 0.00001 cps to 100 kc. Stability is 2 ppm per week. Sensitivity is 0.1 v. The 523CR has an in-line readout and the 523DR has a readout of six columnar neon indicators.

Hewlett-Packard Co., Dept. ED, 275 Page Mill Road, Palo Alto, Calif.

Price & Availability: *Type 523CR is priced at $1485 and can be delivered in seven weeks. Type 523DR is priced at $1285 and can be delivered in two weeks.*

Miniature Isolator 581

S-Band type

Model X-114 miniature isolator provides a minimum of 10 db isolation from 2700 to 3100 mc with less than 1 db insertion loss. Over the same bandwidth the vswr is 1.2:1. Suitable for airborne applications, the unit weighs 6 oz and measures 1 x 1-1/2 x 3-1/2 in. including TNC connectors.

Melabs, Dept. ED, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Availability: *Made on order, units can be furnished in 30 to 45 days.*

NEW PRODUCTS

Magnetic Disc Storage Unit 564

Disc type

Called Memo Disc, this storage unit consists of a magnetic storage disc with wired heads and air supply. Both 16- and 12-in. discs are available; from 1 to 100 heads can be provided. Servo-pneumatic read and write heads are capable of following surface irregularities that would make a fixed-head storage drum unusable. The unit can provide for packing densities up to 400 bits per in.

Aeronutronic, Computer Marketing, Dept. ED, Ford Road, Newport Beach, Calif.

Electron-Tube Tester 601

Accuracy is ±2% for mutual conductance

This electron-tube tester incorporates a mutual conductance measuring circuit that makes possible an accuracy of ±2%. The unit contains a built-in calibration circuit. For complete tube analysis under any standard or non-standard operating conditions, 13 multi-range meters are provided. Five independent power supplies are also furnished. A short-continuity test circuit provides a simultaneous visual display of any or all existing short circuit conditions. A grid current meter provides for analysis of all components of grid current resulting from gas, leakage resistance, or secondary emission.

Westmore, Inc., Dept. ED, 137 South Ave., Fanwood, N.J.

Price: $2645 fob New Jersey.

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CIRCLE 99 ON READER-SERVICE CARD ➤

FROM **Transitron**...INDUSTRY'S BROADEST LINE OF

CONTROLLED RECTIFIERS & SWITCHES

SILICON CONTROLLED RECTIFIERS are now available in both the 7/16" hex and 11/16" hex base packages. Replacing thyratrons and magnetic amplifiers in many applications these rugged devices offer greater reliability and increased efficiency. Some typical applications are:

- industrial control
- lighting control
- solid state inverters
- overvoltage protection
- short circuit protection

Write for Bulletin TE-1356

TYPE	PIV	Max. average amps Forward current at 25°C case	at 100°C case	Hex size of Package
TCR 520	50	20	10	11/16
TCR 1020	100	20	10	11/16
TCR 1520	150	20	10	11/16
TCR 2020	200	20	10	11/16
TCR 2520	250	20	10	11/16
TCR 3020	300	20	10	11/16
TCR 3520	350	20	10	11/16
TCR 4020	400	20	10	11/16
TCR 510	50	10	5	11/16
TCR 1010	100	10	5	11/16
TCR 1510	150	10	5	11/16
TCR 2010	200	10	5	11/16
TCR 2510	250	10	5	11/16
TCR 3010	300	10	5	11/16
TCR 3510	350	10	5	11/16
TCR 4010	400	10	5	11/16
TCR 505	50	5	2	7/16
TCR 1005	100	5	2	7/16
TCR 1505	150	5	2	7/16
TCR 2005	200	5	2	7/16
TCR 2505	250	5	2	7/16
TCR 3005	300	5	2	7/16
TCR 3505	350	5	2	7/16
TCR 4005	400	5	2	7/16

THE TRANSWITCH is a new bi-stable silicon computer element that can be turned *OFF* with a gate current. Extremely uniform electrical characteristics over a wide current range (2-50 ma) permit the device to fulfill low level logic and medium power needs. The device is designed for:

- miniaturized memory circuit
- ring counters
- shift registers
- controlled rectifier driver
- flip-flop equivalent

Write for Bulletin TE-1357A

SPECIFICATIONS AND TYPICAL CHARACTERISTICS (at 25°C Unless Otherwise Stated)

		Typical	Maximum		Test Conditions
Saturation Voltage	V_s	1.0	1.5	Volts	I_c = 50 mA
Forward Leakage Current	I_F	0.1	10	μA	AT RATED VOLTAGE
Reverse Leakage Current	I_R	0.1	10	μA	AT RATED VOLTAGE
Forward Leakage Current	I_F	20	50	μA	at 125°C
Gate Voltage to Switch "ON"	$V_{c\ on}$	0.7	1.0	Volts	R_L = 1 K
Gate Current to Switch "ON"	$I_{c\ on}$	0.1	1.0	mA	R_L = 1 K
Gate Voltage to Switch "OFF"	$V_{c\ off}$	1.2	4.0	Volts	I_C = 50 mA
Gate Current to Switch "OFF"	$I_{c\ off}$	7.0	10	mA	I_C = 50 mA
Holding Current	I_H	2.0	5.0	mA	R_L = 1 K

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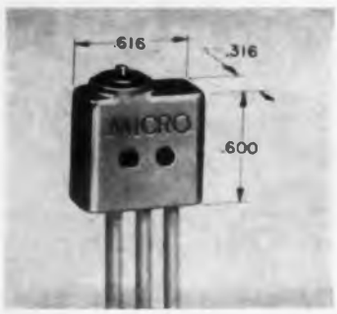
NEW PRODUCTS

Miniature Switch 596

Is rated at 4 amp, inductive, at 28 v dc



Measuring 0.616 x 0.6 x 0.316 in. and weighing 0.2 oz, Type 1 XE1 spdt switch is rated at 4 amp, inductive, at 28 v dc and 5 amp at 115 or 230 v ac at 60 cps. It is suited for mobile, marine and aircraft applications. Leadwires are furnished in 1, 3, 6, and 12-ft lengths.

The switch mechanism and extending leadwires are embedded in epoxy resin inside a corrosion-resistant, aluminum housing.

Ambient temperature range is −65 to +230 F.

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

Price: *List price is $8 ea; discounts are offered for quantity orders.*

DC Amplifiers 606

Have 1-ma outputs

Models M-10 and M-10A multipurpose, chopper-stabilized dc amplifiers have current outputs that are proportional to millivolt inputs.

They operate from inputs of 0 to 5 and 0 to 10 mv, respectively, with a 5-meg input impedance.

Outputs are 0 to 1 ma for use with a 0 to 1 ma meter-movement recorders and meters so that signals from strain gages, remote thermocouples and other transducers in the range of 0 to 2 cps

can be measured. Accuracy is 1%, linearity is 0.5%, and drift is less than 50 mv referred to the input. A trim adjustment provides precise calibration for loads of 0 to 5000 ohms.

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

Price & Availability: *$135 fob Houston; immediate delivery.*

Electron-Beam Vaporizer 630

For refractory metal-coating applications

Model EBV-3 electron-beam evaporating unit vaporizes all metals including those with high melting points such as tungsten, tantalum, and molybdenum. The unit can be installed in laboratory or commercial vacuum equipment that operates at 3×10^{-4} mm of mercury or lower. Applications are in research and development and volume production of coatings for miniature circuitry. The unit includes an electron-beam gun, extra filaments, power supply, control panel and feed-throughs. It is rated at 250 ma at 10 kv and operates from 120 v ac at 15 amp.

The Alloyd Corp., Dept. ED, 32 Cambridge Parkway, Cambridge 42, Mass.

Price: *Including field engineering service, $4500.*

High-Pressure Seals 631

Temperature range is —160 to +500 F

Hexseals, high-pressure seals for toggle switches, pushbuttons, and rotating shafts, operate over the temperature range of —160 to +500 F. Made to meet MIL-B-005423A and MIL-B-19257, the units are of one-piece construction: silicone rubber bonded chemically and mechanically to a lock nut. Rotary shaft seals can be supplied for shafts up to 0.5 in. OD.

Metal Process Co., Dept. ED, 1801 First Ave., New York 28, N.Y.

Availability: *From stock.*

Pulse-Producing Switch 622

Snap-action type

Type 1PD1 pulse-producing, snap-action switch is designed for industrial applications where momentary opening or closing of a circuit is necessary. It is suited for controlling pneumatic valves where permanent-duty solenoids are not used. The spdt switch is rated at 10 amp at 125, 250, and 480 v ac, at 0.5 amp at 125 v dc, and at 0.25 amp at 250 v dc.

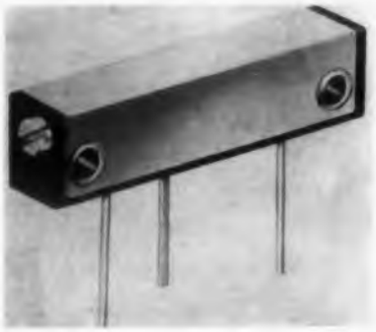
Micro Switch, Dept. ED, Freeport, Ill.

Price & Availability: *$15.74 ea, list price. Delivery is from stock.*

NEW PRODUCTS

Trimmer Potentiometer 593

Power rating is 0.2 w at 70 C



Series 140 trimmer potentiometer has a power rating of 0.2 w at 70 C and can operate to 125 C. A MIL-R-94 carbon element, a contact mechanism with long spring arms for adequate spring range in limited space, and a 25-turn lead screw with clutch stops are used. Units can be furnished with 18-turn lead screws with fixed stops. Resistance range is 500 ohms to 1 meg and case size is 1-1/4 x 19/64 x 21/64 in.

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

Availability: Delivery is three to four weeks for small quantities; five to six weeks for large quantities.

Aircraft Power Test Set 632

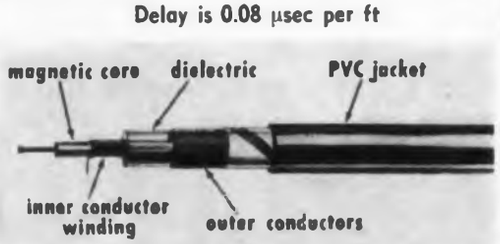
For measuring voltage and frequency

Model 364 aircraft power test set is a dual instrument containing a voltmeter that measures 0 to 150 or to 300 v at 250 to 500 cps and a frequency meter that measures 380, 385, 390, 395, 400, 405, 415, and 420 cps at 115 v. Housed in a drawn aluminum case, the instrument weighs less than 2.5 lb.

The Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

Delay Cable 586

Delay is 0.08 μsec per ft



Type HH-1500A magnetic-core delay cable has an impedance of 1500 ohms and a delay of 0.08 μsec per ft. Ratios of delay-to-rise time of 100:1

can be obtained. The cable has an OD of 0.4 in. and can be supplied in 100-ft lengths. Flexible, it is easily installed in electronic equipment.

Columbia Technical Corp., Dept. ED, 61-02 Thirty-first Ave., Woodside 77, N.Y.

Price & Availability: *For up to 100 ft, price is $1.12 per ft; for 100 to 499 ft, price is $97.50 per 100-ft length; for 500 to 999 ft, price is $89.50 per 100-ft length. Delivery is from stock.*

Oscilloscope 602

Uses null-balance technique

Type 1100/700 oscilloscope uses a null-balance technique to provide a high standard of accuracy and high speeds in measuring analog data directly from the screen. The 1100 main frame is a self-operable, cathode-ray tube indicator and the 700 is a dual-channel plug-in. There are 64 contacts for the transfer of signals and voltages between the two units. Sweep speeds are 0.2 μsec per cm to 50 sec full scale in 22 steps with 5:1 calibrated sweep expansion on all ranges.

Analab Instrument Corp., Dept. ED, 30 Canfield Road, Cedar Grove, N.J.

Price & Availability: *Type 1100 is priced at $385 ea and type 700, $310 ea. The combined price is $695. Delivery time is 30 days.*

Timing Devices 616

Have digital counters or dial readout

Series 18200 precision stepping devices have digital counters or dial readout. Included are predetermined and remotely settable pulse counters and interval timers. The predetermined pulse counters have a wide range of counter and circuit variations and can be supplied with decimal or angle counters. Applications are in automated production equipment, military and commercial control systems, and laboratory timing devices. Requirements of MIL-E-5272C are met.

A. W. Haydon Co., Dept. ED, 232 N. Elm St., Waterbury, Conn.

Price & Availability: *Price ranges from $75 to $600. Delivery is 8 to 12 weeks for sample quantities.*

NEW PRODUCTS

Halltron Multipliers 609

High-voltage type

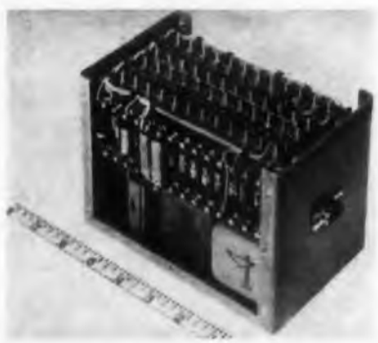
Types MC-1, MC-2, MC-3, MC-4, and MC-5 Halltron multipliers are for general purpose applications requiring high output voltage. The core material used can be driven to linear flux densities of over 10 kilogauss. This core material also provides a good dynamic range and low hysteresis.

Ohio Semiconductors, Inc., Dept. ED, 1035 W. Third Ave., Columbus 12, Ohio.

Price & Availability: *Types MC-1 through MC-5 are priced at $64.50, $64.50, $74.50, $64.50, and $64.50 ea for small quantity orders. Delivery is immediate.*

Timer 591

Measures precise elapsed-time intervals



Model DET-420 digital electronic timer is for use in computer systems needing precise elapsed timing intervals. Error is 100 μsec. Several intervals can be set, such as 5, 25, and 150 sec; any interval can be set by special order. Operating temperature range is —55 to +71 C. Power inputs are 115 v at 400 cps, single-phase and 28 v dc at 1 amp. Output is 26 v at 0.5 amp max when not timing and during the timing interval, about 5 ma. Dimensions are 3 x 3.5 x 6.5 in. Designed for ground check-out equipment, the timer can be used in a number of military and industrial applications.

Bulova Research & Development Labs., Inc., Dept. ED, 62-10 Woodside Ave., Woodside 77, N.Y.

Thermistor Washers 524

Come in designers' kit

Designers' kit KW 125 contains 12 thermistors of six different types plus one A828 mounting kit. The user can obtain a variety of resistance values by series, parallel, or series-parallel connection to cover a complete decade of resistance values for prototype applications.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union, N.J.

Price & Availability: *Kits are supplied through jobbers or directly from the company at the price of $13.50 ea.*

Silicon Mesa Transistors 528

Alpha cut-off frequency is 50 mc

This series of general purpose, silicon mesa transistors features an alpha cut-off frequency of 50 mc and operates throughout a 1 to 50 ma collector current range. Designated types 2N1564, 2N1565, and 2N1566, the units provide ac beta spreads of 20 to 50, 40 to 100, and 80 to 200. Beta at −55 C is a minimum of 12, 20, and 40. Dissipation is 600 mw at 25 C, collector-base voltage is 80 v, and collector-emitter voltage is 60 v. Applications are as small-signal, high frequency, and medium-power devices.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

Availability: *Delivery time is four to six weeks.*

Rate Gyros 491

For missile and aircraft applications

Types RG-100 and RG-101 rate gyros are designed for missile and aircraft applications as control and stabilization elements. Even at rates as low as 10 deg per sec, they stand shock to 150 g and vibration to 30 g at 2000 cps.

Fairchild Camera and Instrument Corp., Dept. ED, Robbins Lane, Syosset, L.I., N.Y.

Availability: *Delivery time is 40 to 60 days.*

CIRCLE 106 ON READER-SERVICE CARD ▶

ELECTRONIC DESIGN maintains a policy which demands accuracy . . . accuracy on which its 36,000 readers have learned to rely in keeping themselves informed of the very latest electronic developments.

This policy is stated in the explicit sentences found in every issue of *ELECTRONIC DESIGN*.

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It is through such dual guardianship—readers and editors—that *ELECTRONIC DESIGN* guarantees highest reliability and detailed coverage.

NEW PRODUCTS

DC Power Supply 583

Delivers 24 v at 0 to 90 ma

Operating from an input of 105 to 125 v ac at 60 cps, model SPS-2011-P transistorized, plug-in power supply delivers 24 v at 0 to 90 ma. Line regulation is ±0.01%. Short term load regulation is ±0.05% from no load to full load and long term load regulation is ±0.1%. Ripple is less than 1 mv rms.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville, Tenn.

Price & Availability: *$50 ea; 7 to 10-day delivery.*

Tunnel Diodes 605

For use as circuit reference elements

Types 1N2041 and 1N2969 germanium tunnel diodes, designed for use as circuit reference elements, have peak current ratings of 4.7 and 2.2 ma, respectively. These ratings are held to a variation of no more than 10%. Peak-to-valley ratio for both devices is 8:1. The 2N2941 has a total capacity of 30 pf and the 2N2969, 20 pf. The units have typical peak point voltages of 55 mv, typical valley point voltages of 350 mv, and typical forward peak point current voltages of 500 mv.

General Electric Co., Semiconductor Products Dept., Dept. ED, Charles Bldg., Liverpool, N.Y.

Price & Availability: *Types 1N2941 and 1N2969 are priced at $5.50 and $6 ea in production quantities. They are immediately available.*

CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 221➤

Thermistor Kit 533

Contains 8 bead thermistors

The KTB1 thermistor kit contains 8 glass-coated, bead thermistors, covering resistance values from 100 ohms to 1 meg. Supplied with each kit are technical data, curves, characteristics, and tweezers for handling the beads.

Victory Engineering Corp., Dept. ED, 519 Springfield Road, Union N.J.

Price & Availability: *$19.50 per kit, supplied from jobbers or directly from the company.*

Rectilinear Transducer 537

Has spring-loaded probe

Type KO variable-permeance transducer has a spring-loaded probe. Four models, having from 0.25 to 2 in. displacement, are offered. Applications are in operations where the probe cannot be coupled to the moving member, such as cam-following and automatic gaging. Units may also be used to measure thickness, roundness, taper, and surface smoothness of production parts.

Crescent Engineering & Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.

Price & Availability: *Price ranges from $147 to $217. Delivery is from stock to 30 days.*

Transformer Kit 531

With 10 miniature transformers

Type C-2650 transformer kit consists of 10 miniature transformers, each encapsulated in a shielded case measuring 1/2 in. in diameter and 7/16 in. deep. Each transformer is a four-winding, eight-terminal device ready for printed-circuit mounting. A manual showing advantages of transformer coupling in transistor circuit design is included.

James Electronics Inc., Dept. ED, 4050 N. Rockwell St., Chicago 18, Ill.

Price & Availability: *$69.50 ea; from stock.*

CIRCLE 107 ON READER-SERVICE CARD ➤
◄ CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 221

NEW PRODUCTS

Vertical-Entry Terminal Block 530

For ground support equipment

Model T-1000 vertical-entry terminal block now has rows of feed-through lugs added to the bottom of the block for positive feed-through electrical connections. It is for use with ground support equipment such as missile launchers and test stand equipment. Construction is of a molded, phenolic base with reinforced barriers between the terminal cavities. One cavity accommodates four terminals; up to 40 connections can be made with one block. Dimensions are 5 x 1-1/16 x 3/4 in.

Twin Lock, Inc., Dept. ED, 1024 W. Hillcrest Blvd., Inglewood, Calif.

Price & Availability: *Units are priced at $7.73 ea in quantities of 1 to 100. Delivery is from stock.*

Insulation Material 565

Added to the Teflon line

Teflon 100, an FEP fluorocarbon resin, is a supplement to the Teflon TFE fluorocarbon resins. Its usual continuous service ceiling is about 100 F lower than the TFE resins. Both materials resist cold down to —450 F. Specific uses for Teflon 100 include jackets for coaxial and multiconductor cable, and molded electronic components. Coil-wound devices, capacitors, and printed wiring and circuitry are viewed as future uses for the material.

E. I. Du Pont de Nemours & Co., Dept. ED, Parkersburg, W. Va.

Price & Availability: *Available from stock. Resin prices per lb (100 lb packages only) are: 100 to 1900, $12; 2000 to 9900, $11.85; 10,000 to 21,900, $11.70; 22,000 or more, $11.60.*

Accelerometer 361

Is self-calibrating

The AS 1025 self-calibrating accelerometer permits calibration both before and during the flight of mis-

◀ CIRCLE 108 ON READER-SERVICE CARD

siles and aircraft. A dual seismic system, with one element as the driver and the other as the sensor, is used. The unit can be used for combined environmental tests such as vibration and temperature, vibration and altitude, and vibration and humidity; it can also be used for missile check-out. The acceleration range is 0.2 to 500 g and the frequency response is 3 to 5000 cps. The unit is 1.13 in. long and 0.88 in. in diameter. It weighs 21 g. Model AS 1025 has side-mounted connectors; Model AS 1030 has top-mounted connectors.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave, Metuchen, N.J.
Price & Availability: *$495; from stock.*

Target Simulators 370

Is all electronic

The RTS-101 all-electronic target simulator is for X-band use but can be modified for other bands. It has a wide range of applications, including the simulation of missile tracking. The unit may be connected to if and video circuits for logical or step-wise trouble shooting. Angular tracking may also be checked.

Remanco, Inc., Dept. ED, 1805 Colorado Ave., Santa Monica, Calif.

Microwave Absorbers 563

May be worked to fine tolerances

Radite 75, a microwave absorbing plastic, is designed for use as both coaxial and waveguide terminations and attenuators. It can be turned, bored, tapped, drilled, threaded, or milled just like a metal; it is rigid, nonporous, and allows working to fine tolerances. The plastic is available in 12-in. bar stock: round, 1/2 to 2-1/8 in.; square, 1/2 to 2-3/8 in. It may be poured or molded to any configuration and size.

Radar Design Corp., Dept. ED, 1003 Pickard Drive, Syracuse 11, N.Y.
Price & Availability: *Immediate delivery. Price is between $6 and $37 for various components in the line.*

CIRCLE 109 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Synthetic Rubber Material 613

For vibration damping applications

These synthetic rubber materials are for vibration damping applications at audio frequencies. They are suitable for fabrication into small and complex shapes and can be made to close tolerances. Compound A321-2 has an elongation of over 600% and a tensile strength of over 600 psi.

Industrial Electronic Rubber Co., Dept. ED, 31945 Aurora Road, Solon 39, Ohio.

Availability: Made on order.

Noise Diode Power Supply 390

For gas-discharge diodes

Model 2140 power supply is designed to furnish starting and operating currents to a variety of gas-discharge noise diodes such as the 6358, 6357, 6356, and 6359. Independent adjustment of heater current and beam current allow for different tube ratings. Both beam current capacity and heater current capacity are 400 ma. Maximum output is 110 v dc. The unit weighs 15 lb and measures 7 x 10 x 9 in.

DeMornay-Bonardi, Dept. ED, 780 S. Arroyo Parkway, Pasadena, Calif.

***Price & Availability:** $220 ea; from stock.*

Inductors 629

Range extends to 10,000 μh

These inductor coils can be furnished with inductances ranging to 10,000 μh. Type 1 Mini-Stab, measuring 0.19 in. in diameter and 0.44 in. in length, has an inductance range of 18 to 1000 μh; type 2 Mini-Stab, measuring 0.22 x 0.6 in., has a range of 1200 to 3300 μh; and type 3 Mini-Stab, measuring 0.24 x 0.74 in., has a range of 3900 to 10,000 μh. The units meet MIL-C-15305. Inductance varies ±2% from —55 to +125 C. Also available, type 101 measures 0.19 in. in diameter and 0.44 in. in length and has an inductance range of 0.15 to 15 μh.

Speer Carbon Co., Jeffers Electronics Div., Dept. ED, DuBois, Pa.

Bonded Cables 371

Are thermoplastic-insulated

For use in the communications and electronics industries, these bonded cables are thermoplastic insulated. One cable consists of 16 individually jacketed pairs of color-coded conductors laid parallel to each other and bonded together. The other is a coaxial type, with 16 conductors individually insulated with Rulan, jacketed, and joined together in a flat cable form.

Phalo Plastics Corp., Dept. ED, Shrewsbury, Mass.

DC-DC Converter 578

Provides a 0.75-w output

Using a single germanium transistor, this dc-dc converter provides a 0.75-w output and has an efficiency of up to 80%. The output voltage is adjustable from 350 to 2100 v dc at currents to 250 μa. Input is 6 or 12 v dc. Maximum ripple is 1% rms. Applications include photomultipliers, cathode-ray tubes, and infrared detection equipment.

American Research & Manufacturing Corp., Dept. ED, 920 Halpine Ave., Rockville, Md.

***Price:** $71 to $88.85 ea for regulated units; $65.25 to $81.50 ea for unregulated units.*

Teflon Tubing 527

Shrinks to form a tight fit

When heat is applied to this Teflon-TFE tubing, it shrinks to form a tight fit. Uses are: encasing irregular shapes and protecting electrical components such as wire connectors, terminals, and semiconductors. Dielectric strength is 500 to 1000 v per mil, dielectric constant is 2, and dissipation factor is 0.0002. Electrical properties do not change from −25 to +250 C or from 60 cps to 100 mc. Thin and standard wall tubing, cut to required lengths, are available.

Pennsylvania Fluorocarbon Co., Inc., Dept. ED, 1115 N. 38th St., Philadelphia 4, Pa.

***Availability:** Small quantities are furnished from stock.*

CIRCLE 112 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Power Supply 599

For remote programing applications

Model MP40—.2 power supply is for use as a component of automatic systems for remote programing. Output is 0 to 40 v dc at 0 to 200 ma, load regulation is 0.05% for zero to full load changes, and ripple is less than 500 μv. The unit is programable from a distant point at 500 ohms per v. Dimensions are 6 x 8 x 8 in.

Mid-Eastern Electronics, Inc., Dept. ED, 32 Commerce St., Springfield, N.J.

Price & Availability: *$159 ea; three-week delivery.*

Digital Voltmeter 561

True rms, four-digit type

Model 800 true rms, four-digit voltmeter has a measuring range from dc through 5 kc. It incorporates a temperature-stabilized diode network operating on the square law principle. Accuracy is 0.1% for crest factors up to 2. Response is 0.1%, and calibration accuracy is held for 30 days. Balance time is 3 sec. Range is 1 to 999.9 v with a manually selected range of 0.1 to 1 v.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

Availability: *Delivery time is 90 to 120 days.*

Microwave Crystals 617

For use in low frequency applications

These gallium-substituted-yttrium iron garnet single crystals are for use in the low frequencies of the microwave region. One type has a saturation magnetization of 1000 gauss per cubic centimeter; for the other type, 600 gauss per cubic

centimeter. Curie temperatures are 206 ±2 C and 160 C. Both have a linewidth of not more than 1 oersted at the C-band. Uses are in magnetically tunable microwave filters, passive microwave power limiters, and three-level traveling-wave masers.

Microwave Chemicals Laboratory, Inc., Dept. ED, 282 Seventh Ave., New York 1, N.Y.
***Availability:** Delivery is in one week to 10 days.*

Coaxial Termination 600

Handles 75 w

Model 1058 coaxial termination handles 75 w of average power without artificial cooling. It is for use over the S-band from 2.5 to 3.5 kmc and has a maximum vswr of 1.15. Length is 10 in. It can be furnished with either UG-45/U or UG-46/U connectors.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.
***Price & Availability:** $161 ea; from stock to three weeks.*

Circuit Tester 653

Tests 60 circuits per min

This automatic circuit tester is able to test 60 circuits per min. Designed for testing cable assemblies and components, the unit has applications in missile, instrument, and industrial fields. Three types are offered: a 50-circuit unit, a 100-circuit unit, and a 200-circuit unit. Continuity currents are 5 and 500 ma and 1 and 2 amp. The hi-pot voltage is variable up to 3000 v dc. The instrument measures 11.5 x 24 x 15 in.

Astral Electronics Inc., Dept. ED, 146 Arminta St., Van Nuys, Calif.

