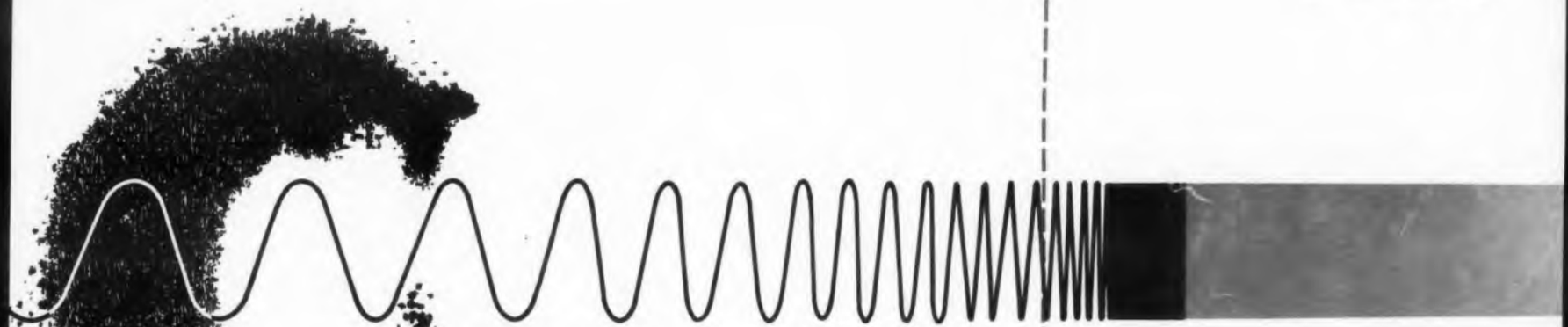
ELECTRONIC DESIGN

MAY 11, 1960

CS+AD



PRECISION SLOTTED WAVEGUIDE FOR 2 mm . . . P 76

COVER: Precision measurement of vsw in the 2-mm range of microwaves is th subject of this issue's cover. *ELEC TRONIC DESIGN*'s art director has use a micrometer to symbolize the order precision involved. The frequency spec trum represents the range of the electro magnetic energy from the vhf to th infrared band. The dotted corser ind cates the portion of the spectrum which this device, with its companio pieces, operates. Its introduction pushe the frontier of coherent microwaves t the very door of infrared.

Selected Topics in This Issu

Coming Next Issue

Missile-carrying subs, armed with the power to cripple U. S. economy in one blow, pose the greatest single threat to national security, say many military and industrial leaders. It is up to design engineers to meet the challenge of the technical cold war's hottest race—bringing up to date the now-inadequate techniques of anti-submarine warfare.

To find out what industry and the military are doing about this threat, *ED* sent editors Robert DeFloria and Alan Corneretto to dig out the facts and get a full report. They talked to dozens of leaders in ASW. The results will appear in the May 25th issue.

"Anti-Sub Warfare—Can Design Meet the Challenge?", the title of *ED*'s report, looks at the problem as would a system designer and comes up with a proposal of what must be done. The editors set forth expert opinion to the effect that solutions to the myriad problems will not be brought about by major breakthroughs. The most feasible solution is modification of existing devices.

According to those in the know, the situation is critical but not hopeless. *ED*'s comprehensive coverage of this all-important phase of national defense tells how industry and the military can best serve the national interest.

In this fiscal year alone, ASW will account for about $1.7 billion in direct procurement alone. Of this, $25 million will go for major electronic equipment. Government and industry both believe that the ASW effort may reach the proportions of the ICBM program, which it resembles in many ways.

What lies ahead? If the offensive capabilities of the advanced submarines continue to outstrip the techniques for hunting and killing, the "black sky" thinking prevalent today will turn out to be more than mere pessimism.

But the three-pronged attack described by the editors can lick the problem. With improved design systems, the ocean that befriends the submarine can be made more transparent. Fast, versatile hunter-killer groups can be provided with new and better automated eyes and ears and with improved weapons. Finally, a U. S. undersea fleet equipped with Polaris and other missiles can provide a retaliatory threat to be a powerful deterrent to Soviet aggression.

CONTENTS FOR MAY 11, 1960 VOL. 8 NUMBER **10**

ELECTRONIC DESIGN

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Ramo Finds Race For Super-Systems Altering Technology

Social, Political, Economic and Ethical Considerations Among Factors To Be Considered Besides Engineering, First Systems Symposium Hears

THE GROWING need for super-systems—"not just for military survival but for the non-military physical operation of the world"—is spawning problems basic and novel enough to change man's fundamental attitude toward technology, Dr. Simon Ramo told the First Systems Symposium in Cleveland.

Dr. Ramo, vice-president of the Thompson Ramo Wooldridge Co. and keynote speaker at the Case Institute of Technology symposium, said that among these problems were:

- The need to adjust to a new degree of interaction between technology and such non-technological sciences as sociology, ethics, politics, economics and public relations.
- The dangers arising from the need for speed in designing and building enormous, complex super-systems.
- International implications in global systems, such as defense, communications and weather control.
- The impossibility of a trial-and-error approach because of the enormous costs and effects of a total system.
- Drastic economic dislocation when systems now operating are displaced.
- The intolerability of "decision by hunch" when developing extremely powerful military systems.

The symposium considered the widening bridge between national objectives and the technology and the need to marry many scientific disciplines into a single integrated effort.

According to Dr. James Reswick, director of Case's Engineering Design Center, "engineering design is concerned with vertical integration of technology from research through development to production, while systems research is concerned with the horizontal integration of many scientific

Airborne TV to Serve Schools in Midwest

Plane Circling at 23,000 Ft Over Indiana Will Transmit Signal to 70,000 Sq Mi Area

First airborne telecasts were transmitted in 1948 from this converted B-29. Educational airborne TV, scheduled to begin next year, will employ DC-6B's. Antenna on tail of the aircraft above received signals from a ground station for retransmission via folding antenna on the aircraft's nose. The planned system will broadcast from videotape recorders inside the aircraft. At left, the target area for airborne TV. Zones are at consecutive 50-mile radii from aircraft which will fly over central Indiana. Outer zone probably will only get fringe reception at the program's outset but later increase in transmitter power will improve coverage.

Electronic equipment for airborne educational TV will soon reach the hardware stage under a contract about to be signed between Westinghouse's Air Arm Div., Baltimore, Md., and the Purdue University Research Foundation, West Lafayette, Ind. Air Arm has been designing equipment on a letter of intent basis and is waiting for the go-ahead to provide airborne transmitters and antennas in time for the February, 1961, deadline set for the beginning of telecasts.

A DC-6B flying at 23,000 ft over central Indiana will beam daily educational television on uhf channels 72 and 76 over a six-state area in the Midwest.

Each airplane will carry two 11-kw TV transmitters, videotape units and other studio equipment, a gas turbine-powered 400-cycle primary power source, and a 32 ft folding antenna.

Transmitters will use the recently developed Varian 833C klystron which can deliver up to 11 kw. Initial telecasts, however, will be limited to only 5 kw because of insufficient primary power. Westinghouse will eventually provide an 85-kw gas-turbine alternator to permit operation at 11 kw. But even the 5-kw signal is expected to result in usable reception over a 150-mile radius.

A slotted-type transmitting antenna has been designed which will give 10 db of gain and which will provide a uniformly circular downward radiation pattern.

(continued on page 6)

isciplines."

The need for an interdisciplinary approach to stems was pointed up by Dr. Russell Ackoff of ase's Operations Research Group.

"As systems analysts know," he said, "few of e problems that arise can be handled with any ne discipline. Such systems are not fundamenlly mechanical, chemical, biological, social, ecoomic, political or ethical. These are merely ifferent ways of looking at such systems. "We ust stop acting as though nature were organized to disciplines in the same way that universities re. The division of labor along disciplinary lines no longer an efficient one."

While systems researchers are drawn from any cientific disciplines, Dr. Ackoff said, the common enominator in their background is advanced athematics, statistics and physics.

One of the most important and least defined reas of systems research, observers at the meetng said, is an effective appraisal of ultimate obectives. This area was discussed by representaves of two leading operations research groups the country.

Charles Hitch, director of the economic center f RAND Corp., cited three outstanding probems:

- "Objectives are multiple and conflicting, and lternative means of satisfying any one are likely produce substantial and differential 'spillover' ffects on others. We are all, or almost all in favor f God, motherhood, peace—and therefore deerrence or winning a war if deterrence fails. But ists of this kind are almost useless for the anayst."
- "We have spoken of deterrence as an objecive—perhaps the primary objective—of our miliary force. But you learn after only a little study hat there are many different forms of deterrence, many different sorts of action by an enemy that would be nice to deter. There is the usual uestion: how far down the deterrence road is it esirable to go? We know we want the military apacity to deter him from striking us directly nd that, on the other extreme, it is probably silly o try to deter him by military means from frownng at us. But where in between do we draw the ine?"
- "Nothing but rigorous, quantitative analysis an tell us whether some objective makes sense r not—whether it is feasible, how much it will ost".

A somewhat different opinion of the job of perations researcher was set forth by Dr. Ellis ohnson, director of the operations research office t Johns Hopkins University. Dr. Johnson said it was the role of the operations researcher to derive bjectives logically from given goals.

"These goals are based on the value scale of the

(continued on page 6)

NEWS

Systems Symposium

(continued from pag

culture," he went on, "and while it is true tha is difficult to get government officials to de goals, we can go back to the Constitution its From this and similar documents which set fo our basic national aims, the researcher can l cally derive alternate sets of objectives and these to the executives with his reasons. And fr these reasons and goals, the executives can m their decision."

Dr. Johnson saw three levels of activity in s tems engineering: basic research, a plann group to translate the results of research and present the data for executive decision, and a sign group to carry out the chosen system desi

Dr. Donald Eckman, director of Case's Syste Research Center, said it "falls to the systems m to analyze, synthesize and evaluate systems." T

Airborne TV

(continued from page

Uniform coverage will be further assured by gyro stabilizing system to keep the antenna ver cal when the airplane banks. The antenna fol under the fuselage at landing.

The weight of all airborne equipment plus t weight of the crew and of fuel for the prima power source must be held below 14,000 lb.

The original airborne TV concept, dating ba to Westinghouse's Stratovision experiments 1948, called for a ground-to-air link to relay l studio broadcasts to the airplane. The advent videotape has made this unnecessary and remov the need for a ground station.

Narrow Band Transmissions Also Planned

The Midwest Program on Airborne Televisi Instruction, which is the planning body for th operation, has also scheduled experiments in na row-band uhf television in anticipation of i creased demands on educational TV channe Narrow-band transmissions will be interspers among the regular educational telecasts for rece tion by five selected schools in the test area. Sp cial airborne equipment and receivers for th aspect of tests is being developed by CBS Labo atories, Stamford, Conn.

Narrow-band transmissions will be over a

oblem, he said, is to seek "the level of ultimate" appraising objectives. At that point he said, e systems engineer should stop asking what he ants to accomplish and start accomplishing it rough an operating system.

The remainder of the work of systems research, her speakers said, is to devise mathematical ols to accomplish objectives through the use of her tools operating in the real environment.

These mathematical tools are concerned with ecisions.

A system operating to make a decision was visaged by Dr. Harry Goode, Professor of elec- ical and industrial engineering at the University Michigan.

In his system, all available information on a ven problem would be fed into a computer, hich would sift and evaluate the information, th relevant and irrelevant, and supply a deci- on based on rewards. The system takes into ac- unt capabilities and limitations, costs and hievements. ■ ■

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c band as opposed to the 6-mc band width ed in conventional TV. A 441 line and 48 field stem has been selected to shoehorn the image to a 3-mc channel. (TV standards are 525 nes and 60 fields). Audio and video carriers are be separated by only 2.3 mc instead of the nventional 4.5 mc.

lectronic Image Enhancement To Be Used

In addition, narrow band receivers will employ Crispening" circuits to compensate for the poorer mage quality inherent in narrow-band transmis- ion. Nonlinear circuitry in the video amplifiers troduces signals to steepen the wave fronts of he video signals. The result is an apparent en- ancement of the image. Medium-long decay hosphors are specified for the kinescopes to liminate flicker caused by the 48-field per second ransmission rate. CBS is supplying special driver nits for the airborne transmitters. Narrow band ideotape units will also be employed.

The 13,000 schools in the area to be served nay ultimately require up to 100,000 TV receivers the system is widely adopted. For small schools sing only a few receivers, each set will be quipped with its own uhf antenna. For economy, arger installations will employ a master antenna, uhf-vhf converter, and a standard vhf closed- ircuit distribution system.

NEWS

Microcircuitry Packaging Concept Detailed By Hughes Researcher

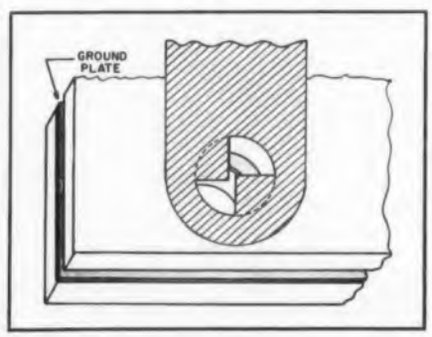
Components May Be Inserted Into Holes In Printed-Circuit Boards

PACKAGING of microminiature components by inserting them into holes punched in printed circuit boards is a technique now under development at Hughes Aircraft Co.'s Semiconductor Div., Newport Beach, Calif.

The program was described by William B. Warren, head of the device-mechanics department in the Division's development laboratory, during the recent Spring Technical Conference in Cincinnati jointly sponsored by the Institute of Radio Engineers and the American Rocket Society.

Hughes will begin marketing diodes designed for the packaging technique in the Fall, Mr. Warren said. The devices will measure 0.050-in. diam by 0.030-in. thick. Prices will probably be about $60 each in sample quantities. A similar transistor package should be ready for marketing by mid-1961, he added.

All Hughes diodes and transistors, except for coaxial-type transistors, should be adaptable to the new design, Mr. Warren said.



Portion of a split printed-circuit board, containing hole for insertion of component, showing how copper tabs extend over holes for contacts. Final circuitry form may differ from this developmental design.

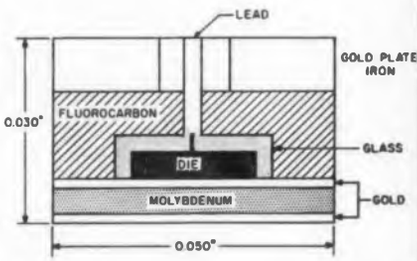


Diagram shows basic construction of silicon diode package, although various portions are not to scale.

Although the component configuration appears to be fairly well established, Mr. Warren indicated that the circuit packaging concept might undergo substantial changes before marketing begins.

Fluorocarbon printed circuit boards, 0.030-in. thick, with prepunched holes for the insertion of components are used in the packaging concept outlined by Mr. Warren. Copper-plated circuit patterns on both the top and bottom of the boards include small tabs of copper extending over the holes for making contact to diode leads. These tabs can be brazed or welded ultrasonically to the components.

The tabs present a problem in insertion of components into the circuit board holes. This is solved in the present Hughes configuration by splitting the board lengthwise. Parts can then be slipped into the holes in the bottom half of the board, and the upper half placed on top.

An important feature of the split circuit board is that a copper ground plate can be plated on the inside of one of the board halves so that ground contact can be established anywhere in the circuit.

One end of the planned Hughes diode is a double gold-tabbed molybdenum

Pencil-like magnet designed to pick up diodes by the iron end may lead to automated production of circuits.

disk. 0.050-in. thick. A silicon pn junction is produced inside a special glass envelope on top of this disk. Various glasses are being tried, Mr. Warren said, and it has been found that with some types a short heating cycle improves electrical characteristics.

The glass is separated from a gold-plated iron disk at the other end of the diode by a structural fluorocarbon layer. The lead material might be aluminum or gold, he commented.

Component densities for this type of circuitry range from about 1.7 to 4 million parts per cu ft, Mr. Warren said. He pointed out, however, that circuit densities fall far below this when interconnections required in operational circuitry are included.

Magnet Promises Automation

A special pencil-like magnet developed for picking up the diodes by the iron end may lead to automation of microcircuit production. Mr. Warren said the magnetic tip had to be specially designed to attain a warped field suitable for picking up the diodes neatly by the iron end rather than sideways.

Hughes development work as well as that of several other manufacturers is aimed at the Type I microelectronics category, Mr. Warren commented. This category is defined as including miniature, prepackaged active components which are testable in advance of use in a circuit. He predicted that Type I circuits will be prominent in the microelectronics field for about 10 years. ■ ■

1970 Power Sources for S

WITHIN the next decade, electrical power requirements for earth satellites and space probes will increase at an almost exponential rate with 1 megawatt needed by the late '60s. This prediction was made by A. W. Thompson of ABMA's Research Project Lab at the Conference on Electrical Engineering in Space Technology held in Dallas, Tex., April 11-13.

Although 20-30 w are adequate in present space vehicles to power transmitters, tape recorders, cameras, clocks, telemetry devices and other electronic equipment, more complex hardware must be sent aloft for such missions as world-wide communication stations and lunar probes. In the immediate future, at least 1 kw will be absolutely necessary, Mr. Thompson said.

However, according to R. E. Horner, Associate Administrator of NASA, it costs several thousand dollars to carry each pound of payload to its destination. Since present power packs, consisting of chemical batteries and solar cell configurations average about 31 w-hr per lb, it is obvious that improved propulsion methods, combined with others in addition to breakthroughs in power systems must be accomplished to achieve NASA's goal of a manned trip to the moon by 1970.

Heavy Demands For Electrical Systems

Much attention is being given to the development of electrical propulsion systems for long-range missions to Venus and Mars, D. D. Wyatt of NASA said. To generate sufficient power for the electrically powered vehicle and associated equipment, several hundred kilowatts to one megawatt will be necessary, he said.

As power requirements increase to meet the needs of more sophisticated space vehicles, the chemical battery has yielded to solar devices, with nuclear power systems on the horizon. For power levels up to 10 or 20 kw, W. R. Menetrey of Electro-Optical Systems, Inc., Pasadena, Calif., indicated solar devices will be competitive with nuclear schemes. Above the 20-kw region, nuclear systems will have lower weight and cost advantages. W. R. Corliss of Martin's Nuclear Div., Baltimore, Md., discussed radio-isotope space power supplies up to 1 kw. These are expected to be available within five years. Nuclear-fission reactors are important, he explained, beyond the 1-kw range. Thermal-energy conversion, by means of radio-isotope decay and nuclear fission seemed

I Have Megawatt Output

to be an almost unanimous choice by most speakers as the ideal answer to a compact, light-weight and reliable high-power source.

However, A. F. Daniel, Chief of the Army's Signal Research and Development Labs' Power Sources Div., pointed out that batteries have demonstrated an enviable record for high reliability during space service as a prime power source for periods up to one month; longer periods of time were attained when the batteries were supplemented with solar converters.

Electromechanical Device Study Urged

Plans for future development of electromechanical devices for space applications must begin with a careful analysis of the unique characteristics of typical applications, said J. T. Duane of General Electric, Erie, Pa. Special characteristics such as freedom from gravity, vacuum, corrosive atmosphere and cyclic-loading may well offer designers new degrees of freedom to permit the use of concepts and components impractical for other applications, he said.

By the same token, many undesirable characteristics are evident, such as penalties associated with operating temperature and loss of efficiency imposed by the problem of dissipating heat.

The most obvious requirement at the present time, Mr. Duane said, is for high-efficiency power generation equipment capable of operation at extreme temperatures. Other needs will develop later, and will include a demand for devices to convert electrical to mechanical energy for actuating and pumping purposes as well as for control and servomechanisms.

Actually there may not be an "ultimate" power source since an "ultimate" for a generator may fall far short of being an "ultimate" for an over-all system, according to F. M. Potter of Bendix Aviation Corp., Red Bank, N. J. The practical "ultimate" will be a compromise, depending on the particular application, environment, prime mover, method of cooling and life expectancy.

Finally, as pointed out by G. W. Wilson of the Westinghouse Research Lab, Pittsburgh, Pa., investigations are being conducted on materials and techniques for improving the efficiency of thermoelectric, thermionic and photovoltaic phenomena. All three methods offer the advantage of requiring no moving parts, eliminating gyroscopic effects associated with rotating machinery. ■ ■

Storage Technique Effectively Lengthens Army Airborne Side-Looking Antenna

RADAR signal storage and processing techniques give high resolution at great ranges with the Army's AN/UPD-1 side-looking radar system, which has just been declassified.

Although an antenna only 5 ft long is used, signal processing permits the forward motion of the aircraft to be exploited to synthesize an antenna of much greater length. This permits the fine azimuth resolution normally associated with long antennas to be accomplished with a short, wide-beam antenna.

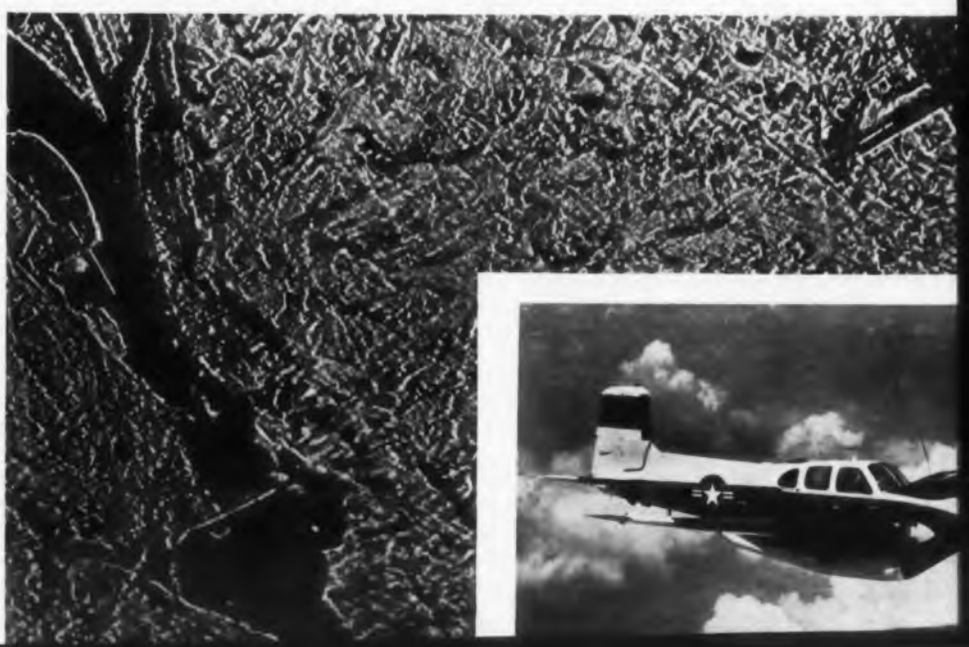
This fine azimuth resolution is also said to be range-independent, so that the system can provide surveillance at extreme ranges. The radar sweeps a narrow strip of terrain at the horizon.

The airborne portion of the system, weighing 700 lbs, includes an inertial-doppler system to provide corrections for variations in the speed and altitude of the aircraft.

Conventionally pulsed radar reflections are continuously recorded on a signal storage film in the airplane. This film is used as an input to an analog computer on the ground after the flight. The computer converts the signals into a detailed, distortion-free strip map which shows terrain as if it had been observed from directly overhead, except for radar shadowing effects.

The University of Michigan's Willow Run Laboratories developed the AN/UPD-1 for the Army, and built the ground-based data-processing equipment. The airborne portion of the system was built and installed in an L-23D aircraft by Texas Instruments, Inc., Dallas.

High-resolution radar picture of metropolitan Washington, D.C., area shows new Jones Point Bridge under construction, lower left, and National Airport, upper left. Radar photo was taken from an L-23D Army aircraft, inset, containing a 5-ft side-looking antenna which is made to perform like a much longer, narrow-beam antenna through signal processing techniques.