NEW PRODUCTS

Coincidence Analyzer 588

Resolution is 0.01 μsec

A flexible instrument for use with a wide selection of single-channel analyzers and linear amplifiers, model 704 coincidence analyzer has a fast channel with a resolution as low as 0.01 μsec. The instrument uses delay line compensation for the transit time of single-channel analyzers. The unit is composed of six circuit sections: a dual-input, fast coincidence channel; the No. 1 slow coincidence channel; the No. 2 slow coincidence channel; the total coincidence circuit; the output circuit; and a regulated power supply.

Interstate Electronics Corp., Dept. ED, 707 E. Vermont Ave., Anaheim, Calif.

Price & Availability: *$875 ea; from stock.*

Transistor Enclosure 654

Permits greater component density

This microminiature transistor enclosure, a flat package measuring 0.125 x 0.18 x 0.06 in., permits greater component density than ordinarily possible. About 42 enclosures can be mounted on a 1-sq in. multi-element wafer, adding about 1/16 in. to the thickness. The cold-welded, metal-to-glass hermetically-sealed package provides a minimum seal length of 0.05 in. It houses any type of computer transistor.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.

Availability: *The firm plans to incorporate the enclosure in computer transistors during the summer of 1960.*

Name Plates 379

These name plates are made of heavy-gage metals and can be attached with rivets or screws. They are chemically etched, lithographed, silk screened or anodized.

Ward's Name Plates, Dept. ED, 8502 Lyndon Ave., Detroit 38, Mich.

Availability: *The plates are made to order to customer specs and can be delivered in 10 to 14 days after receipt of order.*

Power Transformers 380

This line offers ratings of 1 to 600 kva. The single and three-phase, 60-cps units are dry type and meet NEMA and MIL-T027A specs.

Perkin Engineering Corp., Dept ED, 345 Kansas St., El Segundo, Calif.

Frequency Tachometers 381

Having a sine or pulse-form output, TR series tachometers operate into fm-fm telemetering systems where the frequency output is used to modulate the rf carrier. Units can be used in measuring shaft rotation and for control.

Nacimo Products, Dept. ED, 1090 Morena Blvd., P. O. Box 248, San Diego 10, Calif.

HF Transmitter 382

Able to radiate simultaneously two or more independent transmissions on different wavelengths, this unit has a power output of 1 kw in the range of 2 to 24 mc. Antenna selection is automatic.

Marconi's Wireless Telegraph Co., Ltd., Dept. ED, 750 Third Ave., New York 17, N.Y.

Zone Refiner 383

This zone refiner for germanium permits 1 to 12 tubes to be mounted and used at the same time. Each tube accommodates a 30-in. carbon boat. Minimum vibration of the fixture allows single crystal growing in the horizontal position.

Lindberg Engineering Co., Dept. ED, 2450 W. Hubbard St., Chicago 12, Ill.

Vibratory Finishing Machines 385

Included in this line of vibratory finishing equipment is a machine with four rubber air cushions mounted above the vibrating platform and four mounted below. These units are suitable for use in the manufacture of intricate parts such as electronic tubes and components.

Pangborn Corp., Dept. ED, Hagerstown, Md.

Terminal Blocks 387

Type T-1010 terminal block uses diallyl phthalate, a molding material which has superior insulating qualities and dimensional stability under severe environmental conditions.

Twin Lock, Inc., Dept. ED, 1024 W. Hillcrest Blvd., Inglewood, Calif.

Availability: *The product is now in production and is available to the general defense industry.*

NEW PRODUCTS

Power Supply Modules 672

Have outputs to 150 ma at ±18 v

Model 202 solid-state power supply module has a dual output of up to 150 ma at ±18 v or a single output of ±36 v. Line and load regulation is ±1% with less than 6 mv ripple. The unit weighs 2 lb and measures 8 x 3 x 3 in. Model 206, for use where a reference source is needed, has a 0.1% line regulation from 95 to 135 v ac with a continuously variable dc output of 2 to 24 v. Load regulation is 0.1% with loading of 0 to 100 ma. Temperature stability is 50 ppm per deg F from 40 to 120 F. Dimensions are 7.5 x 3.5 x 2.5 in.

Solidyne, Dept. ED, 7460 Girard Ave., La Jolla, Calif.

Price & Availability: *Model 202 is priced at $125 ea for orders of one to four units; delivery time is 14 days.*

Magnetic Amplifier 595

Low-level type

For instrumentation work involving low-level sources, type 4511 linear, magnetic amplifier is compatible with such transducers as photocells, shunts, strain gages, thermistors, and thermocouples. It is useful for driving dc meters and electro-mechanical recording instruments. The output is ±10 v dc in response to signals of ±50 μa dc, with a linearity of ±1% in this range. Nominal termination load is 200 ohms.

Magnetics Inc., Control Div., Dept. ED, Butler, Pa.

Price & Availability: *$160 ea; from stock.*

Crystal Filters 369

Cover 1 to 21 mc

Covering the range of 1 to 21 mc, the KCF series of crystal filters provides bandwidths of 0.01% to 0.45% with 60/6 db shape factors from 4:1 to 2:1. Compact and rugged, the units meet Mil specs. Applications are in Doppler radar, receiver if, and comb filter sets.

The Keystone Electronics Co., Dept. ED, 65 Seventh Ave., Newark 4, N.J.

Adapters 365

For vacuum tubes

Designed to be used in crowded places, these adapters are inserted into vacuum-tube sockets before the tube is plugged in. They can be used for taking voltage and resistance measurements. Breaking into the circuit is accomplished by loosening the screw in the circuits under test and inserting meters or components between the upper and lower lugs. Types 7, 8, and 9 are for seven, eight, and nine-pin miniature tubes.

Laik Electronics Co., Dept. ED, 311 Hickory St., Kearny, N.J.

Price & Availability: *Types 7, 8, and 9 are priced at $2.25, $2.50, and $2.75 ea.*

Relay Rack Cabinets 512

Stand 30-g shock

The M series of relay rack cabinets is designed to surpass vibration and 30-g shock tests of Mil specs. Construction is of 12-gage steel or 0.125-in. aluminum alloy; panels are 18-gage steel or 0.062-in. aluminum. Additional features supplied to meet individual requirements are: refrigerated cooling, thermal and acoustic insulation, ventilation, and blowers. Standard panel height is 19 to 24 in. in 1.75-in. increments; depths are 18 to 36 in. in 2-in. increments.

Western Devices, Inc., Dept. ED, 600 W. Florence Ave., Inglewood 1, Calif.

Availability: *Delivery requires six to eight weeks.*

NEW PRODUCTS

Waveguide Switch 651

Frequency range is 8.2 to 12.4 kmc

Model 678-E waveguide switch is a manually operated, four-port unit for use over the range of 8.2 to 12.4 kmc. It is designed for laboratory use or systems applications. The vswr is less than 1.05, crosstalk or isolation is greater than 45 db, and physical size is 3 x 3 x 3 in. Attenuation through any channel is negligible. Flanges are equivalent to UG-135/U.

Waveline, Inc., Dept. ED, Caldwell, N.J.

Price & Availability: *$215 ea for orders of one to 25 units. Delivery time is 30 days.*

Fluid Silicon Rubber 621

Cures at room temperature

Type RTV 731 single-component, fluid silicon rubber requires no pre-mixing and cures at room temperature. Tensile strength is 200 psi and volume coefficient of thermal expansion is 9.3 x 10^{-4}. The product comes in a tube and can be squeezed into place.

Dow-Corning Corp., Dept. ED, Midland, Mich.

Infrared Source 652

Miniature

Model 521-6 miniature infrared source is for calibrating the seeking head of infrared guided missiles and other infrared-sensitive elements in the temperature range of 200 to 600 C. The unit is for use with the firm's 521-5 temperature controller. The two devices can be used as a secondary standard of radiant energy by comparison with a primary source or by auxiliary temperature measurement of the conical radiating cavity.

Perkin-Elmer Corp., Dept. ED, Norwalk, Conn.

Price & Availability: *Price is $650 ea for the infrared source. Delivery time is 2 to 14 weeks.*

Power Supply 513

Comes with regulator unit

This power supply is furnished with a detachable regulator unit that permits change of regulation without any change of wiring. The power unit can be operated separately as a 1%-regulated supply. Outputs are: 6.3, 12, and 28 v dc at 2 amp. Input is 90 to 130 v ac at 60 cps.

Victory Electronics, Inc., Dept. ED, 50 Bond St., Westbury, N.Y.

Price & Availability: *Price ranges from $150 to $177.25 for units without regulator and $314 to $349 for units with regulator. Units are in stock.*

DC Power Supply 509

Current regulation is ±0.25%, ±0.1%, or ±0.015%

This dc power supply, a combination of magnetic and semiconductor components, is offered with ratings to 100 kw in some models. Three current regulations are available: ±0.25%, ±0.1%, and ±0.015%. Ripple content is low. The unit has forced air-cooling. Remote controls can be furnished.

Cambridge Products Corp., Dept. ED, 141 Main St., Cambridge 42, Mass.

Price & Availability: *Price ranges from $8000 to $46,000. Made on order, units can be supplied in 18 weeks.*

Laminates 401

Fiberglass-reinforced epoxy

These thin, epoxy fiberglass-reinforced laminates with Mylar faces have excellent physical and electrical characteristics. Widths are up to 48 in., and thicknesses are 0.006 to 0.06 in. Both sheets and continuous length rolls can be furnished.

Swedlow Inc., Dept. ED, 6986 Bandini Blvd., Los Angeles 22, Calif.

Price & Availability: *The product will be in stock in two to four months. Delivery time is now 30 to 45 days.*

CIRCLE 120 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Voltmeter 649

Has 10 ranges

Model P-301 electronic millivoltmeter has 10 standard ranges from 0 to 10 mv up to 0 to 300 v. A dc meter, the instrument has an accuracy of ±2% full scale on all ranges. Zero drive is ±1% full scale for 8 hr. The input resistance is 10 meg.

Metronix, Inc., Dept. ED, Chesterland, Ohio.

Price & Availability: *Price is $310 ea; delivery time is one month.*

Counter-Scaler 659

Resolving time is less than 1 μsec

Series SC-750 scalers count random events at a maximum rate of over 1,000,000 counts per sec. Resolving time is less than 1 μsec. Two models in the line provide full storage of 10^7 and 10^8 counts. The third has three decades of storage and a four-digit mechanical register. Printer drive is a standard option. Weighing 13 lb, the scalers are suited for accelerator-counting room service.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley 10, Calif.

Price & Availability: *Price ranges from $975 to $1265 ea. Units are in stock about half the time.*

Silicon-Controlled Rectifier Trigger 624

For full wave and half wave circuits

Series 351 silicon-controlled rectifier triggers can be furnished for full wave and half wave circuits from 50 to 400 cps. A steep wave front

signal is generated for controlling the firing angle of silicon-controlled rectifiers. The output is varied in proportion to control signals which can be ac or dc.

Hanson-Gorrill-Brian, Inc., 85 Hazel St., Glen Cove, N.Y.

Storage Tube 647

Miniature design

Type FW-211 Iatron, a 2.5-in. cathode-ray storage tube, is designed to serve as a panel-mounted radar or infrared indicator in aircraft. The tube fits within standard case dimensions for a 2.75-in. dial instrument and meets MIL-E-5400 environmental specs. It is designed for fast writing and high deflection speeds. A coaxial electron gun system eliminates trapezoidal distortion of the scanning pattern. The display exceeds 4000 ft-L in brightness.

ITT Labs, Dept. ED, Fort Wayne, Ind.

Price & Availability: Price is $1665 ea for orders of one to five units and $1500 ea for orders of six to 20 units. Delivery time is one month.

Motor-Damping Generator 648

For size 8 servomotors

Type M840-001 servo motor-damping generator consists of a modified type of the R123 servomotor and type M863 generator. The low null voltage combined with the high generator output results in a 100:1 signal-to-noise ratio. This size 8 unit has a phase shift of 0 deg and a linearity of 0.2%. Output voltage for the generator is 1.1 v at 1000 rpm, the output impedance is 2100 ohms +j2500, and the rated load is 100,000 ohms. No load speed is 6500 rpm and stall torque is 0.25 oz-in.

Kearfoot, Div. of General Precision, Dept. ED, 1150 McBride Ave., Little Falls, N.J.

NEW PRODUCTS

Clutch 655

Torque rating is 10 oz-in. min

Model MC531 clutch has a minimum torque rating of 10 oz-in. Its diameter measures about 1 in. It is driven by a 1-in. pitch-diameter, nylon bevel gear that is designed to permit driving of several units by a single servo motor. The clutch can be used for driving potentiometers and in other applications. Operating temperature range is −60 to +85 C. Coils are rated at 6 to 110 v dc.

Altair Research and Manufacturing Co., Dept. ED, Box 106, Baldwin Park, Calif.

Price & Availability: *Price is $10.25 ea for orders of one to nine units. Small quantities are furnished from stock.*

Pulse Generator 658

Output widths are 2 to 20 μsec

Model G-47 pulse generator produces positive and negative pulses with an output width of 2 to 20 μsec and an output amplitude that is variable from 0 to 15 v into a 50-ohm load. The unit contains a variable repetition generator with a range of 1 to 1000 cps and two fixed-frequency sources of 1 and 10 cps. Containing both solid state and vacuum tube circuits, the unit is suitable for laboratory or ground support applications.

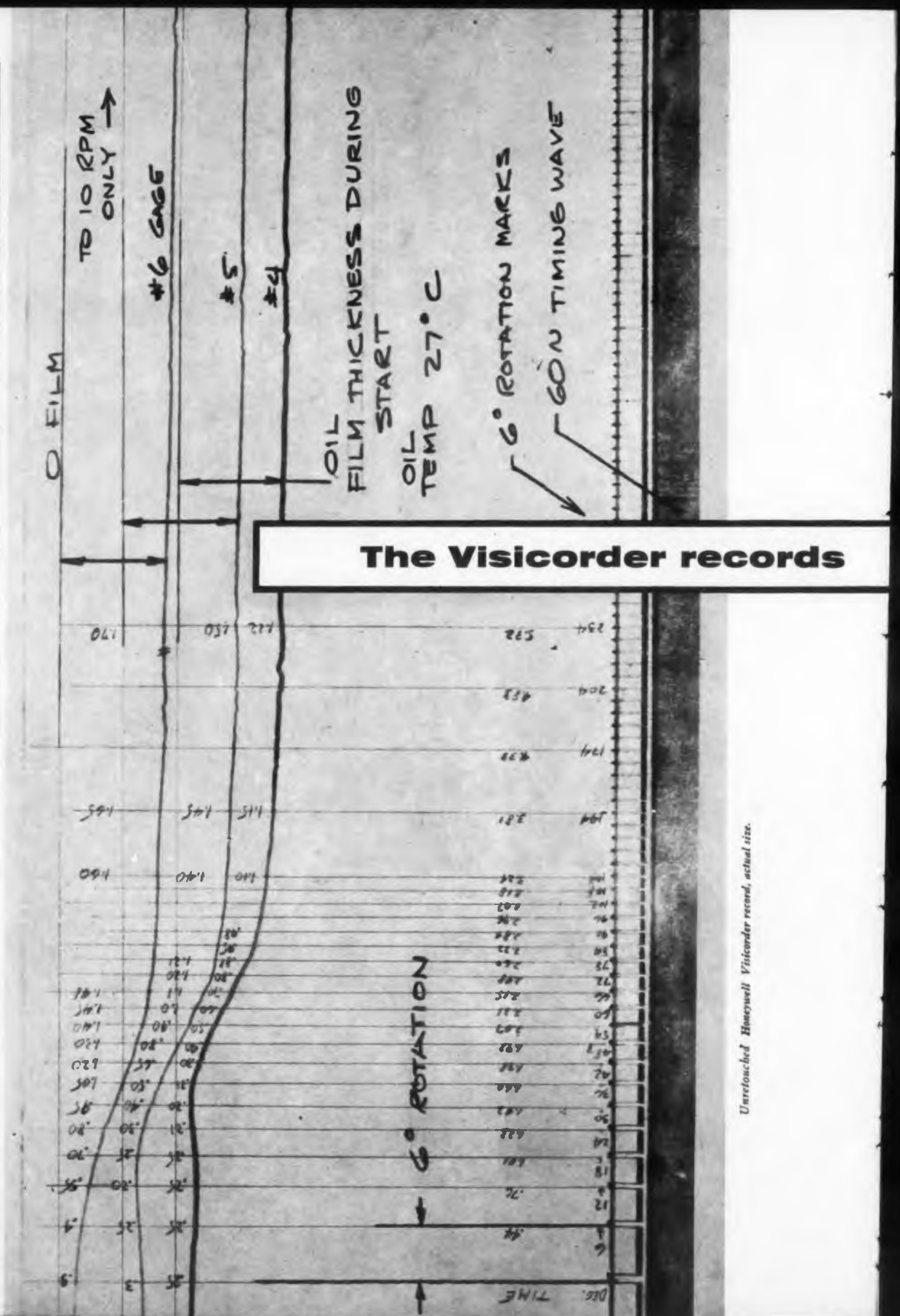
Alto Scientific Co., Inc., Dept. ED, 855 Commercial St., Palo Alto, Calif.

Price & Availability: *$2600 ea; made on order for 60-day delivery.*

Dielectric Material 611

Is stable at 1200 F

Melfoam C-100 foamed dielectric material is stable at temperatures as high as 1200 F. At 3



The Visicorder records

Unretouched Honeywell Visicorder record, actual size.

The Westinghouse Electric Corp. used a Honeywell Model 906 Visicorder to make this directly-recorded chart of oil film thicknesses on the bearing pads of a 67,500 KW water-wheel generator supplied for Chief Joseph Dam at Bridgeport, Washington. In these tests, design engineers at Westinghouse wanted to ascertain bearing lubrication factors (oil film thicknesses) as a function of rotation and speed.

Bearings are designed so that as the water wheel generator comes up to speed, oil is carried mechanically over the bearings, and develops a film thickness that varies from .002 to .005 inches. Film thicknesses at the leading edge, center and trailing edge of one bearing pad were relayed by magnetic reluctance thickness gauges to the Visicorder. The thickness of the film at each of these locations as the bearing passed through each six degrees of rotation are represented by traces #6, 5, and 4 on the chart. Thicknesses as revealed by the test were proved to be close to the predicted design values.

Stephen Chai and Glenn Cooper, Westinghouse development engineers, calibrate the Visicorder and other equipment used in water wheel generator tests.

The Visicorder was selected for these tests because, 1) high galvanometer sensitivities made the use of amplifiers unnecessary, 2) immediate readout was highly desirable and, 3) the portability and ruggedness of the instrument were helpful.

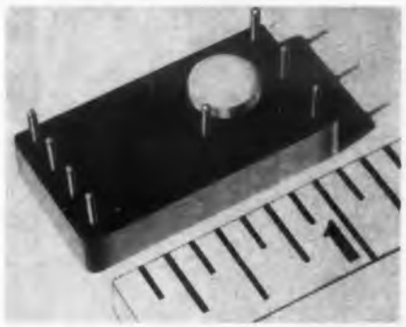
kmc the dielectric constant is 1.78 and the loss tangent is 0.002. It can be used for filters for microwave devices such as high-temperature lenses and for electrical and thermal insulators.

Melpar, Inc., Special Products Dept., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

Price & Availability: *Price is $18.20 for 6 x 6 x 1 in. Delivery time is five days.*

Balanced Resistor Network 665

Measures 1-1/4 x 11/16 x 1/4 in.



The SPR-76 balanced resistor network measures 1-1/4 x 11/16 x 1/4 in. It contains five precision wirewound resistors and one transistor incorporated into a NOR logic circuit. The complete circuit is encapsulated in epoxy. The network stands moisture, temperature cycling, and vibration. Termination is suited for printed circuit or plug mounting.

Dale Products, Inc., Dept. ED, Columbus, Nebr.

Connectors 666

Several types offered

This line of flat conductor cable connectors includes two types of connectors as well as accessories. Pos-E-Kon connectors, designed for flat cable, can be used with printed circuit boards, shielded cable, and round wire. Pos-E-Flex connectors, for commercial equipment, are for low-voltage applications. Accessories include harness clamps, fold clamps, and strain relief fittings.

The Thomas & Betts Co., Dept. ED, Elizabeth 1, N.J.

NEW PRODUCTS

Rack and Panel Connectors 670

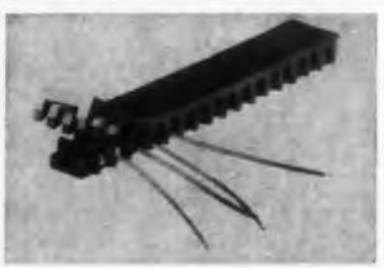
May have to 156 contacts

Series DTD rack and panel connectors are offered with single or double inserts mounted in a die-cast aluminum-alloy shell. Connectors with 50, 78, 100, and 156 contacts are possible. Either male or female inserts are interchangeable in the field as a sub-assembly. The insulating material is Melamine. Silver and gold plating are provided. Series DTD2 uses a screw fastener.

Burndy Corp., H. H. Buggie Div., Dept. ED, P.O. Box 817, Toledo 1, Ohio.
Availability: *Some types in stock; others have a 45-day delivery time.*

Terminal Block Covers 667

Are made of Neoprene, Buna-N, or Silicate rubber



Made for protection from fire, these terminal block covers can be constructed from Neoprene, Buna-N, or Silicate rubber. Three basic forms are offered. One type is a flexible casting, constructed with a wall between each terminal pole. Another type is for barrier strips; the divider between terminals is grooved to receive the strip wall. The third type is a terminal cap that fits over an individual terminal pole.

TA Manufacturing Corp., Dept. ED, 4607 Alger St., Los Angeles 39, Calif.
Availability: *Most sizes, from stock.*

Recorder-Reproducer 614

For digital data systems

Type 5-753 magnetic tape recorder-reproducer is for use as a high-speed storage device for digital data systems. Recording and reproducing at

packing densities up to 2000 words per in. on up to 16 tracks is possible. Tape speeds of 60, 30, 15, and 7.5 in. per sec can be selected. The guidance system has no moving parts. Misalignment correction is provided.

Consolidated Electrodynamics Corp., Datalab Div., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Trimmer Potentiometer 662

Stands 100 g acceleration

The IW-F precision trimmer potentiometers use a 4-40 center screw, centrally soldered on the back of the case. Measuring 2 in. long, the lead wires can be twisted by hand to fit any particular grid pattern. They stand 100 g acceleration, exceeding MIL-R-19; and 50 g shock, exceeding NAS 710 procedure 111. Temperature range is −55 to +140 C with 1.3 w rating at 40 C. Resistance is 10 to 50,000 ohms. Resolution is 0.064%.

Handley, Inc., Dept. ED, 12960 Panama St., Los Angeles 66, Calif.

Price & Availability: Price ranges from $6.80 to $4.70 ea. Delivery requires two weeks.

Subcarrier Discriminator 661

For FM telemetry and data reduction

Model 167A subcarrier discriminator, for FM telemetry and data reduction, uses phase-lock techniques in solid-state circuitry. The unit has a true 60-db dynamic input voltage range. The amplitude of each subcarrier signal can be 10 v rms in a multiplex consisting of 18 subcarriers. Channel selectors are available for center frequencies of 300 cps to 300 kc, as low-pass output filters for 2 cps to 60 kc.

Electro-Mechanical Research, Inc., Dept. ED, Sarasota, Fla.

Price & Availability: $3100 ea; 150-day delivery.

NEW PRODUCTS

Choppers 656

Can be driven from dc to 100 kc

Model 30 chopper can be driven from dc to 100 kc. It will connect and disconnect a load from a signal source and may also be used as a synchronous demodulator to convert ac to dc. Linear switching or chopping can be done over a range extending to a fraction of 1 mv up to ±10 v. The unit stands shock and vibration. Its applications include low-level voltage measurements dc amplifier stabilization, high-speed servo-mechanisms, and thermocouple instrumentation.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepulveda, Calif.

Price & Availability: *Price is $35 ea; delivery is from stock.*

Rack and Panel Connectors 657

Have 48 and 63 contacts

The 500L series rack and panel connectors are available with 48 or 63 contacts. The 63-contact type has 59 size-20 snap-in contacts and four size-16 contacts. The 48-contact type has 43 size-20 and five size-16 snap-in contacts and two RG58/U coaxial leads. The individual snap-in contacts, made for crimp-on attachment of conductors, meet MIL-C-26636 specs.

Consolidated Electrodynamics Corp., Electro Mechanical Instrument Div., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Availability: *Delivery time is two weeks.*

Silicon Transistors 618

PNP types

The 327 series pnp silicon alloy transistors are for switching and general purpose applications at low and medium power levels and are especially designed for audio, servo, and dc amplifiers. Engineered to exceed MIL-T-19500, the

units are more structurally rigid than required in environmental conditions such as extreme acceleration, shock, impact, and thermal fatigue.

Western Transistor Corp., Dept. ED, 13021 S. Budlong Ave., Dept. ED, Gardena, Calif.

Price & Availability: *Most units are in stock; maximum delivery time is 30 days. Price ranges from $9 to $30 ea for orders of 1 to 99 units.*

Meter Relay 660

Controls up to 600 w

The Regohm meter relay can be activated by signals as low as 2 μw and can control up to 600 w of output power. For use in process control, the unit can be driven from low-level electrical signals, or the output of differential transformers, strain gages, gas analyzers, bridges, temperature-sensitive elements, or photocells. The output of the relay is available for sequential operation of up to nine power relays and for stepless control of wattage.

Electrical Regulator Corp., Dept. ED, Pearl St., Norwalk, Conn.

Price & Availability: *$150 to $600 ea; from stock.*

Miniature Resistors 664

Wirewound tape

The Blue X-60 miniature wirewound resistors have a fibre-glass core to which lead and clip assemblies are crimped. The entire assembly is housed in a ceramic enclosure filled with a silicone base cement. Units are usually supplied with gage tinned leads.

Tru-Ohm Products, Div. of Model Engineering and Manufacturing, Inc., Dept. ED, 2800 N. Milwaukee Ave., Chicago 18, Ill.

Availability: *Units can be delivered in 10 days to two weeks.*

NEW PRODUCTS

Voltage and Current Detectors 669

Solid state

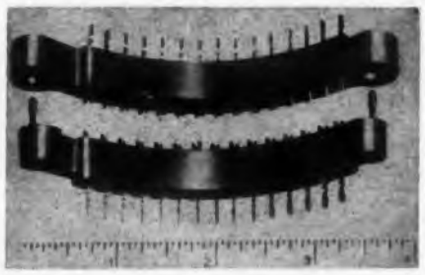
These solid-state voltage and current detectors are for use in systems for industrial process control, temperature monitoring, and other applications requiring maximum stability. For detection and comparison of low-level signals, the units have isolated inputs, can be used with dc power supplies, and respond to the algebraic sum of several weighted inputs. The voltage detectors use individual, solid-state circuits utilizing pulsed magnetic amplifiers to monitor input voltages.

Daystrom, Inc., Control Systems Div., Dept. ED, La Jolla, Calif.

Price & Availability: *Delivery time is 60 days. Price ranges from $500 to $600 ea.*

Radial Connector 668

Has 15 contacts



This radial connector has 15 contacts spaced 5 deg apart, guide pins and bushings, and set-screw locking. Contacts are from the firm's 5000 series. The Varicon contacts, with four mating coined surfaces, have low contact resistance and a high current rating.

Elco Corp., Dept. ED, M Street below Erie Ave., Philadelphia 24, Pa.

Price & Availability: *Limited quantities are now furnished from stock. Production quantities will be stocked by October, or can be supplied to order with eight weeks delivery time. Quantity price is now about $10 to $12 for the mating pair.*

Power Amplifier 650

For use with rf transmitters

Model PA-11 10- to 25-w amplifier is for use with 1- to 5-w rf transmitters in the telemetering band of 215 to 260 mc. The frequency range is continuously tunable. The bandwidth is ±3 mc. Input is 1.8 w and output is 10 w min into a 50-ohm resistive load with 1.8 w of driving power. The unit operates without forced-air cooling at rated temperatures and power. Heat transfer is sufficient for plate dissipations up to 15 w at 185 F. The unit stands shock and vibration.

United ElectroDynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Price & Availability: *The unit is priced at $415 ea in quantities of 1 to 9. Delivery is from stock.*

Coaxial Seals 612

Eliminate rf leakage

Called Conoseals, these seals are for use on rigid coaxial lines and other equipment that must conform to MIL-I-26600. They can be used on any joint where standard flanges are now located. Some versions maintain a perfect seal at temperatures from −300 to +2000 F with pressures to 20,000 psig.