NEWS

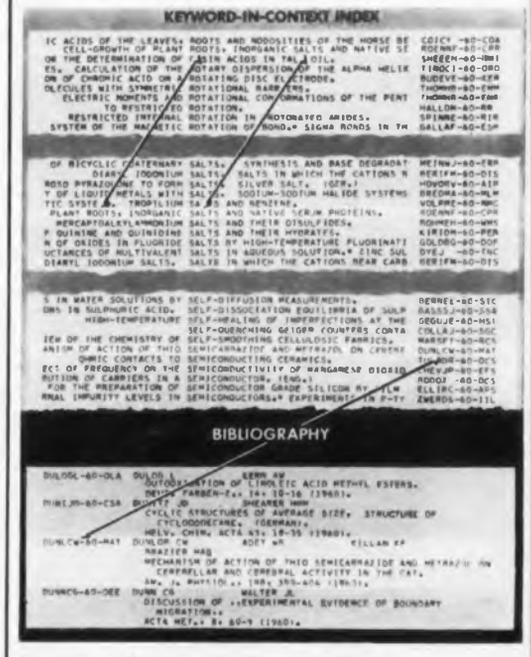
Computer Uses Program To Prepare Periodic Ind

Other Literary Uses Predicted; Employs 960-Word Stored Dictionary

INFORMATION retrieval from technical literature is for the first time being provided on a regularly scheduled basis by an electronic data processing system. "Chemical Titles," a 104-page, semi-monthly index of chemical literature published by the American Chemical Society, is being prepared on a 704 computer that arranges titles by "Key Word in Context" (KWIC).

The KWIC program, developed by IBM's Advanced Systems Development Div., Yorktown Heights, N.Y., requires only 12 minutes of computer time to prepare the index. The process is said to be readily applicable to literature in other fields, and several societies and professional groups are looking into its use.

In preparing the KWIC index, each chemical title selected is punched onto a card, together with the name of the author and publication, and other data. The computer first derives an identi-



Sample printout of "Chemical Titles" arranged by 704 Computer "KWIC" process. The two upper guide lines show how one title can appear a separate time for each of two key words (here, "roots" and "salts"). Lower guide line indicates how code at right of title is keyed to bibliography.

Key Word in Context' of Scientific Literature

fication code for each article and prepares a bibliography accordingly. The title is then compared, word for word, against a 960-word stored "Dictionary of Non-Significant Terms," containing such words as "use," "theory," "chemistry," etc. These words do not contribute to the recognition of subject matter. They are ignored, while the remaining words become "key words."

The title is then positioned within a field, so that each key word assumes a selected location within the field. This process is repeated for each key word, so that a title appears in the index once for each of its key words. Each key word, together with the surrounding portion of the title and the title code, is then printed alphabetically. A bibliography arranged by code is also printed.

To use the index, the reader scans the alphabetical list of key words for his areas of interest. The code number at the end of each entry directs him to the bibliography.

The KWIC program was originated by Hans P. Luhn of IBM. A program for the 704 is now available, and others for the 705 and 1401 computers are expected to be ready soon. Work leading to the development of KWIC was financed by a $150,000 grant from the National Science Foundation. ■ ■

Printout for first issue of "Chemical Titles" is inspected by IBM's Hans P. Luhn, originator of the "Key Word in Context" index. American Chemical Society is the first organization to use the system for information retrieval on a continuous basis.

NEWS

New Transmission System Cuts Army's Inventory Time

Through electronics, the Army Signal Depot at Lexington, Ky., can now report its mammoth inventory to an Army control center in one hour, instead of 13, as was formerly required.

The time reduction is due to the installation at Lexington and the Signal Supply Agency in Philadelphia, the control point for the Army Signal supply system, of a magnetic-tape transmission system.

This uses two transistorized units at each end of the telephone circuit that connects them. One unit transfers data to magnetic tape and the other converts taped data into electrical signals suitable for transmission over telephone cables.

The units can operate in reverse—one decoding electrical signals and the other transferring taped data to a memory device. The system differs from conventional types in that it uses magnetic tape in the transmission process. The tape generally is used for storing data.

The system was developed for the Army by the Collins Radio Co., Burbank, Calif.

Data Unit Prints Cards On Both Sides Simultaneously

A data-processing system that prints information on both sides of a card simultaneously has been developed.

The printing is done between rows of punched data, according to the developer, Remington Rand Univac.

The device is said to print up to 13 lines, 70 characters wide, on 150 cards per minute. At the same time, the unit can punch alphabetical or numerical data on the cards up to 80 columns simultaneously, the company said.

The system is said to have a storage capacity of 50,000 characters. It is designed for use with the Univac 80 computer.

Rapid-Access Computer Being Leased by RCA

A new data-processing system said to have a memory-access time of 1.5 μsec is being offered for lease by its developer, Radio Corp. of America. Called the RCA 601, the system can make up to 666,667 decisions, or can add 183,000 eleven-digit figures in one second, according to the company.

The modular design of the system is said to

add variety and volume to its program capabilities (*ED*, March 30, 1960). By plugging in additional modules, the system can handle up to 20 programs at the same time. Modular design is also said to make the 601's programing compatible with that of other equipment. Rental fees for the system will begin above $20,000 per month. Lease arrangements have been concluded with the Southern Bell Telephone Co. and the New Jersey Bell Telephone Co.

RCA has also introduced a simpler system, the 301, designed for operation by small companies. It is said to be the first system to use magnetic discs for its memory storehouse. It can also use magnetic tape on reels. The 301 can serve either as a complete data-processing system or as auxiliary equipment to larger systems. Monthly rental about $9,000.

First IBM 7070 Computer Getting Shakedown Trial

A group of fifty logicians has begun tests on the first 7070 data-processing system produced by International Business Machines Corp. The group, members of IBM's Applied Programing Dept., is testing new programs it has devised.

The computer is expected to carry out more than 90 billion instructions during the two-month test period. The programs range from one instructing the computer to transfer data from a punched card to a magnetic tape, to one enabling the computer to translate mathematical formulas into symbols that it can understand.

'Computer-Made' Paperweights Promote Automatic Thinking

The Westinghouse Corp. recently set up a completely automatic assembly line for producing monogrammed aluminum paperweights to get its manufacturing managers thinking about automating their plants.

The operation–solely for demonstration purposes–was suggested by D. C. Burnham, the company's vice-president in charge of manufacturing. He said it was unlikely Westinghouse would go into the paperweight manufacturing business.

The manufacturing operation was initiated by an operator who typed a man's initials at a computer. The computer then selected the proper tools and feed rates for a milling machine that cut the initials into the paperweight. The milled aluminum block then went to a finishing machine for painting, and finally it was packaged for hypothetical shipment.

NEWS

DDA Planned Using Fluxlok Memory, Engineer Tells Conference

A digital differential analyzer using the Fluxlok memory (*ED*, March 16, p. 29) developed by Burroughs Corp.'s Research Center, Paoli, Pa., will be completed in August, according to R. M. Tillman, staff engineer.

A 2-mc nondestructive read-out Fluxlok test memory has already been produced, Mr. Tillman said, during a session at the recent Spring Technical Conference in Cincinnati sponsored jointly by the Institute of Radio Engineers and American Rocket Society. The memory uses conventional ferrite cores mounted in phenolic planes. With present techniques several pulses are used to produce a deflecting field which rotates magnetic moments in the core.

Later developments, which were not disclosed because of patent considerations, will permit lowering of pulse power requirements by about a factor of five, Mr. Tillman said.

Missile Plumes Get IR Analysis With Rapid-Scan Spectrometer

Infrared measurements of the spectral distribution of energy in radiation from missile plumes are being made at Melbourne Beach, Fla., with the Perkin-Elmer IR Rapid Scan system.

The rapid-scan spectrometer is shown below mounted on Perkin-Elmer's Recording Optical Tracking Instrument which follows missiles during launch phases from a trainable observation dome (right). The launchings are made from nearby Cape Canaveral.

Missile-plume spectral analysis might lead to development of equipment to detect and identify

Infrared Rapid-Scan equipment for inflight spectral analysis of missile plumes is in use on the Atlantic Missile Range.

IR Rapid Scan system is mounted under the Perkin-Elmer Recording Optical Tracking Instrument inside a trainable observation dome.

fired missiles during launching from satellites.

Scan frequencies for the Rapid Scan can be varied from 2.5 to 180 cps. Various detectors can be used depending on the type of analysis needed. A lead sulfide detector operates in the 0.5- to 3-micron band; a thermistor bolometer detector in the 1- to 10-micron band; and a photomultipler in a 0.4-to-6-micron band.

Electrical Manufacturers Form Electronics-Communications Unit

Electrical manufacturers in seven product categories in the National Electrical Manufacturers Association have joined to form a new Industrial Electronics and Communications Equipment Div. Members of the division plan to work largely on engineering problams common to the various products.

Component sections of the division are: Telephone Equipment, Signaling Apparatus, X-Ray, Power Rectifier Equipment, Power Semiconductor Components, Dry Battery and Electrical Indicating Instruments.

G. L. Nord, vice president of Schauer Manufacturing Corp., will head the division board.

Other members include:

R. L. Glover, general manager of technology for Union Carbide Consumer Products Co.;

W. H. Steinkamp, vice president of marketing, Weston Instruments Div., Daystrom, Inc.;

W. W. Martenis, general manager, Semiconductor Products Div., Minneapolis-Honeywell Regulator Co.;

J. L. Taylor, executive vice president, Edwards Co., Inc.;

H. D. Lohman, sales manager, Telephone Equipment Div., Western Electric Co., Inc., and

W. J. Delaney, manager, X-Ray and Industrial Electronics Div., Westinghouse Electric Corp.

NEWS

Limit of Radiation Tolerance Reported for Tunnel Diodes

The characteristics of germanium tunnel diodes are severely degraded at exposures of about 10^{17} neutrons per cm^2 and 10^{17} 7 mev, researchers of Sylvania Electric Products, Inc., report.

The irradiation experiments that led to establishment of this tolerance limit for the highly radiation-resistant diodes were part of investigations of the characteristics of narrow pn junctions. Sylvania researchers, led by Dr. T. A. Longo at Northlake, Ill., are using irradiation and tunneling spectroscopy to explore the impurity and defect states at the edges of, and deep within, the forbidden band gap of tunnel diodes.

The irradiation experiments were made with pile neutrons and with 7-mev electrons. These doses resulted principally in an increase in valley current, which washed out the negative-resistance region of the tunnel diodes under test. The defect state introduced by irradiation was detected by tunneling spectroscopy methods, the company reports.

The techniques have also shown how it is possible to counterbalance the two mechanisms in tunnel diodes that control the dependence of peak current on temperature. This temperature dependence can be eliminated to a large extent, Sylvania says, by proper control of the impurity content in both the n and the p regions.

Dr. Longo reports that the company plans to market germanium tunnel diodes later this year.

Samos Project Engineers Outline TV Needs For Space

Major technical problem areas for television systems to operate in space were outlined by two Lockheed engineers on the Air Force Samos satellite project.

Additional research and development is needed to find solutions, H. G. Sennert and C. D. Maurer, Missile and Space Div., Lockheed Aircraft Corp., Sunnyvale, Calif., said in a paper prepared for the convention of the Society of Motion Picture and Television Engineers in Los Angeles.

The problem areas include:

- TV camera tubes—Major improvements in resolution and sensitivity are required for some applications. Rugged tubes capable of operating for a year or more unattended are needed.
- Camera controls—Improved controls are required for automatic exposure, shutter operation,

automatic beam current and focus control, image motion compensation, single-frame photography, slow-scan readout and others.

- Data storage—Video data-storage means are needed for applications where transmission is delayed. Either magnetic, electrostatic or thermoplastic recording might conceivably be used.
- Wideband amplifiers—Some applications might involve gathering of vast amounts of information. Data collection capability will undoubtedly be limited by the rate at which data can be transmitted and stored. Video and radio frequency bandwidths far in excess of foreseeable development capabilities are of probable interest.
- Data processing—Much of this information will be redundant or useless and it would be desirable to reject the unwanted data at the source to conserve transmission-band width and time, and reduce data storage and processing.
- Reliability and long operating life—Redundancy will be limited because of the need for small size and weight, so that extreme reliability will be needed.

Rayon Antenna Tower Is Just Full of Air

A new antenna tower is designed to be erected in minutes. The tower is made of fortizan rayon impregnated with neoprene rubber and is raised by being inflated with a few pounds of air pressure.

According to the American Electronic Laboratories, Inc., of Philadelphia, the tower can withstand winds up to 87 mi an hour. It can be used to support external antenna wires, or the antenna wires can be attached or coated to the inside surface. Deflated, the tower stores in a transit case.

The towers are made to order only.

Rayon antenna tower has just been erected by technician in foreground. Developed by the American Electronic Laboratories, Inc., the tower is raised by inflation with a few pounds of air.

WASHINGTON REPORT

Ephraim Kahn

MILITARY R & D SPENDING, mixed with test and evaluation funds under the Defense Department's new budgeting system, has been revealed to the House Defense Appropriations Subcommittee. The Navy's development chief, Vice-Adm. J. T. Hayward, presented a "purified" analysis of the total, and observed that even this is distorted by inclusion of big sums for missiles. The budget set-up, he asserted, is "fictitious." Here's the funds breakdown for three years, in millions of dollars:

Fiscal year	1959	1960	1961
Research & Development	$872.0	$845.8	$819.4
Test & Evaluation	302.3	410.9	349.6
TOTAL	**$1,174.3**	**$1,256.7**	**$1,196.0**

ANTI-MISSILE KILL MECHANISMS will be stressed more in fiscal 1961 by the Advanced Research Projects Agency. Funds are being increased to $9 million and will be devoted to "investigating, analyzing, and devising new methods of destroying ballistic missiles." Work will, of course, continue on present anti-missile concepts. The "special weaknesses" of satellites—said to be not "quite so durable" as missile warheads, will also be investigated. Other projects: radar research, $15 million, for long-range devices with high resolution; guidance and control for missile interceptors, $2 million; new system concepts, $11 million; data-processing techniques, $2 million; and counter-countermeasures, $4 million.

SYSTEMS ENGINEERING MOVE to competitive industry has been advocated by the Milliken Committee of advisers to the Air Force. It recommended that detailed systems engineering of specific projects, now being done by Space Technology Laboratories, become "the responsibility of competitive industry." Alternatives suggested were either "a prime manufacturing contractor utilizing subcontractors," or a "non-manufacturing management engineering company using the associate contractor mechanism or major subsystems." It recognized, however, that the Air Force would, for the foreseeable future, require "scientific and technical assistance in the areas of advanced planning and evaluation of new ideas, 'broad-brush' initial system design, technical evaluation of contractors' proposals, and technical monitoring or limited systems engineering and technical direction of program progress."

NAVY'S CRITERIA in evaluation of anti-submarine warfare proposals have been outlined. Briefly, here they are: (1) Is the proposal sound both technically and scientifically? (2) Does it meet operational requirements now

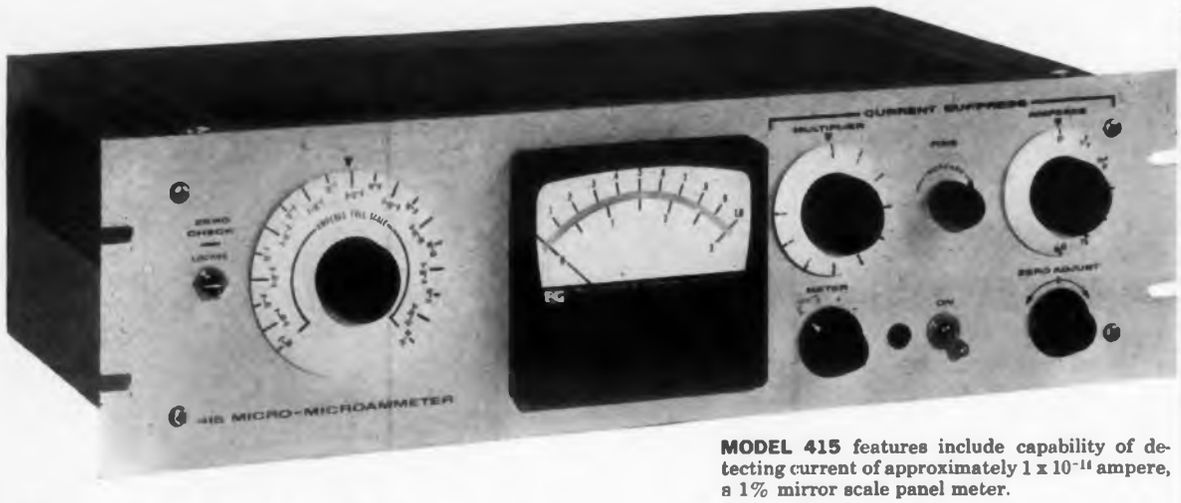
unsatisfied? (3) Does it complement (or duplicate) work in progress? (4) Can it be applied to other problems? Note that the Navy will consider "the economics" of any system offered, as well as other factors.

DESIGN OF ASW EQUIPMENT must be a joint industry-Navy responsibility, says Assistant Navy Secretary (Material) C. P. Milne. The Navy should "avoid overspecification." Industry must "simplify design to the utmost in order to avoid costly and unnecessary complexity." Quality control is essential, too, since provision of two units to make sure that one is in working order is no longer desirable since the number of unit components has "increased beyond comprehension, both as to cost and number."

LONG-DISTANCE COMMUNICATIONS integration by the military may take place sooner than expected. Only recently, it looked as though blueprints for creation of a new Defense Department agency to co-ordinate strategic communications would not take place before late fall. Now Defense Secretary Thomas S. Gates, Jr., expects to take the first step by the end of June. Because "substantial progress" has been made, he hopes the Joint Chiefs of Staff will be able to reach a decision on setting up a Department-wide communications net in the relatively near future.

INTER-SERVICE SUPPORT in logistics and administration should be encouraged to the maximum extent, states a Defense Department directive. This document is believed to have been inspired by repeated Congressional criticism of military inefficiency and duplication of facilities. According to the directive, the following fields are among those in which a more strenuous effort for cooperation is to be made: communications services; research, development, test, and evaluation; storage, distribution, and maintenance of supplies; and construction and disposition of facilities. Responsibility for providing support to other Services is given to the arm that is the "dominant user" of the item that is needed. This responsibility may, however, be shunted to another Service if it has a "peculiar capability" to do a job.

TECHNICAL FEASIBILITY is a "must" in weapons planning, according to the Air Force's chief scientist, Dr. A. H. Flax. New systems, "must not exceed the limits of what is technically possible to achieve in the projected period of development," he asserts, noting that "the natural optimism" of design engineers—plus military demand for maximum capability—may provoke proposals which stand little or no chance of being developed in time for operational use. As Dr. Flax sees it, change is a constant in weapons development, and no system is to have "unchallenged supremacy" for long. Furthermore, new concepts of data processing and collection, processing, and analysis must be devised if full advantage is to be taken of present weapons. Since many devices now are "virtually kidnapped from the laboratory before they are fully grown," he thinks that service life and reliability must be designed into new systems from their very beginnings—"as soon as potential applications are even vaguely predictable."



MODEL 415 features include capability of detecting current of approximately 1×10^{-14} ampere, a 1% mirror scale panel meter.

new high-speed research micro-microammeter

Model 415 offers high speed of response, accuracy, and zero suppression.

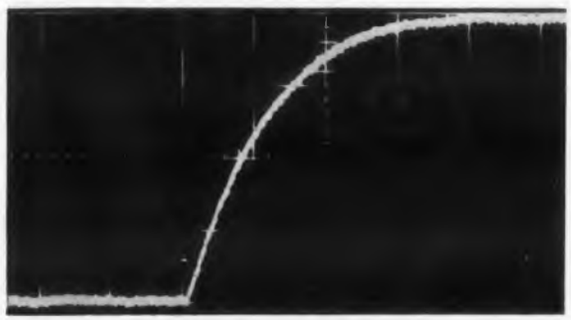
The new Model 415 incorporates advanced high-speed circuitry developed by Keithley Instruments for rocket and satellite experimentation — where measurements of Lyman-Alpha night glow and upper air density require fast response.

A speed response of less than 600 milliseconds to 90% of final value at 10^{-12} ampere is possible where external circuit capacity is 50 picofarads ($\mu\mu$f). Critical damping of the circuit, with any input capacity, is maintained on all ranges through one infrequent adjustment. There is no possibility of oscillation or poor response, on any range.

Accuracy is ±2% of full scale on 10^{-3} through 10^{-8} ampere ranges, and ±3% of full scale on 3×10^{-9} through 10^{-12} ampere ranges.

The 415 also provides zero suppression up to 100 full scales, permitting full scale display of one per cent variations of a signal. Once suppressed to zero, such variations may be observed on any of the next four more sensitive ranges without resetting the suppression.

Excelling other Keithley 400 Series Micro-microammeters in speed of response, the 415 is ideal for current measurements in ion chambers, photomultipliers, gas chromatography, mass spectrometry.



AN OSCILLOGRAM demonstrating response to a current step of 10^{-12} ampere. Input capacity is 35 picofarads ($\mu\mu$f). One major horizontal division equals 200 milliseconds.

BRIEF SPECIFICATIONS

RANGES: 10^{-12}, 3×10^{-12}, 10^{-11}, 3×10^{-11}, etc. to 10^{-3} ampere f.s.

ACCURACY: ±2% f.s. 10^{-3} thru 10^{-8} ampere ranges; ±3% f.s. 3×10^{-9} thru 10^{-12} ampere ranges.

ZERO DRIFT: Less than 2% of f.s. per day after warmup.

INPUT: Grid current less than 5×10^{-14} ampere.

OUTPUT: 1 v f.s. at up to 5 ma. Noise less than 20 mv.

RISE TIME: Typical values given in sec. to 90% of final values.

Range amps f.s.	$C_{in} = 50$ $\mu\mu$f seconds	$C_{in} = 150$ $\mu\mu$f seconds	$C_{in} = 1500$ $\mu\mu$f seconds
10^{-12}	.600	.800	2.5
3×10^{-12}	.200	.300	1.0
10^{-11}	.060	.080	.250
3×10^{-11}	.020	.030	.100
10^{-10}	.006	.010	.030
3×10^{-10}	.002	.003	.010
10^{-9}	.001	.001	.003
3×10^{-9} and above	.001	.001	.001

PRICE: Model 415, $750.00

For complete details, write:

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE CLEVELAND 8, OHIO

CIRCLE 25 ON READER-SERVICE CARD

NEWS

Engineer Has Newsletter Here On Opportunities in Europe

A consulting engineer has begun publishing a newsletter on business opportunities in Europe for electronics and other technologically based companies.

The engineer is Stephen V. Hart, of Wilton, Conn. According to Mr. Hart, his newsletter, "Electronics in the U.S.A. & Abroad," is sent free of charge to managers of "electronics and science companies upon their request."

The newsletter, Mr. Hart said, will cover such items as European research costs, new product opportunities in Europe and comparative salaries paid in the U.S. and in Europe.

Mr. Hart's address is: Box 231, Wilton, Conn.

CHANGES IN PRICES AND AVAILABILITY

SILICON SOLAR CELLS, guaranteed 13 per cent minimum efficiency, are available at Hoffman Electronics Corp. of Los Angeles, Calif., in production quantities. Solar cells with 14 per cent efficiency also are being produced at the Hoffman Semiconductor Center of El Monte, Calif., and are available for immediate delivery in sample quantities. Price for the 13 per cent efficiency cells in quantities of 100 to 999 is $12.50 each.