Aeroquip Corp., Marman Div., Dept. ED, 11214 Exposition Blvd., Los Angeles 64, Calif.

Availability: *From stock.*

Germanium Power Transistors 627

Thermal resistance rating is 0.8 C per watt

These germanium power transistors have maximum thermal resistance ratings of 0.8 C per watt; typical value is 0.6 C per watt. With these units it is possible to switch 1200 w in dc-dc converters and dc-ac inverter circuits. The devices can be used in other high-current applications such as high power audio amplifiers, series regulators, relay drivers, and solenoids.

Motorola Inc., Semiconductor Div., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

NEW PRODUCTS

High Speed Switching Transistor 437

Stands 20,000 g acceleration

Capable of surviving 20,000 g acceleration, type 2N1473 high-speed switching transistor is for use in telemetered torpedoes, projectile fuses, and electronically guided, high-impact missiles. It stands shock tests to 140,000 g and performs critical switching functions in computers at currents to 400 ma. Maximum absolute ratings are: 40 v, V_{cbo}; 20 v, V_{ceo}; and 15 v, V_{ebo}. Junction temperature is 75 C.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.

Printer 585

Speed is 30 characters per sec

Able to print at speeds of better than 30 characters per sec on 5/16 in. tape, this printer measures 9-1/4 in. long, has a self-contained power supply, and fits a 3-in. instrument case. It is suitable as a printer for computer output and can also be used in check-out devices and in aircraft applications.

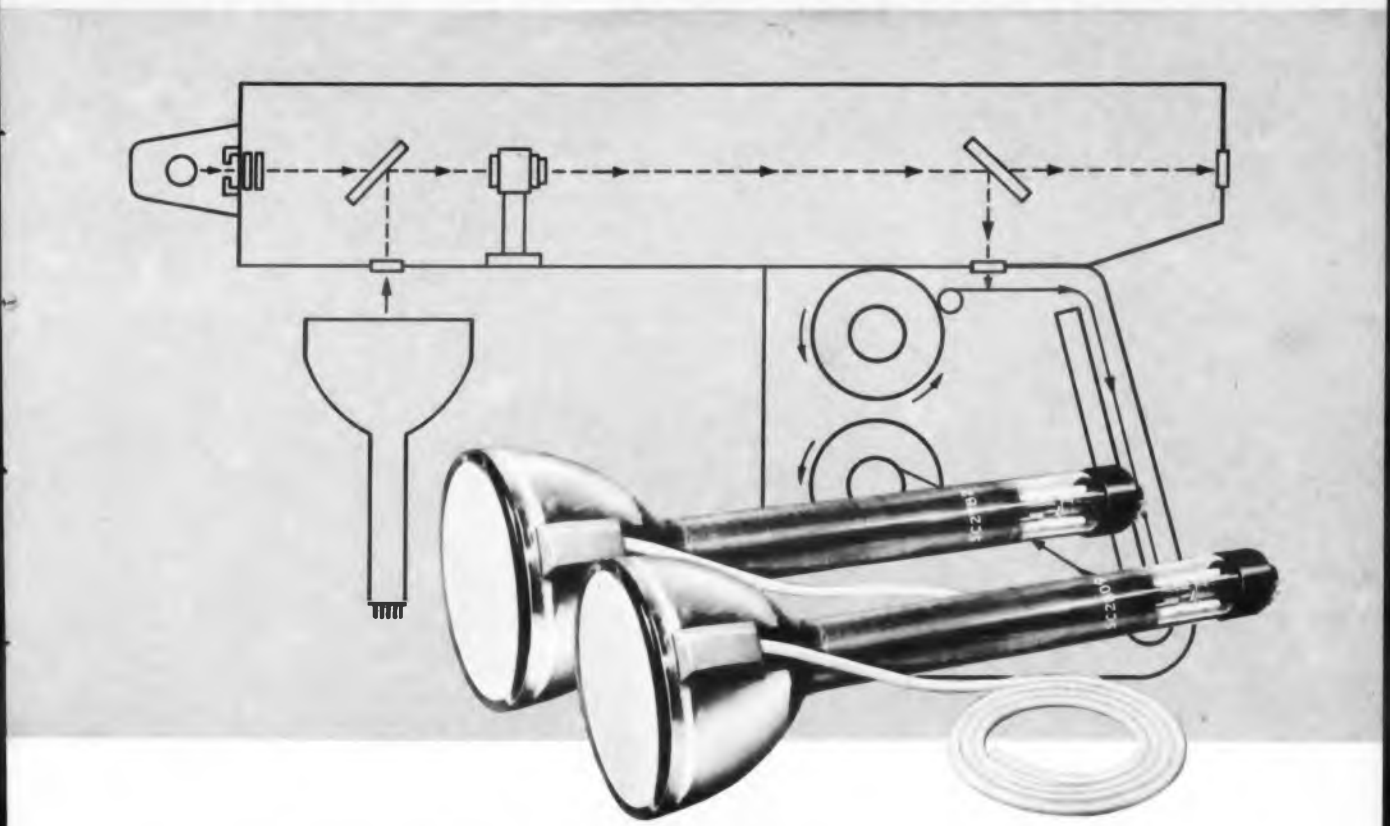
Potter Instrument Co., Dept. ED, Sunnyside Blvd., Plainview, L.I., N.Y.
***Price:** Less than $500.*

AC-DC Converter 597

For use with X-Y recorders

Model A-1 ac-dc converter is a two-channel device for plotting ac voltages on X-Y recorders.

ELECTRON TUBE NEWS
...from SYLVANIA



• HIGH RESOLUTION
• SIMPLIFIED CIRCUITRY
• IMAGE BRILLIANCE

with 2 new Sylvania C.R.T.'s for photo-recording applications

Sylvania SC-2809, SC-2782 utilize precision guns, fine grain P11 phosphor, aluminized screens, clear nonbrowning optical faceplates. Result: remarkably high resolution and excellent brilliance. SC-2809 has a line width of .0008", a resolution of 6000 lines. SC-2782 has a .001" line width and a 3000-line resolution. Both tube types feature conventional magnetic focusing and deflection, simple beam-centering magnets, no ion traps. They simplify external circuitry requirements, offer potential savings in equipment costs. Minimum useful screen area is 4¼". Deflection angle is 50°. Use of an integral encapsulated high-voltage connector minimizes possibility of corona at high altitudes. Screens other than P11 are available if desired. For further information and complete technical data, contact the Sylvania Field Office nearest you.

KEY CHARACTERISTICS	SC-2809	SC-2782
Anode Voltage	25,000 Volts dc*	25,000 Volts dc*
Anode Current (E_{G1}=0)	3 μA dc*	
Grid No. 2 Voltage	2,500 Volts dc*	2,500 Volts dc*
Grid No. 2 Current (E_{G1}=0)	2,000 μA dc*	
Screen Current	2 μA dc	5 μA dc
Line Width	0.0008"	0.001"
Face Diameter	5"	5"
Over-all Length	16⅜"	16"

*Absolute Max. Ratings

NEW SYLVANIA C.R.T.'s FEATURE

LOW HEATER POWER HIGH RELIABILITY "COOL" OPERATION

for battery-powered, portable 'scope applications

Sylvania 3BGP1, 3BGP2, 3BGP7, 3BGP11 . . . feature direct-view rectangular faces, electrostatic deflection and focus, high deflection sensitivity.

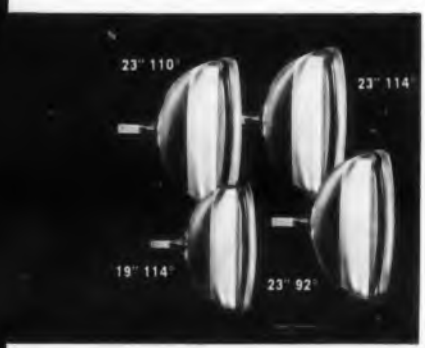
KEY CHARACTERISTICS	
Anode No. 2 Voltage	2,750 Volts dc*
Anode No. 2 Input	6 Watts*
Anode No. 1 Voltage (Focusing Electrode)	1,100 Volts dc*
Heater Ratings	1.5V/140mA
Line Width (Light output of 20 ft. Lamberts)	0.026"
Face Dimension	1½" x 3¼"
Useful Screen Area	1⅛" x 2¾"
Over-all Length	9¼"
*Absolute Max. Ratings	

The 3BGP-family of 'scope tubes is typical of the continuing work of Sylvania to advance the "state of the art." Combining modern C.R.T. technology and powder metallurgy techniques, Sylvania has produced a heater-cathode assembly requiring only 1.5V @ 140mA – less than 7% of the power normally needed. Reduced power demands result in much lower tube operating temperatures and low drain from battery or flyback heater supply. The heater-assembly has a relatively low mass which makes it virtually impervious to vibration of portable equipment. Clear, pressed faceplates are utilized for improved glass quality, greater uniformity of thickness resulting in minimized distortion. Complete information and technical data can be obtained from your local Sylvania Field Office.

The new Sylvania low power heater-cathode assembly holds vast promise for picture tubes for portable, battery-operated TV receivers. This concept is currently under investigation at Sylvania. Your inquiry is welcome.

4 NEW "BONDED SHIELD" TV PICTURE TUBES

all available with new reflection-diffusing, treated caps



Sylvania continues its leadership in "Bonded Shield" picture tubes with an expanded line to help you meet the demand for squared-corner TV. Now, you can offer *broad-angle* and *low-reflection* viewing with the specially treated laminated cap. The treated surface of the tube cap can diffuse up to 70% of reflected light without appreciable loss in resolution–eliminating the old problem of mirror images.

Bonded Shield eliminates front-of-the-cabinet safety glass • Reduces front-to-back cabinet dimensions • Reduces danger of implosion • Reduces production-line rejects significantly • Offers squared-corner screen • Simplifies mounting with integral mounting lugs • Offers potential savings in set manufacture.

Sylvania pioneered the quantity production techniques of bonding cover panels to the face of a picture tube. These same techniques hold exciting possibilities for application in industrial and military cathode ray tubes. You may have a C.R.T. application that can benefit from Sylvania Bonded Shield "know-how." Sylvania Engineers will be pleased to work with you.

If your industrial or military design demands specialized Cathode Ray Tubes, call on the creative experience and production capabilities of Sylvania. Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

The frequency range is 20 cps to 100 kc. Voltage ranges are 0.1, 0.2, 0.5, 1, 2, 5, 10, and 20 v per in. Accuracy is 0.5% from 20 cps to 20 kc, 2% from 20 to 100 kc, and 10% from 100 to 200 kc. The unit is compact and is completely self-contained.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price: About $2500.

Silicon Rectifiers 638

Have piv ratings of 1600 to 10,000 v

These diffused silicon rectifiers are hermetically sealed by a process of pressure molding under heat and pressure. These axial-type units are offered in matched sets with piv ratings of 1600 to 10,000 v at 50 to 350 ma.

Solitron Devices, Inc., Dept. ED, 67 S. Lexington Ave., White Plains, N.Y.

Weir Washer 646

For rinsing electronic parts

For rinsing water-soluble ions from transistor, semiconductor, and other electronic parts, this Weir washer supplies water deionized to 18 to 22 meg. The water is heated and cascaded through a multiple-partitioned tank. The parts to be rinsed are transferred counter-current to the flow of the water. Design of the unit precludes stagnation.

Penfield Manufacturing Co., Inc., Dept. ED, 19 High School Ave., Meriden, Conn.

Vibration Test Equipment 626

Shakers

Types A-246 and 275 shakers produce forces of 7,500 and 10,000 lb, respectively, with inexpensive amplifier requirements and can operate under adverse environmental chamber conditions. They operate at simulated altitudes of 125,000 ft and over a temperature range of −100 to +300 F.

Ling-Altec Electronics, Inc., Dept. ED, 1515 S. Manchester, Anaheim, Calif.

Helix Antennas 620

For telemetering and airborne applications

For telemetering and airborne applications these helix antennas come in 4, 6, 8, and 10-turn types and in a variety of sizes. Complete units with reflectors are made in single, dual, and quadruple assemblies for mounting on manual or mechanized mounts. Polarization is circular.

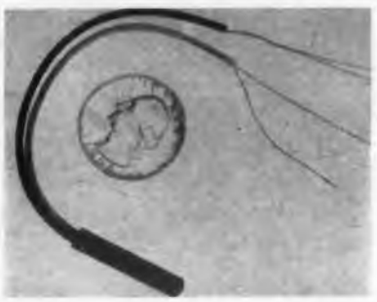
Technical Appliance Corp., Dept. ED, Sherburne, N.Y.

Availability: Some units, from stock.

NEW PRODUCTS

Probe 584

For axial field measuring



Model HP-315 axial field probe is for use as a gaussmeter probe and in other applications where the intensity of axial fields must be measured. Maximum diameter is 0.195 in. and length is 1 in. The device has a low ohmic residual error and a low temperature coefficient. The active element used is indium arsenide.

Ohio Semiconductors, Inc., Dept. ED, 1035 W. Third Ave., Columbus 12, Ohio.
Price & Availability: Sample quantities are priced at $79.50 ea. Delivery is from stock.

Heat Sinks 671

For JEDEC-30 transistors

Types 2208 and 2209 heat sinks, designed especially for Mesa transistors, can be used for printed circuit board applications or can be mounted directly to the metal chassis. Heat generated in the transistor junction is conducted to the sink where it is removed to the surrounding air by means of fins.

Thermolloy Co., Dept. ED, 1214 Rock Island St., Box 4341, Dallas 8, Tex.
Availability: Units are in stock.

Ceramics 644

For transducers

This line of piezoelectric barium titanate ceramics is for high-temperature transducer applications. They are offered in a wide range of

electrical and piezoelectric properties and are manufactured to high tolerances. Also offered, a magnetostrictive toroid for ultrasonic applications; it can be used at temperatures over 350 C.

Curtiss-Wright Corp., Dept. ED, Wood-Ridge, N.J.

Computer Tape 640

For programing applications

These types of reinforced opaque computer tape are for programing applications using photoelectric or mechanical readers. Type R-V-CT 52 is 0.0025 in. thick, comes in lengths of 1800, 1200, 1000, and 500 ft, and is designed for photoelectric reading. For mechanical or photoelectric reading, type R-V-CP 23 is 0.0045 in. thick and comes in rolls with an OD of 8, 6, or 4 in. Both types have a tolerance of ±0.003 in.

Arvey Corp., Lamcote Div., Dept. ED, 3500 N. Kimball Ave., Chicago 18, Ill.

***Availability:** From stock.*

Voltage Standard 633

Accuracy is ±0.01%

Model STV voltage standard is for use with null-balance devices such as potentiometers. Input is 90 to 135 v at 60 cps. Output is 1 to 1.0185 v. Accuracy is ±0.01% of nominal output. Stability is ±0.005% of actual output for an input range of 100 to 125 v over the temperature range of 20 to 30 C. Operational life is 25,000 hr min.

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

***Price & Availability:** Standard unit, $219 ea; panel mounting unit, $234 ea. Delivery is from stock to 60 days.*

Harmonic Multiplier Adapter 639

Frequency range is 1600 to 11,200 mc

When driven by the output of type AN/USM-45 frequency calibrator, this harmonic multiplier produces discrete marker signals spaced every 1600 mc over the range of 1600 to 11,200 mc. Frequency markers spaced every 400 mc are present at a lower power level. Power level of the 1600 mc harmonics is greater than −30 dbm. The output mode is continuous wave or pulse. In the pulse position, the nominal repetition rate is 3000 pps and the pulse duration is 25 μsec.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington, L.I., N.Y.

***Price & Availability:** Price is $980 ea; delivery is from stock.*

NEW PRODUCTS

Chart Recorder 592

Covers 1 to 250 mv

Model 6701 adjustable span, adjustable zero recorder covers spans between 1 and 250 mv, placing the lowest nominal span at 5 mv and the highest at 150 mv. Zero adjustment is from 0 to 1000; any span may be shifted over a maximum of ±50 mv. Carriage travel speeds across full scale are 1, 2, 10, and 20 sec.

Weston Instruments Division, Daystream, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Price & Availability: $1187 ea. Units are made on order and can be delivered in about 90 days.

Ball-Bearing Brake 468

Miniature type

This ball-bearing brake, measuring 1 in. in OD and 0.78 in. long, is for industrial and military applications. The torque output is 35 oz-in. at 24 v dc with zero backlash. Power consumption at 28 v dc is 2 w and temperature range is —65 to +125 C. Made to meet MIL-E-5272 requirements, the brake can be supplied with terminals or leads to meet individual applications.

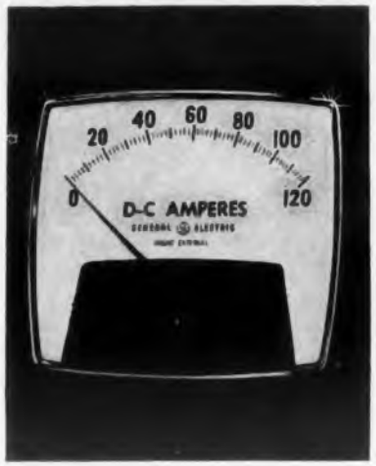
Orbit Instrument Corp., Dept. ED, 131 Eileen Way, Syosset, L.I., N.Y.

Availability: Delivery time is 30 days.

Counter-Scaler 637

Risetime is 5 μsec or less

Model G-M counting system incorporates an



EASY-TO-READ panel meter scale is nearly 4 inches long.

BIG LOOK panel meters

NOW INCLUDE NEW 4½-INCH DESIGN

Designed with modern BIG LOOK styling, this new General Electric 4½-inch panel meter features a snap-on, snap-off cover for easy access to the scale face.

Improved readability, even at extreme distances, results from its expanded scale length . . . *ideal* for multi-scale applications on portable test instruments and panelboards. DC models of this new meter feature the same self-shielded mechanism available on 2½- and 3½-inch designs.

For the complete AC and DC BIG LOOK panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-10, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 145 ON READER-SREVICE CARD

RCL decade-scaler with five-digit, direct-glow transfer-tube readout. Designed for laboratory use, the unit has an input sensitivity of 60 mv with a risetime of less than 5 μsec. Regulation is 0.5% for ±10% line variation at 1000 v. The unit is factory preset at 0.25 v. Resolving time is less than 40 μsec.

Radiation Counter Labs., Inc., Dept. ED, 5121 W. Grove St., Skokie, Ill.
Price: *$695.*

Multimeter 643

Also a null detector

Model 151 multimeter, incorporating a photoconductive modulator, has applications as a bridge null detector, a microvoltmeter, a milli-microammeter and a dc amplifier. It is useful where a suspension galvanometer can be used, also in applications where a galvanometer is not sensitive, fast, or rugged enough. As a null detector, the unit has linear ranges and five non-linear ranges, which cover three decades and have full scale sensitivities of 0.001 to 10 v. As a microvoltmeter or dc amplifier, the unit has 11 linear ranges from 100 μv to 10 v. Input resistance is 10 meg on all ranges. Power sensitivity is 10^{-17} w; currents as low as 2×10^{-18} amp can be detected.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.
Price & Availability: *$395 ea; 60-day delivery.*

Gas-Air Dryer 642

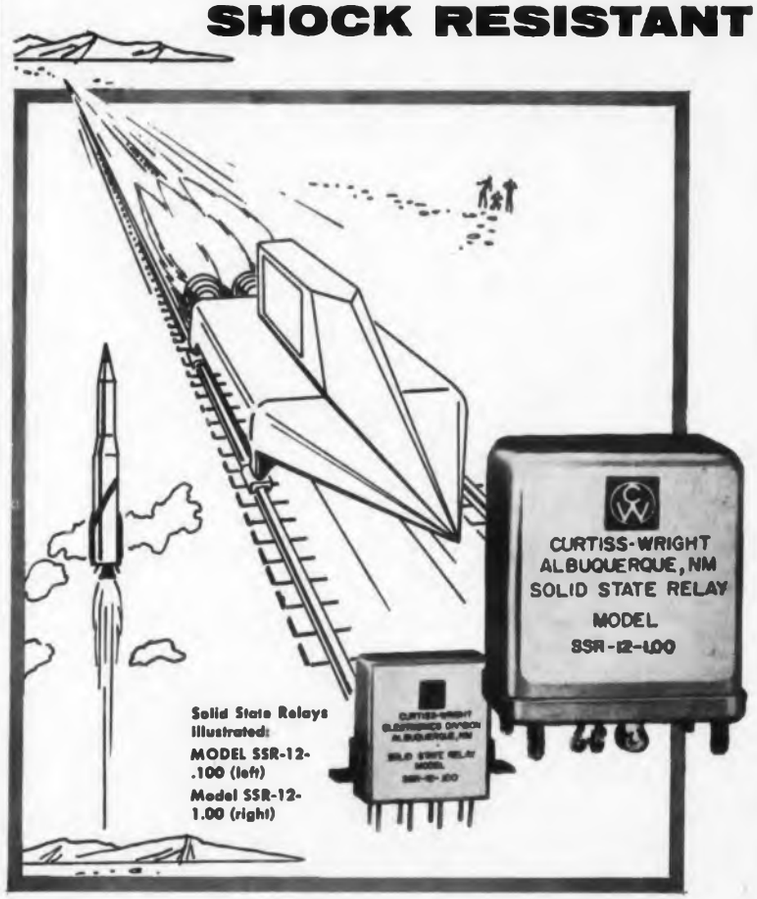
For electronic parts assembly

For electronic parts assembly model MS-R gas-air dryer has an atmosphere recirculating unit. Incorporated into a closed-cycle system, this unit permits substitution of pure dry air with dew points of 100 F or lower for the tank nitrogen ordinarily used. The dried air is circulated from process areas through molecular sieve dryers and a pipeline filter. Controls can be manual, semi-automatic, or fully-automatic. Seven models with capacities to 20,000 cfh are offered.

C. I. Hayes, Inc., Dept. ED, 896 Wellington Ave., Cranston 10, R.I.

High-Speed Solid State Relays

MICROSECOND SWITCHING... SHOCK RESISTANT



Curtiss-Wright Relays have been proven time and again in high speed sled tests and component test equipment switching applications. Designed for missile, aircraft and complex industrial controls and instrumentation and pulse circuit applications, these pulse-triggered relays switch DC power to loads in *microseconds*. There are no moving parts . . . no RF radiation . . . and "On" resistance is constant. Models are available for high temperature service; also custom designs for special applications.

WRITE FOR INFORMATION ON COMPLETE SOLID STATE RELAY LINE

TRANSISTOR TEST EQUIPMENT—Curtiss-Wright has wide experience in engineering and building test equipment to meet your needs.

INTER MOUNTAIN INSTRUMENTS BRANCH • ELECTRONICS DIVISION

CURTISS WRIGHT

CORPORATION • P. O. BOX 9324, ALBUQUERQUE, N. M.

SOLID STATE RELAYS • TRANSISTOR TEST INSTRUMENTS AND SYSTEMS • DIGITAL DATA ACQUISITION AND PROCESSING SYSTEMS

CIRCLE 146 ON READER-SERVICE CARD

NEW PRODUCTS

Drift-Angle Indicator 641

Also indicates ground speed

Constructed in accordance with ARINC 540, type T8608-21 ground-speed and drift-angle indicator is for use in commercial transport aircraft. The unit contains a servo amplifier and a dc power supply. It operates from 115 v at 400 cps, weighs a maximum of 4 lb, and offers reliable service for more than 2000 hr.

Kearfott, Div. of General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Cartridge Heaters 625

Diameter is 1/8 in.

Able to operate at temperatures to 1250 F, these cartridge heaters have 1/8-in. diameters. Lengths are from 1 in. Uses include missile and aircraft applications. These units can also be employed as high-temperature resistors, supplying up to 50 w per sq in. maximum density for electrical and electronic applications. The heating wire is near the outside surface. Voltages, including 115 and 230 v, may be specified.

Hotwatt, Inc., Dept. ED, 75 Maple St., Danvers, Mass.

Price & Availability: *Price ranges from $4.10 to $10.70. Delivery time is 10 days.*

UHF Command Receiver 610

Operates in the range of 400 to 550 mc

Model 2620 transistorized uhf command-destruct receiver operates in the range of 400 to 550 mc, has a sensitivity of 5 mv, and requires 1.5 w of input power. Transistorized, the unit is designed for use in missile environments, with specialized application in the field of target missile or drone radio command systems. It occupies 16.8 cu in. and weighs 1 lb.

R S Electronics Corp., Dept. ED, P. O. Box 368, Station A, Palo Alto, Calif.

Availability: *Made to customer requirements, units can be delivered in 30 to 90 days.*

NOT AFFECTED by magnetic fields.

BIG LOOK panel meters

SELF-SHIELDED DC MECHANISMS FOR GREATER RELIABILITY

SELF-SHIELDED DC MECHANISM is one of the big built-in features you get with General Electric d-c BIG LOOK panel meters. Self-shielding eliminates special calibration problems . . . allows more flexibility in locating meters on panelboards through minimizing interaction.

Here's why: Unlike many other designs, the BIG LOOK's core is around the magnet . . . *where it belongs* . . . and shields the entire d-c mechanism. This means that interaction is eliminated, even when meters are cluster-mounted. Also, stray magnetic effect is minimized!

For the complete AC and DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597–02, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 149 ON READER-SERVICE CARD

Silicon Base Varnish 551

Type A-100 silicone base varnish, made for use as a protective coating for electronic components, reduces moisture absorption and acts as an insulator. It is suited for transformers, coils, capacitors, resistors and printed circuit boards.

Melpar, Inc., Special Products Dept., Dept. ED, 3000 Arlington Blvd., Falls Church, Va.

Disc Thermistors 677

Furnished in diode cans, these discs have high-power handling capacities in resistances of 5 to 11,000 ohms. The mount can be electrically and thermally insulated from the mounting surface.

Fenwal Electronics, Inc., Dept. ED, 51 Mellen St., Framingham, Mass.

Two-Park Epoxy Adhesives 675

These adhesives are packaged in small plastic containers, each holding a premetered quantity of adhesive and catalyst.

Plastic Associates, Dept. ED, 2900 S. Coast Blvd., Laguna Beach, Calif.

Polyethylene Copolymer Casting Resin 679

Stycast TPM-5 is a one-part system for use above 225 F. It is moisture resistant, has low loss and low dielectric properties, and is useful as insulation in microwave, waveguide, and coaxial components.

Emerson & Cuming, Inc., Dept. ED, Canton, Mass.

Temperature Control 688

Designed for refrigeration or heating applications, model GVS maintains temperature by controlling the flow of steam, oil, gas, or electricity. Range is −30 to +1100 F. The device can be used in hazardous locations.

Partlow Corp., Dept. ED, 534 Campion Road, New Hartford, N.Y.

Bench Welder Control 691

For resistance welding, this control weighs 21 lb and measures 6 x 10 x 10 in. It is designed for use in electronic tube manufacture.

Robotron Corp., Dept. ED, 21300 W. Eight Mile Road, Detroit, Mich.

Potentiometers 692

Model 160 precision, 10-turn unit has a standard resistance range of 35 to 100,000 ohms, ±0.5% linearity, and a power rating of 2.5 w at 40 C. Unit stands temperatures to 400 F.

Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.

From CHASSIS-TRAK NEW FEATHER-LIGHT DETENT SLIDE!

Model C-300 Detent locks in three service positions — 90° up, horizontal, 90° down

Chassis-Trak continues to set the pace in slide design with the new Model C-300 Detent. Never before has a tilt-lock slide come in such a small package, yet despite its space-saving size — 1¾" high, ⅝" wide — the Model C-300 Detent will support chassis loads up to 50 lbs. Not the least of the new slide's attractive features is its low price — lowest of any detent slide on the market.

Made of hard, cold-rolled steel, each slide is cadmium plated and then coated with Poxylube 75, a bonded film formulation of molybdenum disulfide, which provides permanent dry lubrication. Solid bearings on all surfaces afford high resistance to shock and vibration.

Model C-300 Detent Slides are available in seven lengths — 12 to 24 in. — and are designed for mounting electronic equipment in any standard rack or cabinet. Like all Chassis-Trak Slides, they are easy to install and smooth and trouble-free in operation.

Model C-300 Detent slide shown locked in horizontal position.

chassis Trak inc.

For further information contact:

525 South Webster, Indianapolis 19, Indiana

CIRCLE 150 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Power Dividers 587

Series covers 500 to 4000 mc

The RDD series consists of four coaxial power dividers made to cover the range of 500 to 4000 mc. Power equality is ±0.1 db and the vswr is below 1.25. All joints are silver-soldered. Type N connectors are used.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.

Price & Availability: *$55 to $65 ea, depending on model. Delivery is from stock.*

Closed-Circuit TV Camera 645

For aircraft and missiles

For aircraft and missile applications, type TE-9-A closed-circuit TV camera has protection against conditions present in a rocket launching. It needs no auxiliary housing. Cylindrical in design, the camera weighs 9 lb. Horizontal resolution is 650 lines. Power input is 18 w.

General Electric Co., Communications Products Dept., Dept. ED, Mountain View Road, Lynchburg, Va.

Battery Holders 429

Vibrationproof

These vibrationproof battery holders are for size D mercury batteries. Type 2570 holder is insulated at one end only. Type 2870, suited for transistor and other low voltage applications, is insulated at both ends to permit floating of the voltage supply. The mounting holes are on 0.4 x 2 in. centers, permitting easy mounting on printed-circuit boards. A locking strap keeps the battery in place.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Price & Availability: *$0.85 to $0.95; from stock.*

COMPLETE PROTECTION of internal mechanism assured.

BIG LOOK panel meters

SEAL Reliability in —LOCK Contaminants Out

Only General Electric offers sealed cases as standard equipment on commercial 2½- and 3½-inch panel meters. Best of all, the sealing of the cases lengthens BIG LOOK operating life by *protecting* internal mechanisms against contaminants such as fibers, dirt, dust and chemicals.

Sealed cases on 2½- and 3½-inch BIG LOOK meters are made possible by a tough gasket and zero-set seal.

For the complete AC-DC BIG LOOK panel meter story, just contact your nearby General Electric Apparatus Sales Office or distributor, or write for Bulletin GEA-7034 direct to General Electric Company, Section 597-03, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 153 ON READER-SERVICE CARD

Ruler For Drafting 700

The Par-A-Glide, for use in drafting, can measure distance in both directions, cross hatch, draw circles, and erect perpendicular lines. It is made in West Germany.

Calmart International, Dept. ED, 417 Amapolo Lane, Los Angeles 24, Calif.

Price: $3.95 ea.

Synchros 701

Any two size 8 or 10 synhros are offered in a single size 10 housing 2.875 in. long. Construction is stainless steel.

Clifton Precision Products Co., Inc., Dept. ED, 9014 W. Chester Pike, Upper Darby, Pa.

Availability: Delivery time is 90 to 120 days.

Pick-Up for Measuring Welding Tip Current 704

This product measures ac welding current at the welding tip. Ranges are 0 to 10,000 amp and 0 to 25,000 amp. The unit has polarity reversal so that current in each phase of a complete cycle can be checked to determine performance of the ignitron tubes.

Lebow Associates, Dept. ED, 14857 W. 11-Mile Road, Oak Park 37, Mich.

Cladding Process 702

This process is for the manufacture of laminated precious metals, base metals, and refractory metals for components of semiconductor devices. It enables wrought metals to be bonded together without the use of bonding agent at interfaces.

Composite Industrial Metals, Inc., Dept. ED, 237 Georgia Ave., Providence, R.I.

Potting Compound 695

Type 777 polyurethane-based compound is now available as a two-part material. Temperature range is −65 to +350 F. It has good electrical and physical properties.

Coast Pro-Seal & Manufacturing Co., Dept. ED, 2235 Beverly Blvd., Los Angeles 57, Calif.

Pulse Camera 696

Model 370 pulse camera is operated shutter-normally-closed for usual pulse photography and is suited for time-lapse work. It uses 100-ft roll film. Auxiliary equipment permits slow-motion pictures of cyclic events at speeds of 10,000 cps.

Chadwick-Helmuth Co., Dept. ED, 472 E. Duarte Road, Monrovia, Calif.

Price & Availability: Camera with lens, $1850; accessory equipment, $2000. Delivery time is 30 to 60 days.

REC's.....

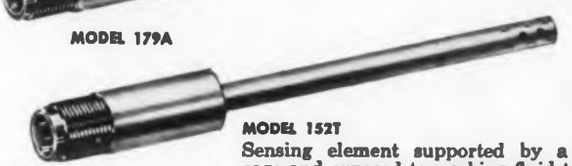
Precision Temperature Probes.....at off the shelf prices!

Want low cost temperature probes on short notice – without sacrifice in quality? Rosemount Engineering Company now offers high-performance platinum resistance temperature sensors from stock.

MODEL 179A

Sensing element fully supported, mounted in ceramic insulation. Stainless steel guard tube with additional support at the element tip gives maximum protection from flow.

MODEL 179A



MODEL 152T

MODEL 152T

Sensing element supported by a light cage and exposed to working fluid to give extremely fast response in fluids which are not electrical conductors. Element protected by stainless steel guard tube with additional support at the element tip.

Fourteen stem lengths and 6 different fittings of each model available. These immersion probes have wide application in research, development and industrial process controls. Recommended for use in most hydrocarbons, gaseous or liquid air, oxygen, nitrogen, hydrogen or helium. Sensing elements, of precision platinum, are calibrated at liquid helium point and the ice point. General specifications:

- **Temperature Range – from −435°F to 500°F**
- **Stability – Stable within 0.20°F at 32°F**
- **Pressure – 6,000 psi maximum**
- **Element Length – from 1⅛" to 2¾", in ⅛" increments**
- **Time Constant – 152T – 0.2 seconds } Dow Corning No. 200**
  179A – 0.5 seconds } 1.5 CTSK Oil
- **Resistance at 32°F – 152T – 200 ohms**
  179A – 500 ohms

For additional information write for advance bulletin number 5603.

Plus Circuit Modules

Rosemount also offers a series of preassembled circuit components, featuring small size and durability. Built to meet environmental requirements of MIL-E-5272 and MIL-E-8189.

- **General purpose amplifier, Model 510A, 40 db voltage gain minimum, 10 cps to 100,000 cps, −55°C to 125°C.**
- **High impedance input amplifier, Model 511A, 20 db power gain, input impedance greater than 1 x 10^6 ohms, 10 cps to 50,000 cps, −55°C to 125°C.**
- **Power supply, Model 531A, 117 volts, 400 cps; 20 volt DC regulated, 10 milliamperes, 0.1 percent ripple, −55°C to 125°C.**
- **Rectifier-filter, Model 532A, diodes and RC filter for two full wave DC supplies. Rated 30 volts DC each at 0.1 percent ripple. −55°C to 125°C.**

For additional information write for advance bulletin 46028.

(Size 1 x 1 x 1 Inch)

REC ROSEMOUNT ENGINEERING COMPANY

4900 West 78th Street, Minneapolis 24, Minn.

CIRCLE 154 ON READER-SERVICE CARD

NEW PRODUCTS

Motor-Starting Capacitors 548

Use Mylar, Teflon, and mica dielectrics

These motor-starting capacitors are offered in a capacitance range from 0.05 μf. The Mylar units have a working temperature range of —65 to +300 F; the Teflon units, —65 to +400 F; the mica units, —65 to +700 F. The Mylar and Teflon types are wound of thin, metallized film. The mica type is wound of aluminum foil and pure mica ribbon.

Airborne Accessories Corp., Dept. ED, 1414 Chestnut Ave., Hillside 5, N.J.

Availability: Sample quantities can be furnished in 40 days.

Nuvistor Tetrode 615

Small signal type

Designed for both military and industrial applications, this nuvistor, small-signal tetrode is one-third the size of conventional rf amplifier tetrodes and consumes half as much heater power. Maximum plate dissipation rating is 30 w. The tube has an output of several watts with less than 75 v on the plate.

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

Availability: The product is immediately available on a limited sampling basis.

Silicon-Controlled Rectifiers 469

Provide forward currents of 10 to 50 ma

Types 010, 025, and 050 pnpn, diffused, silicon-controlled rectifiers provide forward currents of 10 to 50 ma for on-off switching, 5 to 20 ma gate current to switch on and —5 to —20 ma to switch off. Maximum holding currents are 5 to 25 ma. The output current is 1 amp at a case temperature of 80 C and the average rectified forward current is 300 ma at 125 C case temperature with piv and minimum breakover voltages at 50 v.

Texas Instruments, Inc., Dept. ED, P.O. Box 312, Dallas, Tex.

Price & Availability: Price is $10.65 to $14 ea for 1 to 99 units. Delivery is from stock.

"DRESSES-UP" your panels, switchboards, other products.

BIG LOOK panel meters

MODERN DESIGN IMPROVES END PRODUCT APPEARANCE

Now, General Electric's BIG LOOK panel meter styling can help improve the appearance of your switchboards, panels and other equipment. BIG LOOK *styling* is the result of careful planning, development and field testing. It represents more than 28 years of General Electric leadership in creative panel meter design.

Now, BIG LOOK panel meters are available in your choice of seven attractive color windows to complement the appearance of your products or equipment.

For the complete AC and DC BIG LOOK panel meter story just contact your nearby General Electric Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-04, Schenectady, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 157 ON READER-SERVICE CARD

Insulated Screws 689

The Sleev-Scru fasteners consist of a metal screw with the shank insulated with Mylar polyester film. Dielectric strength is up to 10,000 v. Uses are in relay stacks, miniature motor-generators, transistor bases, and thermoelectric assemblies.

Pylon Co., Inc., Dept. ED, 200 N. Main St., Attleboro Mass.

Availability: *Sizes are produced to user's requirements.*

Crossbar Switch 697

Consisting of a switching matrix and a coordinate actuating mechanism, this switch is for handling complex circuitry such as found in data processing and automation systems. Features are: operational simplicity, economical installation, and single-source control. Contacts are beryllium-copper alloy for stable mechanical closure.

James Cunningham, Son & Co., Inc., Dept. ED, Rochester 8, N.Y.

Magnetic Shield 694

This unit protects TV cameras from a variety of flux intensities, either dc or ac transient situations. Access to the camera for service and adjustment is provided for.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

Availability: *Generally from stock.*

Floating Self-Clinching Fasteners 699

These fasteners provide load-bearing threads in very thin metal sheets with a captive floating nut that permits up to 1/32-in. adjustment. Thread sizes are 4 to 10.

Penn Engineering & Manufacturing Corp., Dept. ED, Doylestown, Pa.

Handles 703

These oval, instrument-panel handles are finished in nickel plate, chrome plate, black oxide, black matte, and other custom finishes. They measure 9/32 x 5/8 in. and are offered in several lengths.

Goe Engineering Co., Dept. ED, 219 S. Mednik Ave., Los Angeles 22, Calif.

Toggle Clamps 463

These vertical-handle toggle clamps have a rated holding pressure of 100 lb. Model 102 has a straight handle and model 102T, a T-handle. They are for light-duty assembly operations and are designed to fit aircraft and electronic pegboard assembly fixtures.

Detroit Stamping Co., Dept. ED, 330 Midland Ave., Detroit 3, Mich.

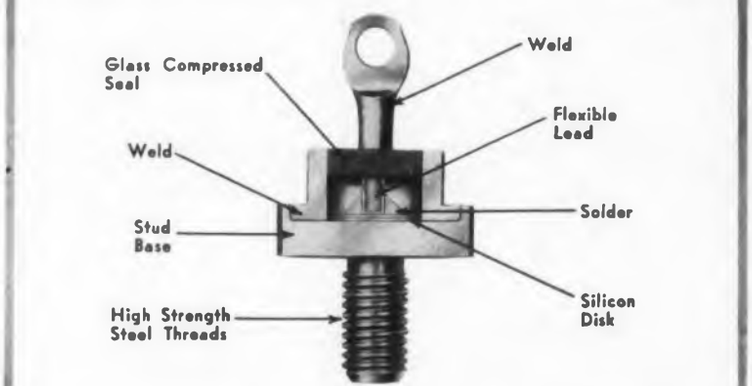
Price & Availability: *$2.15 ea in quantities of 1 to 49; from stock.*

Specify reliable all STEEL construction

Silicon Rectifiers

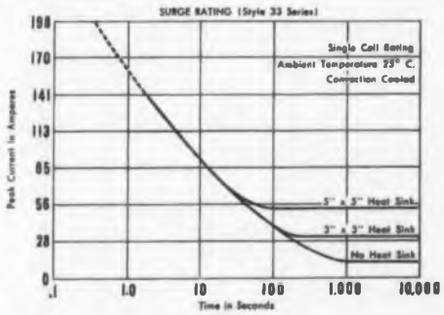
by

SYNTRON



Style 33

SYNTRON'S exclusive all STEEL assembly—high tensile strength 100% welded construction



100 inch pound mounting torque for maximum heat transfer—less corrosion—greater reliability—better contact. Mechanically and electrically superior.

Write for information and specifications

SYNTRON RECTIFIER DIVISION

SUBSIDIARY OF LINK BELT COMPANY

283 Lexington Ave. Homer City, Penna.

Sales Engineers in: New York, Chicago, Los Angeles and Canada
Canadian Manufacturing Plant: Syntron (Canada) Ltd., Stoney Creek, Ontario
Export Representative: Dage Corporation, 219 E. 44th Street, New York, N. Y.
Sales and Engineering Representatives: Robert O. Whitesell and Associates, 6620 East Washington Street, Indianapolis 15, Indiana, Offices in Cleveland, Dayton and Cincinnati

CIRCLE 158 ON READER-SERVICE CARD

NEW PRODUCTS

Commutators 594

Draws 60 ma at 28 v dc

This 5-rps telemetering commutator draws 60 ma at 28 v dc, occupies 8.6 cu in. and weighs 350 g. It contains two poles with 60 contacts, one pole with 30 contacts, and one pole master contact. The unit operates at temperatures from −40 to +125 C and stands 30 g vibration at 36 to 2500 cps and 100 g sustained acceleration. The rf noise filter is designed to MIL-I-6181B. Contact resistance is 0.1 ohms and interchannel leakage resistance is 500 meg.

Lind Instruments, Inc., Dept. ED, 357 Nassau St., Princeton, N.J.

Price & Availability: $1547 ea; from stock.

Infrared Radiant Heater Assembly 674

This device can be used for drying parts on belts, baking out metal, ceramic and glass-vacuum systems. Effective heating lengths are 18 to 78 in. Wattages are 750 to 3250 w.

Thermel, Inc., Dept. ED, 9400 Robinson Road, Franklin Park, Ill.

Linear Count Rate Meter 690

This instrument gives direct meter indication of the rate of random pulses. An audio circuit provides for aural monitoring and connection for a strip chart recorder.

Radiation Counter Labs, Inc., Dept. ED, 5121 W. Grove, Skokie, Ill.

Electrostatic Shields 681

These glass shields are for use as windows and transparent partitions that drain off electromagnetic interference. Applications include in computers. The coated panel shield transmits 70% of visible light.

Corning Glass Works, Dept. ED, Corning, N.Y.

Piezoelectric Transducers 680

The White Line piezoelectric transducers are for ultrasonic non-destructive testing, come in sizes from 200 kc to 10 mc, are compatible with all types of equipment, and use a ferroelectric element.

Automation Industries, Inc., Dept. ED, 3613 Aviation Blvd., Manhattan Beach, Calif.

UP TO 28 PERCENT increase in scale length improves meter readability.

BIG LOOK panel meters

DESIGNED FOR AT-A-GLANCE READABILITY

In designing the BIG LOOK panel meter, engineers placed particular emphasis on achieving an important balance between distinctive appearance and excellent readability.

This balance of aesthetic and functional design values makes BIG LOOK panel meters *easier to read*, relieves eye tension and stress—and reduces reading error.

Accurate, at-a-glance readability is a prime requisite for panel meters. To achieve it, G-E first eliminated the problem of shadows by designing a cover to admit light from top, sides and bottom. The color area of the window completely hides the distraction of the moving internal mechanism. This gives you exactly what you want . . . a clear uncluttered view of the scale and an accurate reading.

For the complete AC-DC BIG LOOK story just contact your nearby G-E Apparatus Sales Office or distributor; or write for bulletin GEA-7034 direct to General Electric Company, Section 597-05, Schenectady 5, New York.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 161 ON READER-SERVICE CARD

Signal Generator 663

For servo components and systems

Model 100-C signal generator generates the waveshapes necessary for frequency and transient response tests of servo components and systems. These include the forcing voltages for the servo and the accessory waveshapes for display on the CR oscillograph. Outputs are low-frequency signals for dc servos or suppressed carrier modulations for ac servos. Data frequency coverage is in ranges of 0.01 to 1 cps and 0.5 to 30 cps. The unit accommodates carrier frequencies from 60 to 2500 cps.

Industrial Control Co., Dept. ED, Central Ave., at Pinelawn, Farmingdale, L.I., N.Y.

Price & Availability: *$910 ea; 30-day delivery.*

High Temperature Cements 685

Astroceram cement type A, for use in joining ceramics, glass, and metals, can be air dried. Type B must be fired to develop a bond. Its uses are as sealer, mortar, casting compound, and surface coating for refractories.

American Thermocatalytic Corp., Dept. ED, Mineola, N.Y.

Ceramic Insulators For Thermocouples 673

For use to 3200 F, these insulators are up to 48 in. long. They are 96% alumina and have a Silica content of 1% or less. OD is 0.04 to 1 in. with single or double holes as small as 0.015 in.

Saxonburg Ceramics, Inc., Dept ED, Saxonburg, Pa.

Tweezers 684

For moving wafers from acid baths to a neutralizing liquid, the Eremite tweezers are anti-magnetic and have a high resistance to acids.

R. N. Hunter Sales Co., Inc., Dept. ED, 9851 Alburtis Ave., Sante Fe Springs, Calif.

Voltage Regulator 693

Type LR-10 restores proper operation of any electronic equipment when the line voltage varies from 117 v.

Vidaire Electronics Mfg. Corp., Dept. ED, 44 Church St., Baldwin, N.Y.

CIRCLE 162 ON READER-SERVICE CARD ➤

Cary Electrometers measure insulation resistance of 10^{15} ohms at potentials of one volt or less with ±1% accuracy

Provide fast accurate leakage measurements; eliminate instrument loading of the test circuit

In addition to measuring large resistance values Cary Electrometers are used for measuring charging phenomena, hysteresis and photo effects of semi-conductors and insulating materials. Applications include air ionization studies, measurement of ion currents in mass spectrometry, radioactivity measurements of solids, liquids and gases and Hall effect studies.

Cary Electrometers detect currents as small as 10^{-17} amperes; charges to 6×10^{-16} coulombs; and voltages as low as 20 microvolts.

High stability (less than 5×10^{-17} amperes steady drift), high accuracy (±0.25% using a precision potentiometer), and operation independent of changes in vacuum tube and component characteristics are just a few of the features contributing to the superior performance of Cary Electrometers.

Choose from several models: **MODEL 31 for measuring currents from grounded sources and voltages from ungrounded sources; MODEL 31V for voltage measurements from grounded sources; MODEL 31-31V for measuring voltage or current from grounded sources.**

Cary INSTRUMENTS

Additional information on Cary Electrometers and Accessories is yours for the asking. Write for data file M14-60

Electrometers • UV—Visible—Near IR and Raman Spectrophotometers

APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.

NEW PRODUCTS

Power Supply 705

Current and voltage-regulated

Designed for powering solid-state equipment, model CVS-300 power supply provides up to 400 ma at 30 v max on constant current operation and up to 500 ma at 4 to 36 v on constant voltage operation. A front panel switch sets the unit for constant current or constant voltage operation. Regulation is better than 1% against line and no load to full load variations. Ripple is less than 5 mv. For bench use or rack mounting, the unit measures 4.75 x 4.5 x 6.25 in.

Mathew Laboratories, Dept. ED, 3344 Fort Independence St., New York 63, N.Y.
***Price & Availability:** $126.50 ea; from stock.*

Vertical Velocity Indicator 686

Type T8614-11 is for use in submarine and aircraft applications to measure vertical velocity as a function of an ac input voltage. Accuracy is ±5 mv.

Kearfott, Div. of General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Tube Tester 687

Type TE-15 provides sockets for 7-pin miniature, 9-pin miniature, octal base, loctal base, noval, and subminiature tubes. It checks shorted elements, cathode emission, filament continuity, and leakage.

Lafayette Radio Electronics Corp., Dept. ED, 165-08 Liberty Ave., Jamaica 33, N.Y.
***Price:** $19.95.*

Drafting Pencil 682

The FTR is for making tracings on polyester-based film. Copy print drawings using this pencil are claimed to have black-ink clarity.

John Dixon Crucible Co., Dept. ED, Jersey City, N.J.

Portable Recorder 500

Type CF-8 registers watts and vars on a single chart. It can be used in polyphase circuits. Weight is 13 lb and dimensions are 10 x 8 x 6 in.

General Electric Co., Schenectady 5, N.Y.
***Price:** about $350.*

Isolation Amplifier 604

Input impedance is 200,000 ohms

Model 250 isolation amplifier has an input impedance of 200,000 ohms and an output impedance of 700 ohms. Gain is unity. The unit uses silicon transistors and operates on standard 28 v dc power. Uses are in computers, servo devices, and automation applications. Able to meet MIL-E-5272 requirements, the unit operates from −55 to +125 C.

Control Technology Co., Inc., Dept. ED, 1186 Broadway, New York 1, N.Y.

Availability: *Two-week delivery time.*

Tool for Handling Minute Parts 459

Called the Pickup, this pencil-shaped device is for handling parts such as germanium and silicon crystals. Air or inert nitrogen is forced through a tube at 1 to 2 psi; negative pressure attracts and holds the particle. Finer stops provide release.

Penfield Manufacturing Co., Inc., Dept. ED, 19 High School Ave., Meriden, Conn.

Stamps for Drafting 460

The Symbostamps transparent vinyl and lucite stamps provide a fast method of reproducing drafting symbols.

John Griffin Co., Dept. ED, 2117 Grand Ave., St. Paul 5, Minn.

Multiconductor Cables 461

These multiconductor cables are plastic jacketed. They can be furnished in a variety of sizes with any number of conductors. They are color-coded.

Lenz Electric Manufacturing Co., Dept. ED, 1751 N. Western Ave., Chicago 47, Ill.

Self-Clinching Fasteners 698

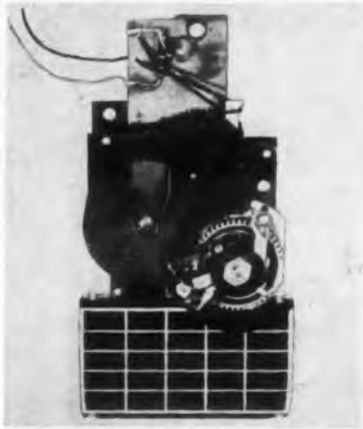
Designed for providing load-bearing threads in sheet metal as small as 0.032 in. thick, these fasteners are made in carbon steel with rust resistant finishes or in type 303 stainless steel with thread sizes of 0 to 3.

Penn Engineering & Manufacturing Corp., Dept. ED, Doylestown, Pa.

Electronic Products NEWS
by CARBORUNDUM®

Temperature Compensation in Electric Eye Movie Camera provided by GLOBAR® Thermistor

Energy from a built-in photoelectric cell automatically sets the lens opening for correct exposure in the Bell & Howell "Electric Eye" movie camera. The high standard of accuracy usual in Bell & Howell products is indicated by the use of a GLOBAR Type 479H Thermistor for temperature compensation.



The output current of the photocell varies with temperature. In addition, the resistance of the coil in the operating mechanism varies with temperature because of copper's positive temperature coefficient. A negative coefficient thermistor, in parallel with a fixed resistor, provides the necessary compensation.

GLOBAR thermistors are your answer to a variety of problems where a temperature-sensitive resistor is required. Disc and rod shaped bodies are available in a wide range of sizes, providing desired resistance values, thermal time and dissipation constants and temperature coefficients. For information, write to Globar Plant, Refractories Division, Dept. EDT-60, Carborundum Co., Niagara Falls, N. Y.

ALUMINA BUBBLES... new transformer potting material can withstand temperatures over 1000° C.

Trends to higher temperatures and upgrading of insulation systems have spurred the search for new potting materials for metal-encased electronic power transformers.

Research by Bell Telephone Laboratories suggests unusual possibilities in a special form of aluminum oxide developed by Carborundum's Refractories Division. The material is made by a process which converts alumina powder into microscopic, light-weight, free-flowing, non-abrasive bubbles. Ordinary granular alumina won't serve the purpose.

Since the material can withstand over 1000° C., all practical temperature limitations are removed. Electrical insulating properties are excellent. A particular advantage is the simplicity of the potting operation. The powder is simply poured into the transformer case and tapped or vibrated so that it fills all cavities. No curing or heating facilities are necessary. Because of these factors, the material may merit consideration even in applications where high temperature is not involved. For more information, write Refractories Division, Dept. EDP-60, Carborundum Co., Perth Amboy, N. J.

Metallized Ceramics permit high-temperature soldering or brazing

Carborundum's Latrobe Plant can supply metallized steatite which can be used with any soft solder including those melting at approximately 600° F. Re-soldering can be done without adverse effects. This offers advantages over the usual silver or platinum firing of steatite material, which requires a silver bearing tin-lead eutectic solder melting at about 360° F. These joints cannot be resoldered without dissolving the metallizing. Further, top use temperature is only 320° F. With the Carborundum metallizing, use temperature is determined only by the solder alloy used.

This type of metallizing is also used with high-alumina material for brazing. When assemblies are copper brazed, installations can be made with comparable hard solders.

For information, write Latrobe Plant, Refractories Div., Dept. EDC-60, Carborundum Co., Latrobe, Pa.

NEW BOOKLET AVAILABLE ON GLOBAR® TYPE BNR VARISTORS

Non-linear, voltage sensitive resistors are finding many electronic applications. This booklet gives full information on characteristics and sizes of GLOBAR Varistors. For your copy, write Globar Plant, Refractories Division, Dept. EDV-60, Carborundum Co., Niagara Falls, N. Y.

CIRCLE 164 ON READER-SERVICE CARD

NEW PRODUCTS

Microwave Diodes 598

Cut-off ranges to 120 kmc

Having outside dimensions of 1/8 x 1/8 in., these microwave diodes offer cut-off frequencies up to 120 kmc. Applications are in traveling-wave, broadband parametric amplifiers. The diodes can be supplied to ±10% capacitance tolerance. Other uses are as low-loss rf switches in resonant cavities at microwave frequencies and for doppler radar sideband modulators. Type 4253X has a cut-off frequency of 120 kmc and type 4254, 100 kmc. Capacitance at zero bias is 1.4 pf.

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

Availability: Delivery time is 20 days.

Shielding Can Clips 438

For attaching shielding cans to printed circuit boards, these spring clips are made of 0.016-in. pretinned brass. They come in chain form on reels for rapid application.

Malco Manufacturing Co., Dept. ED, 4025 W. Lake St., Chicago 24, Ill.

Calibrator Adapter 471

The use of a harmonic multiplier adapter increases the frequency marker signals of model 121 vhf-uhf frequency calibrator from 100 to 11,200 mc. Accurary of the calibrator is ±0.005%.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Sta., L.I. N.Y.

Teflon Bushings 472

These bushings provide mechanical and electrical protection for through-hole wiring. Insertion time is kept at a minimum.

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

Loop-Type Cable Clamp 467

This clamp is molded rather than heat-formed to provide greater strength at critical angles. It is deformed only to insert cable, harnesses, and it can be installed with one nail or screw.

Commercial Plastics Co., Dept. ED, 945 George St., Chicago 14, Ill.

AC Volt-Ammeter 473

Is accurate within 0.05%

Model B transfer volt-ammeter is designed for measuring ac voltages and currents between 5 and 50,000 cps with an accuracy within 0.05%. Voltage ranges are 0.5, 1.5, 3, 6, 7.5 and 15 v, while current ranges may be set at 7.5, 25, 50, or 100 ma. A 5%, direct reading rectifier-type meter is used in the instrument to indicate approximate values of voltage and current. A major application for the unit is in standards' laboratories for original calibration and later checking of other instruments.