MODEL XV-100/6299 SOCKET used with General Electric's GL6299 triode and other tube types has been reduced in price up to 20 per cent by Instruments for Industry, Inc. of Hicksville, N.Y. The new prices are: $20 each in quantities of 1 to 25; $18, 26-100; $16, 101-500, and $13, over 500.

CERAFIL CAPACITORS have been reduced 10 per cent in price for quantities of 25,000 and up, by the Hi-Q Div. of Aerovox Corp., Olean, N.Y.

TWELVE DIFFUSED-JUNCTION POWER TRANSISTORS of the silicon npn type are available at RCA Semiconductor and Materials Div. of Somerville, N.J. The new group include medium-power types 2N1479, 2N1480, 2N1481 and 2N1482 in the JEDEC TO-5 package; intermediate-power types 2N1483, 2N1484, 2N1485, and 2N1486 in the JEDEC TO-8 package; and high-power types 2N1487, 2N1488, 2N1489, and 2N1490 in the JEDEC TO-3 package. These silicon transistors feature high-current and power dissipation ratings, high beta at high current, low saturation resistance, high power-handling capability, and top performance at high temperatures up to +175 C.

CIRCLE 26 ON READER-SERVICE CARD

New from Polarad

ANTENNA PATTERN MICROWAVE RECEIVER

ULTRA-BROADBAND COVERAGE

2,000 to 75,000 mc in a single unit

- **A** **External Mixer.** May be located at or near antenna, any distance up to 75 feet from receiver.
- **B** **Flexible cable connects mixer to receiver.** Eliminates cumbersome rigid waveguide.
- **C** **Internal electronic 1000 cps sweep** allows direct operation into any standard make AC antenna pattern recorder.
- **D** **CW, AM, FM and pulse reception.**
- **E** **Sensitivity.**
  2 kmc to 10 kmc....–85 dbm.
  10 kmc to 35 kmc....–80 dmb.
  35 kmc to 75 kmc....–70 dbm.
- **F** **Linearity** maintained over 40 db dynamic range.

The Model RW-T is another example of the versatility of the well known Polarad Model R Microwave Receivers. The RW-T is excellent to measure antenna gain, pattern, minor lobes, front-to-back ratio, SWR and bandwidth.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N.Y.

Model RW-T Microwave receiver being used to make antenna pattern measurements on Polarad range.

P.D

POLARAD ELECTRONICS CORPORATION:

Please send me information and specifications on:

- ☐ Model RW-T Antenna Pattern Receiver
- ☐ Model KSS Microwave Power Source (see reverse side of page)

My application is_____

Name_____

Title_____ Dept._____

Company_____

Address_____

City_____ Zone_____ State_____

New from Polarad

COMPACT MICROWAVE POWER SOURCE

1,050 to 11,000 mc 4 PLUG-IN UNITS

Model KSS Power Source being used to make antenna pattern measurements on Polarad Antenna Range. Can also be used for minor lobes, front to back ratio, SWR and gain measurements.

The new Polarad Model KSS features an advanced modulator design that provides CW, FM and internal square wave (10 to 10,000 pps). External pulse capabilities permit rise times to 0.15 μsec. The unit has an adjustable attenuator and low incidental AM and FM at relatively high power.

Ⓐ Basic unit (HU-4) includes modulator and power supply into which is plugged any one of four R-F tuning units Ⓑ that cover the frequency range 1,050 to 11,000 mc. Tuning units are equipped with UNI-DIAL control Ⓒ that automatically tunes klystron cavity with reflector voltages.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 18, Long Island City 1, N.Y.

POLARAD ELECTRONICS CORP
43-20 34th St., Long Island City 1, N. Y.

POLARAD

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.

Man-In-Space Heat Shield Found Effective in Test

A laboratory test of satellite re-entry has confirmed the validity of the type of heat shield selected for Project Mercury, the National Aeronautics and Space Administration has announced. The model used in the test was shaped similar to the blunt forward face of the capsule now being developed for NASA's manned-space flight program.

The test took place at the NASA Ames Research Center, Moffett Field, Calif. Using an atmosphere-entry simulator, scientists were able to subject the model to the same changes in air density and velocity that an object re-entering the earth's atmosphere would experience, it is reported.

After the test, the model, about 1/4-in. diam, was weighed and analyzed to find out how much material was lost by vaporization during re-entry. It was found that well under 5 per cent of the model's plastic ablation material had been vaporized. Peak temperatures near 20,000 F are said to have occurred in the air just ahead of the propelled model.

The satellite-recovery test is part of a program in which NASA scientists are trying to reach ever higher speeds under laboratory test conditions. They are now aiming to duplicate in the laboratory speeds typical of space craft re-entries from lunar or planetary missions.

Electronics Teaching Machine

Medical students at the Chicago Lying-In Hospital are trained in cancer screening with this push-button device. It consists of a matrix with individual sections of interlock functions, with no interaction between sections. By pressing a series of buttons, a student records his diagnosis of specimens of tissue. When the instructor pushes the correct buttons, the student's score appears on a punched card. The device was developed by engineers of the Illinois Bell Telephone Co.

◀ CIRCLE 26 ON READER-SERVICE CARD

Alphanumeric Reader Due In Commercial Versions

Prototype page reader developed for Air Force is housed in three cabinets. Scanning equipment is at left. Center cabinet contains tape punch, and cabinet at right houses logic and addressing equipment. Commercial models will be transistorized and fitted into one cabinet.

First Transistorized Units Slated for Delivery in Fall; Typesetting, Data-Reduction and Language Uses Seen

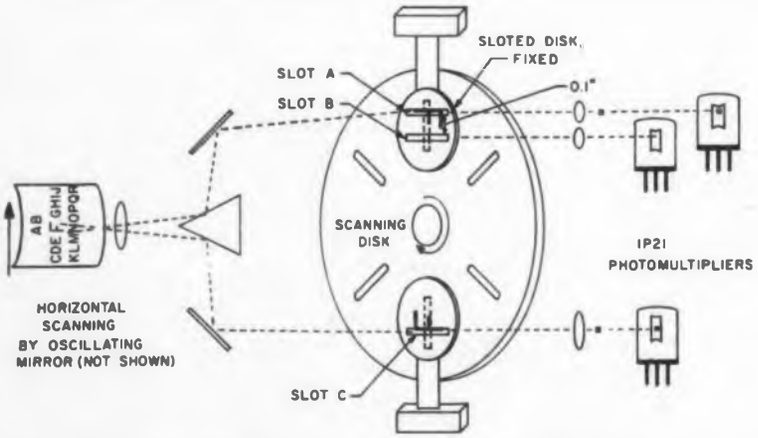
PLANS for the commercial application of alphanumeric page readers are in full swing following the successful development of such a machine for the Air Force. A refined, transistorized version of the machine now undergoing testing at Griffiss Air Force Base, Rome, N. Y., is being readied for production by the Intelligent Machines Research Corp. of Alexandria, Va., a subsidiary of the Farrington Manufacturing Co. of Needham Heights, Mass.

Three 10DM2 page readers have been ordered by a publishing concern to convert subscription and mailing lists and other typewritten copy into magnetic tapes for computer processing. Delivery of these units is scheduled for the fall of this year. Active interest has also been shown in using the page reader for automatic typesetting, data reduction, literature abstraction and language translation. The National Bureau of Standards is considering the possible reprograming of a sister machine to read Russian-language documents for translation by computers.

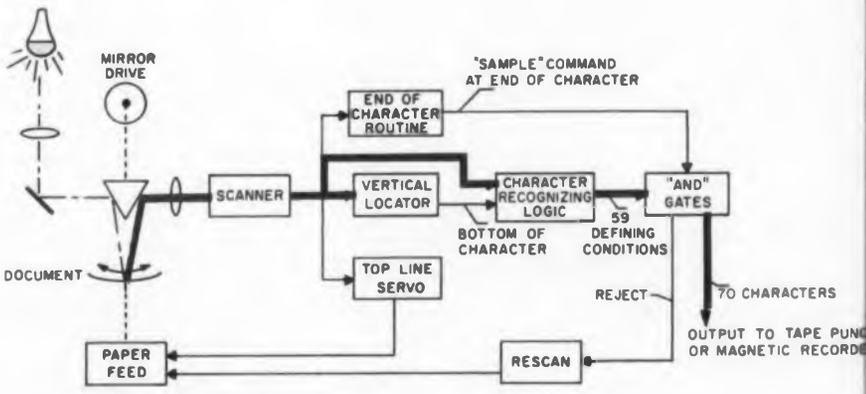
The page reader now in test at Griffiss is designed to convert the entire input of a message center into pre-addressed teletype tape at an average rate of about 200 double-spaced typewritten pages an hour.

The commercial units will have approximately this capacity, but will be housed in a single cabinet rather than in the three cabinets now required. This will be accomplished through replacement of about 1,000 vacuum tubes by transistors and the elimination of certain redundant logic functions. Commercial readers will handle various paper widths (though not simultaneously), have a faster top-line locator and will be available with either punched-tape or magnetic-tape outputs. Rentals are expected to be in the neighborhood of $4,500 a month, including maintenance.

The reading machine will accommodate a variety of character blackness, line tilt, erasure, character misalignment and smearing encountered in ordinary typewritten copy. An error rate of one character in 1,000 has been specified by the Air Force, but the reader is so designed that it will tend not to read a character rather than to read it incorrectly. A reject mark or blank space is transmitted for that character. The acceptable rejection rate for the Air Force application is 1 per cent. The commercial page readers, however, will operate with printed matter of higher quality and



Scanning system uses rotating and fixed slotted disks. The scan through slot "A" locates the bottom of the character. Slot "B" scans for character structure. Combination of slots "B" and "C" detects slanted lines.



Simplified block diagram of page reader shows operating scheme used in character recognition. Information from scanner is processed by character-recognizing logic to derive the character-defining conditions. These are sampled and gated at the end of the character to provide machine output.

jection and error rates approximately two orders f magnitudes less can be expected.

anning Scheme Described

The character-recognition scheme for the com- ercial page readers now being designed is es- ntially the same as for the Air Force machine.

In the Air Force unit each character is scanned oth horizontally and vertically. Horizontal scan- ng is accomplished by a mirror oscillating across e width of the paper. A spot of light synchron- ed to the mirror illuminates the area to be anned. Vertical scanning is performed by a otted wheel and slotted disks (see accompany- g diagram). The combination of vertical and orizontal scanning gives up to 25 successive ertical slices through each character. Scanning solution is 0.005 in.

The three vertical scanning stations operate multaneously. The first scan (through slot *A*) cates the bottom of the character. This infor- ation helps to identify the descenders of "p," "q," ," etc. and provides a reference for vertical cation of other character features by the suc- eding scan. The next scan (through slot *B*) is e character width behind the first scan. To- ether with the vertical reference established by e first scan, it determines the character struc- re for interpretation by the logic system. The ans through slots *B* and *C* are separated hori- ontally by 0.01 in. to detect stroke characteristics, ke the slanted portions in "M," "N," and "W."

haracters Recognized by Key Elements

As in human logic, the page reader recognizes ach character by its several key elements. The 0 characters identifiable in the Air Force reader equire the definition of 59 key elements, some uite subtle but capable of recognition by ma- nine logic.

As the character is scanned, appropriate circuits ecognize the presence or absence of each ele- ent. After the character is scanned, these cir- uits are sampled by "and" gates. Each character as its corresponding gate, which conducts only all the criteria for that character are present. he logic of all gates is mutually exclusive; that is, partial definition of one character is never a omplete definition of another character. Thus an mperfectly typed "E" cannot yield outputs of tters "E" and "F" simultaneously.

If no definitions are satisfied, the character is escanned. After a predetermined number of un- uccessful scans, the character is rejected.

A truth table for recognition of numbers is il- ustrated. These numbers are of the Selfchek ype design used in Farrington's numerical read- rs for credit-card and billing applications. Self- hek numbers are shaped so that there are at east two differences between any one number

NEWS

and all others. A single stroke can be added or deleted from any number without causing it to be mistaken for another number.

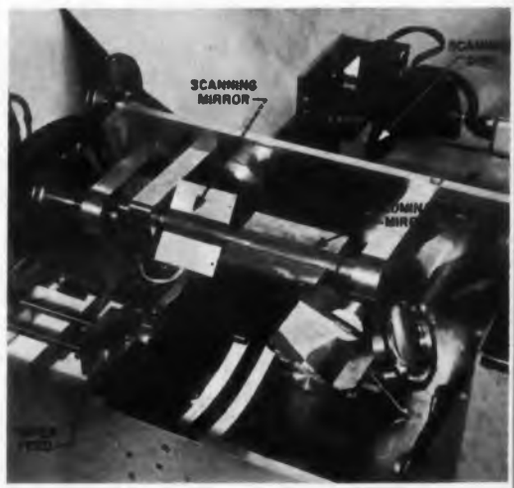
The typewriters at Griffiss will have Selfchek numbers. The alphabetic characters to be used are of sans-serif elite gothic face. Minor changes in five characters were made to improve machine legibility under deteriorated printing conditions. Most of the changes involved opening up stroke gaps that are sometimes closed by heavily inked ribbons. The alphabetic characters are, therefore, quite standard in appearance (though not necessarily self-checking).

How to Tell a Period From a Comma

An example of how alphabetic characters are recognized by the machine is the following definition for "A":

- No substantial vertical left edge.
- No wide top.
- Wide lower section.
- No substantial vertical right edge.
- Open bottom.

One rather tricky problem in designing the logic was that of distinguishing between a period and a comma. After several attempts, a period was successfully defined as a very small character having an equal height-to-width ratio while a comma has a larger height-to-width ratio. These definitions were found to hold true regardless of how lightly or heavily the characters are typed. To the machine, the colon and semi-colon are defined, respectively, as a "period with something very small above it" and a "comma with something very small above it."



Business end of Air Force page reader. Scanning and illuminating mirrors on common shaft oscillate across the width of the page to be read. Paper is curved to provide equally long optical path at every point.

	0	1	2	3	4	5	6	7	8	9
Long Vertical Left	+		−	−	−	−	+	−		−
Long Vertical Right	+	+	−	+	+	−	−	+		+
Horizontal Top	+	−	+	+	−	+	−	+	+	+
Horizontal Middle	−	−	+	+	+	+	+	−	+	+
Horizontal Bottom	+	+	+	+	−	+	+	−	+	−
Short Vert. Upper Left & Lower Right	+	−	−	−		+	+	−	+	+
Short Vert. Upper Right & Lower Left	+	−	+	−	−	−	−	−	+	−
Short Vert. Left & Right Simultaneously	+	−	−	−		−	+	−	+	+
Short Vert. Upper Left				−	+					
Long Vert. Left & Right Simultaneously	+								−	
Middle Projecting Right					+					−

+ Condition Must Be Detected

− Condition Must Not Be Detected

Square Holes and Round Holes

Other examples of troublesome letters are "D," "O" and zero. Since the Selfchek zero is rectangular rather than round, the reader was programed to distinguish between square and rounded corners. The presence and location of square corners serves to differentiate these three otherwise very similar characters.

In general, seven or eight defining elements are required for each character. Certain definitions relating to the openings in such characters as "a," "b," "d," "g," etc., are recognized as separated black spots in each vertical scan repeated for a given number of consecutive vertical scans. The number of repetitions is counted and, together with the position of the spots in each scan, indicates the size and location of the opening.

As the document to be read is fed into the machine, it is scanned and advanced until the top line enters the scanning area. The top-line servo then positions the line in the center of the horizontal scanning area and character reading begins.

Format Control Provides Flexibility

Format control can be applied so as to ignore material in specified areas of the document (such as letterheads, rubber stamps, signatures, etc.). An "x" typed in the left margin next to a line containing a typing error will cause that line to be skipped.

The Air Force machine also includes an automatic addresser that punches a complete address into the tape from a routing number typed at the beginning of the message. This feature is a special Air Force requirement.

Format control, automatic address and other such refinements are custom-built features that may be omitted or modified as required in the commercial page readers. ■ ■

New NBS Standard Frequency of 20 Kc Reported Furnishing Accuracies to 10^{10}

A NEW 20-kc standard frequency broadcast is providing users with a measurable accuracy approaching one part in 10^{10}, according to the National Bureau of Standards. Broadcasting from Sunset Canyon in Colorado, the bureau's station, WWVL, uses a 20-kw transmitter that is providing coverage as far as Alaska and Hawaii.

Both time signals and the national standard of frequency are transmitted on a world-wide basis by two of the bureau's short-wave stations—WWV at Beltsville, Md., and WWVH on Maui, Hawaii. These are generally limited in accuracy to about one part in 10^7 due to progressive movements of the ionosphere. Measurements over a 30-day period can extend this to a few parts in 10^{10}, but very expensive laboratory equipment is required.

The low-frequency waves from the Sunset installation will not be affected by changes in the height and density of the ionosphere. Unlike the other stations, WWVL uses the ionosphere as a boundary, following its curvature to guide signals over long distances. Both WWV and WWVH bounce signals off the ionosphere and are more susceptible to its changes.

Half-Mile Antenna Used

The antenna used at the new station is a copper-coated steel cable stretching more than half a mile across the top of Sunset Canyon. From the cable's center, another cable was dropped to transmit-

Artist's conception of the antenna across Sunset Canyon for National Bureau of Standards new-20 kc standard frequency broadcasts. The copper-coated steel cable weighs more than a ton, stretches 3,400 ft from anchor to anchor and 900 ft above canyon floor.

The heavy antenna cable for Radio Station WWVL is hoisted into position in Sunset Canyon. The station uses a 20-kw transmitter to provide coverage as far as Alaska and Hawaii.

ters at the canyon floor, forming a top-loaded antenna. The canyon walls act as giant supports to hold the cables above ground.

The Sunset signal will be primarily used in studies that will help prepare for eventual 300-kw world-wide transmission. The studies will include attenuation, phase stability, modulation for time-signal distribution and receiving techniques, such as receiver design and optimum receiver applications.

Before the 20-kc signal can be used to provide a time reference, studies in cycle identification and time-signal modulation must be made. The National Bureau of Standards is now conducting research in these fields.

The eventual global transmitter is expected to be of particular value to the National Aeronautics and Space Administration and far-flung military bases and missile ranges. It is estimated that the number of such users will exceed 500 within five years after activation. Receivers for the transmission will be moderately complex and, including a clock, might cost $3,000 in small production quantities. ■ ■

NEWS

Transistor Reactor Controls For Navy's Atom Destroyer

TRANSISTORIZED reactor-control systems for what will be the Navy's first nuclear-powered destroyer are now being built. The systems, under construction at Bendix Aviation Corp.'s Baltimore Radio Div., will control two reactors in the ship.

The nuclear destroyer is the Bainbridge, officially designated DLG(N)—large destroyer, guided-missile battery, nuclear power. The vessel is on the ways at the Quincy, Mass., shipbuilding yard of the Bethlehem Steel Co.

Bendix has already built a third control for the Navy's land-based nuclear destroyer prototype, a General Electric project in cooperation with Bethlehem at West Milton, N.Y.

Commercial Version in Works

A commercial version of the Bendix transistorized control system is being introduced by the company's Cincinnati Div. These systems will range in price from about $60,000 to $100,000, depending on complexity, according to J. P. Quitter, supervisor of electronic engineering for the division.

Up to 200 ft of cable can be used between counter tubes and pulse amplifiers in the start-up channels of the system without preamplifiers, according to Mr. Quitter. He attributed this to the low impedance of the transistor circuits.

Control rods are being suspended by magnets that will lose power in case of serious malfunction of the system. Coincident circuits control the magnets, so that loss of any input will cause scram action, or shut-down of the reactor. Six inputs to this AND circuit are normally used, including nuclear instrumentation inputs and such others as high pressures and temperatures.

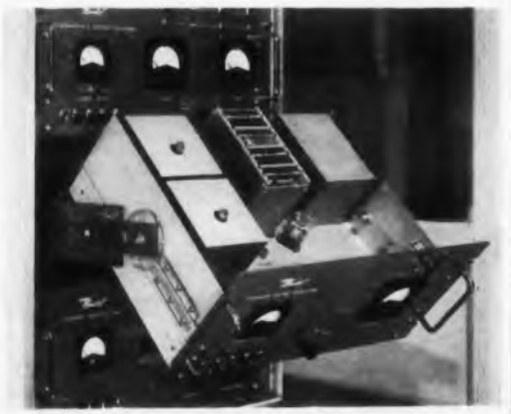
Transistors Share Load

The magnet switch in the Bendix system is a transistor in either a fully conducting or a cut-off condition. Transistors are wired in a load-sharing manner, so that if one should open, another will maintain current to the magnet served by that transistor. Meanwhile a panel light will go on indicating that a transistor should be replaced.

Transistorized nuclear-reactor-control and flux-monitoring system designed by Bendix Aviation Corp. is being offered commercially by the company's Cincinnati Div. Similar control units will be used in the Navy's first nuclear-powered destroyer.

This design allows test of the magnet switch transistors while the reactor is still operating. A scram command is fed to half of the switches, while magnet current is maintained by the other transistors. If a transistor is shorted, its indicator will not light during the test, and it can be replaced.

Although the commercial and Navy versions of the reactor control systems are similar in concept, packaging is considerably different because of special military requirements. ■ ■



Power level channel slides out for maintenance in the Bendix reactor flux monitor and safety system.

NEWS

Satellite Study of Ionosphere Planned as Joint Venture

A scientific partnership has been formed to develop satellite equipment for study of the electron density of the upper ionosphere. The Central Radio Propagation Laboratory of the National Bureau of Standards and Airborne Instruments Laboratory of Long Island, N.Y., are planning the venture.

Study of the ionosphere is expected to shed light on the various effects of the solar atmosphere, sun spots, the earth's magnetic field, cosmic rays, ultraviolet radiation and other phenomena relative to the ionosphere. The program will attempt to determine these relationships by orbiting a satellite above the ionosphere. The life of each satellite payload is expected to last from 6 to 12 mos.

Warren Offutt, in charge of the project for Airborne Instruments, said the initial part of the program called for rocket testing at Wallops Island, Va. Eventually, he said, satellites will be launched from the Pacific Missile Range, Calif.

Under the general plan, the Government laboratory will have prime responsibility for setting experimental parameters and for interpreting experimental data. Airborne Instruments will have prime responsibility for making the experimental hardware, including airborne, ground-checkout and ground display units.

Students Build a Cyclotron

Two-ton cyclotron, built by students at Levittown High School, L.I., N.Y., is adjusted at magnetic poles by Mark Heller (left) and James Kraus. The students belong to the Junior Engineering Technical Society, a nationwide organization sponsored by industry and schools to foster youth interest in science.

Rolling Marble Gathers Fuze Data

Helical channel above is the analog of a missile range. A steel marble that is rolled down the channel provides a moving short circuit and simulates a missile closing in on its target. The device is used by Internation Telephone and Telegraph Corp., Nutley, N. J., for analyzing the sensitivity of fuzes used to guide the missile and detonate the warhead.

Powder Metallurgy Conference Slated June 13-17 in New York

The 1960 International Powder Metallurgy Conference will be held June 13 to 17 in New York.

The conference, in the Biltmore Hotel, will review the fundamentals of powder metallurgy and go on to the latest developments. Participants also will tour local plants that produce powder, powder presses and articles from the powder.

Music Recording Industry Reassures Public on 7 1/2 IPS

A pledge to protect the music-on-tape market against 7-1/2 ips obsolescence has been adopted by the board of directors of the Magnetic Recording Industry Assoc.

The pledge, which members may stamp on recorders or tape packages, reads:

"The producer and distributor of this fine stereophonic music will continue to honor your requirements for 7-1/2 ips on open reel for as long as a market exists."

NEWS

84-Ft, Full-Azimuth Antenna Being Built for Missile Agency

A paraboloidal radio antenna, 84 ft in diam, is under development for the Army Rocket and Guided Missile Agency.

Adapted by D. S. Kennedy Co. of Cohasset, Mass., from an existing design, the antenna will be capable of rotating 360 deg and varying its elevation over a 90-deg arc. Complete coverage above the horizon will therefore be provided.

Each axis of the antenna will be powered by a 50-hp electric motor, which will enable it to vary its elevation at rates up to 5 deg per sec and to rotate at rates up to 12-1/2 deg per sec.

The radio equipment for the antenna will be capable of operating from 100 to 3,000 mc. The system will have automatic tracking capabilities throughout this range.

Part of a system under development by the Ordnance Missile Laboratories Div. of ARGMA, the antenna will be used initially in tracking artificial satellites and for research in radio-wave propagation. Future plans call for the addition of radar equipment at the site in support of the worldwide Zeus anti-missile system.

Dummy a Sound Help to Science

Two heads are better than one in this experiment into the ways people locate the direction of sound. Bell Telephone Laboratories of Murray Hill, N.J., which is conducting the study, put microphones in the dummy's ears as substitutes for human ears. R. L. Hanson (above), acoustics scientist, sends sounds through the dummy to the girl subject. By introducing artificial differences in the time lag and intensity with which sounds reach each of the subject's ears, the confuses the girl but clarifies for science problems in stereophonic listening.

Flying Telescope Will Spot Ultraviolet Sources in Space

A telescope with six photo amplifiers has been developed to televise unknown ultraviolet sources in space.

Built at a cost of $1,500 by a five-man team of scientists at University College, London, the Flying Telescope, as it is called, is intended for mounting in the nose cone of a rocket.

The telescope will be used on its first flight in a Skylark rocket at the Woomera range in South Australia. The rocket-powered Skylark is expected to reach a height of 100 mi above the earth's surface before pictures are taken with the telescope.

The pictures will be transmitted to earth by a radio telemeter. Scanning will be achieved through the yawing of the rocket itself.

The six photo amplifiers, each fitted with a pure quartz window and transparent gold cathode, are set in a cast-metal framework at various angles to the vertical, so as to scan different areas of space. One of the amplifiers is fitted behind a Cassegrain telescope, constructed by cylindrical mirrors and arranged to scan only a fraction of a degree wide.

Combined readings will build up a composite picture of space and distinguish between point sources of ultraviolet light from stars and other sources of light.

The bearing of the earth's magnetic field will also be taken by a magnetometer, and bearings on the earth's horizon will be obtained from the photo amplifiers themselves.

The telescope will be in use only 5 min, but during that time, it is hoped, results will give precise positioning to within 1 deg.

Device Eases Doctor's Labor In Tending Expectant Mothers

An electronic device that continuously monitors the rate of heart beats in the human fetus has been developed.

The device distinguishes the fetal heart-beat from that of the mother and records it in visual and written form.

Physicians use the fetal heart rate, conventionally measured with a stethoscope, to detect and diagnose fetal distress, such as umbilical-cord strangulation.

The device, called Hon Fetal Monitor, was developed by Dr. Edward H. Hon, assistant professor of obstetrics and gynecology at the Yale University Medical School, with engineers from Epsco, Inc., Cambridge, Mass. The price of device is listed as $9,950.

NEWS

EIA Condemns Congressio Pick Receiving Channels

Sees 'Arbitrary' and 'Unconstitutional' Use of Power by U.S. in Move to Make Use of UHF With Compatible Receivers

THE Electronic Industries Association has condemned as "arbitrary" and "unconstitutional" proposed legislation that would permit the Federal Communications Commission to specify what receiving channels are to be built into TV sets at the factory. FCC-sponsored bills in both houses of Congress would give the commission authority to dictate "performance standards" of all TV receivers shipped in interstate commerce. It is agreed that these standards allude strictly to which receiver channels and how many are to be wired into television sets.

The bills are the first step in the FCC's plan to untangle the increasingly complex TV-allocation problem. Though 70 uhf channels are available to supplement the 12 heavily used vhf channels, traffic is extremely light at the upper end of the spectrum.

FCC Cites 'Critical' Need

John C. Doerfer, while chairman of the FCC, gave the following testimony in Congress in support of the proposed measures:

"If it were given such power, the commission would be able to take effective steps toward relieving the problem of receiver incompatibility. A measure of this kind appears to be critically important to the success of whichever of our five long-range allocation plans may ultimately be adopted."

The five allocations plans being considered are:

- Retention of the present 8-channel vhf-uhf system.
- A 70-channel all-uhf system.
- A 50-channel vhf system retaining the present 12 vhf channels.
- A contiguous 50-channel vhf system retaining the present channels 7 through 13.

EIA Sees Consumers Hurt

The EIA's position was expressed by James D. Secrest, its executive vice-president, who told ELECTRONIC DESIGN:

"The FCC proposal would for the first time give the commission authority to fix standards for the manufacture of TV receivers and would force televiewers to purchase additional equipment at a

To Allow FCC To Sets Built at Factory

gher price, regardless of the needs or desires of e consumers.

"It would give the FCC authority over the manacture of products through the control of interate commerce, which the courts have held to be nconstitutional. It would substitute arbitrary govnment regulation for public control in the conmer field."

The National Association of Broadcasters is still rmulating its position on the FCC bills, but it is pected to be against the legislation. A top NAB ficer told ELECTRONIC DESIGN, "In matters of this rt we generally want to present a united front ith the manufacturers."

ll-Channel Receiver Cost Debated

Opinion is divided as to the increased cost of l-channel TV receivers. FCC engineers believe at a continuous TV spectrum, which might perit the use of continuous-strip tuners, might add o more than $10" to the retail cost of each massroduced receiver. An NAB engineer felt, howver, that allocation of a continuous spectrum was y no means assured. A divided spectrum would sult in the use of turret tuners that would cost t least $25 per set."

The FCC feels that the existence of a large arket for all-channel TV sets would stimulate esign efforts to create a really low-priced tuner nd that present cost figures do not mean much in he light of possible new developments. The FCC as further proposed that the 10 per cent excise ax be waived in the case of the proposed allhannel receivers.

Still another EIA objection to the proposed bills based on the granting of uncontrolled power to he FCC in fixing the TV spectrum. The FCC lans to use this authority to bring about the manfacture of compatible all-channel receivers for whatever TV spectrum is finally decided upon. Once the spectrum is determined, standards would e issued, and after a specified number of years, ll-channel receivers would be available to enourage station operators to move into the new requencies.

The EIA fears, however, that the FCC might hort-circuit this plan and merely call for the manfacture of all-channel receivers for the present ixed uhf-vhf spectrum, thus freezing TV broadasting at the present spectrum. This, the EIA has ndicated, does not offer a satisfactory long-term olution to the allocation problem. ■ ■

NEWS

Company Grants $25,000 For Science Collegiates

Six eastern universities and colleges will sh a $25,000 fund for scholarships established American Machine and Foundry Co., New Y

The schools are Princeton University, Har University, Dartmouth College, the Massac setts Institute of Technology, Cornell Univers and Rensselaer Polytechnic Institute.

The scholarships will be in different fields different schools. For example, at Princeto studies leading to a Master of Science degree Chemistry will be financed, while at Renssela and MIT, the awards will go to students in ele trical or mechanical engineering.

Automatic Weather Observer Detects Different Precipitations

An automatic weather observer for remote, u attended weather stations is said to distingui between different forms of precipitation wi human-like recognition.

The system, developed by Thompson Ra Wooldridge, Inc., makes use of digital electro techniques. It is comprised of sensor units, wh are integrated into a logic interpreter system complex digital electronic memory) to differ tiate and record data. The data can be relay through a series of automatic teletype systems data-gathering centers.

The system is one of four electronic sens being developed by Thompson Ramo Wooldrid for the Weather Bureau's Automatic Meteorolo ical Observing Stations project.

Engineers examine data recorded by automat weather sensors developed by Thompson Ramo Woo dridge. The sensors distinguish between different for of precipitation. Data can be relayed by digital ele tronic techniques from remote weather stations to dat gathering centers.

:WS BRIEFS

ODUCTION OF DATA-TRANSMISSION ' handling equipment will be doubled by In- national Telephone and Telegraph Corp. in next five years, announces H. S. Geneen, ident.

'RROUGHS 205 SYSTEM, an electronic com- ıter, "speaks" the international language of ıthematics. It is on its way to the National Lab- ratory, Tokyo, to translate wind-tunnel data on ə flight behavior of aircraft.

WO TRANSISTORIZED SOLID-STATE dig- l computer systems developed by Daystrom, c., of Murray Hill, N.J., will be installed in the uth by power utilities.

VER-THE-AIR PHONEVISION system, de- loped by Zenith Radio Corp. of Chicago, will e used by RKO General, Inc., New York, in a ree-year trial of subscription TV in Hartford, onn.

RITISH CLOSED-CIRCUIT TV SYSTEM now enabling busy Wall St. executives to study latest stock market prices without leaving ir offices. Developed by EMI Electronics, d., of England, the system relays a continuous ture of moving ticker-tape to seven large eens throughout the building.

EW PERSONNEL PLACEMENT company, avies & Shea, Inc., is opening at 332 S. Michi- an, Chicago. Eugene B. Shea and C. A. Davies, rmerly with Cadillac Associates, will deal ex- usively with placement and procurement in the ectronics field.

WO-WAY RADIO SYSTEM, so compact that can be carried in a hat, is under development t Bendix Aviation, Baltimore. The system will quip flight-deck crewmen on aircraft carriers ith helmet-enclosed receiver and transmitter nits for continuous voice contact with flight- ntrol stations aboard ship.

00-KW TURBINE GENERATOR SET devel- ped by Garrett Corp.'s Air Research Manufac- ring Div. of Phoenix, Ariz., is reported to have 5,000-hr overhaul period; insensitivity to dust, old or heat, and completely automatic single- witch operation. Utilizing silicon-controlled rec- fiers, the unit generates 3,200-cycle electricity. he output is statically converted to either 60 r 400 cycles.

PROJECT '60s: DESIGN NOW FOR THE GREAT YEARS AHEAD ... with GENERAL ELECTRIC electronic components

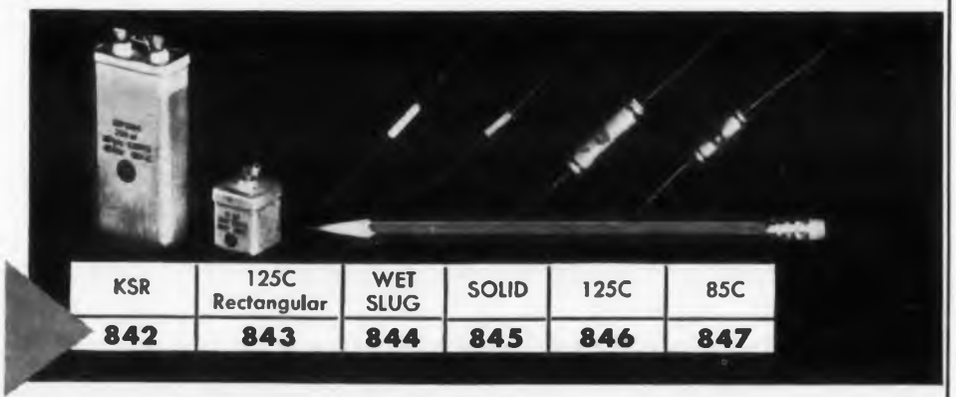
Most electronics manufacturers face the continuing challenge of staying ahead of obsolescence. These General Electric components, designed specifically for the needs of the '60s, can help solve that problem.

Custom-built d-c power supplies such as this silicon rectifier unit (designed to charge a 7,000,000 joule capacitor bank every 15 minutes) give you efficient power to meet special requirements. G-E power supplies can be designed to meet virtually *any* high-voltage d-c requirement from approximately 10-kv to 1000-kv, d-c, and from milliampere values to 250 amperes. Save time, space, and money by specifying G.E. Our Holyoke, Mass. plant stands ready to supply the units you need.

For more information, circle 840 on reader service card.

AC and DC BIG LOOK Panel Meters are now available in a complete family, including 2½-, 3½-, and 4½-inch designs. BIG LOOK meters give you truly distinctive appearance, excellent readability and extra-long operating life. With the BIG LOOK design, you get up to 28 percent scale increase, large numerals which cannot be obscured by the pointer and elimination of shadows. Self-shielded mechanism on d-c meters eliminates interaction.

Circle 841 on reader service card.



The complete line of General Electric Tantalytic* capacitors fills a wide range of critical electronic applications. Small in size and unsurpassed in reliability, G-E Tantalytics perform within specification requirements even at environmental extremes.

For more information about General Electric Tantalytic capacitors, circle these numbers on the reader service card.

KSR	125C Rectangular	WET SLUG	SOLID	125C	85C
842	843	844	845	846	847

* Registered trademark of General Electric Co.

671-01

GENERAL ELECTRIC

NEW PRODUCTS

NEW Tantalytic Capacitors in ratings to 300 volts

The General Electric Company ha announced the availability of new high-voltage foil capacito rated to 300 volts at 85C and 25 volts at 125C, in both polar an non-polar designs. The new unit are smaller than any previousl available capacitor with simila voltage ratings and also provid size and weight advantages ove series arrangements of lower volt age units.

Circle 848 on reader service card

NEW Radar Transforme

Typical of G.E.'s line of custom designed high-voltage transform ers, this new 1800-lb pulse uni has a specially developed molde epoxy bushing for operation abov 250 kv. It incorporates a speci series reactor for protection fro load transients. The new unit i still another example of the wid range of specially engineered high voltage transformer products avail able from General Electric.

For more information on thes and other specialty transformers circle 849 on reader service card

EDITORIAL

We Need Some Rules For The 'Numbers' Game

The "numbers" craze that has bitten so many electronic engineers no doubt started simply enough—probably with the fellow who made the first microminiaturization speech. Needing some index to show volumetric decreases, he picked the cubic foot. First examples of 25,000 parts per cubic foot were almost comprehensible. But when the figure hit 100 million, it bordered on the absurd. Nevertheless anyone who could come up with the next higher number issued a press release.

Of course, others play the game, too. The space age requires many to use astronomical numbers. The length of time it will take a signal to travel to another galaxy is measured in light years. But these magnitudes unnerve the reliability boys who are still trying to get MTBF's in hours. A neat way to avoid the obvious is to play the smaller numbers. Components, therefore, have reliability indexes stated with large negative subscripts—for example, $3x10^{-7}$ (part of the charm of the numbers game is its paradox: it requires the microminiature engineer to talk in terms of large figures and the reliability engineer in small figures, when it should be just the reverse).

Numbers games are fun. But would we be spoil sports to ask for just a couple of rules?

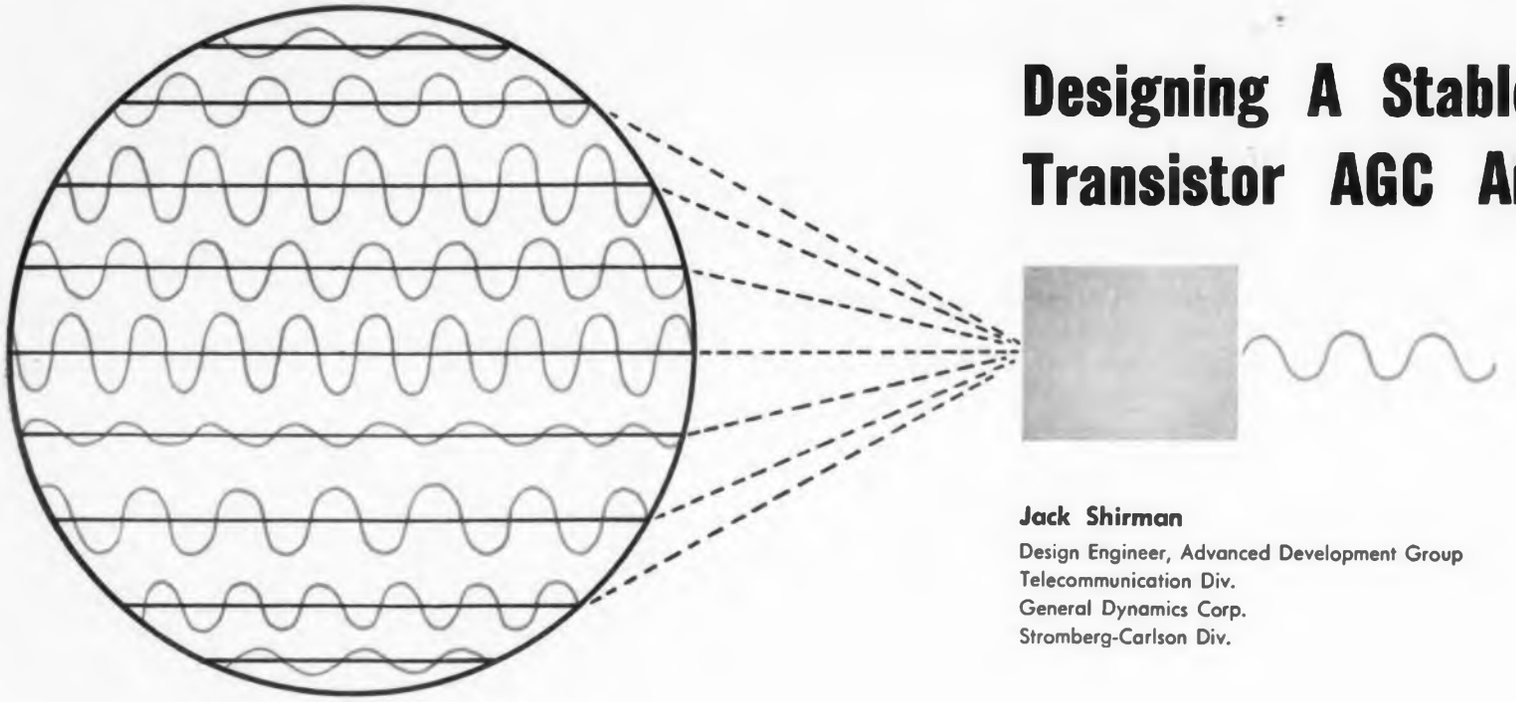
Millions per cubic foot is without merit in describing microminiaturization of parts unless facts on how to inter-connect the parts are furnished. A necessary rule, therefore, is to rate the achievement in terms of numbers of connections eliminated, or, more specifically, the number of parts that can be connected successfully in a practical system.

Reliability ratings are also next to meaningless if the condition of the test is not spelled out. So a second essential rule is that the test condition be specified.

A rule that Electronic Design will adopt is to desist from playing the numbers game without qualifications. We hope others will play our rules, too.

James G. Kippfer [signature]

CIRCLE 840 THRU 849 ON READER-SERVICE CARD



Designing A Stable Transistor AGC Amplifie

Jack Shirman
Design Engineer, Advanced Development Group
Telecommunication Div.
General Dynamics Corp.
Stromberg-Carlson Div.

Transistor parameter variations and supply voltage fluctuations are internally compensated in the agc circuit described. A detailed design procedure is outlined and a typical application problem is solved.

PROPERLY designed agc circuits should be capable of maintaining constant output over a wide range of input levels and should provide a high degree of stability despite component or temperature variations. By incorporating the variable impedance properties of biased diodes into a servo-type closed loop feedback network, a transistor agc amplifier can be designed which is relatively immune to parameter variations and power supply fluctuations.

Circuit Operation

The block diagram of Fig. 1 shows a simplified representation of the main sections of the circuit. The ac amplifier has a fixed gain determined by the range of input voltages to be controlled. Generally it will include its own loop feedback to aid in gain stabilization.

The output of this amplifier is fed back to a peak rectifier circuit comprised of a transistor and diode. This voltage is then amplified in the dc amplifier stage which supplies the current to the variable impedance Z_1. This impedance is usually comprised of one or more diodes in series, parallel, or bridge connection to give the desired dynamic impedance range when in the forward-biased direction. The input signal is therefore attenuated by the variable L pad consisting of fixed resistor R_1 and variable Z_1. The operation of this pad is such that the voltage at point A kept constant over the control range of the diode

A low-level input signal, at the low end of t control range of the diodes, will be amplified t the ac amplifier and arrive at the output at a pr determined level set by the gain of the amplifie This output is then fed back through the rectifi and dc amplifier, but due to its low level, delive very little current to Z_1. This results in a hig diode impedance and no attenuation of the inp signal.

If a high-level input, at the maximum contr level of the agc system is applied, the fixed ga amplifier delivers a much higher output. This si nal is again fed back around the loop and resul in a large current in Z_1, lowering its dynamic im pedance. This results in considerable attenuatio of the input signal which, with proper adjustme

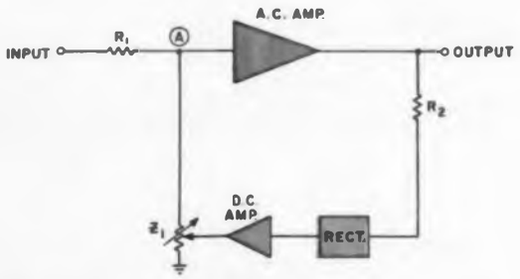


Fig. 1. Simplified block diagram representation of an agc amplifier.

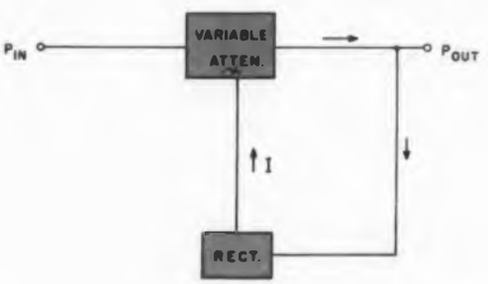


Fig. 2. Basic agc circuit showing relationship of main parameters.

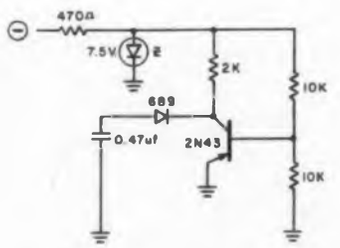


Fig. 3. Recommended peak-rectifier circuit.

of the L pad, now produces the same output level as the low-level signal.

The time it takes the servo loop to operate and pull down the level at point A is referred to as the "attack time" of the agc circuit. For this type of circuit configuration, the attack time is in the order of 5-10 millisec.

Resistor R_1 determines the output level at which the circuit operated while R_2 regulates the minimum and maximum inputs at which regulation is obtained. These two values plus the gain of the dc amplifier are the main determining factors in obtaining the proper operating range and level for the agc amplifier.

Circuit Analysis

The variation in output level encountered for a given change in input level is known as the "stiffness ratio" of an agc circuit and is indicated mathematically as:

$$\frac{dP_o}{dP_i} \tag{1}$$

where P_i and P_o are input and output power respecively in db.

If the dc and ac amplifier gains are assumed to be constant, the simple block diagram of Fig. 2 may be drawn, from which a mathematical analysis of the circuit can be made.[1] From the diagram the relationship between input power, output power and attenuation is found to be:

$$P_o = P_i - x. \tag{2}$$

Also, since the diodes are current-controlled devices, the following must be true:

$$I = f_1 (P_o) \tag{3}$$

and the attenuation is a function of the current through the diodes:

$$x = f_2 (I) \tag{4}$$

By differentiation and combination of the preceding equations, it follows that

$$\left(\frac{\partial I}{\partial P_o}\right)\left(\frac{\partial x}{\partial I}\right) = \text{constant} \tag{5}$$

which is the basic design equation for the agc circuit. The slope of bias current versus output power curve is $\frac{\partial I}{\partial P_o}$, while $\frac{\partial x}{\partial I}$ is the slope of attenuation versus bias current.

Design Procedure

If the following step-by-step design procedure is followed, the development of a highly stable agc circuit becomes quite simple and straightforward.