Englehard Industries, Inc., Dept. ED, 113 Astor St., Newark, N.J.

Price & Availability: Delivery made 90 days after order received. Price is $1900.

Hole Punch 474

Type CJ punches holes that are round or have other shapes. Conversion is by changing shaped parts. Keying maintains positive, accurate alignment.

Wales Strippit, Inc., Dept. ED, Akron, N.Y.

Plastic Spray Coating 502

Using Teflon or Kel-F, this coating protects all metal parts. It is impervious to chemicals, stands temperatures to +450 F, and has good insulation characteristics. Applications are with resistors, transformers, capacitors, and potentiometers.

Fluorocarbon Co., Dept. ED, 1206 E. Ash Ave., Fullerton, Calif.

Microphones 503

Types 652 and 652A dynamic tape microphones with semi-rigid tubing can be tilted through a 120-deg arc with respect to the stand coupler. They give a smooth response from 50 to 12,000 cps.

Electro-Voice, Inc., Dept. ED, Buchanan, Mich.

Fluorosilicone Sponge Rubber 504

The COHRlastic 10530 compound has excellent dielectric properties and is resistant to fuels and lubricants. For use from −100 to +500 F, it is suitable for vibration damping applications.

The Connecticut Hard Rubber Co., Dept. ED, 407 East St., New Haven, Conn.

Price: $14 per sq ft.

RF Sealing Material 505

Alu-Flex H.T. silicone rubber with aluminum mesh prevents rf energy from escaping at joints in closed containers with rf emitting apparatus. It also provides positive air and fluid sealing. It comes in thicknesses of 0.016 and 0.02 in.

Auburn Manufacturing Co., Dept. ED, Middletown, Conn.

NEW PRODUCTS

Photo-Electric Microscope 373

Able to read down to 0.00001 in., the Microptic photo-electric microscope has a total range of 0.05 in. It is housed in a tube 7.5 in. long and 1 in. in diameter.

Engis Equipment Co., Dept. ED, 431 S. Dearborn St., Chicago 5, Ill.

Pressure Indicator 374

Model 236 is for use where the indication and control of the measured force must be removed from the transducers because of field location. The instrument operates from line voltages of 105 to 125 v at 60 cps. Dials can be calibrated up to 10,000 psi.

Taber Instrument Corp., Dept. ED, N. Tonawanda, N.Y.

Control Computer 375

This desk-top computer solves statistical quality control problems. Raw numerical information is fed to the computer by a keyboard. Mean value and standard deviations are indicated on a panel meter. Accuracy is better than 2%.

Boonshaft and Fuchs Inc., Dept. ED, Hatboro Industrial Park, Hatboro, Pa.

Price & Availability: $925; from stock.

HF Dielectric Heaters 506

Designed for laboratory development and general processing where rapid through-heating is required, these heaters contain compact, built-in ovens. A forced-air system exhausts vapors. Operation is by foot or panel switch.

Sherman Industrial Electronics, Dept. ED, State College, Pa.

Price & Availability: Available for two to three-week delivery, units range in price from $900 to $8450.

Automatic Insulated Slot Bobbins 507

These bobbins eliminate the use of washers and tape for insulating the starting lead on bobbin wound coils. They are for use with automatic winding equipment.

American Molded Products Co., Dept., ED, 2727 W. Chicago Ave., Chicago 22, Ill.

Teflon Insulated Hook-Up Wires 470

Type E insulated wires have been granted UL approval. This line includes AWG sizes 20 through 26, Teflon insulated lead or hook-up wires in the 105 C temperature range, with stranded or solid conductors.

American Super-Temperature Wires, Inc., Dept. ED, 2W. Canal St., Winooski, Vt.

Urethane Adhesive 464

Type 7070, having greater oil resistance than neoprene and other synthetic rubber adhesives, forms a strong bond with natural and synthetic fabrics, cork, wood, nylon, phenolics and many types of plastic. It is cured at room temperature.

B. B. Chemical Co., Dept. ED, 784 Memorial Drive, Cambridge Mass.

Test Probe Tip 465

This device can be used with any standard collet-type test lead handle. Size AT-146-1 is for standard connectors; AT-146-2 is for miniature connectors.

Autotron, Inc., Dept. ED, 2413 Main St., Santa Monica, Calif.

Availability: The product may be obtained directly from the manufacturer.

Centrifuge 466

Model A931 has a range of 0.5 to 20 g. Angular velocity of the arm is variable in 10 discrete steps. Drift is 1 ppm per week; rms deviation from average angular velocity is less than 1 part in 50,000.

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

Drafting Symbols 678

Select-A-Circuit consists of all ASA and IRE symbols, individually printed on self-adhesive transparent plastic. Lengths are 2-1/2 and 4-1/2 in. The finished diagram can be reduced photographically.

Engineering and Science Aids Co., Dept. ED, 435 W. 119th St., New York, N.Y.

Availability: Symbols are furnished in quantities of 50 and 100.

Corrosion Indicators 477

Offered in visual and electrical types, these corrosion indicators can detect as little as 5×10^{-9} in. of metal loss. Applications include use in missile systems.

Crest Instruments, Dept. ED, 11808 S. Bloomfield Ave., Santa Fe Springs, Calif.

Heat Dissipators 478

For aircraft and ground support equipment, these units remove 8.5 BTU per min at 150 w. The maximum air pressure drop is 3.46 in. water at 2 lb per min air flow at 160 F. Weight is 3-3/8 lb.

Horkey-Moore Associates, Dept. ED, 24660 Crenshaw Blvd., Torrance, Calif.

Chopper for Airborne Servo Systems 479

Series C1425 has an 83-deg nominal phase-lag at 400 cps, is of non-resonant design, and exhibits shock and vibration resistance. It measures 1-3/8 x 3/4 in.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

NEW PRODUCTS

Flexible Shaft Assemblies 412

These shaft assemblies are supplied in over 180 variations. They are assembled from stock components.

F. W. Stewart Corp., Dept. ED, 4311-13 Ravenswood Ave., Chicago 13, Ill.

Aircraft Fan 413

Designed for cooling the radio equipment compartment of the Lockheed Electra, type 4054 fan and flow control operates on 400-cps, three-phase power and provides controlled air volume at up to 30,000 ft in altitude. The unit is adaptable to airborne electronic chassis or compartment cooling wherever constant airflow is required despite changing inlet pressure. The unit weighs 5.2 lb; over-all length is 9.5 in. and diameter is 4.88 in. max.

Task Corp., Dept. ED, 1009 E. Vermont Ave., Anaheim, Calif.

***Availability:** Units will be in stock in June for 15-day delivery.*

Coil Form 414

This one-piece coil form is for printed-circuit, if coils and oscillator coils. It has constant core torque. It is designed to avoid wire breakage.

American Molded Products, Dept. ED, 2727 W. Chicago Ave., Chicago 22, Ill.

***Price & Availability:** $35.90 per 1000; delivery two weeks after receipt of order.*

High-Vacuum Evaporator System 415

This system consists of a stainless steel evaporator chamber measuring 12 in. in diameter and 18 in. in length, a 4-in. pumping system for a vacuum to 0.01 microns, a 2-kva low voltage filament supply, and controls. A built-in flange permits the system to be attached to a controlled-atmosphere enclosure.

Temperature Engineering Corp., Dept. ED, Landing Road, N.J.

***Availability:** Units are made on order.*

Temperature Detectors 416

Class H resistance temperature sensors, for applications to 260 C, are made in widths of 0.3 to 1.25 in. and in lengths from 6 to 22 in. Resistance values are from 10 ±0.02 ohms to 120 ±0.6 ohms.

Minco Products, Inc., Dept. ED, 740 Washington Ave., N. Minneapolis 1, Minn.

***Price & Availability:** $12 to $24; some models are in stock.*

Correction Notice

Model SS-2-5 environmental chamber, made by Associated Testing Laboratoratories, Inc., is priced at $1075, not $1705 as reported in the March 16th issue.

Fastening Devices 417

Made of mositure-conditioned nylon, Plasti-Grommets, self-retaining blind screw receptacles, are easily snapped in place. They provide insulation at the fastening point and are corrosion-free.

Fastex, Div. of Illinois Tool Works, Dept. ED, 195 Algonquin Road, Des Plaines, Ill.

Synchronous Motor Generators 418

These units deliver precise 400-cps power in ratings from 7.5 to 150 kva for commercial and military applications where extreme reliability is required. Silicon diode rectifiers and solid-cast frame construction are used. All rotating parts are assembled on a common shaft.

Leach Corp., Inet Div., Dept. ED, 18435 Susana Road, Compton, Calif.

Monitoring Oscilloscopes 419

Series 218 is designed for continuous function monitoring of up to seven channels simultaneously. The units are suited for tape recording and data handling systems plus measuring and analyzing mechanical quantities through a transducer.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Drive, Menlo Park, Calif.

Harmonic Absorption Filter 420

Designed to absorb spurious and harmonic signals generated by high power klystron and magnetron tubes, model 204A is rated at 25 kw avg, 1 mw peak. Insertion loss in the pass band is less than 0.1 db.

Sierra Electronics Corp., Dept. ED, 8835 Bohannon Drive, Menlo Park, Calif.

Wire Cutter 501

Called the Little Snipper, this long-nose cutter is for use in difficult-to-reach wire arrangements. Made of aircraft steel, it comes in six models ranging from 2 to 18 in. long.

E. V. Nielson Inc., Dept. ED, 575 Hope St., Stamford, Conn.
Price: starts at $3.95.

TV Camera 421

The size of a shoe box, this TV camera permits close inspection of nuclear reactors where radiation is too intense for observation windows.

International Telephone and Telegraph Corp., Dept. ED, 67 Broad St., New York 4, N.Y.

Mobile Test Bench 422

The Unistruc test bench is equipped with extension work surfaces, a tool drawer, and adjustable shelves. Shelf assemblies are shock-mounted. The bench is suitable for checkout applications.

Skydyne, Inc., Dept. ED, Port Jervis, N.Y.

NEW PRODUCTS

Temperature-Resistant Tape 423

This plastic tape provides dimensional stability, flexibility, abrasion resistance and splice strength over the temperature range of −50 to +145 C. Thickness is from 0.004 in. Uses are in vertical scale instruments, in counter assemblies, as a display medium or as a drive belt.

Gentape Corp., Dept. ED, 165 Third Ave., Paterson, N.J.

Semiconductor Alloying Furnaces 424

Model 20-D-2 continuous firing furnace can maintain an inert atmosphere throughout. Precision control of temperatures to 1875 F and of speeds from 5/16 to 4 in. per min is provided.

Sandland Tool and Machine Co., Dept. ED, 52 Duryee St., Newark, N.J.

Price & Availability: $2995; two to four weeks delivery time.

WWV Receiver 425

Model WWVTR receiver has instantaneously selected carrier frequencies of 2.5, 5, 10, 15, 20, and 25 mc. Sensitivity is 2 mv and selectivity is 10 kc at 20 db down. Battery-operated, it occupies 3.5 in. of rack space.

Sherman Products, Dept. ED, 21051 Costanso St., Woodland Hills, Calif.

Price: $725.

Miniature Power Diodes 426

Types 554, 589, and 6339 are clipper diode rectifiers and the 545 is a rectifier type. PIV range is 5 to 17 kv, peak plate current is 160 to 470 ma, and operating temperature range is −60 to +165 C. High-vacuum thermionic units, they are for missile and airborne use.

Ling-Altec, Dept. ED, 42 Spring St., Newark 4, N. J.

Ceramic Insulation 427

These beryllium oxide compositions have excellent heat transfer properties, a low dielectric constant, and a low-loss factor at high temperatures.

Coors Porcelain Co., Dept. ED, 600 Ninth St., Golden, Colo.

Saturable Core Reactors 428

Design of these units accommodates a range of control extending down to 1% of power. No tap changes are needed for different load conditions. Sizes are 1 mw to 50,000 w.

Cornwell Electronics Corp., Dept. ED, 84 W. Water Street, Port Chester, N.Y.

Impregnation for Corrugated Board 439

This easily applied impregnation improves the strength of corrugated board. Uses include the housings of delicate equipment such as electronic and airborn devices.

Ehrlich & Irany, Dept. ED, 350 W. 31st St., New York, N.Y.

Polyester Laminates 430

For use in electrical apparatus, these laminates are glass-mat-reinforced. They resist flame, moisture, arcing, and leakage currents and can be heated to 130 C. Plates, angles, and sheets are standard; other shapes can be ordered.

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

Shielded Cable 431

Type 8421 has a cellular polyethylene insulation and a spiral-tinned copper shield. The conductor is AWG 25. The cable is supplied on 15, 25, 50, 100, and 500-ft spools.

Belden Manufacturing Co., Dept. ED, 415 S. Kilpatrick, Chicago 80, Ill.

Component Holder 432

The Space Saver holder projects above the electronic chassis 0.012 in. more than the component held. Basic material is beryllium copper. Components are protected against shock and vibration.

Atlee Corp., Dept. ED, 47 Prospect St., Woburn, Mass.

DC Power Supply 433

Designed for 208 v, three-phase, 60-cps operation, model PSC 25-200-2 supply can deliver 200 ma at 25 kv. All high-voltage components are immersed in insulating oil.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mt. Vernon, N.Y.

Low Frequency Mounting System 434

Model W472, developed for the AN/WRR-2 single-sideband shipboard radio receiver, provides shock attenuation and low-frequency vibration isolation over the range of 5 to 33 cps. It has all-metal construction and conforms to MIL-STD-167 and MIL-T-17113.

Robinson Technical Products Inc., Dept. ED, Teterboro Air Terminal, Teterboro, N.J.

Power Supply 435

This 25 va, ac supply had an amplitude stability of 0.1% and frequency regulation of 0.1%. Frequency output is variable. The unit meets Mil specs.

Industrial Test Equipment Co., Dept. ED, 55 E. 11th St., New York 3, N. Y.

Availability: Made on order, units have a delivery time of 45 days.

Soldering Irons 436

Designed for soldering densely packed electronic circuits and suitable for continuous production or general use, these irons weigh 2 oz and are 7.5 in. long. One is for heating elements up to 35 w and has a 3/8-in. barrel; the 50-w unit has a 1/2-in. barrel.

Kwikheat Manufacture Co., Dept. ED, 3732 San Fernando Road, Glendale 4, Calif.

Availability: Units are nationally distributed.

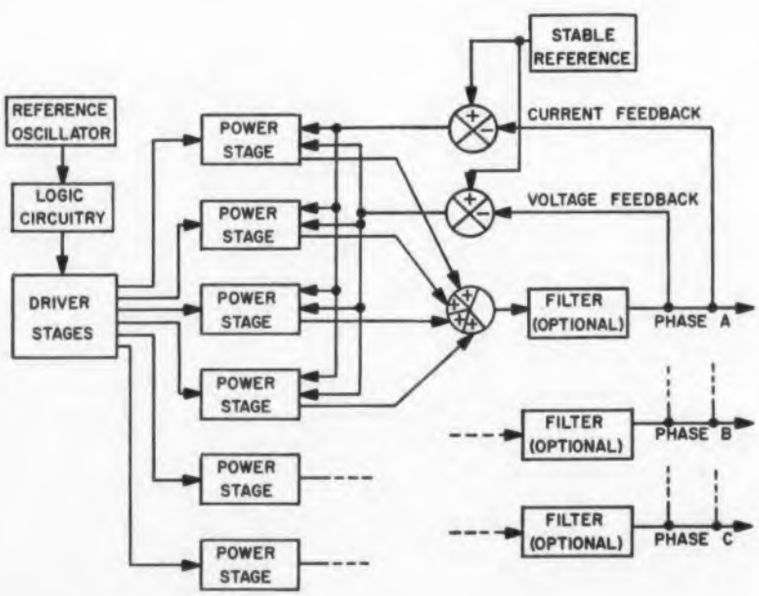
In production, this breadboard static inverter will be compressed into a package providing 50 w per lb, 3.5 w per cu in. of 3-phase, 400 cps, stepped-sine-wave, 110 v ac.

Synchronous Switching Boosts Inverter Efficiency

STATIC inversion by synchronous switching has been developed for smaller, lighter, more efficient inverters with lower output impedance. The new method of power conversion has the high-efficiency advantages of switched mode operation, eliminates the high harmonic content inherent in square-wave operation. Output is a stepped sine wave.

Since, in switched mode operation of semiconductor diodes, the current is high in the "on" state while the voltage drop is low (about one volt for silicon controlled rectifiers), and in the "off" state the voltage is high while the current is low (milliamps for germanium and microamps for silicon), the dissipation is low and the efficiency good. But the output waveform is square: odd harmonics are strong, and the total percentage harmonic distortion of the waveform is about 47 per cent.

The synchronous switching scheme developed



Synchronous switching provides a stepped sine-wave output from this static inverter. Total harmonic distortion is only 19 per cent without "optional" filters; with filters, it can be less than 5 per cent.

by C. J. Amato, a development engineer at the Electronics Division of Thompson Ramo Wooldridge Inc.'s Tapco Group in Houston, Tex., synthesizes a sine wave pretty much devoid of the third and fifth harmonics. The seventh harmonic is reduced to about 8 per cent, and the total harmonic distortion to about 19 per cent.

Many ac power needs can be satisfied by this stepped waveform with no filtering. Addition of a small, lightweight filter can produce an output with a total harmonic content which is less than 5 per cent.

The breadboard inverter at Tapco converts 24 to 28 v dc to 3-phase, 400-cps ac. Frequency control is within 0.002 per cent, 3-phase output regulation to 0.3 per cent. The unit has input voltage regulation, output short-circuit protection, and transient protection. Efficiency is from 85 to 90 per cent.

Production goal of the Tapco Group: 50 w per lb and 3.5 w per cu in., with a 100 C temperature tolerance. The inverters will be used for powering missile and aircraft instruments and can also be used as stand-by power sources for process-control computers.

The frequency reference oscillator shown in the schematic may either be a precise crystal oscillator (one part in 10^7) or a relaxation or sine-wave-type transistor oscillator with a typical accuracy of 1 per cent. By means of suitable logic circuitry the oscillator output is converted to the desired pulse train. This pulse train triggers the output driver stages.

Interconnection of the outputs of the power stages yields the desired stepped output waveform. Constant output voltage is maintained by a stable voltage reference. The output voltage is compared to this reference and the error voltage used to modify the switching characteristics of the power stages.

The same reference provides the desirable short circuit protection: the load current is transformed to a signal voltage and compared with the reference voltage. When this current exceeds a predetermined level the switching characteristics of the power stages are modified so as to reduce the output voltage to a fraction of its rated value therefore maintaining a given maximum short-circuit current.

Synchronous switching can be applied to an inverter of any volt-ampere rating, says Mr. Amato. Maximum rating is solely determined by thermal limitations imposed by environment and state of the art in solid state devices.

An additional advantage of the technique is that many inverters may be slaved to the same triggering circuits—the reference oscillator and logic circuit blocks shown in the schematic. This is needed for power systems where reliability and power synchronism are prime considerations. ■ ■

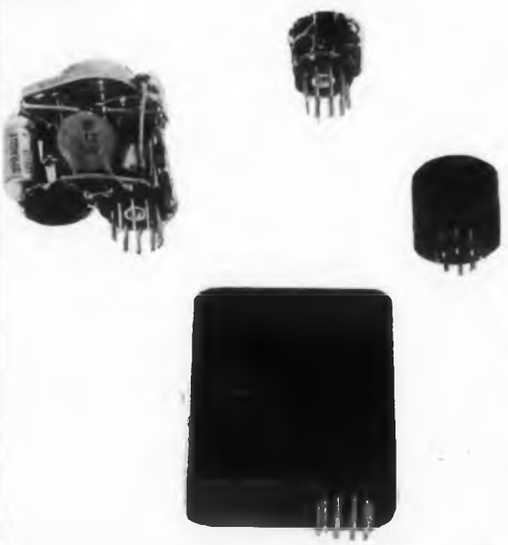
DESIGN DECISIONS

Flexible Logic Modules Standardize on NOR Circuitry

Seeking the "least common denominator" for a line of standard logic modules for some of their systems, engineers at Radiation Inc. of Melbourne, Florida settled on NOR logic as being the most flexible type of digital circuitry.

They developed a group of small logic modules, called Radilogs, based on NOR circuitry. With three basic modules, each made for each of three speed ranges, they feel they can handle almost any requirement in digital circuitry.

The three Radilogs, a NOR logic module, a power driver, and a differentiator, are made in color-coded, encapsulated packages for operation at pulse repetition rates to 25 kc, 250 kc, and 1 mc. The units plug in to conventional 9-pin tube sockets.



NOR logic modules, using conventional components, can be combined to fulfill almost any requirement in digital circuitry.

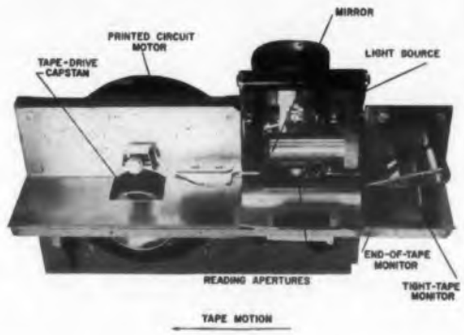
Paper-Tape Reader Has No Brakes, No Clutches, No Solenoids

Really quiet operation and extended reliability result from the simplified drive mechanism in Photocircuits Corp.'s model 100 photoelectric tape reader. In this reader, the paper tape is friction-driven directly by a drum capstan which is pinned to the shaft of a printed-circuit motor.

A power transistor, biased by a multivibrator, drives the motor. The multi receives a stop pulse when a control hole on the tape passes between a light source and a photodiode. Start pulses are generated for the multi either from control-track

preamps (after a line of holes is read) or from an external source.

The dynamic braking characteristic of the printed-circuit motor halts a sprocket hole directly over the reading aperture. Sprocket holes define and control tape positioning, but they do not drive the tape. In effect, the only moving part in this tape reader is the motor shaft.

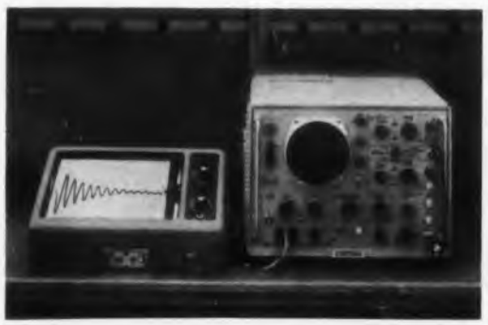


Direct-drive paper-tape reader has no clutches, brakes, or solenoids to slow down operation. Capstan on motor shaft drives tape directly.

Pen Recorder Displays Sampled Scope Waveforms

Reasoning that it's a lot easier to analyze and measure a pen-and-ink waveform than a scope display, Hewlett Packard engineers developed the model 166C Display Scanner. This device plugs into H-P scopes, samples a waveform being displayed, effectively slows down high-speed waveforms, and transmits the waveform to conventional X-Y recorders.

A scaled-up version of the scope display on the recorder gives not only a permanent record, but high resolution and, of course, no parallax. The pen-and-ink display makes it easy to measure rise and decay time accurately, and to analyze complex waves.



Display scanner (plugged into lower left part of scope) drives conventional pen recorder to present duplicate of scope waveform. (Waveform on paper has been touched up slightly to compensate for photographic losses.)

SERVICES FOR DESIGNERS

Custom Nylon Extrusions

Customer specifications can be met in preparing nylon extrusions—film, tubing and strips—for a variety of needs. The extrusion center is also maintaining deliveries from stock inventories in standard weights and gages of all its extruded nylon products.

Users and potential users are offered facilities for laboratory, experimental testing and special-run functions in the handling of every type of custom compounding and special shape nylon extrusion.

M & Q Plastic Products, Dept. ED, Freehold, N.J.

Data Handling Units and Systems

A newly formed organization offers to design, develop and manufacture data handling units and systems for specific customer applications. Company personnel are said to have comprehensive experience in the design and production of solid-state logical computer components and in devices for the punching, printing, and reading of cards, paper, and paper tape at high speeds. Included in this work background are design of adding and accounting machines, and typewriters.

Connecticut Technical Corp., Dept. ED, 3000 Main St., Hartford, Conn.

Ferro-Electric Ceramics

The company's research group is prepared to make ferro-electric ceramics to meet the needs of specific applications.

The ceramic compositions are said to be available with the following breadth of properties:

- Curie Temperature—for normal operation from 100 to 570 C. For special purposes, lower temperatures can be obtained.
- Operating Range—compositions are available which can operate at temperatures as low as liquid nitrogen and as high as 350 C.
- Mechanical Q—available in a range of 20 to 1600. Linear couplings as high as 75 per cent are available and can be made over a wide range up to this optimum figure. Radial couplings to 55 per cent are also available.
- Dielectric Constants—ferro-electric ceramics can be made with relative dielectric constants over a range of 200 to 1400.
- Sensitivity—a range of sensitivity constant materials can be made with g constants up to

$$\frac{0.04 \text{ v per m}}{\text{Newton per sq m}}$$

U.S. Sonics Corp., Dept. ED, 625 McGrath Highway, Somerville 45, Mass.