Step 1: Design the ac amplifier to have a gain equal to the range over which the input level will vary plus about five db as a safety margin. In order to assure good stability allow one common-emitter amplifier stage for every 10-15 db of gain required. If two or more stages are used, add some loop feedback to the amplifier. The design of multistage common-emitter amplifiers is sufficiently covered in the literature and will not be discussed further.

Step 2: Next, design the feedback loop starting with the rectifier circuit. The complexity of design is largely determined by the stability of the battery voltage. As would be expected, the output level of the rectifier varies considerably with fluctuations in battery voltage. If this is a problem, the supply should be regulated by the use of a Zener diode. Any convenient rectifier design can be used, as filtering is not too critical. Fig. 3 shows a peak rectifier circuit employing a transistor, diode and capacitor. (Note the use of Zener regulated voltages at both the collector and base).

Before the design of the dc amplifier can be undertaken, the type of variable impedance must be determined. The dc amplifier is strictly a linear device; that is, the output current is a linear function of the input. In order to achieve rapid agc action, it is necessary to have a nonlinear resistance as the variable element.[2] Diodes are therefore one of the obvious inexpensive solutions. Once the diode type and configurations have been decided, the minimum and maximum currents required can be determined. These then determine the specifications for the amplifier.

Diode Selection

In order for the designer to make a wise choice on the type of network to employ, pertinent diode characteristics are reviewed.

It is necessary to find a diode with a sufficiently wide dynamic impedance in the forward direction. The plot of Fig. 4 shows bias current versus forward impedance for a silicon diode. Silicon diodes act as linear-to logarithmic variation in dynamic impedance for a linear input current change. The ideal relationship for the conversion is given by:

$$A = e^{CB} \tag{6}$$

where A and B are variables and C is a constant. The current-voltage relationship for a diode is given by:

$$I = I_s (e^{qv/kt} - 1) \tag{7}$$

neglecting the IR drop of the diode. At room temperature, q/kt is a constant. Also, at the normal voltage encountered across a diode

$$e^{qt/kt} \gg 1 \tag{8}$$

which means that Eq. 7 reduces to

$$I = I_s e^{CV} \tag{9}$$

where I_s (the saturation current) and C are constants. This equation is now in the form of Eq. 6.

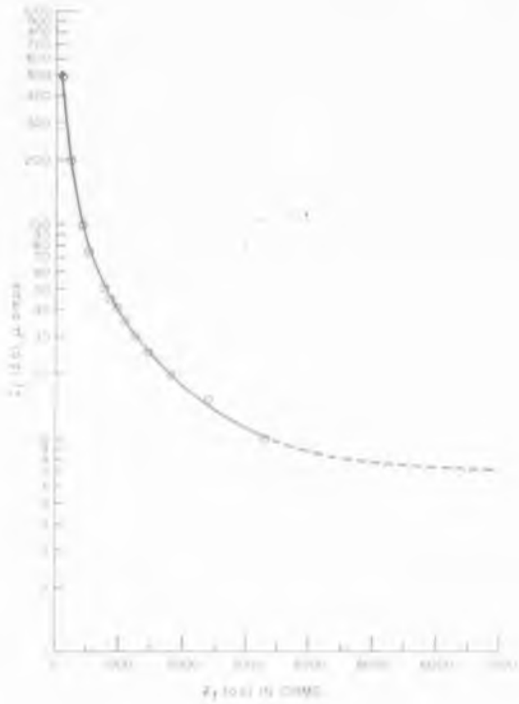


Fig. 4. I_f vs Z_f (ac) for 689 si diode at 25 C.

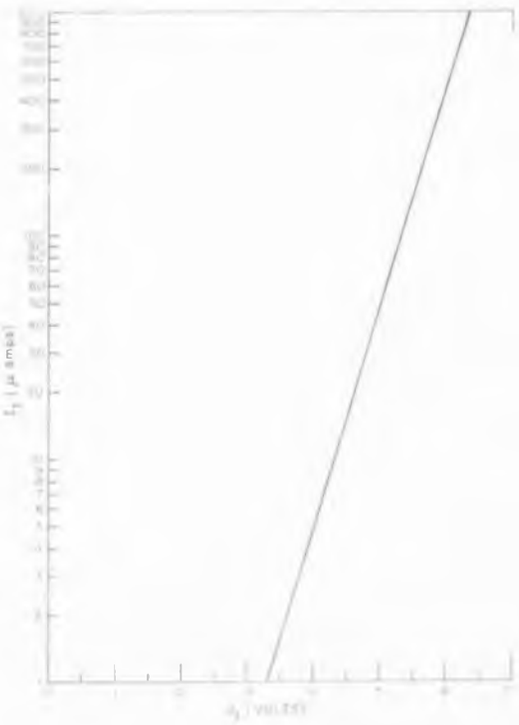


Fig. 5. I_f vs V_f for 689 si diode at 25 C.

Fig. 5 is the *V-I* diode curve for the silicon diode mentioned over the range where Eq. 9 is valid. The linear-to-logarithmic conversion is seen to be about 0.1 v/decade.

Step 3: The *L* pad design now follows. Given the maximum input level to be controlled, the pad must be so designed that it will attenuate this signal to a level equal to the minimum input plus another five db (due to the extra gain in the ac amplifier). Select some value of R_1, usually in the range of 1000 ohms to 3000 ohms. Then calculate the value of Z_1 needed to give the required attenuation at the *L* pad terminal; this gives the minimum value of Z_1 required. Having determined the end values of Z_1 required, the diode currents necessary are readily obtainable from the bias current-forward impedance curve.

Step 4: Once the range of diode currents is determined, a dc amplifier can be designed to supply these values based on the voltages available from the rectifier. It is generally sufficient to use a single transistor but more can be used if required. Difficulty is usually encountered in controlling the collector current when operation is required over a wide temperature range. The use of low I_{co} transistors is recommended. By placing a forward biased silicon diode in the emitter, further stabilization of the operating point can be achieved. This method is employed in the example given later.

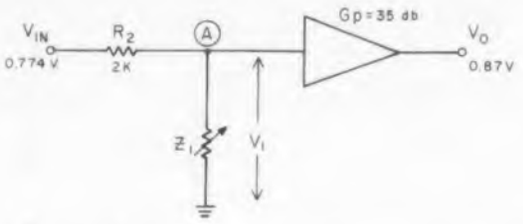


Fig. 6. Equivalent circuit used to calculate *L*-pad values.

Step 5: The various blocks can now be connected together. It is generally necessary to put an emitter follower stage between the *L* pad and the ac amplifier. This isolates the two circuits from mutual loading effects due to impedance variations. It is also advisable to make R_1 and R_2 variable at first so that minor adjustments can be made in operating points.

Design Example

Assume that it is required to design an agc amplifier to give a +1 dbm output level ±1.5 db for an input variation of −30 dbm to 0 dbm. Transistor beta variation is 20 to 200 over the temperature range of 30 F to 130 F. The battery voltages available are ±13.4 v but can go as high as ±14.5 v and as low as ±10.0 v.

Design Procedure

In order to allow for output level variations due to the environmental conditions described above, it is decided to design the agc circuit with an allowable variation in output of 0.5 db for a 30 db swing in input. This means that the stiffness ratio required is:

$$\frac{d P_o}{d P_i} = \frac{1}{60} \qquad (10)$$

Step 1: It is first necessary to design an ac amplifier of about 35 db. The amplifier consists of three stages each containing emitter degeneration. All three stages are designed with dc operating point stabilization through the use of base biasing resistors. Overall loop feedback of about 10 db is also included. Each stage has about the same gain, approximately 12 db. Fig. 7 shows the completed amplifier with emitter follower stages at the input and output for adequate isolation.

Step 2: The rectifier circuit is the same as previously described and shown in Fig. 3. A 7.5 v

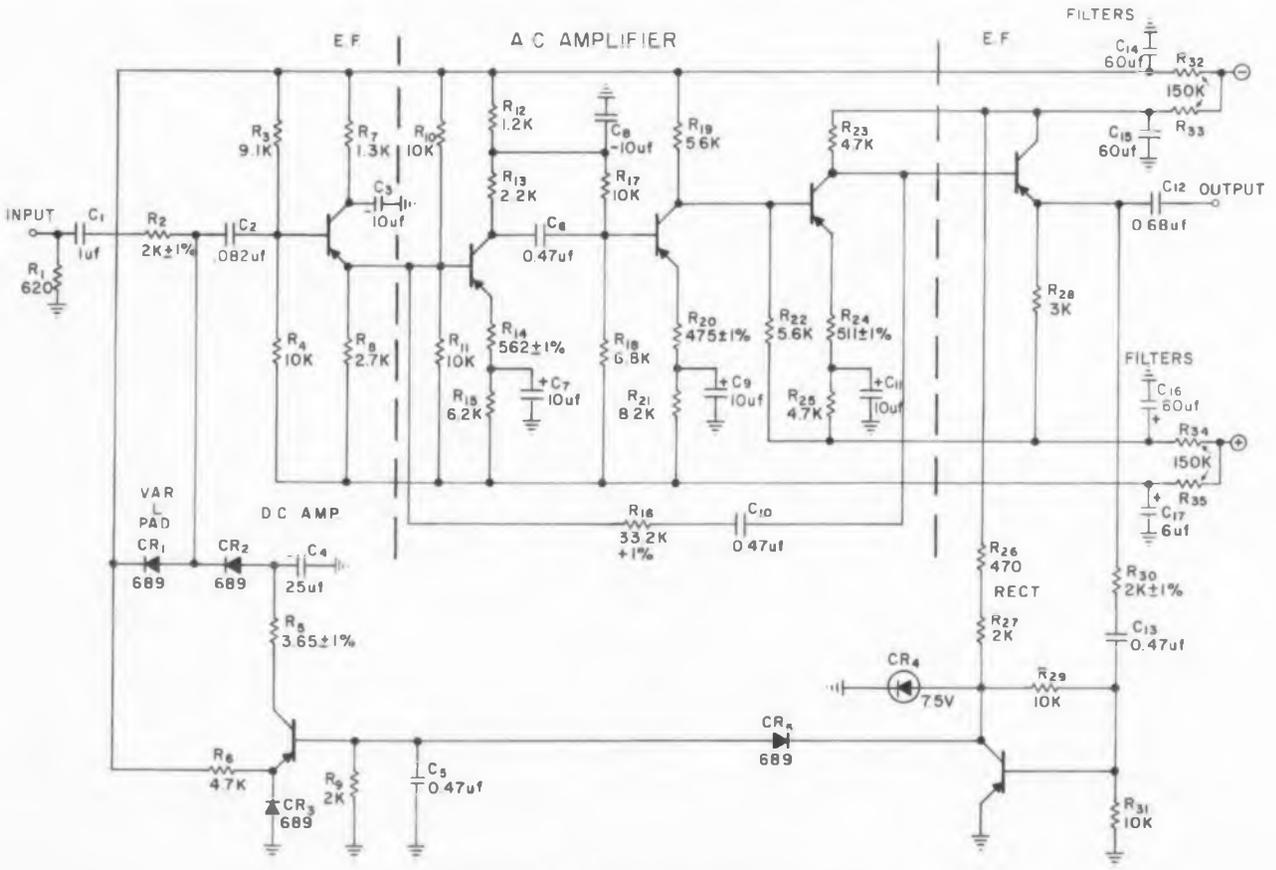


Fig. 7. Schematic of agc system discussed in text.

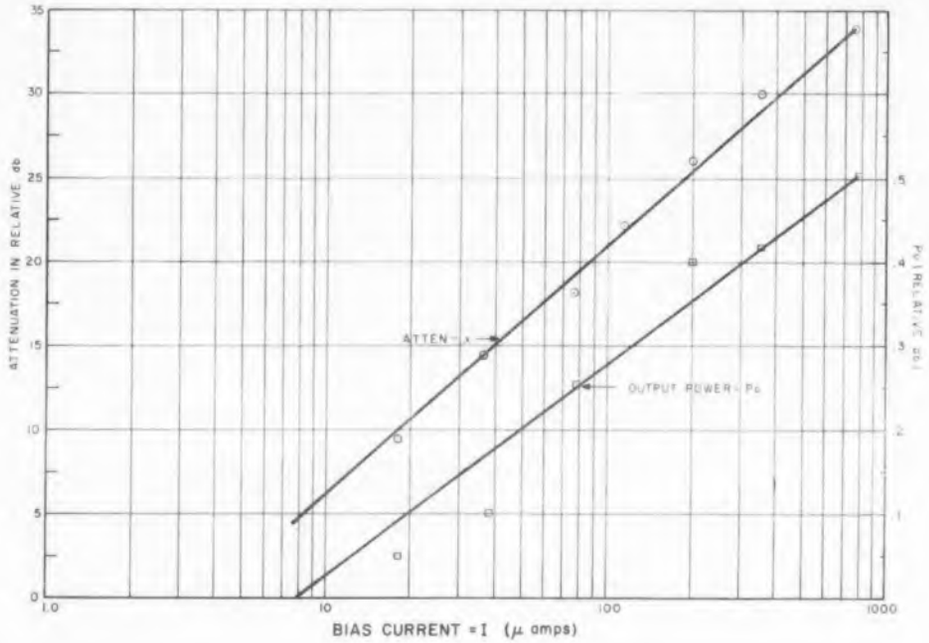


Fig. 8. Typical agc characteristics obtained during development of example circuit.

±5 per cent Zener is used which guarantees regulation over all battery conditions.

Step 3: The next step is the design of the *L* pad. The output level at which the system must operate and the designed gain of the amplifier are known. Since the input of the amplifier must remain a fixed value through the entire operating range, the attenuation requirements at both extremes can be calculated.

From the equivalent circuit shown in Fig. 6, the required *L* pad needed to give +1 dbm output for a 0 dbm input signal can be calculated. If a value of 2000 ohms is selected for R_2, V_1 must be 15.5 mv at the input. This means that Z_1 should be about 40 ohms. Referring to Fig. 4, an ac impedance of 40 ohms is seen to require a very high dc current. Therefore two diodes are used in parallel. A careful check at Fig. 7 will show that diodes CR_1 and CR_2 are actually in parallel in an ac equivalent circuit; thus each diode should present an impedance of 80 ohms; from If Vf curve of the diode, the required bias current is 750 μamp.

In the same manner, the value of Z_1 required for an input of −30 dbm (24.5 mv) can be calculated. In this case, the output level can drop down to +0.5 dbm (0.825 v). This gives a value for Z_1 of about 3000 ohms or an individual diode impedance of 6000 ohms and a diode bias current of 7.5 μamp. These two bias currents indicate the range of currents required from the dc amplifier.

Step 4: The dc amplifier is a single stage common emitter amplifier. A special low I_{co} unit of 2 μamp maximum at 25 C is used. A forward biased silicon diode in the emitter further helps stabilize operation over the temperature range. The collector resistor is a plus or minus one per cent unit. A large decoupling capacitor is also required in the circuit as shown.

Step 5: Fig. 7 shows the completed agc circuit. Four decoupling circuits have been added to avoid low frequency oscillations and to prevent inter-circuit interference problems.

Experimental Results

Fig. 8 shows typical curves of attenuation and output power versus diode bias current. It is the slope of these curves which must satisfy Eq. 5. A check will show that correlation is quite close over most of the operating range.

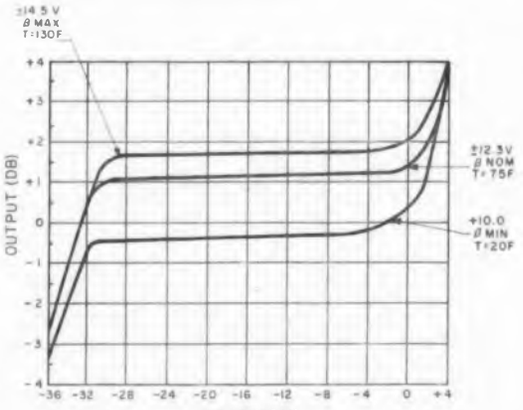


Fig. 9. Input vs output at $f = 2500$ cps. (β min = 20, β nom = 60, and β max = 150).

One factor which tends to limit the usefulness of this particular circuit is distortion. Due to the fact that the diodes are used over a very wide dynamic range, they tend to introduce distortion at the higher input levels. Distortion at −30 dbm input is about 5 per cent. However, at an input of 0 dbm the total rms distortion increases to a value of 10-15 per cent. Although this was found adequate for the particular requirements of this circuit, in most applications lower distortion values are required. This can generally be obtained by a bridge diode configuration in the *L* pad.

Fig. 9 is a curve of input versus output for the complete age circuit. The upper and lower curves are "worst condition" results and show that the design requirements were easily met. It was found that output level variation with beta and temperature resulted almost exclusively from the effects of these conditions on the rectifier circuit and to some extent on the dc amplifier. It should also be noted that temperature has some effect on the range in which the diodes act as good logarithmic units.

Although dc resistance of the diodes is widely affected by ambient temperature, tests indicated that ac impedance was only slightly changed. Frequency response of the system is flat, ±0.5 db from 400 cps to 10 kc. It was found, however, that the circuit had a 3 db peak at about 150 cps. This peak results from some of the *RC* time constants in the circuit. Since this circuit was intended for use primarily over the audio band of 300 to 3500 cps this was not considered a serious problem.

A very interesting result was noted with the ac amplifier when connected into the age circuit. As indicated above, the stability of the amplifier alone was ±0.4 db. When connected into the feedback loop, this variation in gain was almost completely eliminated.

Changing the three transistors from betas of 20 to 150 the output level changed less than 0.1 db. This results from the operation of the feedback loop in maintaining the output at a fixed level. The high beta transistors acted in the same way as a higher amplitude signal resulting in greater attenuation in the feedback loop. The opposite is, of course, true in the case of the low beta units. For this reason, the age circuit is quite insensitive to beta variation, the only transistors having any effect being the two in the feedback loop. ■ ■

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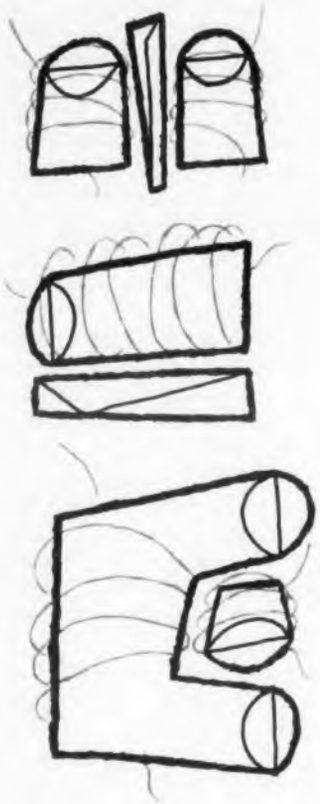

An Engineer's Guide to Straight-Pull and Rotary Solenoids

Clifford R. Strain
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Author Cliff Strain (right) feels that too many engineers stick to conventional solenoids only because they have never tried other types. Hence, they don't use the best solenoid for a particular job. Cliff wrote this article to outline the advantages and disadvantages of the most important solenoid types.

If Cliff looks worried in the photo, he's probably thinking of his two children and what will become of them. Why? Cliff is an active Republican committeeman. His wife is an ardent Democrat.

USED properly, a solenoid provides an excellent means of delivering a short, fast-acting movement of moderate force. It usually delivers a snap-action movement between definite limits or steps. To use solenoids to best advantage, it is good to know the types available and the particular forte of each type.

Ac vs. Dc Solenoids

Essentially, there are two main groups of solenoids, ac and dc.

Ac solenoids are generally limited to pulls of 50 lb or less, and are used when the cost factor is paramount and quality and reliability secondary. As a rule, they are bulkier, noisier, more complex and less reliable than dc solenoids. However, they do cost less than dc solenoids combined with rectifiers.

AC Solenoids

The most common type of ac solenoid is the one used in household appliances. It eliminates the need for a rectifier. Also, because of the increase in inductance inherent in an ac coil as the air gap is closed, it has the advantage of a drop in current consumption at the end of the stroke. However, this can also be a disadvantage if the solenoid jams and does not complete its stroke. Overheating will destroy it.

Most of the disadvantages of the ac solenoid stem from the fact that the magnetic part is made of laminated iron to minimize eddy currents.

DC Solenoids

Although more expensive, dc solenoids are more efficient and reliable than ac solenoids. Even here, however, the design engineer has a number of possibilities.

Basically, there are two types of dc solenoids, straight-pull and rotary. Which one to use depends on certain factors: the straight-pull solenoid is less costly, the rotary solenoid generally takes up less space.

Straight-Pull Solenoids

Flat-Faced, Lifting Type. The most efficient straight-pull unit for the amount of pull or work to be done, per unit volume or weight, is probably the flat-faced, lifting-type magnet. It has the smallest air gap. When equipped with a flat armature plate, it will produce a very high force in its small air-gap area. Its coil is shaped somewhat like a doughnut, with ferrous material going through the center, or core, and around the outside of the coil to complete the magnetic circuit.

Its use, however, is limited to very-short-stroke applications.

Horseshoe Type. Not as efficient, but much easier to construct, is the horseshoe-type magnet. Similar in many ways to the flat-faced, lifting-type magnet, it too requires flat-faced poles and is limited to short-stroke work.

Flat-Faced, Plunger Type. A third kind of straight-pull solenoid—and the most commonly used—is the flat-faced, plunger-type solenoid. It has a cylindrical coil and an armature, or plunger, that is simply a cylindrical piece of ferrous material which is drawn into the center of the coil.

Compared to the horseshoe-type magnet, its force increases only half as fast with a decrease in gap length. Hence it produces only half the work for a given stroke. Less efficient than the first two types mentioned because of its large air gap, it can be used for both short and long-stroke applications.

The magnetic force of the exciting coil is effective across one working gap instead of two in series. Thus, one can change its pull characteristic and develop a small force through twice the gap by varying the face of the plunger and the plunger stop.

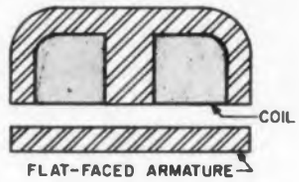
There are different versions of plunger-type solenoids—cone, cylinder and other variations of pole-face shaping. They vary greatly in their force-vs-stroke curve. Although, in general, the

straight-pull solenoid starts very weak and ends very strong, the plunger-type solenoid can achieve curves with various functions of pull versus stroke.

As a rule, the more even the force-vs-stroke curve, the lower the work-to-weight ratio and the less efficient the solenoid.

A solenoid should be matched to its load. Thus, if a load requires a uniform force during its travel, the solenoid should likewise have a uniform force. Since most straight-pull solenoids have a high-end force, the excess energy at the end of the stroke can reduce the life of both solenoid and load.

There are, however, loads such as brakes and clutch mechanism where a high force is required at the end of the stroke. In most of these cases a long stroke is not desirable and a flat-faced, plunger-type magnet, or a horseshoe unit, should be used.



Flat-faced, lifting-type solenoids concentrate a high force in a small air gap. They are very efficient but are limited to very short strokes.

Rotary Solenoids

Straight-Pull for Rotary Loads. In many cases, a straight-pull solenoid can be used on a rotary load by adding a linkage to an offset shaft or crank arm. But when the stroke is basically rotary, the best method, especially if space and weight savings are important, is to couple a rotary solenoid directly to the shaft.

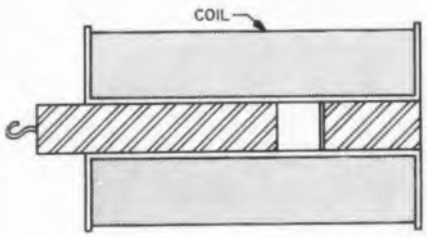
Rotary for Linear Loads. By the same token, a rotary solenoid can also be used, with a proper linkage and crank arm, to produce a straight-pull motion when there is not enough length for a straight-pull solenoid.