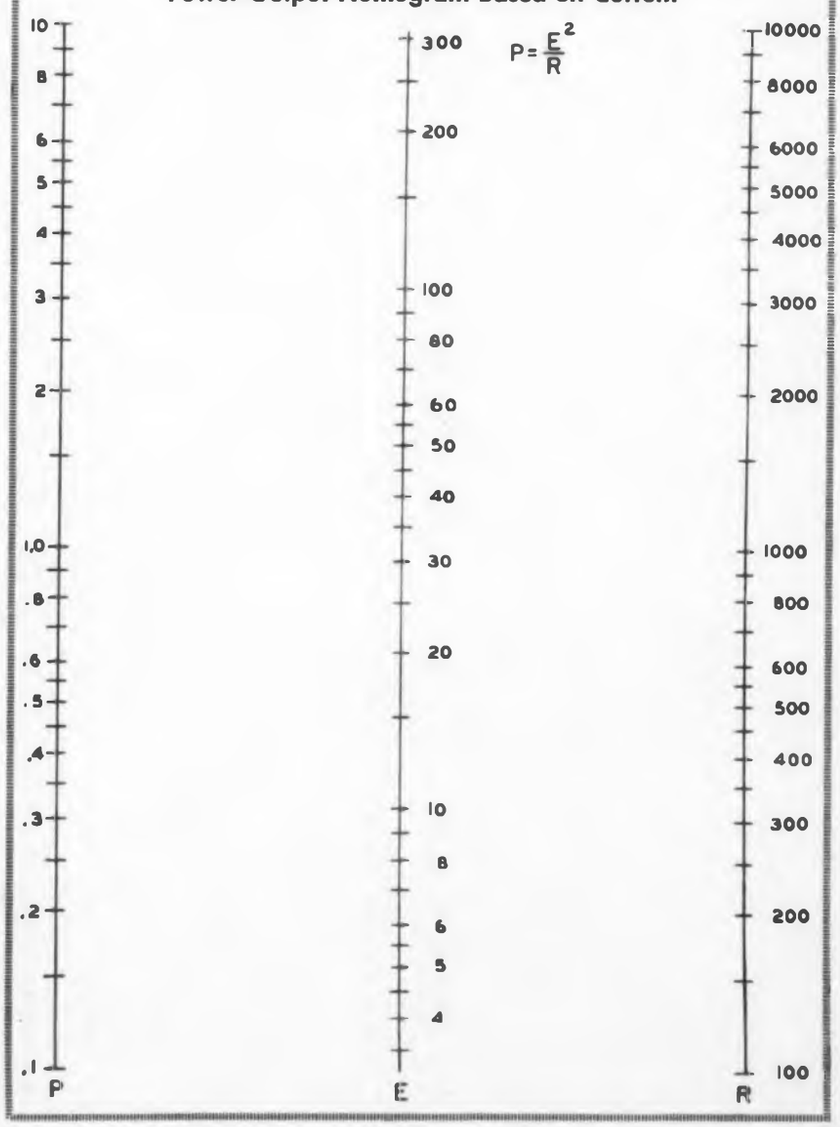
DESIGN ENGINEERING

Power-Output Nomograms

L. J. Striednig
Radio Corp. of America
Electron Tube Div.
Harrison, N. J.

(Text on following page)

Power-Output Nomogram Based on Current



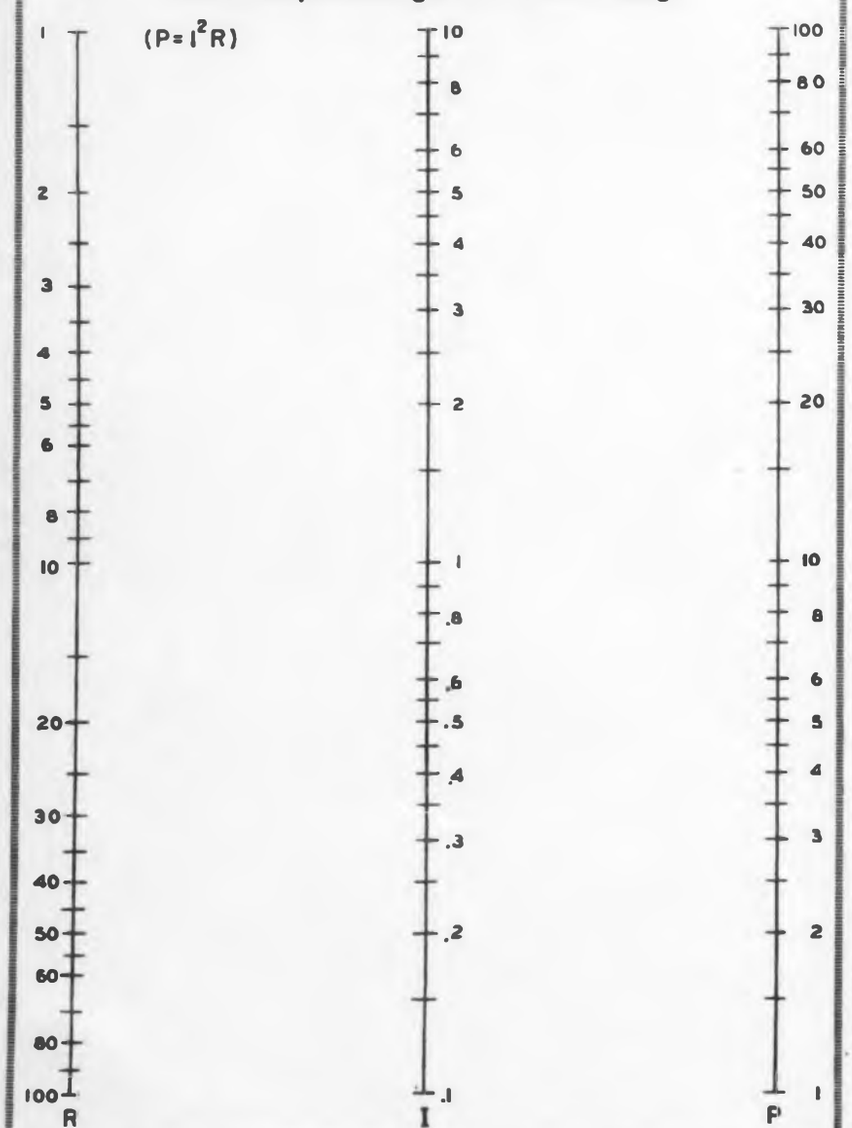
(Continued from page 173)

THE FAMILIAR and oft-recurring power equations, $P = E^2/R$ and $P = I^2R$, are quickly and easily solved with the aid of these two nomograms.

In a typical application, the E^2/R nomogram can be used to determine the power output of audio tubes as a function of the voltage across a load resistor. The I^2R nomogram is typically applied in determining the power dissipated by a current flowing through a resistor.

Of course, the E^2/R nomogram can be used to solve any equation of the form $Z = Y^2/X$ or $Y^2 = XZ$, while the I^2R nomogram can solve any equation of the form $Y^2 = Z/X$ or $Y^2X = Z$. ■ ■

Power-Output Nomogram Based on Voltage



NEW LITERATURE

Technical Data Catalog

This 1960 technical data catalog is a pocket size edition. It covers the following fields: Power Transmission Machinery; AC Motors and Generators; Electrical Transmissions; AC and DC Electricity; Transformers, Relays and Meters; 5 Place Trig and Log Tables; Conversion Tables and others. *Send $1.25 to Lefax Publishers, Dept. ED, Philadelphia 7, Pa.*

Cold Cathode Tube Manual

The complete line of cold cathode counting tubes is described in this 36-page manual. Included in the manual are specifications, applications, and numerous circuit diagrams and design criteria on all counting tubes, trigger tubes, register and voltage reference tubes offered by the company. *Send $1 to Baird-Atomic, Inc., Dekatron Handbook Section, Dept. ED, 33 University Road, Cambridge, Mass.*

Antenna Instruments 260

Listed in this 1960 short form catalog is information on various antennas and associated equipment, such as: antenna pattern recorders; antenna positioners; a Fourier computer; remote tuned signal sources; synchro transmitters; model range towers, and wide range receiving systems. Scientific-Atlanta, Inc., 2162 Piedmont Road, N.E., Atlanta 9, Ga.

Semiconductor Products 261

This 12-page brochure titled "Dependable Quality in Quantity" covers the firm's line of industrial semiconductor products. Specifications are also listed. Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Road, Phoenix, Ariz.

Multipoint Recorders 262

Specification sheet 153-23, four pages, describes a universal multipoint recorder. Specifications and instrument characteristics are included. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Epoxy Materials 263

Bulletin E360, one page, lists acoustic insulation, polyester and epoxy putties, and clean epoxy finish. Photographs are included. Fibre Glass-Evercoat Co., Blue Ash Road, Cincinnati 36, Ohio.

NEW LITERATURE

Laminated Plastics 264

Government agencies' specifications corresponding to 26 of its laminated plastic grades are listed in two-page bulletin 3.0.1. The grades listed include phenolic-paper, phenolic-cotton, phenolic-asbestos, phenolic-glass, phenolic-nylon, melamine-glass, silicone-glass, and epoxy-glass. Taylor Fibre Co., Norristown, Pa.

Reactor Controllers 265

Specification sheet S801-3, four pages, describes the 3-mode nuclear reactor controller, lists specifications on a current-output model and a contact output model, and describes certain auxiliary equipment. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Motor-Starting Capacitors 266

Bulletin PS-6A, four pages, contains photographs of Mylar and Mica capacitors, plus outline drawings and tabular material reflecting part numbers, available styles, physical size and weight. Details of standard operating characteristics of both are given. Airborne Accessories Corp., S. Banaski Marketing Dept., 1414 Chestnut Ave., Hillside 5, N.J.

Crystal Transducers 267

Bulletin 101160, four pages, shows a full line of natural quartz crystal transducers for pressure, force, acceleration, and vibration instruments. It describes the range, sensitivity, and construction of the transducers. Sixteen pick-up adaptors are shown with descriptive text to point out applications. The final section describes and illustrates piezo-calibrators, amplifier-calibrators, low-noise cables, manual selector switch, and indicator or transducer systems. Kistler Instrument Corp., 15 Webster St., N. Tonawanda, N.Y.

Speedomax H Range Conversion 268

This four-page data sheet No. NY2(1) provides a guide to selecting the necessary components to change the range of any standard Speedomax H instrument. A master table lists the basic items required to change range for the same type of primary element or from one type of primary element to another. Individual tables list the specific part numbers of scales, charts, etc. for each type of range. Wiring diagrams to simplify electrical connections are also listed. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Electronic Components

Design, development, and application engineering are outlined in this brochure on electronic components, systems, and sub-systems. Included are product categories, with electrical and mechanical specifications, typical product applications, environmental capabilities of each product group, and a summary of technical manufacturing and testing equipment. *Write on company letterhead to Voi-Shan Electronics, Dept. ED, 13259 Sherman Way, N. Hollywood, Calif.*

Portable Calibration Kits 270

A portable calibration kit for use on a wide variety of load and force measuring systems involving tension and/or compression loads is described in four-page data sheet 4504. Photographs, line drawings, and tables are included. Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.

Conversion Factors 271

"Conversion Factors," circular 1956, is a 21-page pocket-size compilation of multiplication factors involved in converting fundamental electrical and magnetic units. Automatic Electric, Director of Control Equipment Sales, Northlake, Ill.

Thin Film Coatings 272

This 12-page booklet contains information on the properties of fluorocarbon coatings, silicones, epoxy resins, and other coatings. Included are examples of applications that have simplified operations, increased production rates, and improved finished products. National Glaco Chemical Corp., Industrial Coatings Div., 1949 N. Cicero Ave., Chicago 39, Ill.

Amplitude Density Analysis 273

The 20-page "Technical Review" No. 4, 1959 describes the concepts of amplitude density analysis of non-periodic noise. Graphs and diagrams are included. B & K Instruments, Inc., 3044 W. 106th St., Cleveland, Ohio.

Rotary Trimmer Capacitors 274

Standard, split bushing, and precision rotary trimmer capacitors are described in two-page data sheet CE-4.00. It contains illustrations of each of the 3 models and detailed specifications of each of the 10 types. Corning Glass Works, Bradford, Pa.

NEW LITERATURE

Voltage Regulator 275

Bulletin 3300, 14 pages, describes a voltage regulator of the tubeless magnetic-amplifier type. It covers advantages and uses, and includes a detailed description of operation with schematic wiring diagram, connection diagrams, and dimension diagrams. Instructions for maintenance and trouble-shooting are given. Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Pa.

Hermetic Seals 276

Catalog 1259 lists basic types of precision hermetic seals. Each type is clearly illustrated and listings give complete dimensional specifications. A special section gives latest accepted glass seal nomenclature. The 28-page catalog also covers general manufacturing techniques and usage recommendations. Dage Electric Co., Inc., 67 N. Second St., Beech Grove, Ind.

Paste Solder Materials 277

A new line of electrical and electronic paste solder materials is described in this brochure, the E-series bulletin. A table covers melting point, types of alloy, specification and application data. Four solder types are described. Fusion Engineering, 17921 Roseland Ave., Cleveland 12, Ohio.

In-Line Switches 278

Catalog 7300-A describes circuit codes available in single-pole and double-pole decimal, binary coded decimal, and octal binary notations. Odd bit parity and simultaneous complementary output are also described. The Digitran Co., 660 S. Arroyo Parkway, Pasadena, Calif.

Battery Chargers 279

Bulletin No. 237, four pages, describes 12 automatic battery chargers. Bulletins No. 203 and No. 236 describe non-automatic battery chargers. All bulletins include data on input and output voltages, list prices, and dimensions. Automatic Switch Co., Florham Park, N.J.

Semiconductor Equipment

This semiconductor replacement guide, by equipment brand and model number, provides replacement information and mechanical specifications for transistors, diodes, and rectifiers used in TV receivers, radios, phonographs, and tape recorders. *Send 50¢ to Sylvania Electric Products Inc., Dept. ED, Box 37, Buffalo 9, N.Y.*

Semiconductor Directory

The Allied Semiconductor Directory No. 6, 16 pages, includes power, high-speed switching, high-current, Zener and diffused junction mesa type transistors; micro-diodes; voltage-variable capacitors; and photo-sensitive devices. *Write on company letterhead to Allied Radio Corp., Dept. ED, 100 N. Western Ave., Chicago 80, Ill.*

Molybdenum Products 280

This 24-page booklet gives full details on the various sizes, forms, conditions of use, tolerances, weights, and methods of identification of the firm's products now available for commercial use. The booklet also discusses the wide range of uses to which the products are suited in the electrical, chemical, and other fields. Climax Molybdenum Co., Div. American Metal Climax, Inc., 1270 Ave. of The Americas, New York 20, N.Y.

Strain Gage 281

Product data sheet No. 4325 describes a photoelastic strain gage. In addition to axial static and dynamic strains, the data sheet indicates lateral bending and torque. Sections are included on gage function, specifications, fixtures and installation. Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Waltham, Mass.

Silicone Guide 282

This 16-page brochure gives a summary of the forms, properties and applications of the company's silicones. Illustrated with photographs, tables and charts, the brochure describes silicones for laminating, dielectrics, transducers, and electrical insulation. Dow Corning Corp., Midland, Mich.

Standard Frequency Receivers 283

Models WWVT and WVTR receivers that utilize the transmissions of the National Bureau of Standards radio stations WWV and WWVH are described in this four-page bulletin. Included are a block diagram, and notes on RF and AF frequency standards. Specific Products, 21051 Costanso, Woodland Hills, Calif.

Formica Molded Products 284

Molded products for a wide range of industrial applications are described in an eight-page booklet entitled, "Formica Molded Products." Properties of 25 formica laminates available in molding grades are listed. Photos show typical applications. Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

NEW LITERATURE

Transformers and Printed Circuits 285

Methods of forming molds for casting resins by vacuum-drawing heated thermoplastic sheets over electrical components are described in this eight-page booklet entitled "Conformal Casting of Motors, Transformers and Printed Circuits." Photographs demonstrate the vacuum forming process. One section discusses materials and equipment required for developmental study. Minnesota Mining & Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

Metal Film Resistors 286

Vamistor specifications, characteristics, performance, and shelf life are all detailed in six-page bulletin No. 04-101-A. Derating curves and wattage ratings included cover all sizes of Vamistors in the miniaturized line for missile applications as well as the standard military line. Daystrom, Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N.J.

Insulating Material 287

Booklet MB-1908-A, eight pages, describes the properties and uses of Limitrak surface-coating insulating material. It includes discussion of physical and electrical properties of the coating, data on its chemical resistance to various materials, and on its arc and track resistance. Photos show typical test installations. Westinghouse Electric Corp., Benolite Plant, Manor, Pa.

Time Delay Relays 288

This series of data sheets cover engineering specifications on the firm's time delay relays. Engineering data is in tabular form and includes voltage and temperature ranges, contact ratings, time delays, duty cycles, voltage limitations, accuracy, performance, environmental capabilities, and physical dimensions. Voi-Shan Electronics, Dept. ETm, 13259 Sherman Way, N. Hollywood, Calif.

Transistor Application Guide 289

Presented in booklet form, this guide indicates suitable transistor types for major applications. Transistors are classified in terms of one or two important parameters. Applications covered are listed under the following categories: Communications Circuits, Untuned Amplifiers, Switching Circuits for computer applications, and Switching Circuits for noncomputer applications. Information is primarily presented in graphs and curves. Philco Corp., Lansdale Div., Lansdale, Pa.

Paper-Dielectric Capacitors 290

Bulletin No. GET-3032, 28 pages, gives detailed information on a range of standard commercial, MIL-C-25A, and Permafil capacitors. The bulletin contains graphs, tables, outline drawings, and application information. Complete rating and dimension tables are included for applications ranging from 100 to 50,000 v dc and from 236 to 660 v ac. Units described range from a few ounces to 150 lb. General Electric Co., Schenectady 5, N.Y.

Tantalum Foil Capacitors 291

Plain and etched foil tantalum electrolytic capacitors are described in this four-page bulletin, No. 152F. Data include operating temperature range, dc working voltage rating, power factor, 120-cps ripple voltage rating and dc leakage current. Ohmite Manufacturing Co., 3612 Howard St., Skokie, Ill.

Gears 292

This four-page brochure describes a complete line of stock and special gears. Information is included for bevel, helical, miter, worm and spur gears as well as steel racks. Both 14-1/2 and 20-deg pressure angle styles are also included. Ohio Gear Co., 1200 E. 179th St., Cleveland 10, Ohio.

Ceramic Capacitors 293

Monolythic ceramic capacitors are described in this two-page data sheet, No. 6201B. The illustrated bulletin gives temperature ratings, insulation resistance, dissipation factor and life test information. Sprague Electric Co., N. Adams, Mass.

Plastics Chart 294

Included in this plastics chart are listings of the several basic types of transfer foil, their properties, and recommended applications on thermoplastics, thermosets and miscellaneous materials. Acromark Co., 403 Morrell St., Elizabeth 4, N.J.

Microwave Absorbers 295

Microwave absorbers are presented in their two basic categories of free space absorbers and waveguide and coaxial absorbers in this four-page folder. Given in chart form, the folder lists all of the company's Eccosorb products. It is in color and comes in file form for ready reference. Emerson & Cuming Inc., 869 Washington St., Canton, Mass.

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Detection, Techniques and Equipment
Human Factors
Industry, General
Materials
Measurements, Instrumentation, Test Equipment
Microwave Components, Techniques
Navigation and Guidance Techniques
Nuclear Science
Packaging Techniques, Electromechanical-Thermal Design, Production Processes and Equipment
Power Sources
Radio Frequency Interference Reliability
Semiconductors, Solid State Devices
Telemetering
Tubes, Electron
Ultrasonics

The kind of article is identified by the following reference keys:

ART Article (bylined by an authority)
DD Design Decision
DIG Digest
DYF Designing Your Future
ED Engineering Data
EDN ELECTRONIC DESIGN News
GA German Abstract
IFD Ideas for Design
RT Russian Translation

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1960 diode report discusses the efforts by the military and industry to stem the swelling diode listing. Through industry cooperation, a handy guide has been prepared as a rapid means for locating a "most popular" diode type for a particular application. For the military equipment designer, a complete list of military approved diode types is given with specification references ..... ART p30 April 27

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Rapid measurement of diode and transistor parameters on panel meters rather than scopes ..... PF p76 Feb 17

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TELEMETERING

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ULTRASONICS

IDEAS FOR DESIGN

Get $10.00 plus a by-line for the time it takes you to jot down your clever design idea. Payment is made when the idea is accepted for publication.

Klystron Is Switched Off, But Remains On To Avoid Cooling

Turning a klystron off by switching its repeller voltage to a value outside of the operating mode can keep the tube from cooling down during off periods required for equipment adjustment.

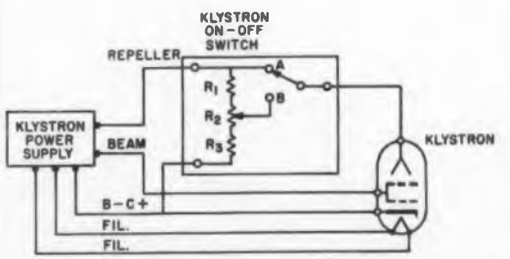
When a low power klystron is used in the general run of laboratory microwave measurements, it often is necessary to turn the klystron off momentarily (for example, while zeroing a power meter). The usual klystron power supply has a switch which performs this function by turning off the beam supply.

However, this method can be undesirable because the klystron cools during the off period, and takes some time to re-establish its equilibrium when it is turned on again.

The circuit shown switches the klystron's repeller voltage off mode, thus reducing its output to zero. But, since low power klystrons are generally inefficient, the non-oscillating beam current is almost equal to the oscillating beam current. The result is that the klystron stays at essentially the same temperature both on and off.

The circuit consists of a potentiometer connected across the repeller supply. The total resistance ($R_1 + R_2 + R_3$) should be large enough not to exceed the current capability of the repeller supply. The resistors R_1, R_2 and R_3 should be chosen so that the potentiometer arm voltage lies between two klystron modes.

To operate the circuit, set the switch in position *A* and adjust the klystron repeller supply to give maximum klystron output power (peak of the power mode). Next, turn the switch to position *B*



Switching the repeller voltage to an off-mode value while maintaining beam current allows the klystron to remain heated during test equipment adjustment.

and adjust R_3 until there is no power output (operation is off the power mode). The klystron can now be turned on and off by throwing the switch back and forth.

Emanuel Kramer, Senior Engineer, Emertron, Inc., Silver Springs, Md.

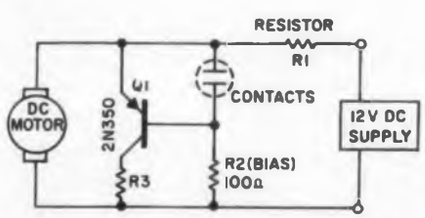
Transistor Improves Response and Speed Regulation of DC Motor

Placed in parallel with the armature, a transistor can help to improve the response and speed regulation of a dc motor.

The speed regulator on a dc motor is often a centrifugal switch whose contacts are placed in series with the motor. They operate to disconnect the supply whenever the motor overspeeds. The desired speed level is set by adjusting the tension on the spring of the switch. A common problem with this type of operation is the elimination of the dynamic breaking feature. No forcing is available to bring the motor quickly back to the desired speed. Additionally—the contacts have to carry the full motor current and are liable to arc and pit, causing drift and inaccuracy in regulation.

A substantial improvement is introduced by using the circuit shown in the figure. The centrifugal switch contacts are now placed from the base to the emitter of transistor *Q1*. When they are closed, *Q1* is turned off and all the current flows into the motor. When the contacts open, transistor *Q1* is biased on through resistor *R2*. *R3* limits the maximum current and dissipation of *Q1*.

The transistor shunts the motor armature and acts both as a dynamic breaking path and, in combination with *R1*, as a speed regulator. As soon as the motor overspeeds the contacts open. Because *Q1* is conducting there is an additional drop across *R1*. This lowers the voltage applied to the motor and tends to bring it back to the preset level.



The transistor, used with the centrifugal switch contacts, helps to improve the speed regulation of the dc motor.

Baruch Berman, Chief Engineer, ACF Electronics, Paramus, N. J.

IDEAS FOR DESIGN

Oscilloscope Mask Permits Rapid Digital Readout

The oscilloscope mask shown in the figure permits rapid reading, in digital form, of numerical information. The mask, made of metal or cardboard, consists of two lines of holes of as many binary places as one is interested in reading. Vertical lines are drawn on the face of the mask to show the octal division of each word.

In use, the scope trace length is adjusted to match the digit spacing drawn on the mask. The trace is positioned in the vertical direction so that the base level is in line with the holes in the mask. Thus, reading from left to right, the octal readout shown in the sample photograph is 701010.

Because the mask is separated from the tube by the plexiglass grid, parallax problems may develop if the observer is not directly in front of the tube. Making the holes small in relation to the digit width will reduce this parallax effect and will permit wider viewing angles. Or, if the scope trace is broadened by advancing the astigmatism control, the trace will fill the holes instead of appearing as sharp lines.

The central portion of the mask shown has been cut out so that the scope can be used in the normal manner without removal of the mask from the scope. With a dual trace unit the set of octal numbers can be read by means of the upper set of holes.

Placed over the oscilloscope tube face, the cardboard mask permits the display to be rapidly transformed to a digital form.

Eugene W. Herr, Computer Engineer, Emerson Electric Mfg. Co., St. Louis, Mo.

LC Ringing Circuit Sharpens Oscillator Trigger Points

The repetition frequency of blocking oscillators and multivibrators can be made much more stable by adding an LC ringing circuit as shown in the schematics, Fig. 1.

Frequency instability in these circuits is often due to the exponential decay curve used for timing. At the triggering level, the slope of this curve, Fig. 2, is not always great enough to give a sharp, stable trigger point. The LC combination in series with the RC timing circuit yields a timing curve where sinusoidal oscillations are superimposed on the exponential decay. If the time constants are suitably chosen, the resulting curve will cross the trigger level at a steep, clear-cut angle. The triggering point will be sharper and better defined, thus leading to more stable circuit operation.

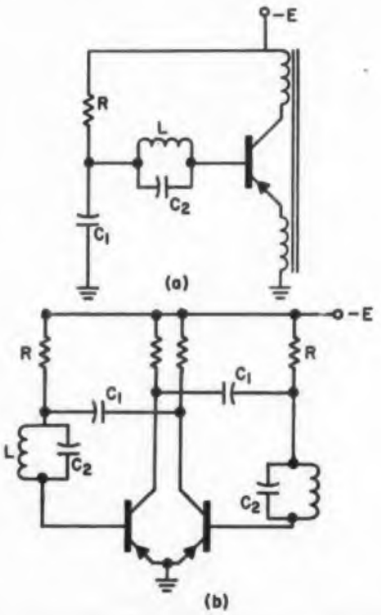


Fig. 1. An LC ringing circuit added to a (a) blocking oscillator and (b) multivibrator helps to stabilize the circuit triggering points and leads to greater frequency stability.

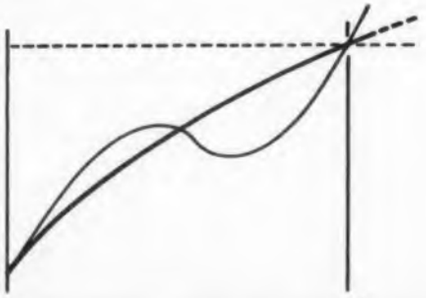


Fig. 2. The oscillations of the LC combination, superimposed on the exponential timing curve, cross the trigger level at a steep angle. Thus, the triggering point is sharp and clearly defined.

Roy P. Foerster, Baltimore, Md.

IDEAS FOR DESIGN

Polarized Relay Circuit Measures Duty Cycle Electrically

Measuring the duty cycle of a periodic pulse train is readily accomplished by driving a high-speed polarized relay, Fig. 1. The output is measured with a high impedance voltmeter and reads zero for a duty cycle of 50 per cent and full scale for 0 and 100 per cent. The polarity of the output changes as the duty cycle goes through 50 per cent. Accuracies of 0.1 per cent are readily obtainable for low frequency square waves.

The circuit uses an overdriven transistor to energize the relay. The stationary contacts are connected to accurate reference voltages and the moving contact is connected to an averaging network. The output of the network is an accurate representation of the charging time and polarity. The time constant should be selected to be at least ten times the period of the input.

A high speed version of the device, Fig. 2, uses transistors throughout. The transistorized version can be used for high frequencies or where high accuracy is desired.

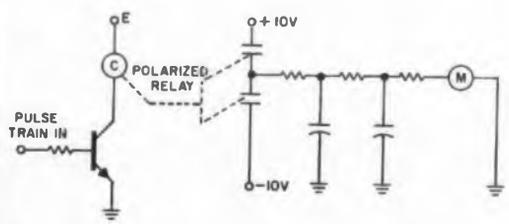


Fig. 1. High-impedance meter reads zero for a 50 per cent duty cycle, and full scale for 0 and 100 per cent.

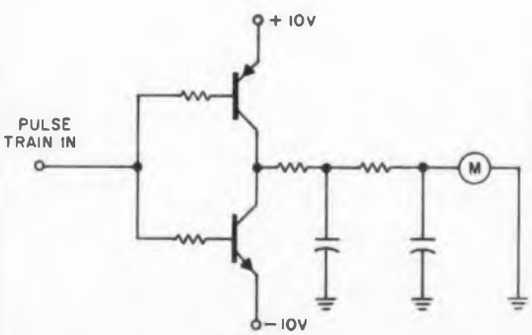


Fig. 2. Polarized relay can be replaced by transistors for high frequency application.

Jim Curry, Engineer, Tasker Instruments Corp., Hollywood, Calif.

Blocking Diode Improves Multivibrator Waveform

The square wave output of the transistorized multivibrator, Fig. 1, can be made much sharper by modifying the circuit as shown in Fig. 2.

The logarithmic shape of the output waveform in the circuit of Fig. 1, is due to the charging of capacitor C through R_L when Q_1 cuts off. By inserting the blocking diodes D_1, the capacitor is prevented from charging through R_L. Instead, the charge path will be through R_D. The collector of transistor Q_1 will be free to approach the supply voltage E as fast as the transistor permits it to do so.

It is suggested that $R_D = R_L$ so that the capacitor will be fully charged when the next half period begins. Note that with R_D present, the effective load resistance on the transistors is: $R_L R_D/(R_L + R_D)$. The base resistance R_B will have to be adjusted so that the transistors will be in saturation when they are "on."

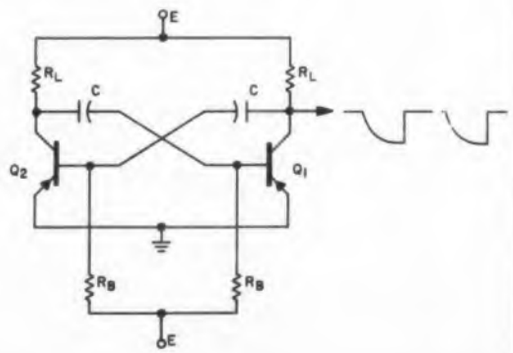


Fig. 1. Output waveform of conventional multivibrator has logarithmic shape due to charging of capacitor C through load resistor R_L.