Three-Ball Type. There are a number of rotary solenoids available—the most efficient, undoubtedly, being the type that uses three ball races to convert straight-pull energy into rotary motion, almost without friction. Like the flat-faced, lifting-type magnet, which completely encases the coil with magnetic material, this type of rotary solenoid provides a fast increase of pull for the axial distance moved.

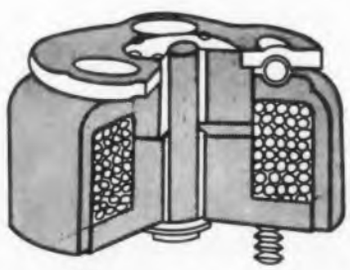
In this conversion, the incline of the ball races is steep at the beginning of the rotary stroke and gradually decreases as the balls approach the deep end of the ball races. This transfers torque to the start of the rotary stroke where it is usually needed.

This rotary solenoid develops tremendous torque for its size and power input, and combines the high efficiency of the flat-faced, lifting-type configuration with the linear force curve needed for most applications.

Distorted-Field Type. Another type, available in an ac model, uses the distorted-field or stalled-motor principle. However, because it is designed for ac use and, like the compensated plunger-



Flat-faced, plunger-type solenoids have a relatively large air gap. They are less efficient than the lifting type or the horseshoe type but they can be used for short or long strokes.



Cut-away view of rotary solenoid shows density of magnet wire which contributes to the large torque available from a small package.

type solenoid, it uses shaped pole pieces which are not flat and parallel, it loses some efficiency.

All rotary solenoids can generally meet severe shock and acceleration requirements better than straight-pull solenoids can. This is because their armatures are in a state of inertial balance or they approach it closely. A counter-balance must be linked to a straight-pull solenoid to eliminate the armature's tendency to be shocked out of position.

Designing for High-Speed Operation

It is seldom practical to try to predict how fast a solenoid will act. As a rule, solenoids are designed *in the direction* of a desired speed.

Both speed and life of a solenoid depend on the inertia, or mass, of the moving system. A large mass limits speed, while deceleration of a large mass can cause failure. Hence, for high speed, the mass in the armature system to be moved by the solenoid should be minimized.

Excess Force for Higher Speeds. Another way to obtain high speed is to use the excess force available from a larger solenoid. This can accelerate the mass and complete the solenoid stroke faster. But too much excess force can reduce life.

Special Circuitry for Higher Speed. Special circuits can be used to deliver maximum power under continuous-duty conditions. By having a solenoid open a normally closed switch at the end of its stroke, and by thus switching a resistor in series with the coil, the solenoid can be designed to deliver the force normally available with much lower duty cycles. The resistor prevents the coil from exceeding its continuous-duty rating, though the coil may operate from currents suitable for one-tenth duty-cycle operation.

Low Inductance for Higher Speeds. A low-inductance solenoid can build up a magnetic field faster than a high-inductance unit. For high-speed operation, it is necessary to build up a magnetic field before the solenoid can start moving.

Laminated Cores for Higher Speeds. Another way to obtain a high-speed, straight-pull solenoid is to use a laminated core like that used on the ac solenoid. This core minimizes the back-emf developed by the increasing magnetic field.

Circuitry for Slower Release. The circuit used to switch a solenoid will affect its release time. If the field breaks down slowly the solenoid will stay in longer and release more slowly. A large capacitor or a diode across the coil will slow the solenoid's release.

Design Consideration with Straight-Pull and Rotary Solenoids

Watch the Load. Several factors must be considered in designing with any solenoid. For example, the force curve of a solenoid must be related to the force needed to move the load. If too much

force is used to move the load, the life of both load and solenoid will suffer.

The excess energy in the solenoid must be dissipated. In most cases, this energy in the form of heat, goes into the metals in the equipment and in the solenoid. It can lead to fatigue, wear, and excess noise.

Watch the Heat. When a solenoid has finished its motion it becomes a purely resistive device and acts like a heating element. All solenoid coils dissipate heat which causes a temperature rise. The ultimate allowable temperature is limited by the type of magnet-wire insulation and lubricants used. If the unit heats to a high temperature, the magnet-wire insulation may break down and cause a progressive shorting of the turns. Or the lubricant may boil off, leaving a gummy substance that stalls the solenoid.

Since some solenoids transmit heat from their cases into the bodies on which they are mounted, it is extremely important that they not be isolated from the mounting surface which acts as a heat sink.

Watch the Duty Cycle. As an example, a particular solenoid rated for 20-w dissipation produces a 65 C temperature rise. It has a coil which can withstand 120 C.

This unit can operate on continuous duty with 20-w input up to an ambient temperature of 55 C. For the same temperature rise this unit can operate at a 40-w input with an on-time of 50 per cent to give an average of 20-w input.

This same unit can also operate 10 per cent of the time with an input of 200 w, producing possibly 10 times the force produced at the continuous-duty rating.

Watch the Voltage Source. The resistance of a solenoid coil increases with temperature. If the power supply delivers a constant voltage, the current decreases and reduces the ampere-turns within the solenoid thereby reducing the pull-in and holding force. At 120 C, these can be reduced by about 40 per cent.

Use A Safety Factor. Because of the many variations in design—both electrical and mechanical, the design engineer should allow a safety factor of about 50 per cent over the manufacturer's specifications. This should take care of uncalculated friction and losses due to heating of the solenoid coil.

Consult the Company. If cost, space, or weight problems make it necessary to design very closely, a representative of the company that supplies the solenids should be consulted.

In any event, the initial design should be considered as an experiment, and a number of working prototypes should be built before production quantities are considered. ■ ■

For the engineer who hasn't the time for complex equivalent-circuit calculations, the hybrid pi can prove a great convenience.

Find Transistor Gain and Impedance Quickly Using Hybrid-Pi Equivalent

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Clifton, N. J.

THE hybrid-pi equivalent quickly yields gain and input impedance of common-emitter circuits. Parameters necessary for applying this equivalent are given on the data sheets of some manufacturers. When they are not, they are easy to measure.

Three cases can show how easy it is to apply

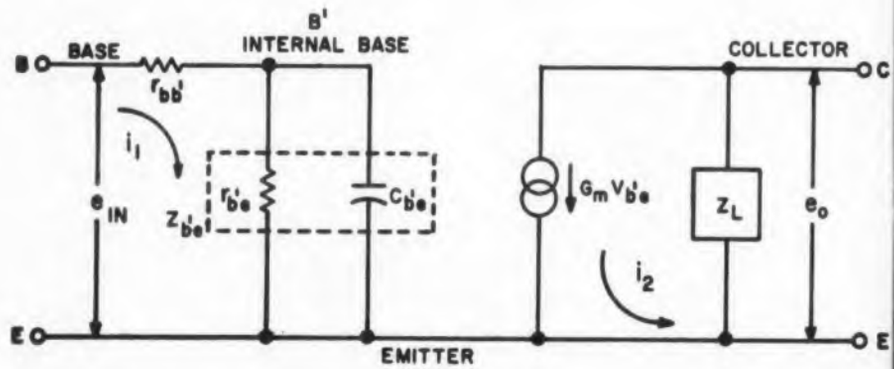

Fig. 1. Hybrid equivalent of a common-emitter circuit with the emitter grounded.

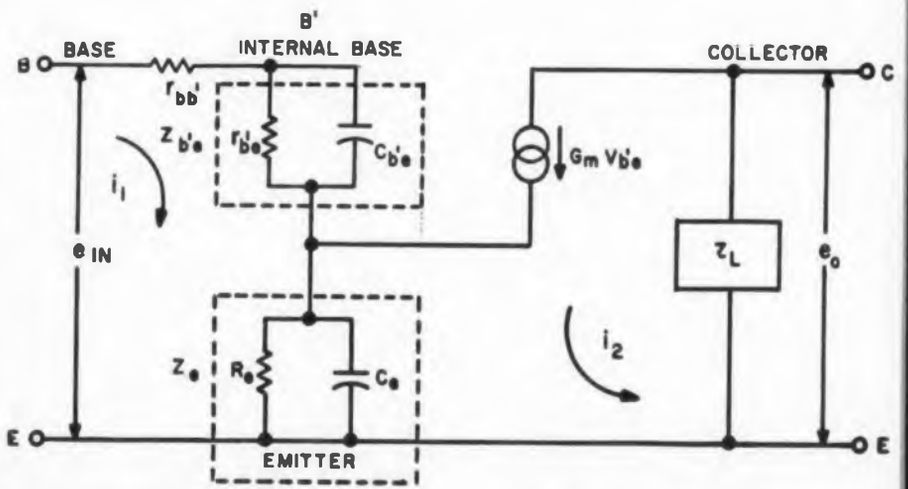

Fig. 2. Hybrid-pi equivalent with emitter impedance considered.

the hybrid pi to determine voltage gain and input impedance.

Case 1. Emitter grounded. $Z_e = 0$, $Z_{b'c} = \infty$. (See Fig. 1.)

$$\frac{e_o}{e_{in}} = \frac{G_m Z_{b'c} Z_L}{r_{bb'} + Z_{b'e}}$$

$$Z_i = r_{bb'} + Z_{b'e}$$

Case 2. Emitter impedance considered. $Z_{b'c} = \infty$. (See Fig. 2.)

$$\frac{e_o}{e_{in}} = \frac{G_m Z_{b'e} Z_L}{r_{bb'} + Z_{b'e} + (1 + G_m Z_{b'e}) Z_e}$$

$$Z_i = r_{bb'} + Z_{b'e} + (1 + G_m Z_{b'e}) Z_e$$

Case 3. Emitter impedance and degenerative effect of $Z_{b'c}$ considered. (See Fig. 3.)

$$\frac{e_o}{e_{in}} = \frac{G_m Z_{b'e} [Z_{b'c}/(Z_{b'c} + Z_{b'e})] Z_L}{r_{bb'} + Z_{b'e} + Z_e \left(1 + \frac{G_m Z_{b'e} Z_{b'c}}{Z_{b'c} + Z_{b'e}}\right) - \frac{Z_{b'e}^2}{Z_{b'c} + Z_{b'e}}}$$

$$Z_i = r_{bb'} + Z_{b'e} + Z_e \left(1 + \frac{G_m Z_{b'e} Z_{b'c}}{Z_{b'c} + Z_{b'e}}\right) - \frac{Z_{b'e}^2}{Z_{b'c} + Z_{b'e}}$$

In using the hybrid pi, one must remember that some of the parameters vary with dc emitter current and with collector-to-base voltage. $C_{b'e}$ and G_m vary directly with dc emitter current, $r_{b'e}$ varies inversely with emitter current, and $C_{b'c}$ varies inversely with a power of the collector-to-base voltage. The power can range from about 1/2 to 1/3.

Sample Design

Find the gain and input impedance of a 2N247 drift transistor operating at 1 mc with a 1-K load resistor. Collector voltage and current are 9 v and 1 ma respectively. The data sheet gives: $r_{bb'} = 40$ ohms, $r_{b'e} = 1620$ ohms, $C_{b'e} = 200$ pf, and $G_m = 37{,}000$ μmhos.

For simplicity, assume Case 1 operation as in Fig. 4. Then:

$$\textit{Voltage Gain} = \frac{e_o}{e_{in}} = \frac{G_m Z_{b'e} Z_L}{r_{bb'} + Z_{b'e}}$$

$$Z_{b'e} = \frac{r_{b'e}\,(1/j\,\omega C_{b'e})}{r_{b'e} + 1/j\,\omega C_{b'e}} = \frac{r_{b'e}}{1 + j\,\omega r_{b'e} C_{b'e}}$$

$$= \frac{1620}{1 + j\,6.28 \times 10^6 \times 1620 \times 200 \times 10^{-12}} = -j\,229$$

$$\textit{Voltage Gain} = \frac{37 \times 10^{-3} \times (-j\,229) \times 10^3}{40 - j\,229} = 37.$$

(continued on p 55)

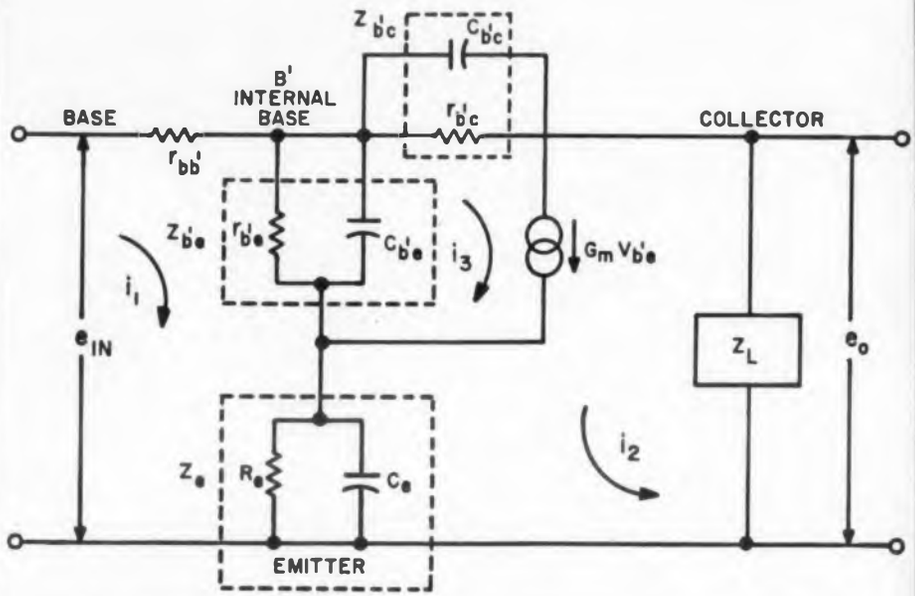

Fig. 3. Hybrid-pi equivalent with emitter impedance and degenerative effect of collector-to-base impedance considered.

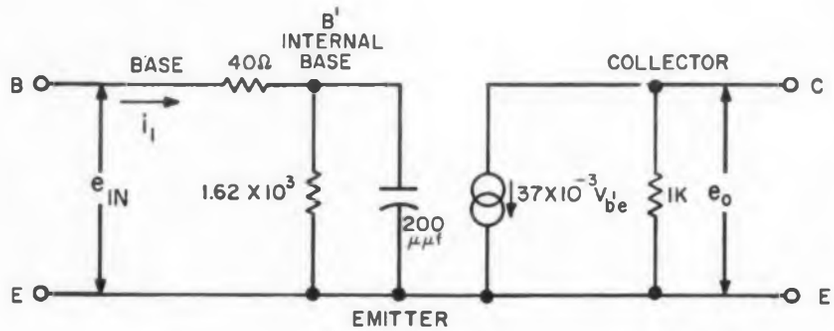

Fig. 4. Equivalent circuit for the sample problem in the text.

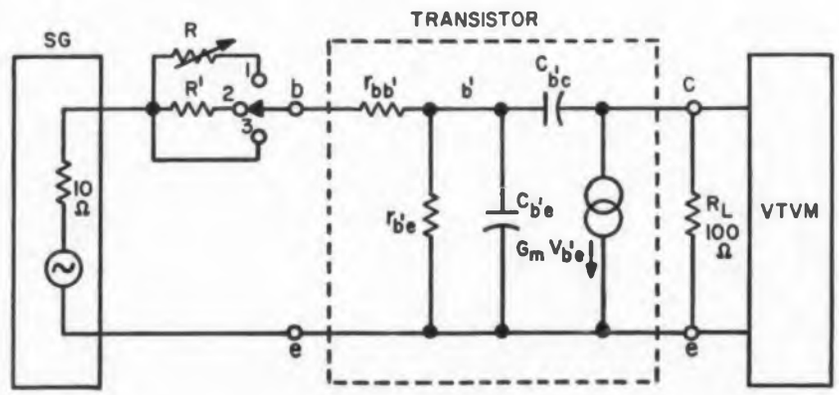

Fig. 5. Test setup for measuring $C_{b'e}$, $r_{b'e}$ and $r_{bb'}$.

In this case, the voltage gain approaches $G_m Z_L$.

Input Impedance = $Z_i = r_{bb'} + Z_{b'e}$ = 230 ohms.

Since the input impedance is almost entirely composed of $Z_{b'e}$ in this case, it is almost purely capacitive so it will increase almost linearly with frequency beyond 1 mc.

How to Measure $C_{b'e}$, $r_{b'e}$, and $r_{b'b}$

Step 1. Set up a signal generator and a vtvm as shown in Fig. 5. Set the generator to a low frequency of about 1 kc where the reactance of $C_{b'e}$ is much larger than $r_{b'e}$. Short out resistor R between the generator and the transistor. Adjust the generator level till the output meter reads about 20 mv. Increase R from zero till the transistor output voltage drops 6 db.

Note this value of R. It is equal to $R = r_{bb'} + r_{b'e}$.

Step 2. Substitute R' (56 K) for R. Set the generator so the output voltage is again about 20 mv at 1 kc. Holding the generator output constant, raise the frequency till the transistor output drops 3 db. Note this frequency and call the corresponding angular frequency ω_1. Since the transistor is effectively driven from a constant-current source, this yields:

$$\left| r_{b'e} \right| = \left| \frac{1}{\omega_1 C_{b'e}} \right|$$

Step 3. Short out R' and again adjust the generator to provide 20-mv transistor output at 1 kc. Increase the frequency till the output falls 3 db. This will occur at ω_e which will be higher than ω_1, found in Step 2. Since the drive to the transistor is now "constant-voltage," this step yields:

$$\left| \frac{r_{bb'} \times r_{b'e}}{r_{bb'} + r_{b'e}} \right| = \left| \frac{1}{\omega_e C_{b'e}} \right|$$

Steps 2 and 3 yield the equations for finding $r_{bb'}$, $r_{b'e}$ and $C_{b'e}$.

$$r_{bb'} = \frac{\omega_1}{\omega_e} (r_{bb'} + r_{b'e}) = \frac{\omega_1}{\omega_e} R \qquad (1)$$

$$r_{b'e} = R - r_{bb'} \qquad (2)$$

$$C_{b'e} = \frac{1}{\omega_1 r_{b'e}} \qquad (3)$$

Describing these operations takes longer than performing them. ■ ■

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C. R. Wilhelmsen, "Some Notes on the Hybrid-Pi Transistor Equivalent Circuit," *IRE Transactions on Broadcast and Television Receivers*, March 1958, p 92.

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What Happens to . . . Magnetic Properties of Core Materials at Elevated Temperatures

Data on magnetic core materials at high temperatures has been in demand by many electronics designers. In this article, author D. E. Meehan discloses some interesting results of tests on three commonly used electrical steels.

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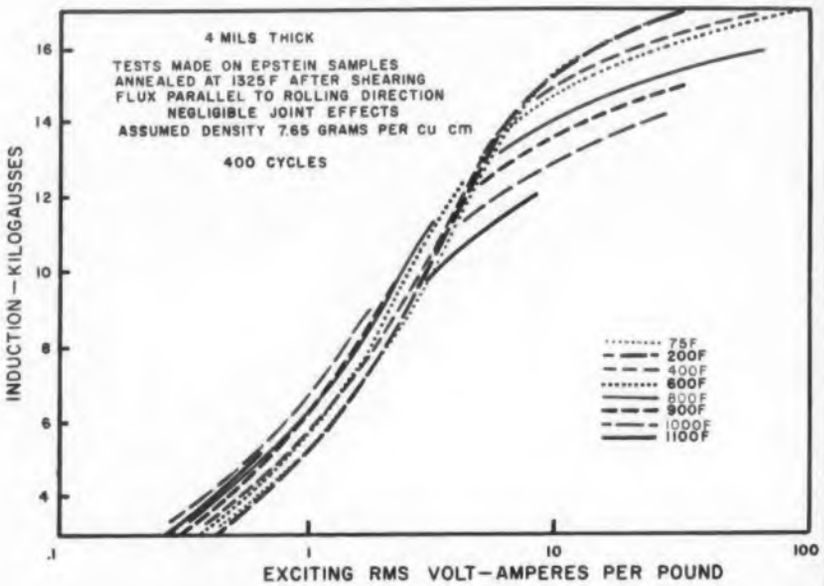

Fig. 1. Exciting rms volt-amperes per pound at high inductions and elevated temperatures for Armco oriented T.

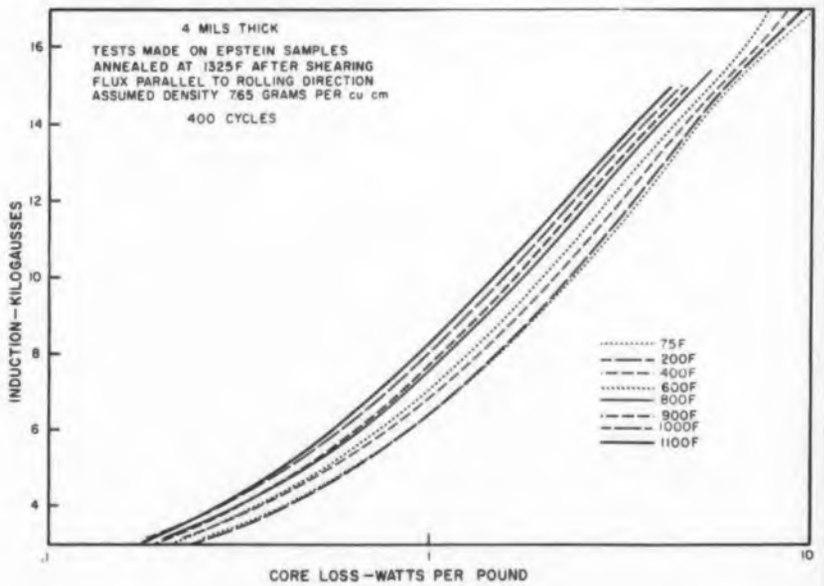

Fig. 2. Core loss at high inductions and elevated temperatures for Armco oriented T.

THREE commonly used core materials, 4-mil Armco Oriented T, 12-mil Armco Oriented M-6, and 0.095-in. thick Armco Magnetic Ingot Iron were tested from room temperature to 1100 F for the silicon alloys; also to the Curie point for Armco Magnetic Ingot Iron. In the case of the silicon steels, stress-relieved Epstein strips (see ASTM Designation: A343-54, Section 3(a) were used as test specimens, while Armco Magnetic Ingot Iron was tested in 4.8-in. outside diameter by 0.4-in. wide rings.

The oriented materials were tested in the form of parallel-gain, stress-free Epstein strips with double-lap joints (of negligible reluctance compared with the joints usually found in commercial cores). Magnetic Ingot Iron was tested in the form of stacked rings. These tests virtually eliminated the effects of factors that are frequently large and variable in commercial core forms; also which sometimes obscure or counteract the inherent properties of the core materials. Thus a high degree of sensitivity to actual changes in magnetic properties as a function of temperature was obtained. The data can be directly applied design-wise, to "gapless" or wound-core devices without complicated design allowances. Performance of cores containing joints can be estimated by applying standard design techniques that allow for effects in the final design form of gaps, joints, non-uniform cross sections, fabricating or assembly stress, and lumped windings. Designers can now compare the properties of these alloys at high temperatures with previously available information.

Oriented T and Oriented M-6 samples were tested in a nitrogen atmosphere in a special

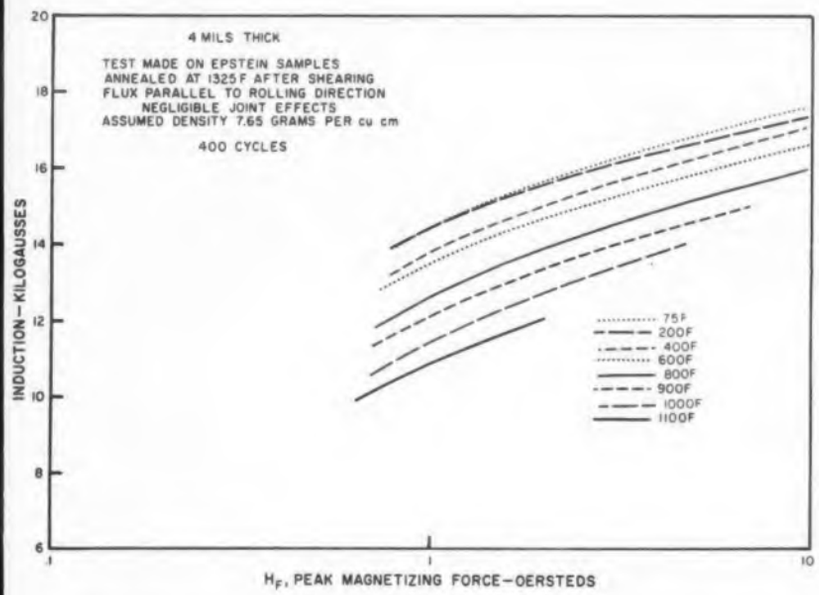

Fig. 3. Ac magnetization curves at high inductions and elevated temperatures for Armco oriented T.

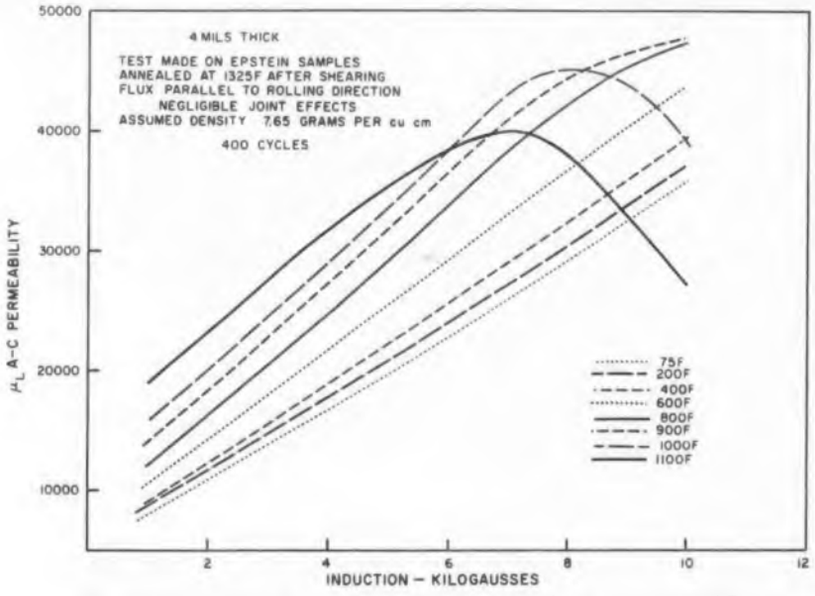

Fig. 4. Ac permeability at elevated temperatures for Armco oriented T.

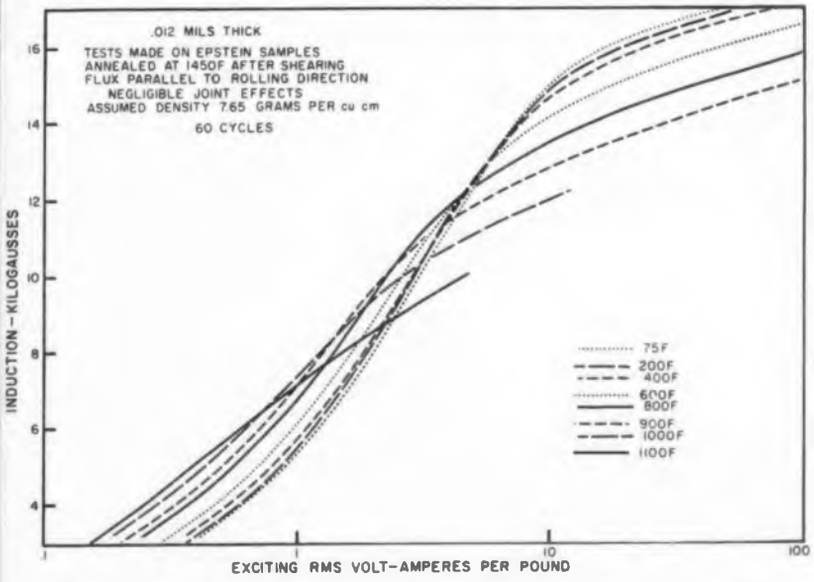

Fig. 5. Exciting rms volt-amperes per pound at high inductions and elevated temperatures for Armco oriented M-6W.

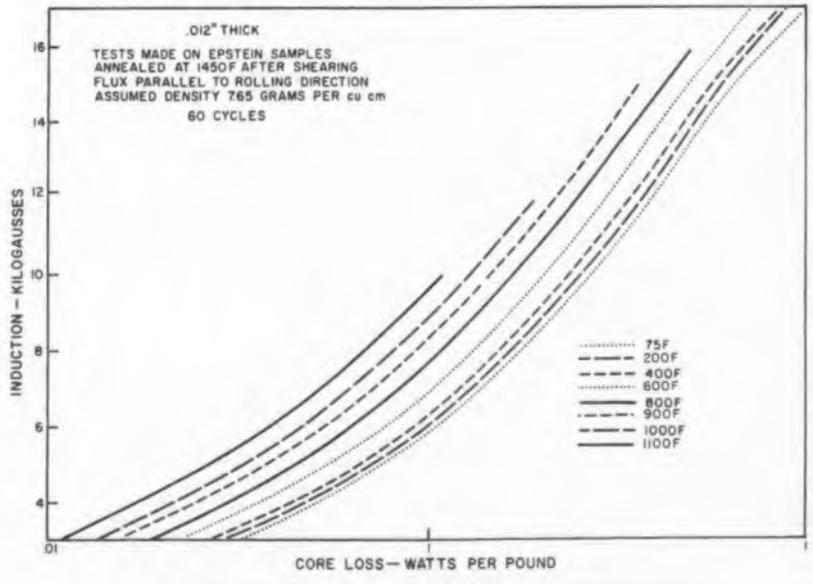

Fig. 6. Core loss curves at high inductions and elevated temperatures for Armco oriented M-6W.

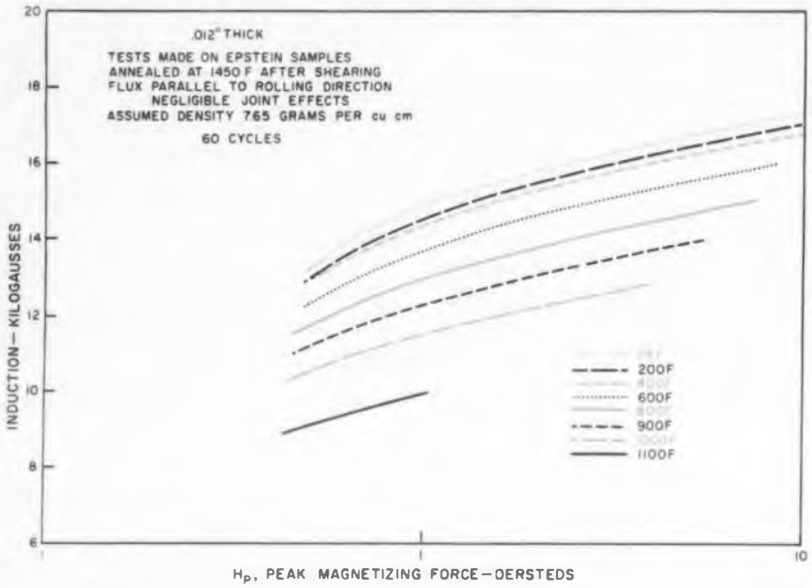

Fig. 7. Ac magnetization curves at high inductions and elevated temperatures for Armco oriented M-6W.

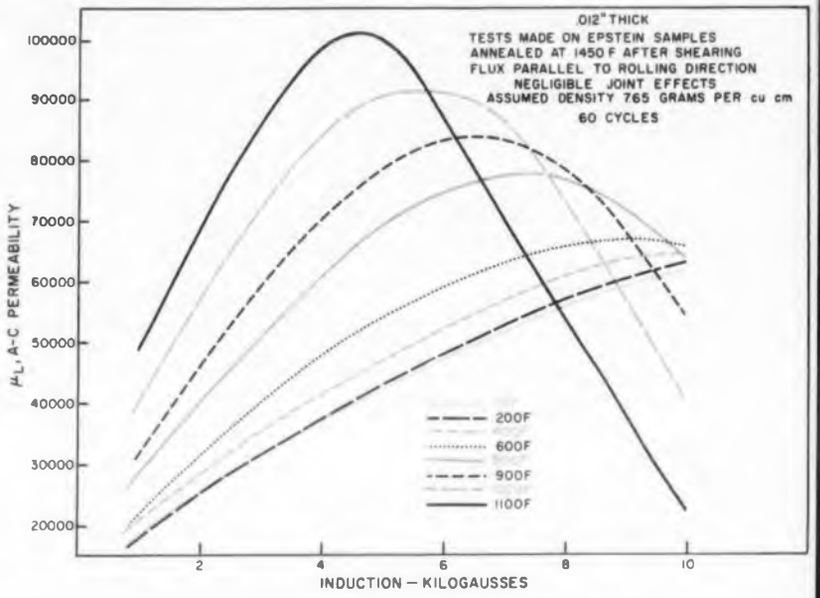

Fig. 8. Ac permeability at elevated temperatures for Armco oriented M-6W.

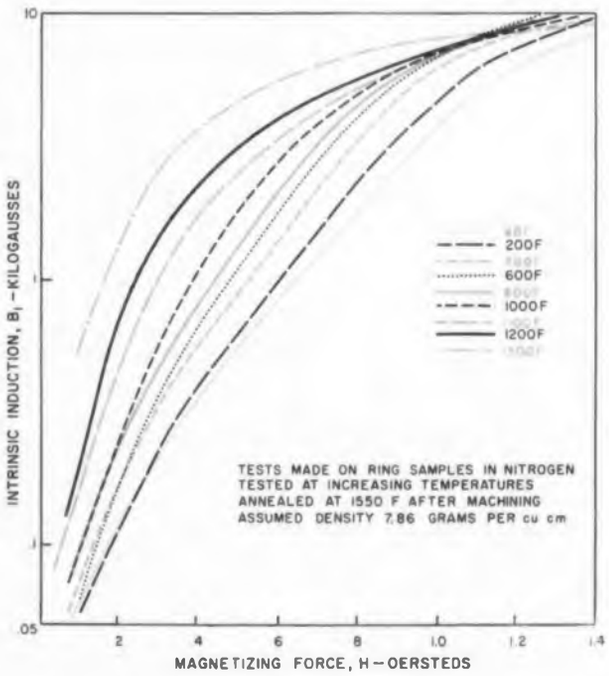

Fig. 9. Dc magnetization curves at low inductions and elevated temperatures for Armco ingot iron.

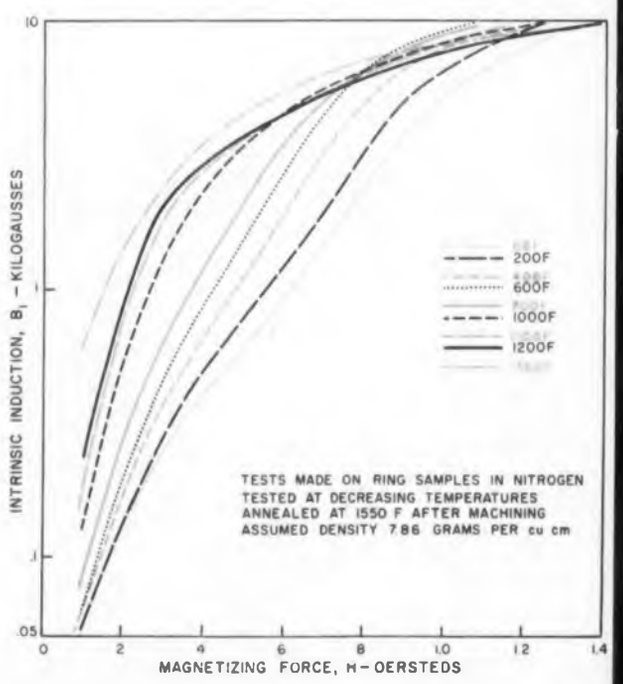

Fig. 10. Dc magnetization curves at low inductions and elevated temperatures for Armco ingot iron.

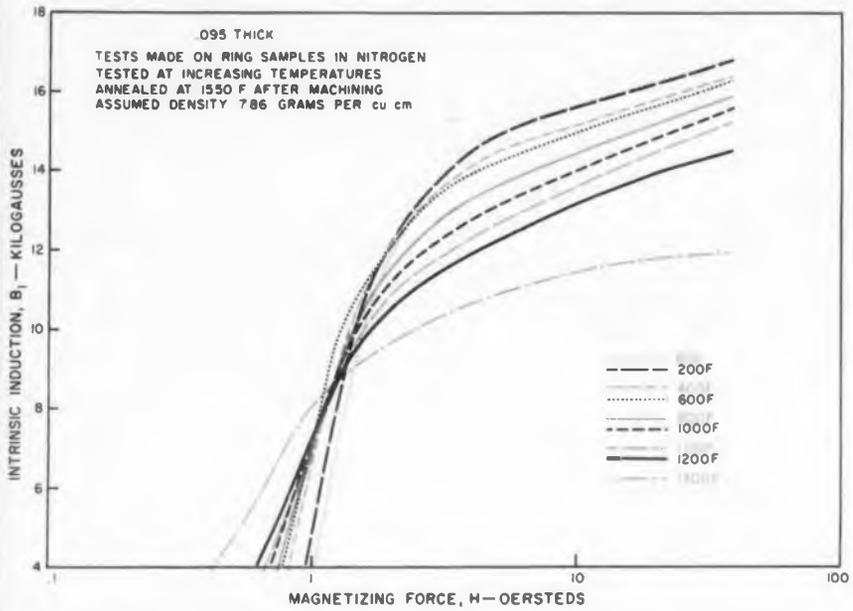

Fig. 11. Dc magnetization curves at high inductions and elevated temperatures for Armco ingot iron.

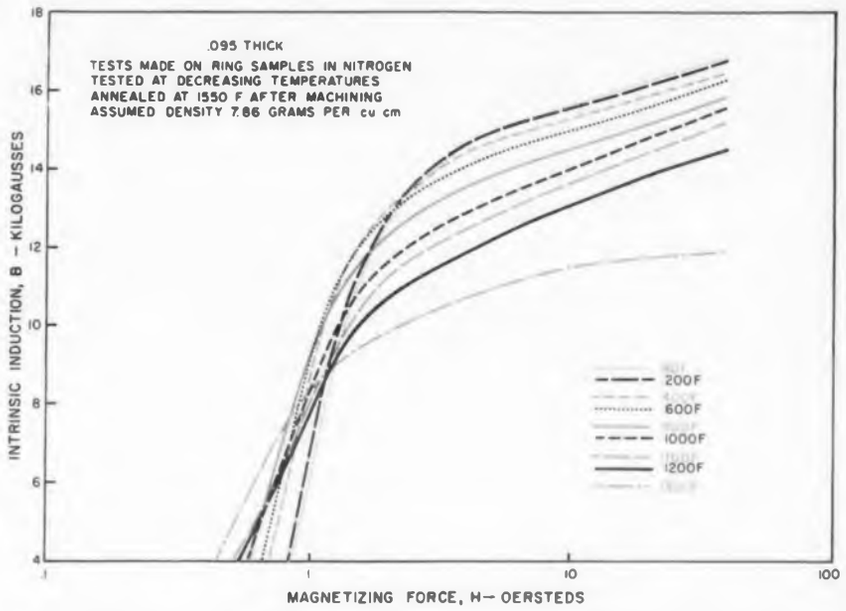

Fig. 12. Dc magnetization curves at high inductions and elevated temperatures for Armco ingot iron.

Epstein test frame constructed of refractory materials. This arrangement proved suitable for ac tests up to 1100 F, but at higher temperatures the frame was subject to premature conductor failure. The frame also proved unsuitable for sensitive dc measurements at elevated temperatures because of sharply increased leakage currents through the insulating materials.

Magnetic Ingot Iron rings were stacked into cores and stress-relief annealed. Toroidal windings, insulated with refractory beads, proved usable through the Curie point in a nitrogen atmosphere. Inaccuracies of data points taken near the Curie temperature appeared to be caused mainly by difficulties in control and measurement of temperature.

Figs. 1 to 4 show exciting rms volt-amperes per pound, core loss in watts per pound, peak magnetizing force, and ac permeability (all at 400 cps) as correlates of induction for 4-mil Armco Oriented T. Figs. 5 to 8 show the same functions for 12-mil Armco Oriented M-6W at 60 cps. Figs. 9 and 10 show normal dc magnetization curves at low inductions for Armco Magnetic Ingot Iron for increasing and decreasing temperatures respectively. The same functions are shown at high inductions by Figs. 11 and 12. Fig. 13 shows the dependence of induction on temperature at constant magnetizing forces throughout the range tested.

All three materials display the general behavior observed previously in similar investigations[1,2] of ferromagnetic materials. These can be summarized in this way:

- At high magnetizing field strengths the permeability changes continuously in inverse ratio to temperature change. These changes are abrupt in the vicinity of the Curie temperature but relatively gradual at lower temperatures.
- At low magnetizing field strengths the permeability changes gradually in direct proportion to temperature until it peaks sharply near the Curie temperature, reflecting low magnetic anisotropy just below that point.
- Core loss is inversely proportional to temperature. This reflects the direct dependence of volume resistivity (which affects eddy currents inversely) of the core material on temperature; also the inverse relation of hysteresis to temperature.

In general, the properties of all three grades were reversible with temperature at the higher field strengths under the conditions of the tests. Changes might result from heating in air, or difference combinations of time-temperature relations and different temperature cycling. At lower field strengths, where only Armco Magnetic Ingot Iron was investigated, permeabilities were somewhat higher during the cooling period. ■ ■

References

1. Booklet, "Armco Thin Electrical Steels, 1956" Curves No. 6014 to 6016, inclusive (pp 24, 25, 26)
2. AIEE Conference Paper, "Magnetic Properties at High Operating Temperatures" M. L. Manning, *Elect. Eng.*, 1949, No. 68, Page 336, abstract.

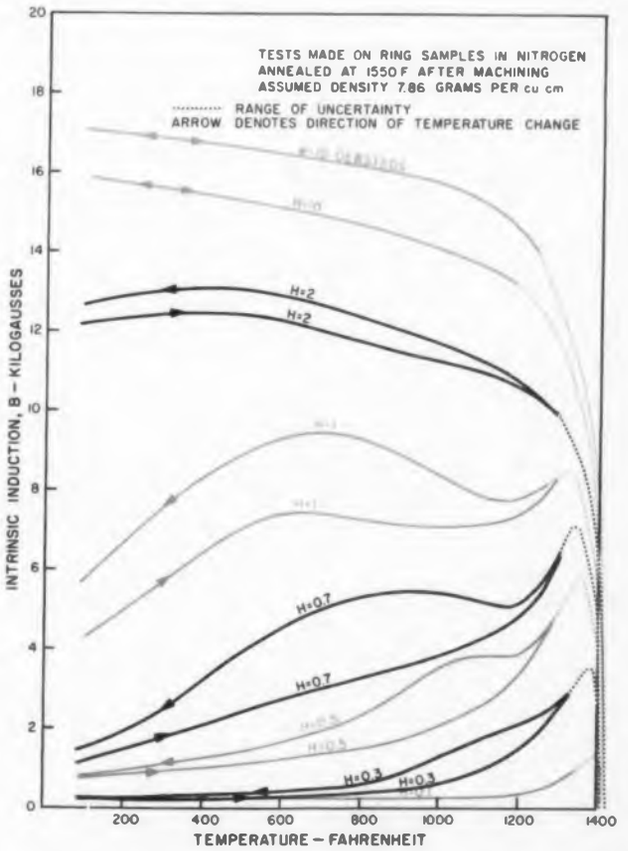

Fig. 13. Temperature dependence of flux density at constant magnetizing forces for Armco ingot iron.

Generation of High Power Sin² Video Pulses

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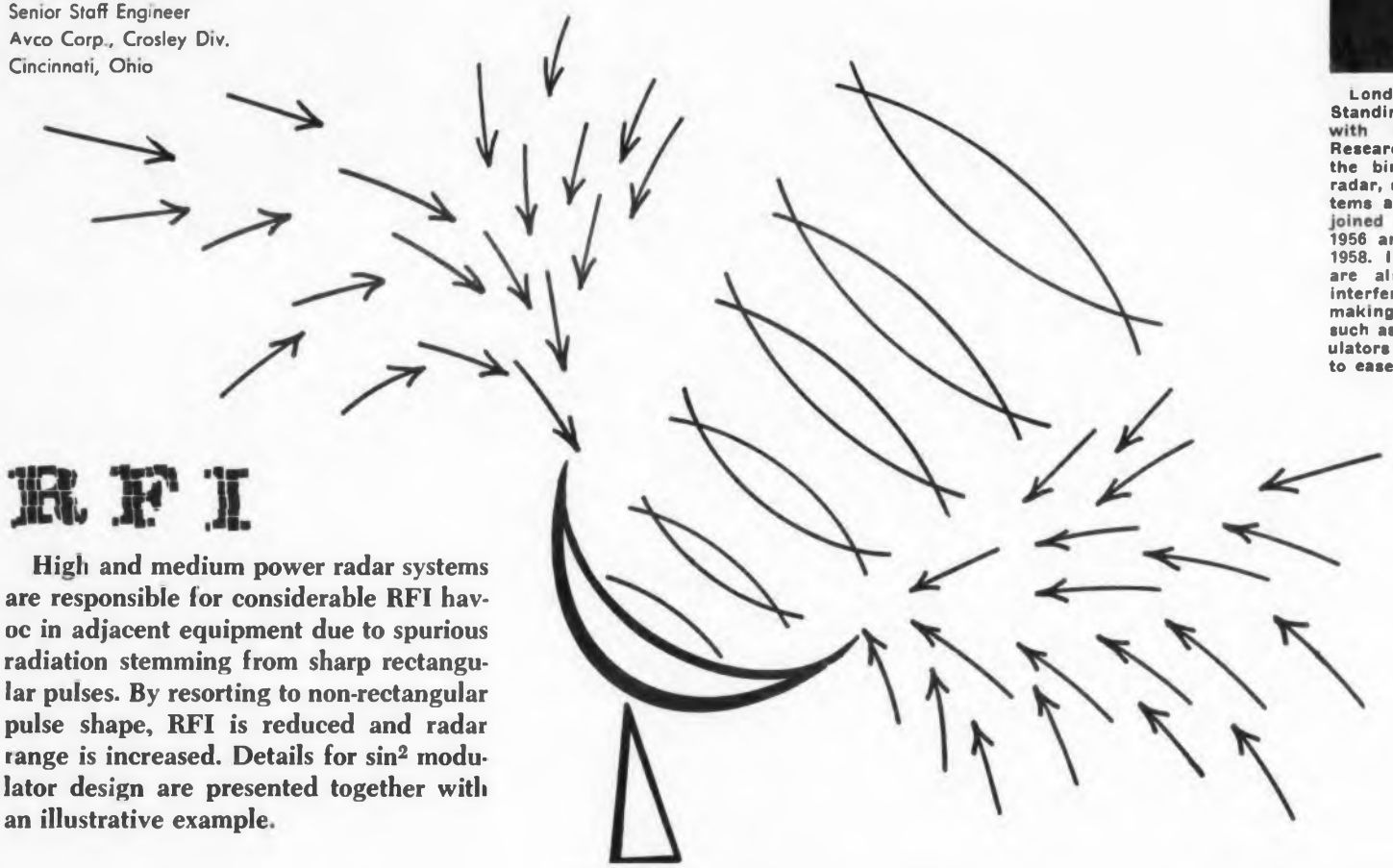
London-born Arthur P. Standing spent 13 years with TeleCommunication Research Establishment, the birthplace of British radar, designing radar systems and components. He joined Westinghouse in 1956 and Avco/Crosley in 1958. In his opinion, "we are almost drowning in interference of our own making and techniques such as shaped pulse modulators should be pursued to ease the situation."