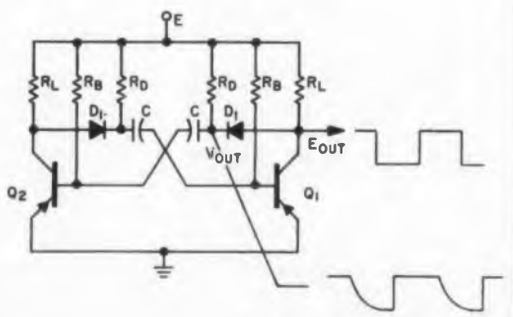


Fig. 2. Output waveform is now sharper because blocking diode prevents capacitor C from charging through R_2. Instead C charges through R_D and output returns to potential E as fast as transistor capacitance will allow.

Burt H. Liebowitz, Engineer, Airborne Instruments Laboratory, Melville, Long Island, N.Y.

PATENTS

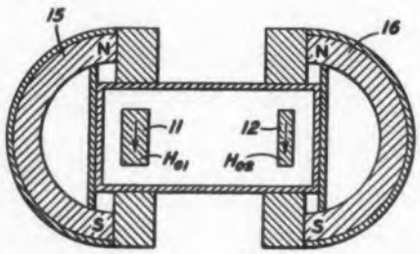
Benjamin Bernstein

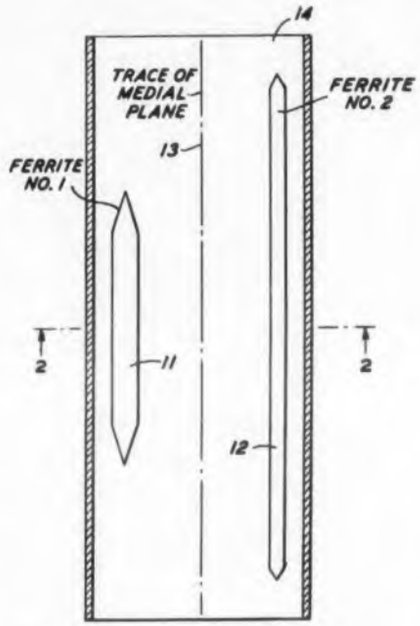
Broadband Nonreciprocal Transmission Device

Patent No. 2,923,899. H. Boyet and S. Weisbaum (Assigned to Bell Telephone Laboratories)

A very flexible nonreciprocal transmission structure is calculated in which a ferrite slab is mounted on each of the narrow walls of a waveguide. The spacing from the medial plane of the different sized ferrites can be adjusted so that the device is insensitive to changes in frequency and ambient temperature.

In a typical arrangement the U-shaped magnets *15* and *16* provide the necessary





field strength for ferrites *11* and *12*. The mathematics defining the system parameters is given in matrix form.

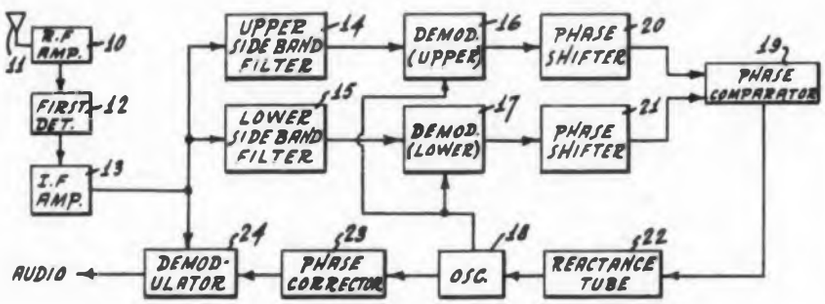
Receiving System for Suppressed Carrier Waves

Patent No. 2,930,891. L. L. Lakatos (Assigned to RCA.)

In double sideband suppressed carrier systems the carrier is inserted in the receiver in precise frequency and phase by phase comparison of the sideband signals. It is shown analytically that the sidebands contain the requisite information; therefore the communication link may be established, with a saving of power, at carrier frequency.

Here, the double sideband signal is detected in the demodulator *24* in which the if amplifier *13* output beats against the output of oscillator *18* to produce the audio output. The frequency of the oscillator is controlled by the reactance tube circuit, *22*, adjusted by phase comparator *19*.

As shown, the two sidebands are filtered and separately demodulated to clamp the phase of the oscillator. Phase shifters *20* and *21* produce a total shift of 90 deg since the upper and lower sidebands normally are shifted 90 deg in phase.



BOOKS

Basic Ultrasonics

Cyrus Glickstein, John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y., 137 pp, $3.50.

Although originally heralded as a technique for the cleaning of objects, ultrasonics has grown to include military, chemical, medical, and many other applications. This text was written as a basic introduction to this rapidly expanding field. However, its level of presentation restricts its usefulness to technical institutes and vocational schools. It can also be used for industrial personnel upgrading and general home study.

The book is divided into three major sections. The first section includes a discussion of the general theory of ultrasonics with reference to the nature of sound and ultrasound waves. The second section covers the basic types of ultrasonic equipment. The third part describes in some detail the more important ultrasonic applications. Review questions are contained at the end of each section and a glossary of ultrasonic terminology also is included.

Selected Semiconductor Circuits Handbook

Edited by Seymour Schwartz, John Wiley & Sons, Inc., 440 Park Ave. S., New York 16, N. Y., 300 p, $12.00.

Collected here are over 150 practical, well designed semiconductor circuits. Useful as a reference source for the electronic engineer, the handbook presents

circuits in the following categories: direct-coupled amplifiers, low-frequency amplifiers, high frequency amplifiers, oscillators, switching circuits, logic circuits, power converters, small signal nonlinear circuits, and transistorized magnetic circuits. Design philosophy discussions, comprising the first half of every chapter, precede each group of selected circuits.

A hard-covered, more durable version of the Handbook previously reported on in Electronic Design (*ED*, May 11, 1960, p 236), this edition contains an extra chapter on transistorized magnetic circuits. Included in this chapter are circuits for a magnetic shift register, a core current driver, and a magnetic differential sense amplifier, the chapter also has a discussion of design philosophy.

Wave Propagation In A Random Medium

Lev A. Chernov, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 168 p, $7.50.

Translated from the Russian, this is one of the first available textbooks on the problem of wave propagation in a random medium. The author gives a systematic account of the influence of refractive index fluctuations on the characteristics of electromagnetic and acoustic waves propagating through the troposphere or the ocean. Among the problems receiving particular attention are amplitude and phase fluctuations of a plane wave as a function of the distance penetrated into the random medium and correlation between the fluctuations; and the influence of refractive index fluctuations on image formation in focusing systems.

Part I studies the problem of wave propagation using the ray approximation. Part II deals with the diffraction theory of wave propagation. In Part II the author also examines how fluctuations in the incident wave affect the diffraction image formed by a focusing system. This question is of considerable interest in hydroacoustics and astronomical optics. Some theoretical deductions are compared with experimental data.

The book was written while the author was with the Acoustics Institute of the Academy of Sciences of the USSR.

RUSSIAN TRANSLATIONS

J. George Adashko

Printed Antenna Has Conical Directivity Pattern

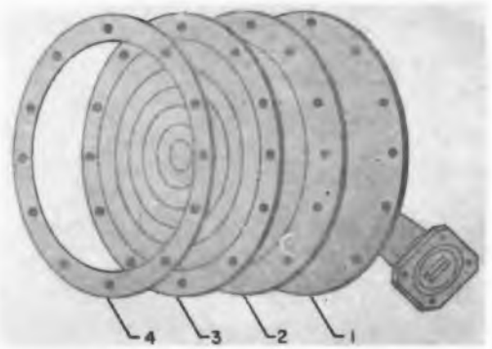


Fig. 1. Disassembled view of printed antenna.

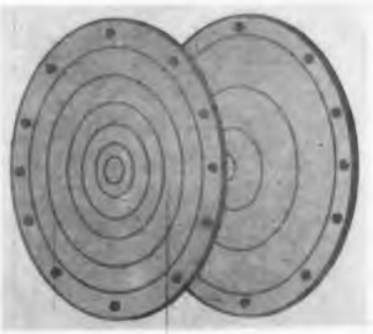


Fig. 2. Varying radiation characteristics are obtained by printing on different conducting patterns.

A PRINTED, conical directivity patterned antenna has been developed which is small, easy to mount and protect. Designed for the 3-cm band, the antenna side-lobe levels are extremely low.

The antenna system consists of a cylindrical cavity the diameter of which is much larger than the wavelength. Its height is about equal to it. The upper and lower walls of the cylinder are made of electrically conducting material. Radiating annular slits, symmetric about the cylinder axes and concentric with each other, are cut in the upper walls. A radiator, which produces a cylindrical wave propagating radially from the cylinder axis, is located in the center of the lower cylinder wall. The radiator used is an ordinary rod, mounted exactly on the axis of the cylinder and electrically coupled to the feeding waveguide. As the wave is propagated to the side wall of the cylinder, on which periphery is placed an absorbent load, radiation takes place from the

annular slits. The calculated amplitude-phase characteristic, which determines the actual radiation pattern, depends on: (1) the relative spacing of the slits (in fractions of a wavelength), (2) the widths of the slits themselves, and (3) the height of the cylindrical cavity.

Fig. 1 is a drawing of the (disassembled) antenna. The base of the antenna is a current-conducting mechanically-rigid disk, *1*. The dissipative load, *2*, is made in the form of a conical ring, fastened on the generatrix of the disk. The radiating grid of annular loops, *3*, is produced by a printed-circuit technique on a high-frequency dielectric 1 mm thick. The radiating grid is uniformly clamped to the base by a metallic clamping ring *4*. The drawing also shows the waveguide for feeding high-frequency energy to the antenna radiator.

The construction makes it possible to assemble and disassemble the antenna rapidly. Thus, different radiating grids can be used for the same base and radiator configuration.

It is relatively easy to adapt the antenna for the conical scanning needed to produce an equal-signal zone. The center of the radiator is shifted away from the cylinder axis and the disk is rotated at the required eccentricity. Alternately, the dielectric disk with the radiating slit can be shifted relative to the axis and rotated.

Printed Grid Pattern Determines Radiation Characteristics

Fig. 2 shows two printed grids, designed for different radiation characteristics. Both of the slotted grids shown have an in-phase slit distribution with an amplitude distribution which drops sharply towards the edges and is symmetrical with respect to the center of the grid.

Experiments on the antenna of Fig. 1 yielded the following results:

At a useful window diameter $D = 220$ mm and an operating frequency $f = 9340$ mc, the width of the directivity pattern at a level of 0.5 P_{max} was 9 deg with an attenuation of the lateral radiation (first side lobe) of 22 db. The SWR varied from 0.7 to 0.8.

This antenna has several advantages over certain existing types of printed antennas with sharply-directional patterns[1,2]. It is simple to construct and easy to manufacture. The absence of resonant elements makes it easier to operate at high powers.

Translated from News of the Higher Institution of Learning, *Instrument Building Section, No. 4, 1959, pp 149-151.*

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1. IRE Trans. Microwave Theory and Techniques, March, 1955.
2. IRE National Convention Record, 1957, pp 114-151, 116-172, 173-176.

GERMAN ABSTRACTS

E. Brenner

Parametric Amplifiers

Parametric Amplifier References

Reference to Proc. IRE Vol(year)page	Investigators	Signal in Kmc	Signal out Kmc	Pump Kmc	Idler Mc	Gain Db	Band Mc	Noise F Db
47(1959) 584	Knechtli & Weglein	3.1	3.1	6.2	3.1	—	—	1.2
46(1958)1301	Herrmann et al	6	6	11.7	6	18	8	6
46(1958)1301	Heffner & Kotzbue	1.2	1.2	3.5	2.5	19	1	4.8
47(1959) 42	Oguchi et al	4.17	4.17	8.1	4.17	15-20	15-25	10
47(1959) 42	Brand et al	2.9	2.9	5.8	2.9	19	0.5	2.7
46(1958) 583	Salzberg & Sard	0.001	0.021	0.020	—	10	—	0.42
47(1959) 583	Kibler	0.53	0.53	1.06	0.53	10	0.6	3.8
47(1959) 81	Chang	0.214	0.214	0.15	—	8	0.25	2.5
46(1958)1383	Bloom-Chang	0.38	0.38	0.3	0.22	10	3.4	8.5
46(1958)1655	Engelbrecht	0.38	0.38	0.63	0.25	10-12	3.5	—

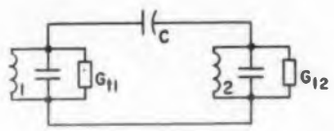

Fig. 1. Model of parametric amplifier.

THE CONTROLLING element in a microwave parametric amplifier is the nonlinear capacitance of a semiconductor diode. Usually of silicon, these diodes have a capacitance of about 1 μμf. The amplifiers' noise characteristics are superior to those of "conventional" heterodyne circuits, and they are easier to fabricate than molecular (maser) amplifiers.

In the reactance-controlled parametric amplifier, small-signal power is transformed into low-

Regulated Transistor Power Supplies

TRANSISTOR circuits often require regulated power supplies furnishing several amperes at 6 to 24 v. A basic circuit, using a transistor as a controlled series resistance with reference voltage supplied by a Zener diode, is the "series compounded" circuit shown in Fig. 1. The performance of such a circuit is characterized by the change in output voltage Δv_o produced by changes in input voltage Δv_i, load current Δi and temperature ΔT. Thus

$$\Delta v_o = \frac{1}{\sigma}\Delta v_i + R_o \Delta i + C_T v_o \Delta T$$

Where

$$\frac{1}{\sigma} = \frac{\delta v_o}{\delta v_i}$$

$$R_o = \frac{\delta v_o}{\delta i}$$

$$C_T = \frac{1}{v_o}\frac{\delta v_o}{\delta T}$$

A typical circuit using a source v_i with output impedance R_e and an auxiliary source v_1 with output impedance R°, is shown in Fig. 2. Transistor *T1* is the controlled resistance and *T2* is an error-amplifying transistor. For this circuit it can be shown that

$$\sigma = \frac{R' K_2}{n r'}$$

$$R_o = \frac{R_e n}{K_2} + \frac{nR^\circ r'}{R' K_2} - R_f (n-1)$$

where

K_2 = voltage gain of transistor *T2*
n = $1 + R_1/R_2$
r' = internal impedance of Zener diode *Z2*

The temperature effects are governed by the

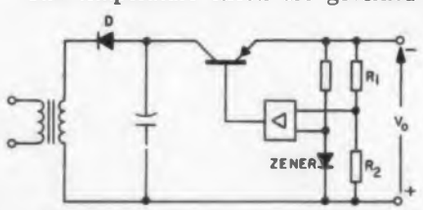

Fig. 1. Series compounded power supply.

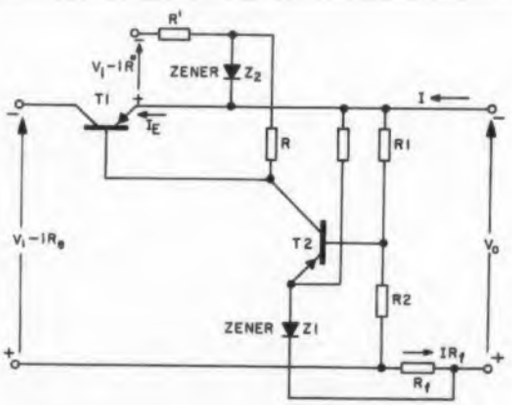

Fig. 2. Basic circuit of series-regulated supply.

characteristics of the Zener diode *Z1* and transistor *T2*. Approximate analysis shows that R_2 should be chosen small compared to the input impedance of *T2*. The value of R_f is best adjusted experimentally.

The original article also includes a detailed description of 7-30 v power supply capable of delivering 0.3 amps with σ approximately 2,000, R_o less than 0.02 ohms and C_T less than 0.01 per cent per deg C.

Abstracted from an article by W. Larass, Elektronische Rundschau, *Vol. 14, No. 2, February, 1960, pp 51-55.*

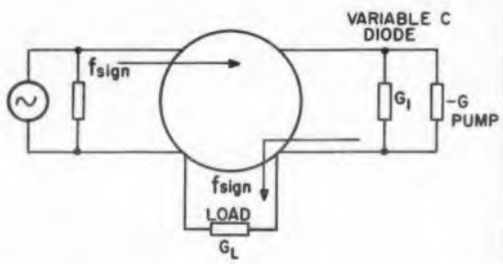

Fig. 2. Circulator isolates input and output signal to reduce noise figure. The coupled cavities are represented by their resonant conductances.

noise side band power by drawing on a high power "pump" source. A system is typically described through the two-tank model of Fig. 1. The tuned circuits are coupled through the controlled capacitance and tuned to the signal frequency f_1 and the idler frequency f_2. The pump frequency, $f_3 = f_1 + f_2$ controls the capacitance so that $C = C_o + C_3 \sin \omega_3 t$. When oscillating with its natural frequency, each tank circuit presents a negative real conductance to the other tank. This controlled conductance has the value

$$G(f_1) = -f_1 f_2 C_3^2 / 4 G_{t2}$$

where G_{t2} is the total conductance of tank 2. Denoting by G_L and G_g load and source conductance respectively, the power gain is

$$K_p = \frac{4\, G_g G_L}{G_{t1} - G(f_1)^2}$$

The noise figure, defined with reference to signal-noise power ratio, is

$$F = 1 + G_1/G_g + G_{t1} f_1 / G_g f_2$$

A "circulator," Fig. 2, can be used to isolate the input and output loops to improve the noise figure to

$$F = (f_3 Q_x / f_2 Q_{t1}')$$

Where $Q_{t1}' =$ over Q of tank cavity 1 loaded by G_1 and G_g

$Q_x =$ external Q of cavity 1

The accompanying table summarizes the parametric amplifiers reported on as of August 1959.

Abstracted from an article by H. Urbarz, Nachrichtentechnische Zeitschrift, *Vol. 13, No. 2, February 1960, pp. 57-63.*

ELECTRONIC DESIGN
DIGEST

The Corporate Structure Antenna . . . Organized Along Business Lines

EXTENSIVE development work has been conducted at Raytheon's Wayland Laboratory in recent years on an extremely versatile type of microwave antenna known as the corporate structure. The name is derived from the resemblance between the circuit diagram of the antenna feed system, Fig. 1, and the organization chart of a business corporation.

The power from a single input feed line is distributed among the radiating elements of the antenna by a network of power dividers. The nature of the radiated beam is determined by the number and type of radiating elements and by the phase and amplitude of the energy at each element. The fundamental advantage of the corporate structure is the high degree of control which can be exercised over the radiation from each of the elements of the antenna.

The price paid for this control is complexity. When the number of radiating elements is small, the corporate structure is correspondingly simple.

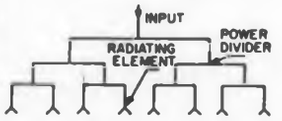

Fig. 1. The corporate structure gets its name from the resemblance of its antenna feed system to the organization chart of a business corporation.

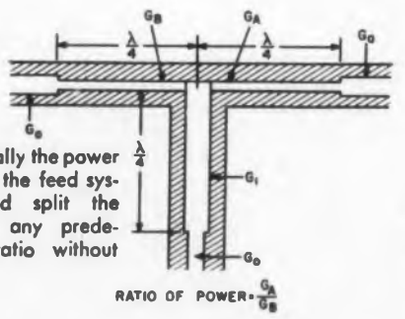

Fig. 2. Ideally the power dividers of the feed system should split the power in any predetermined ratio without any loss.

The corporate structure antenna is divided into a myriad of separate radiating elements, each of whose radiation can be carefully controlled.

As they increase in quantity, the number of components in the corporate structure rapidly become astronomical. As we approach, say, 100 elements, the mechanical engineers shudder at the weight involved, the customer dares not think what the cost will be, and everyone is wondering how it can ever be put together. All of these are valid objections and can be outweighed only by operational requirements which cannot be satisfied by any of the more conventional antenna designs.

Corporate Structure Components

The key components of the corporate structure antenna are the power dividers and the radiating elements. A clear understanding of the power divider is essential to an understanding of the antenna.

Consider a power divider with a single input and two outputs, Fig. 2. Ideally, this tee should be capable of splitting the power in any predetermined ratio without any loss. Furthermore, this ratio should be unaffected by frequency or by the terminations on the output lines. We have been able to approach all but the last of these conditions using a tee developed by John Reed and Gershon Wheeler at Wayland Laboratory. The power division ratio is determined by the diameters of the inner conductors of the coaxial transmission line making up the tee. The device is relatively insensitive to frequency changes because the ratio is controlled by the characteristic impedance of the lines. Some frequency dependance is introduced by the quarter-wavelength sections of line which are used as transformers. The power in each output arm is V_j^2G where V_j is the driving voltage at the junction of the tee and G is the conductance looking into the arm. Since V_j is the same for both output arms, the power ratio is simply G_A/G_B. If both arms are terminated in reflectionless loads, the power ratio is fixed by the line diameters.

In a real situation, voltage-standing wave ratios,

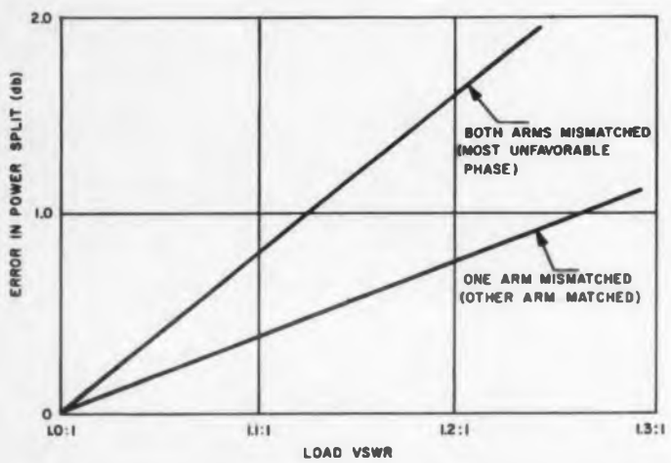

Fig. 3. Mismatched loads can cause errors in power splits. Here, maximum errors on outputs of a three-port power divider are shown.

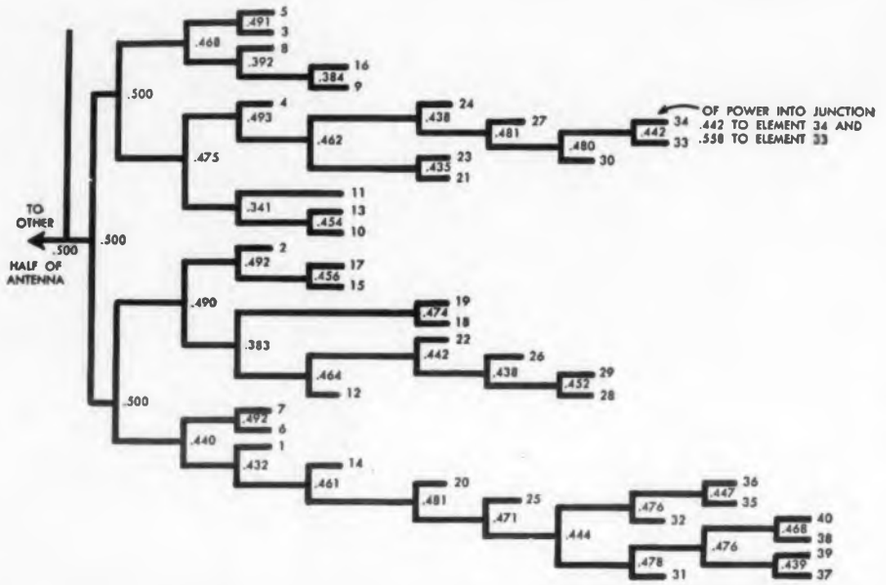

Fig. 4. An 80-element corporate structure feed divides power in varying ratios.

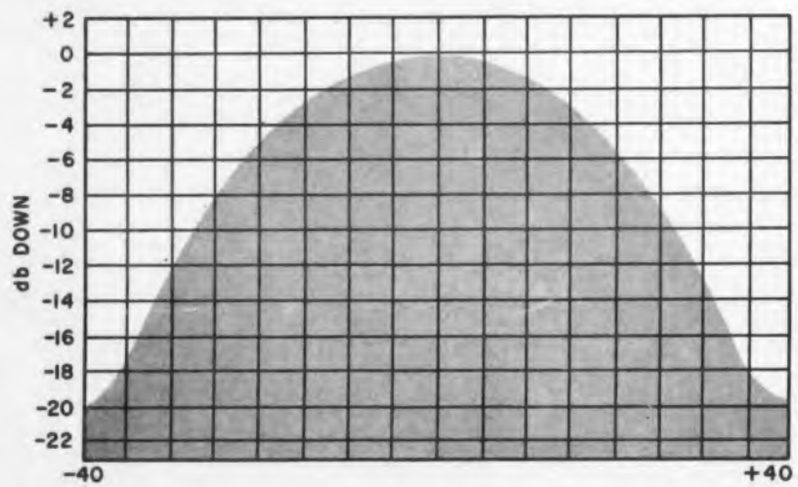

Fig. 5. Taylor amplitude distribution for the 80-element array of Fig. 4.

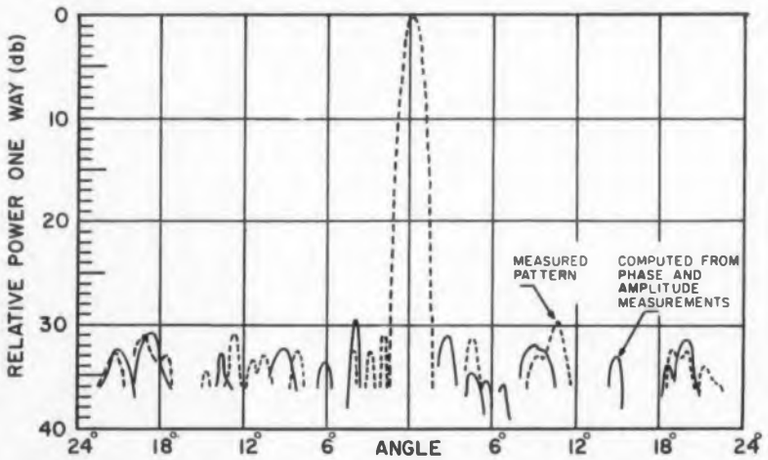

Fig. 6. Reasonable correlation exists between measured and calculated antenna lobe patterns.

r_a and r_b will be present in each line. The conductance of line A will vary between the limits $g_a \times r_A$ and g_a/r_a, where G_a is defined as the characteristic conductance of line A at the junction of the tee. The value G_A within these limits is determined by the phase of the reflected wave. When $r_a = r_b$ and the reflected energy in both lines has the same phase, the power division ratio is undisturbed by the reflection. This occurs whenever identical discontinuities are equidistant from the junction. When these two conditions are not met, the ratio is disturbed. Even small reflections can cause large errors, as shown in Fig. 3.

This places severe requirements on the design of the corporate structure because the distribution of energy among the radiating elements is correct only when the lines are reflectionless or when the reflections are of the special character described above. On the other hand, the device for controlling this distribution has the important advantage of being relatively insensitive to changes in frequency. Broadband operation is seen to be characteristic of the corporate structure.

Generally a corporate structure is used to feed a line of radiating elements. This linear array determines the beam in one plane. The beam in the other plane is formed independently by the radiating elements, by a reflector, or even by an array of second corporate structures. We shall concentrate on broadside linear arrays: that is, arrays with all elements fed in the same phase so that the beam is normal to the line of radiating elements. Arrays fed by corporate structures with the elements phased to produce an oblique beam are quite feasible and have been discussed to some degree in the literature.

With a broadside array the power division ratios are not disturbed because the radiating elements are not reflectionless terminations or because some of the radiated energy is coupled into adjacent elements. In the broadside case the radiating elements fed by a particular power divider are all electrically equidistant from that divider. If the radiating elements are identical the reflections from the radiators are identical in phase

and amplitude. Mutually coupled energy also has the properties of reflected energy. This arrives in phase at each tee and, except for elements near the end of the array, the equivalent reflection coefficient is the same at all tees. (This assumes that the amplitude distribution from the center to either end of the array is monotonic.) Thus the special conditions for reflected energy that does not alter the power division ratios have been met.

Since the radiating elements do not add to errors in the power distribution, we need only deal with reflections within the corporate structure. In many applications the tees cannot be equally spaced from each other. In addition, the transmission lines joining the tees are neither identical nor reflectionless. Thus the corporate structure must be designed so that the undesirable effects of these errors on the radiated beam are minimized.

Corporate Structure Design

In the case we have selected—the broadside linear array—all elements are in phase. The amplitude distribution is yet to be chosen. With the corporate structure feed, many choices are open which are not feasible with other antenna types such as the reflector fed by a horn.

One such possibility is uniform amplitude distribution. This has the advantage that, for a given antenna length and wavelength, the beamwidth is minimized. Another type is the Dolph-Tchebyscheff: for a given wavelength, antenna length, and beamwidth, the minimum side lobe level is achieved. Much of our work has been with the Taylor distribution, which is similar to the Dolph-Tchebyscheff.

While slightly less efficient, the Taylor type has side lobes which decrease in magnitude as the angle from the main lobe increases. For the Dolph type, all side lobes are equal in magnitude. Regardless of the choice made, there is high aperture efficiency (roughly defined as the ratio of antenna length to beamwidth, wavelength being fixed), and low side lobes may be realized.

It is essential that the corporate structure be designed to avoid periodic errors. Such errors may occur when, say, every fifth element of the array is fed from a single power divider. The effect would be as if an array with an interelement spacing five times that of the basic array were superimposed. Because of the wide spacing, this new array has several principal maxima, all but one being off the axis of the main beam. These maxima show up as side lobes, which could be excessively high.

By careful design, it is possible to build a high degree of randomness into the corporate structure. Fig. 4 is an example of such a corporate structure, in this case an 80-element feed. The

DIGEST

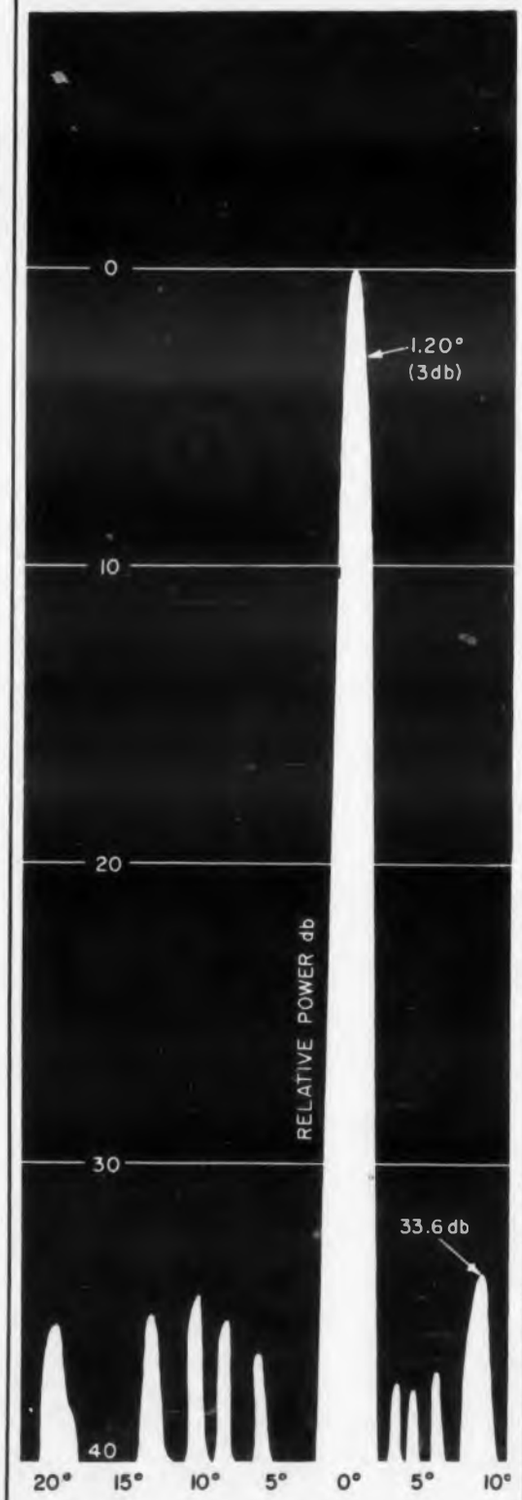

Fig. 7. Antennas have been made with side lobes more than 32 lb below the main lobe over a 30 per cent frequency band.

network is symmetrical about the center line with the elements being numbered from 1 to 40 from the center to either end. The number at each tee indicates the fraction of the input which goes to the upper output arm. This network yields the distribution shown in Fig. 5, in this case the Taylor type for side lobes, 40 db below the main lobe.

If we assume that the corporate structure does feed the array so that errors will be random, statistical theory may be used to predict the side lobe levels which will occur. This is valuable because it allows antenna pattern requirements to be translated into design criteria for the corporate structure components. Furthermore, from measurements of phase and amplitude of the signal at each element of the array, the antenna pattern can be computed. This is often desirable when the large size of an antenna or the very low side-lobe levels make antenna pattern measurements difficult. Reasonable correlation between measured and calculated patterns has been achieved, as shown in Fig. 6.

Capabilities and Limitations

To date at Wayland Laboratory our interest in the corporate structure has been concerned with its broadband, low side-lobe capabilities. We have made antennas with side lobes more than 32 db below the main lobe over a 30 per cent frequency band, and below 35 db over much of this band. Fig. 7 is an example of the sort of patterns which have been measured. This performance is superior to that of a reflector for which 24 db side lobes and a 10-per-cent band of operation might be typical.

The upper limit on bandwidth has not been determined, but it is probably close to 40 per cent, a figure which is not far from the useful range of waveguide. Lower side lobes are also attainable, but no significant improvements should be expected without a different type of power divider. A device is needed in which all reflected signals would be absorbed, rather than being bounced around inside the corporate structure and coming out as error signals.

The advisability of using a corporate structure antenna should be considered whenever the antenna designer is faced with requirements which cannot be met using ordinary techniques. But first—he must be sure he has a generous budget, a distant delivery date and a group of indefatigable engineers.

Digested from The Corporate Structure Antenna, A. M. McCoy, C. F. Winter, Electronic Progress, *The Raytheon Co. March-April 1960, Vol. IV, No. 5, pp 7-11.*

REPORT BRIEFS

Inverse Networks

"Inverse networks" are introduced as a class of two terminal-pair, linear, passive structurally dual networks. From a given network composed of combinations of lumped resistance, inductance, and capacitance another "inverse" network, with an identical voltage transfer function, may be formed by using the concept of inverse impedances together with a topological transformation procedure. *Inverse Networks, Charles F. White, Naval Research Laboratory, Washington, D.C., Nov., 1959, 11 pp, Microfilm $2.40, Photocopy $3.30. Order PB 143407 from Library of Congress, Washington 25, D.C.*

Systems Planning

A general concept for the formulation of detailed design and evaluation criteria for complex developmental systems is outlined. Achievements necessary to develop a suitable end product are described. The report points out that any process begins with the need for a system, and that a general description and an understanding of performance requirements are necessary to accomplish the mission. A group of combined functional elements for efficient system design are defined. Theoretical mechanization requirements are validated by the design, construction, and evaluation of an experimental model. *Planning Philosophy For Complex Systems, P. Waterman, W. Hodgson, and C. Francis, U. S. Naval Research Laboratory, Washington, D. C., 12 pp, 50 cents. Order PE 151764 from OTS, U.S. Department of Commerce, Washington 25, D. C.*

Magnetic Ring Telemeter

The magnetic ring telemeter is a multichannel pulse position modulated telemeter that utilizes small saturable reactors in place of vacuum tubes in the ring counter chains. These chains are required in the transmitter premodulator to effect time division for the several channel pulses. A magnetic ring counter chain is also used in the receiver decoder for separating the channel pulses before recording the transmitted intelligence. The magnetic ring telemeter was developed to provide a telemeter with increased intelligence-handling capabilities. The size was to be kept at a minimum and the reliability increased over former models by using new techniques. *Magnetic Ring Telemeter Development, M. G. Pawley and T. B. Jackson, Naval Ordnance Laboratory, Corona, Calif., June 1954, 27 pp, Microfilm $2.70, Photocopy $4.80. Order PB 144747 from Library of Congress, Washington 25, D.C.*

Printed Circuit Antennas

Novel types of wideband driving circuits are being investigated which can be constructed by printed circuit techniques and have particular application to ECM antennas. These circuits included strip-line 3-db directional couplers, broadband 90 deg phase shifters, and wideband baluns. The studies of wideband radiating structures were concerned with flush-mounted leaky-wave antennas, printed-circuit zig-zag radiators, and dielectric-filled ECM-horn antennas. *Investigation Of Printed Circuit ECM Antennas, E. M. T. Jones, Stanford Research Institute, Menlo Park, Calif., Dec. 1955-Aug. 1958, 12 pp, Microfilm $2.40, Photocopy $3.30. Order PB 137448 from Library of Congress, Washington 25, D.C.*

Linear Micro-Microammeter

A prototype fast-response linear micro-micro-ammeter has been developed which uses the 100 per cent feedback type of circuit without the usual dc-to-ac input converter. The circuit consists basically of an ORNL electrometer and a new type of push-pull magnetic amplifier. The output impedance of the electrometer matches the input impedance of the magnetic amplifier. The mag-amp output is fed back to the electrometer input to obtain fast response time (less than 1 sec) and negligible drift. The accuracy of measurement depends on the values of input and feedback resistors, and voltage gain is eliminated as a measure of accuracy and linearity. The ranges of current measurement extend from 10^{-11} amp full scale to 5×10^{-6} amp full scale, in 18 steps. *Fast-Response Linear Micro-Microammeter, J. R. Gardner, Convair, Fort Worth, Tex., Aug., 1958, 19 pp, Microfilm $2.40, Photocopy $3.30. Order PB 145346 from Library of Congress, Washington 25, D.C.*

Waveguide Transformers

A simple method for designing transformers to match between two arbitrary impedance, circular waveguides is described, and an example given. The method combines a generalization of measurements made on tubes of Teflon in circular waveguide with the general knowledge concerning the nature of multistep transformers. The experimental results of the application of the technique to design a match between standard-size X-band circular guide and a complex dielectric-ferrite-loaded reduced-size circular guide are included. *A Technique For Designing Transformers To Match Between Two Circular Waveguides, N. Karayianis, Diamond Ordnance Fuze Laboratories, Washington, D. C., 15 pp, Microfilm $2.40, Photocopy $3.30. Order PB 144705 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Coiled Waveguide

A comparison is made between the performance of a coiled waveguide section and a straight section of equivalent length. Stages of development and properties of coiled waveguides are discussed, and test results of several coils and assembled units are given. Theoretical calculations and an empirical determination of waveguide time delay are included. *Electrical Characteristics of Coiled Waveguide, H. S. Jones and H. K. Morlock, Diamond Ordnance Fuse Labs., Washington 25, D.C., Nov. 1958, 18 pp, Microfilm $3.40, Photocopy $3.30. Order PB 144857 from Library of Congress, Washington 25, D.C.*

Flow Graph Techniques

The flow-graph approach is presented for analyzing multi-loop sampled-data systems. Two techniques for finding the sampled output are examined. These are the construction of a "sampled" signal flow-graph from the original system, and the application of the general gain formula to the original system. The first technique allows two possible modes of solution. The sampled output can be found directly from the "sampled" flow graph by the use of Mason's Formula, or in case of a more complicated multi-loop system, the problem of enumerating non-touching feed-back loops can be simplified by the use of topological matrices. Techniques developed in the paper are also applied to the solution of multirate systems. *General Flow Graph Technique for The Solution of Multi-Loop Sampled Systems, R. Ash, W. H. Kim and G. M. Kranc, Columbia University School of Engineering, New York, N.Y., July 59, 33 pp, Microfilm $3.00, Photocopy $6.50. Order PB 144752 from Library of Congress, Washington 25, D.C.*

Quartz Crystals

A prototype thermistor-bridge power meter for measuring the rf power dissipated in vhf quartz crystals was constructed and tested. An experimental uhf capacitance bridge oscillator was built that displayed characteristics suitable for use with the coaxial bridge. Crystal controlled oscillations as high as 420 mc were obtained with a modified version of this oscillator. *Investigation Of Methods For Measuring The Equivalent Electrical Parameters of Quartz Crystals, Douglas W. Robertson, S. N. Witt, Jr. and William R. Free, Georgia Institute of Technology, Engineering Experiment Station, Atlanta, Ga., June, 1957, 71 pp, Microfilm $4.50, Photocopy $12.30. Order PB 138495 from Library of Congress, Washington 25, D.C.*

Silicon Carbide Transistors

Boron-tin-platinum alloy was found to be promising for forming pn junctions in n-type silicon carbide. The rectification ratios for the fused junctions were higher for increased fusion temperature and greater temperature gradient normal to the regrowth layer. *Research On Silicon Carbide Transistors, Westinghouse Electric Corp., Boston, Mass., Jan.-July 1959, 42 pp, Microfilm $3.30, Photocopy $7.80. Order PB 144975 from Library of Congress, Washington 25, D.C.*

Ferroelectric Materials

A theory based on the scattering matrix approach is presented for high dielectric constant materials. Correction formulas for the non-uniform field effect in disc and rectangular shaped samples at high frequencies have been verified. *Investigation Of Microwave Properties Of Ferroelectric Materials, C. B. Sharpe, Michigan University Research Institute, Ann Arbor, Mich., Aug. 1958, 15 pp, Microfilm $2.40, Photocopy $3.30. Order PB 138790 from Library of Congress, Washington 25, D.C.*

Delay Lines

Delay properties of networks containing several variable parameters are studied and compared. The effect of a parameter change on the delay function of the network yields information that aids in the synthesis of high order variable delay lines. The bridged-T network is used as a prototype section in this investigation. *Variable Parameter Delay Lines, G. Aaronson, Microwave Research Institute, Polytechnic Institute of Brooklyn, N.Y., March 1959, 78 pp, Microfilm $4.50, Photocopy $12.30. Order PB 145149 from Library of Congress, Washington 25, D.C.*

Acoustic Sources

Material on acoustic sources and related fields is arranged in outline form under four major topics: single sources and receivers, arrays of sources and receivers, transducer properties, and acoustic fields. References listed are from 1935 through 1958. The subject outline in the bibliography is repeated elsewhere by author, date, and topic title. Some entries are cross-referenced. The appendix includes a list of abbreviations of journal titles used. *A Bibliography On Acoustic Sources And Their Related Fields. G. B. Thurston and R. Stern, Willow Run Laboratories, University of Michigan, for Office of Naval Research, Feb. 1959, 68 pp, $1.75. Order PB 161330 from OTS, U.S. Department of Commerce, Washington 25, D.C.*

STANDARDS AND SPECS

Sherman H. Hubelbank

Aircraft Electronic Modules

Three types of modules have been defined in a new spec covering the design and manufacture of electronic modules for piloted aircraft. Issued by the Bureau of Naval Weapons, this spec supersedes MIL-E-19600(AER), Sept. 1, 1956, and MIL-Q-19614(AER), Feb. 1, 1958.

Type A module will have forced-air cooling; type B, conduction, and type C, free-air or natural cooling. Each module must encompass a discreet and logical portion of an electronic circuit. Modules are to be mountable on either a flat chassis or plenum chamber (normal equipment chassis). To reduce wall thickness between modules, it must be possible to remove the cover when converting from the flat to the modular plug-in installation.

The interchangeability requirements of MIL-E-5400 (Basic Electronic Design Specs) will be extended to require interchangeability of all production models of a specific classification without the necessity of realignment of the replacement module or other modules in the main unit.

A primary design consideration is high reliability. Module mean time between failures will be 2,000 hr. Total operating life of repairable modules will be at least 10,000 hr.

See MIL-E-19600A(WEP), General Requirements for Aircraft Electronic Modules, 1959.

Ground Support Equipment

Technical information about ground-support equipment for aircraft and missile weapon systems is covered by a recently released spec.

As used in the publication, GSE includes ground operations equipment, ground handling equipment, and ground servicing equipment. GSE further defines any and all implements or devices needed to inspect, calibrate, gage, measure, repair, overhaul, modify, assemble, disassemble, transport, store, and/or otherwise maintain the required functional operational status of military weapon systems, components, and parts. The handbook does not cover common tools.

This publication is vital in the preparation of Ground-Support Equipment data requirements for Air Force contracts. The full title is MIL-HDBK-300(USAF), Technical Information File of Ground-Support Equipment for Air Weapons Systems.

LETTERS

Measure Power Supply Impedance, Not Load

Dear Sir:

"Measuring Power Supply Impedance," in your April 13th issue, is a fine article as far as it goes. But its limitations should be clarified.

The author uses a precision 10-ohm resistor in his Fig. 2 to determine the total dynamic load variation which causes a voltage variation across the power supply and its load. This voltage variation causes a current variation in the power supply as well as in the load.

In his discussion, the author uses the total varying current of both load and power supply to compute the power-supply impedance. Actually, his method will provide the total impedance of both power supply and its load. But the object is to measure load impedance alone.

In the author's second method, the same problem exists: the computed impedance is that of the power supply and its load, rather than that of the power supply alone.

While the methods are usable where the power supply impedance is much less than the load impedance, errors will result where the load impedance approaches the power supply impedance.

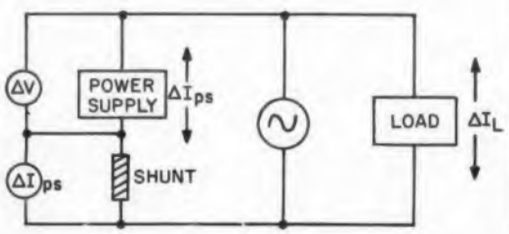

Fig. 1. Measurement configuration gives load impedance as well as power-supply impedance. Measurement is adequate where power-supply impedance is much less than load impedance.

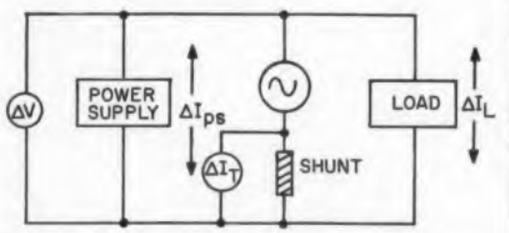

Fig. 2. Moving the current measuring device allows convenient measurement of power-supply impedance alone.

Fortunately, moving the current indicator, as shown in the attached illustrations, gives correct readings for power-supply impedance alone.

Melvin N. E. Bachman
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ENGINEER-IMPROVEMENT COURSES AND SEMINARS

Below are courses and seminars intended to provide the engineer with a better knowledge of various specialties. Our grouping includes several different types of meetings: National Courses—those held on consecutive days and intended to draw attendees from all geographical areas; One-Day Seminars—one-day intensive seminars which move from city to city; and Regional Lectures —regional symposia or lecture series which generally run one night a week for several weeks.

National Courses

AMA Summer Program, Colgate University, July 6-August 31

The American Management Association begins its 6th annual summer program which will open at the Colgate University campus in Hamilton, N.Y., July 6. The program this year will run nine weeks (July 6-Aug. 31) and will consist of more than 80 individual meeting sessions.

Units of six continuing courses including an "alumni" session of the Executive Action Course also will be given. The summer program will feature two groups of three day meetings. They will be held July 6-8 and Aug. 29-31. All other programs will last five days. Some of the topics to be covered include the following: collective bargaining, government research and development, applications for data processing systems, marketing's roles and goals in the total packaging program, and key areas of corporate insurance administration. For detailed information write to: D. G. Keen, American Management Association, 1515 Broadway, New York 36, N.Y.

Regional Courses

Special Summer Session At Moore School

The Moore School of Electrical Engineering of the University of Pennsylvania has announced a Special Summer Session on recent developments in the field of electrical engineering. Three two-week programs will be given during the period June 20 through July 16. Titles of the programs are as follows: Modern Radar Techniques, New Devices in Amplifying and Switching, and Numerical Analysis for Digital Computation.

The aim of the session is to provide a coordinated presentation of developments of the past five to ten years in these technical fields and thus to help bring engineers, scientists, and technical administrators abreast of new and prospective

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CAREER COURSES

electronic techniques in fields closely related to their own.

Further details on these courses may be obtained by writing: Special Summer Session Office, The Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia 4, Pa.

Course in Instrumental Analysis, June 20-25

The Department of Chemistry at Rensselaer Polytechnic Institute, Troy, N.Y., will offer a special comprehensive course in Instrumental Analysis from June 20 to June 25. This course is intended to broaden the training of chemists and chemical engineers in industry and in academic and governmental work. In this course theoretical concepts as well as practical applications of instrumental analysis will be emphasized. Particular stress will be given to recent developments in each field. Laboratory experiments will be scheduled so that each individual will have ample time to work with all of the instruments.

The course will be under the direction of Prof. Stephen E. Wiberly. Closing date for registration is June 1. Application blanks and additional information may be obtained by writing to: Prof. Stephen E. Wiberly, Department of Chemistry, Rensselaer Polytechnic Institute, Troy, N.Y.

Infrared Courses, University of Minnesota, July 5-15

Two continuation courses in infrared spectroscopy will be given under the auspices of the Molecular Spectroscopy Laboratory, Department of Chemistry of the University of Minnesota. The courses begin with fundamentals and carry through to include recent developments. Participants should have basic training in chemistry and physics, but no experience in spectroscopy will be assumed. The first course, "Techniques of Infrared Spectroscopy," will run from July 5 through July 9. The second course, "Chemical Interpretation of Infrared Spectra," will run from July 11 through July 15. If interested, write to Professor Crawford at the Chemistry Department, University of Minnesota, Minneapolis 14, Minn., or to the Director, Center for Continuation Study, University of Minnesota, Minneapolis 14, Minn.

PAPER DEADLINES

Convention Program Chairmen have issued the following deadlines to authors wishing to have their papers considered for presentation.

July 1: Deadline for abstracts of papers for the Annual Conference on Electrical Techniques in Medicine and Biology to be held in Washington,

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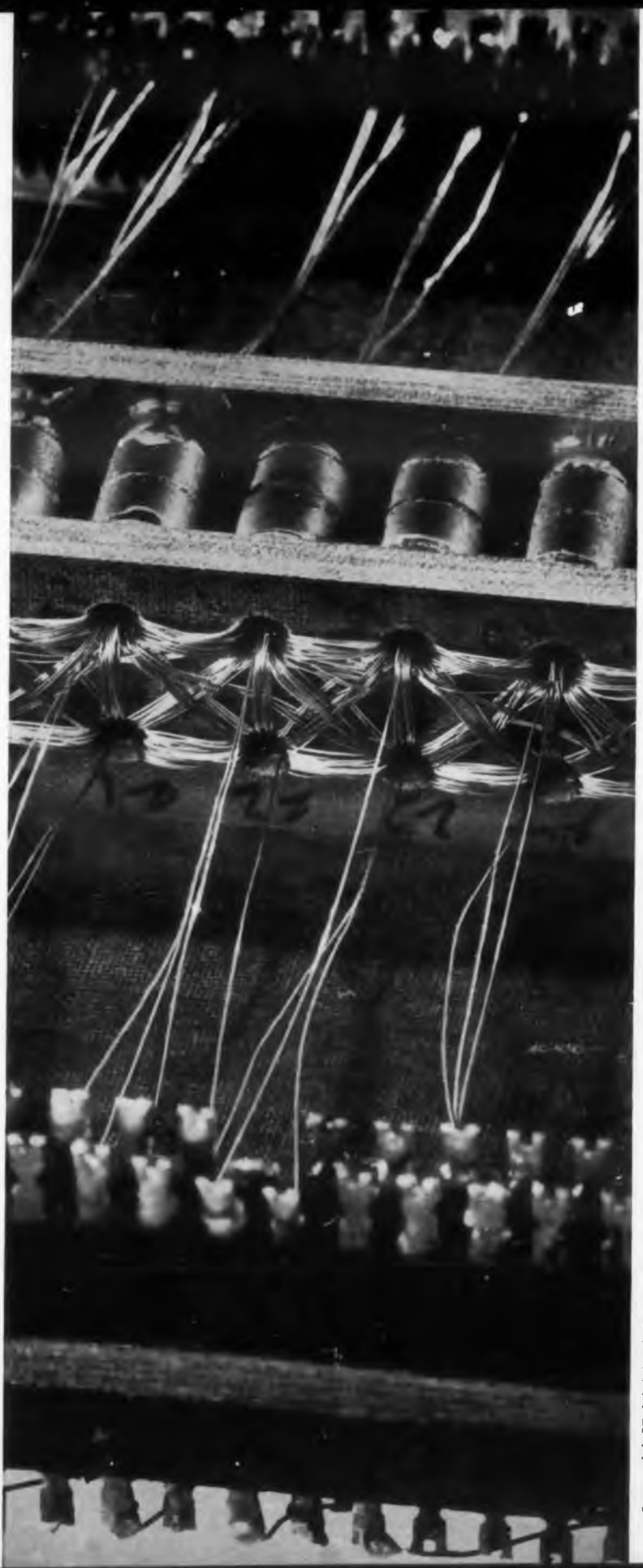

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CAREER COURSES

D. C., October 31, November 1-2, 1960 at the Sheraton-Park Hotel. Abstracts (200-500 words in length, which can be accompanied by supplementary illustrations) with author's name, company affiliation and position title, business and home address, telephone contact, and brief biographical sketch, should be submitted in double-spaced typewritten form (and in triplicate). The theme of the conference will be the application of electronic techniques to analytical instrumentation. Typical subject areas are: Polarography and specific electrodes; Electrical generation of titrant coulometric methods; Nuclear and electron magnetic resonance analysis procedure; Dielectric dispersion of high-frequency titration; Mass spectrometry; Microwave spectroscopy. Papers representing original contributions in these and related fields are invited. Send abstracts to: *George N. Webb, Room 547-CSB, Johns Hopkins Hospital, Baltimore 5, Md.*

July 1: Deadline for titles and abstracts of papers for **The Ninth Annual Industrial Electronics Symposium**, jointly sponsored by the IRE Professional Group on Industrial Electronics and the AIEE, to be held in Cleveland, Ohio, at the Sheraton Cleveland Hotel on September 21 and 22, 1960. Prospective authors are requested to submit papers relating to the main theme of the Symposium—Industrial Applications of Electronics stressing application and use of new products and ideas rather than basic research. Send titles and abstracts to: *Mr. G. E. Hindley, Chairman, Paper Procurement Committee, Ninth Annual Industrial Electronics Symposium, Reliance Electric and Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.*

July 15: Deadline for either complete papers or 400-500 word abstracts, in triplicate, for the 1960 **Northeast Electronics Research and Engineering Meeting** (NEREM) plus 50-word summaries for advance program mailings. The 1960 NEREM will be held on November 15, 16, 17, 1960, in the Commonwealth Armory and the Sheraton-Plaza Hotel, Boston, Mass. A suggestive list of subject areas for NEREM 1960 is: Antennas; Circuit Theory; Components, Production Techniques and Reliability; Electronic Computers; Engineering Management; Feedback Control Systems; Information Theory and Processing; Biomedical Electronics; Microwave Devices; Theory and Techniques Involving Ferrites, Masers, Parametric Amplifiers and Ionized Media; Military Electronics; Semiconductor Devices and Circuits. Send all material to: *J. H. Mulligan, Jr., Department of Electrical Engineering, New York University, New York 53, N. Y.*

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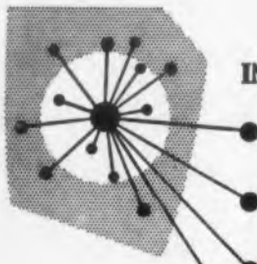

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2N1513	60	40	6	25	0.67	25-75	60	30
2N1512	100	55	6	25	2.00	10-50	60	30
2N1511	60	40	6	25	2.00	10-50	60	30
				V_{CB}=30v	I_C=1.5 amp	I_C=1.5 amp		
2N1490	100	55	6	25	0.67	25-75	60	30
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				V_{CB}=30v	I_C=0.75 amp	I_C=0.75 amp		
2N1486	100	55	3	15	1.00	35-100	15	7.5
2N1485	60	40	3	15	1.00	35-100	15	7.5
2N1484	100	55	3	15	2.67	15-75	15	7.5
2N1483	60	40	3	15	2.67	15-75	15	7.5
				V_{CB}=30v	I_C=0.2 amp	I_C=0.2 amp		
2N1482	100	55	1.5	10	7	35-100	4	2
2N1481	60	40	1.5	10	7	35-100	4	2
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