High and medium power radar systems are responsible for considerable RFI havoc in adjacent equipment due to spurious radiation stemming from sharp rectangular pulses. By resorting to non-rectangular pulse shape, RFI is reduced and radar range is increased. Details for sin² modulator design are presented together with an illustrative example.

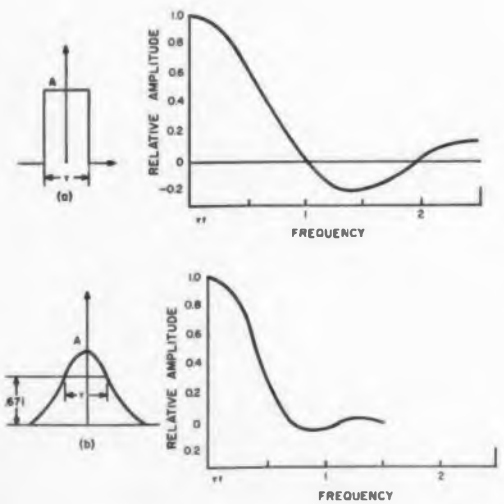


Fig. 1. Comparison between spectrum requirements for rectangular (*A*) and sin² (*B*) pulses.

VIDEO pulse and rf leakage, radiation from power lines and direct pickup of the transmitted rf pulse spectrum represented key sources of radio interference involved in a radar system. All but direct rf pickup can be substantially reduced by suitable screening, filtering and careful equipment location.

Direct pick-up of the transmitted rf pulse spectrum presents a major interference problem[1] since fractions of one per cent of the radar peak power can paralyze communication systems situated many miles distant and operating on frequencies well spaced from the offending radar.

Pulse Shaping to Reduce RFI

One possible way to reduce this interference is to reduce the spectrum associated with the rf pulse by operating the radar with a pulse shape other than rectangular. The use of such a shaped pulse can also result in improved radar range since first spectrum lobe energy constant will be greater than the 92.6 per cent associated with a rectangular pulse, resulting in improved receiver signal to noise figures. Since a rectangular pulse offers the best energy package for transmitter efficiency and radar resolution, the use of shapes other than rectangular leads to a reduction in resolution and transmitter efficiency, depending on the particular pulse shape chosen.

Selection of Pulse Shape Involves Compromise

The choice of pulse shape is a complex one and many shapes can be selected with different spectrums; however, the generation of these different pulse shapes presents many problems, the final choice depending on practical matters such as ease of generation and the attendant degradation of radar range information both absolute and relative.

1. Radar Interference to Microwave Communication Systems, A.I.E.E., November 1952

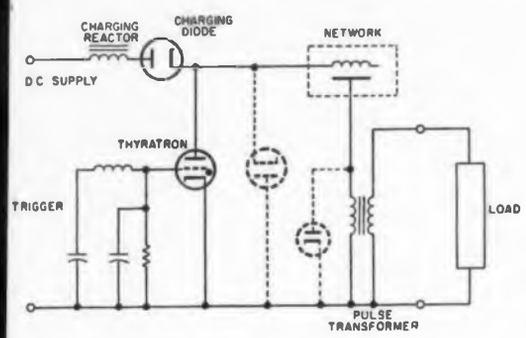


Fig. 2. Conventional line type modulator cannot generate pulses with sloping edges.

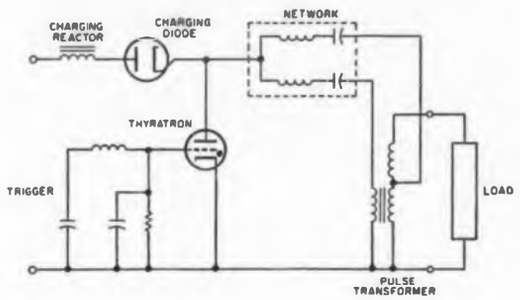


Fig. 3. Sin² thyratron modulator uses network currents obtained from the primary and secondary windings of a pulse transformer to achieve the equivalent of negative circuit components.

The particular pulse shape discussed in this article is the sin² pulse, chosen mainly for ease of generation, which has a very much reduced spectrum spread, Fig. 1, over the rectangular pulse. To generate an rf pulse of sin² shape requires the modulation of a triode or tetrode high power tube; this type of operation is restricted to the lower rf bands until the problems of modulating high frequency tubes, such as klystrons, with shaped pulses can be solved.

Negative Components for Sin² Modulator

Before any rf generation of shaped pulses can be achieved, it is necessary to generate at high power and efficiency a video pulse of the shape required.

The normal line-type modulator,[2] Fig. 2, cannot generate pulses whose front and back edges slope greater than $0.2\tau^2$ without requiring negative components in the pulse forming network. It is obvious from this that a new approach is required if a pulse with sloping edges is to be generated.

The requirement for negative components really means the generation of a load current of opposite sign or negative slope to the main load current, thus subtracting from the main current and generating a pulse of sloping edges. A transformer is capable of introducing a change in sign when approximately connected as a phase inverting device—its normal connection in the standard line-type modulator—and can thus change the sign of a current component.

In this manner, the matching pulse transformer in the line-type modulator can be used as a phase inversion device to achieve sloping pulse edges[2] beyond those normally achievable without requiring the use of negative components in the pulse forming network.

The pulse then is built up by feeding network currents into both primary and secondary of the pulse transformer giving a positive or negative initial current slope at the load, depending on which side of the pulse the transformer is used, Fig. 3. Computer results proved that an acceptable approximation to a sin² pulse could be produced by two single-stage networks, one producing negative currents, used in a normal modulator. Thus two networks, both of realizable positive components, one connected to the opposite sides of a phase inverting pulse transformer to convert the network load currents into the required sign. Thus, the modulator has a new type of two-stage network connected to both sides of the pulse transformer and charged by any of the normal methods.

Design Equations Derived from Computer Calculated Results

The design equations to follow were derived from curves resulting from computer analysis and are presented as facts with appropriate comments.

Referring to Fig. 3 the following notations are used to develop the circuit equations: Let

τ = equivalent rectangular pulse width for equal energy (see paragraph on "Pulse Measurement")
Z_n = network impedance
L_1 = inductance of branch *1* of the network
L_2 = inductance of branch *2* of the network
C_1 = capitance of branch *1* of the network
C_2 = capacitance of branch *2* of the network
E = network voltage at pulse initiation
I_1 = current in branch *1* of the network
I_2 = current in branch *2* of the network
I = thyratron current during the pulse
I_c = network charging current
V = peak pulse voltage across Z_n

The inductors L_1 and L_2 must be equal, with a 1 to 1 network input transformer ratio, since for the required tangential start to the sin² pulse, the initial rate of change of current in the network branches must be equal and thus their sum at the load zero. This initial rate of change of current is determined only by the initial voltage and inductance; and since the initial voltages are equal, the inductors must also be equal.

Thus:

$$L_1 = L_2 = Z_n\tau \tag{1}$$

The capacities are chosen to keep the correct frequency ratio between the network branches.

Giving:

$$C_1 = \tau/Z_n \tag{2}$$

$$C_2 = C_{1/9} \tag{3}$$

A very important characteristic of this modulator is the relationship between E, the network voltage, and V, the pulse voltage; this is not the same as in a normal line-type modular and V is in fact greater than $E/2$ giving an advantage for high voltage designs, since the peak circuit voltages are lower than normally required.

$$V = 0.74\,E \tag{4}$$

The currents in both the network and the thyratron are shown in Fig. 4 and given by the appropriate equations.

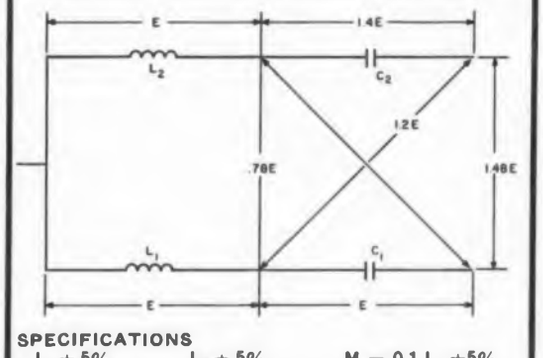
$$I_1\,(peak) = \frac{0.69\,E}{Z_n} \tag{5}$$

$$I_2\,(peak) = \frac{0.34\,E}{Z_n} \tag{6}$$

$$I_{(peak)} = \frac{0.94\,E}{Z_n} \tag{7}$$

$$I_{(mean)} = \frac{0.375\,E}{Z_n} \tag{8}$$

$$Rate\ of\ Rise\ of = I\,\frac{3.38\,I(peak)}{\tau} \tag{9}$$



SPECIFICATIONS
$L_1 \pm 5\%$ $L_2 \pm 5\%$ $M = 0.1\ L_1 \pm 5\%$
$C_1 \pm 5\%$ $C_2 = C/9 \pm 5\%$
Resulting Pulse Width Limits +5.5%-7.8%

Fig. 4. Pulse voltages developed across the modulator network components in terms of network voltage E. The maximum voltages between points during pulse generation are shown; these maximum voltages do not necessarily occur at the same time in the pulse.

2. Radiation Laboratory Series Pulse Generators Vol. 5 Page 202, Sec. 6.3

It is necessary for voltage rating reasons to know the peak voltages across the network components, Fig. 4. The peak voltages in the network can exceed E during the Pulse (see section on networks)

$$Peak\ Voltage\ C_1 = E$$

$$Peak\ Voltage\ C_2 = 1.4\ E$$

Before detailed modulator design information can be given it is necessary to know how to measure the pulse width and its peak and mean values. The use of a shaped pulse introduces many problems in the definition of pulse shape, width and other constants.

Pulse Measurements

Since it is necessary to compare the performance of a radar using a $\sin^2$ pulse to that of a normal rectangular pulsed radar, some connecting factor beneath the pulse shapes and radar performance must be used.

A rectangular pulse radar has the interesting characteristic that the rf voltage and power pulses have the same shape.

This is not true in $\sin^2$ pulse radar; the power pulse in $\sin^4$ and the voltage pulse is $\sin^2$ in shape, but since antennas are sensitive to voltage or current the transmission of a $\sin^4$ power pulse results in a $\sin^2$ voltage pulse at the antenna terminals.

Radar range depends on energy per pulse, energy being the product of power and time; to produce equal range radars then the energy contained in the pulses should be equal. Equating the energy in a $\sin^4$ power pulse with a rectangular power pulse and assuming equal power gives equal radar ranges and allows both radars to have the same value for their pulse width. The remaining problem is at what percentage pulse amplitude does the equal energy, equal peak power $\sin^4$ pulse have the pulse width of the equivalent energy equal amplitude rectangular pulse. Calculations from the computed results show that the following relationships hold:

(a) Measure pulse width of the $\sin^4$ power pulse at 0.45 of peak power.

(b) Measure pulse width of the $\sin^2$ voltage or current pulse at 0.671 of peak amplitude.

(c) Peak pulse current

$$= \frac{0.75 \text{ mean pulse current}}{\text{duty cycle}}$$

(d) Duty cycle = pulse width × repetition rate

In this manner full equivalence can be held between the radars and a reasonable measurement standard has been set up for the $\sin^2$ pulse width. As stated earlier, the reduction of spectrum associated with the equal energy $\sin^2$ pulse allows a greater percentage of the returned energy to be passed by the equal bandwidth receiver than possible with the rectangular pulse. Since receiver bandwidth choices depend on many things, this possible improvement, some seven per cent, has not been considered in the previous analysis.

Example of Medium Power $\sin^2$ Modulator Design

As an example, a medium power $\sin^2$ modulator has been chosen since this illustrates the technique without imposing unnecessary restrictions on the design. (Normal details of protection devices, etc. are not considered in this example since they follow normal practice and only complicate the system.)

Modulator Specifications

A resonant charged soft tube modulator, having as output a 30-kv $\sin^2$ pulse 10 μsec width across 500 ohms at a repetition rate of 250 pps, is required.

An orderly approach has been taken and the necessary design steps are listed in their natural order; this order will, of course, change if different restrictions are placed on the design—for example, the power supply voltage may be specified for reasons outside the modulator requirements.

$$\text{Load pulse current} = \frac{30 \times 10^3}{500} = 60 \text{ amp}$$

$$\text{Peak output power} = 30 \times 10^3 \times 60 = 1.8 \text{ megawatts}$$

$$\text{Duty cycle} = 10 \times 250 \times 10^{-6} = 2.5 \times 10^{-3}$$

$$\text{Mean output power} = 1.8 \times 10^6 \times 2.5 \times 10^{-3} = 4.5 \text{ kw}$$

At this stage, a pulse transformer ratio and efficiency must be chosen; a few rough calculations, bearing in mind the available thyratron ratings, soon lead to an estimated value for the transformer ratio. Most pulse transformers at this power level ran about 92 per cent efficient, but actual figures can be obtained from past designs. In this case a 2-1 ratio gives approximately 20-kv network voltage well within the ratings of the 5944 and larger hydrogen thyratrons.

Thus set pulse transformer ratio 2-1 at 92 per cent efficiency

Peak input power to the transformer

$$= \frac{1.8 \times 10^6}{0.92} = 1.96 \text{ megawatts}$$

Voltage input to transformer

$$= \frac{30 \times 10^3}{2} = 15 \text{ kv}$$

Network impedance

$$Z_n = \frac{V^2}{Power} = \frac{(15 \times 10^3)^2}{1.9^6 \times 10^6} = 115\ \Omega$$

Network Voltage E from Eq. 4

$$= \frac{15 \times 10^3}{74} = 20.25 \text{ kv}$$

Every thyratron has a gas drop and a value of 250 v is reasonable at this power level.

Thyratron gas drop = 250 v
Thus $E = 20.25 + 0.25 = 20.5$ kv
I *peak* thyratron current

$$= \frac{0.94 \times 20.5 \times 10^3}{15} = 167.2 \text{ amps}$$

I *mean* thyratron pulse current Eq. 8

$$= \frac{0.375 \times 20.5 \times 10^3}{115} = 66.6 \text{ amps}$$

Mean current = $66.6 \times 2.5 \times 10^{-3} = 166.6$ ma

From these figures it is possible to choose a hydrogen thyratron, and the 5959 offers a good conservative choice. Once the choice of thyratron has been made, it is necessary to check all the other ratings to insure that operation remains at a safe level.

Thyratron rating check

$rms = 167.2 \times 0.1666 = 5.27$ amps
Max. $epy \times ib \times prf = 20.5 \times 10^3 \times 167.2 \times 250 = 0.856 \times 10^9$
Anode current rate of rise = 56.6 amp/μsec from Eq. 9.

These values prove to be well within the 5949 ratings showing that a conservative choice has been made.

Having calculated the main voltage and current values throughout the modulator, it is necessary to calculate the component values required to achieve the performance:

From Eq. 1, $L_1 = L_2 = 115 \times 10 \times 10^{-6} = 1.15 \times 10^{-3}$

From Eq. 2, $C_1 = \frac{10 \times 10^{-6}}{115} = 0.087\ \mu f$

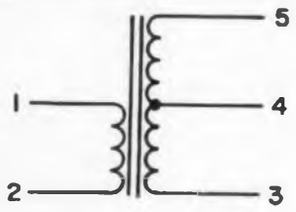
From Eq. 3, $C_2 = \frac{0.087}{9} = 0.00966\ \mu f$

C_n (Total network capacity) = $0.096\ \mu f$

Assuming the charging system to be a standard type resonant charge, the reactor and diode combination can be calculated in the normal manner.

$$L_c < \frac{1}{(\pi^2)\ (C_n)\ (prf)^2} = \frac{1}{\pi^2 \times 0.096 \times 10^{-6} \times (250)^2}$$

$L_c < 16.8$ h
Mean current (as before) = 166.6 ma
Peak charging current = $\pi/2 \times 166.6$ ma = 262 ma



SPECIFICATIONS

Open Circuit L ≥ 10L,
Leakage = 0.1 L, + 0% - 50%
Smaller Leakage Within + 0% - 20% of the Larger Leakage.

Leakage Measurement

	Measure	Short	Leakage
al	1 - 2	3 - 5	0.1 L, + 0% - 50%
bl	4 - 3	3 - 5	0.1 L, + 0% - 50%

Primary Inductance Measurement

	Measure	Open Circuit Inductance
al	1 - 2	3 - 4 - 5 ≥ 10L,
bl	4 - 3	1-2 & 3-5 ≥ 10L,

Fig. 5. Design equations for suitable pulse transformer required in a $\sin^2$ modulator.

Assuming a reasonable charging efficiency and using a multiplying factor of 1.85 gives the required dc supply voltage.

$$\text{Dc supply voltage} = \frac{20.5}{1.85} = 11.1 \text{ kv}$$

This completes the basic design of the modulator; however, tolerances and voltage ratings have to be established for the various components, and these are discussed under the appropriate headings.

Charging Choke and Diode Limitations

Tolerances for charging reactors are set by the repetition rate and network variations. These variations, however, normally result in fairly tight limits, and it is usual to set the limits by cost and manufacturing ability with a charging diode to allow looser tolerance. Reasonable values can be obtained by choosing the inductance value to be 20 per cent down from the value set by maximum repetition rate and maximum network capacity and setting a ±10 per cent tolerance on this value.

Since it is necessary to prevent saturation of the charging reactor affecting the charging cycle efficiency, the inductance value at half peak current should be within 5 per cent of the peak current.[3]

The choice of this diode depends on protective circuitry and physical requirements, but the diode must of course be capable of passing the peak and mean charging currents and be able to withstand any fault over voltage permitted by the protective circuits.

3. Radiation Laboratory Series Pulse Generators Vol. 5 Page 366, Sec. 9-3

Leakage Critical in Pulse Transformer

This transformer has to meet a vastly different requirement from the normal pulse transformer, and rectangular pulse transformer design techniques must be used with great caution. Any leakage inductance can be considered to add to the network inductance and thus be absorbed into the circuit. However, if this approach is taken the leakage must be carefully controlled, and it is usually better to reduce the leakage to a negligible value. Primary inductance cannot be specified on pulse droop considerations but must be greater than the network impedance at the minimum frequency set by the network. A value of ten times the network impedance gives good results; it is possible, of course, to reduce this ratio, but the pulse shape becomes affected.

The problem of pulse permeability requires careful consideration since an ac signal is passed through the transformer on a bias set by the mean pulse level; it is possible, however, to produce good designs without undue trouble and suggested design tolerances are given in Fig. 5.

Network Tolerance Affects Tangential End of Pulse

The peak voltage distribution and a suggested tolerance system are given in Fig. 4. It has been found in practice that the tangential end of the pulse is very sensitive to network tolerance and a very small change in a component will raise or lower this tangential part about the zero axis.

This change, however, loses sensitivity rapidly with distance from the axis and does not offer a problem in normal use.

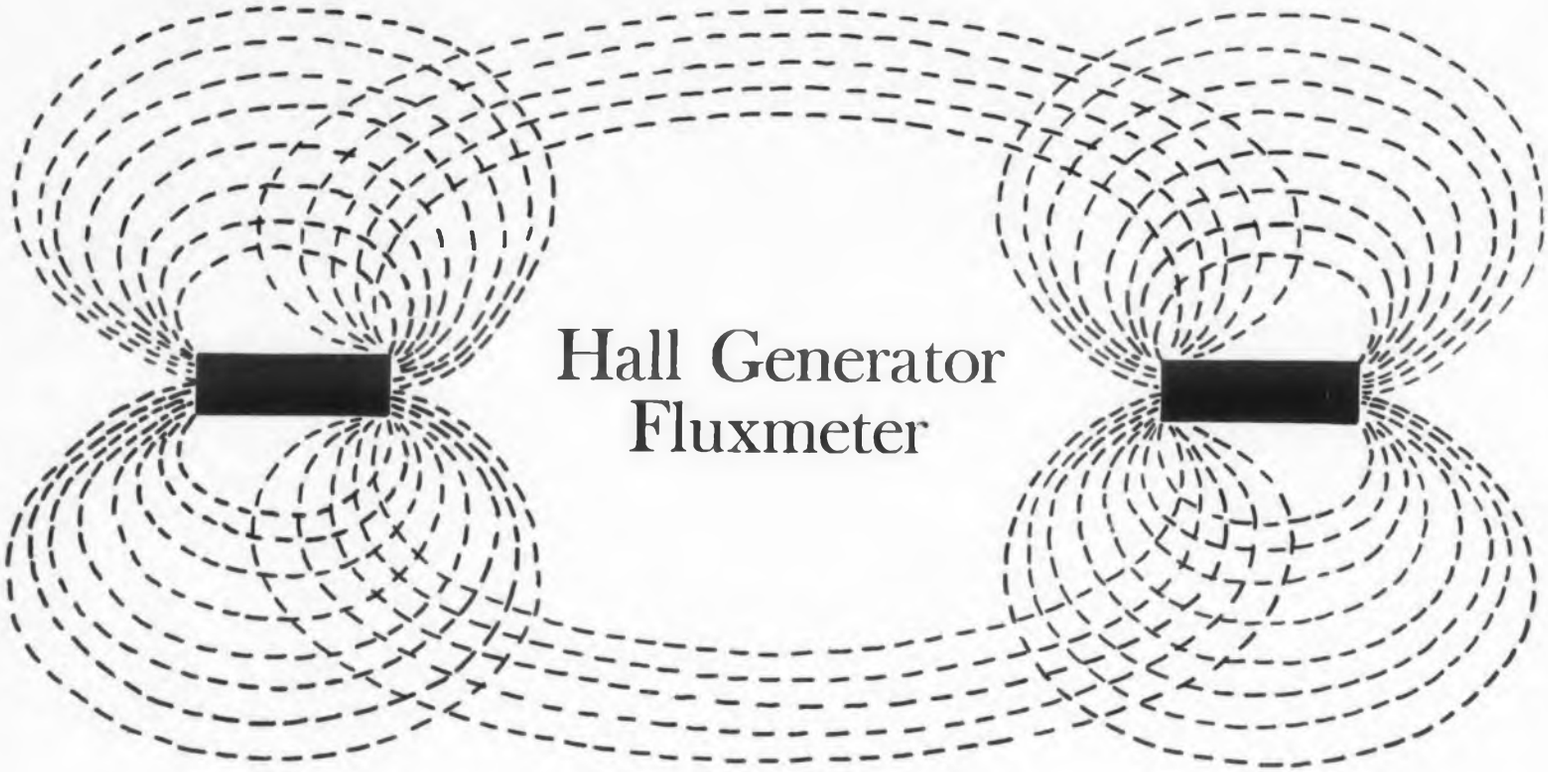
General Modulator Consideration

The basic design of hydrogen thyratron modulators is well known,[4] and thus no attempt has been made to cover any of this ground in the present article. The use of over-swing and clipping diodes follows normal practice, with the network diodes setting the charging voltage in the usual manner.

Protective devices can follow normal practice. It is not, however, possible to measure mean pulse current by means of a meter in the bottom of the pulse transformer. This follows from the modulator design in which both primary and secondary of the transformer carry network and load currents. Any mean pulse current meter must take current from the high voltage part of the secondary that carries load currents only. ■ ■

4. Radiation Laboratory Series Pulse Generators Vol. 5

5. *ELECTRONIC DESIGN* "Line-Type Modulator", I. Limansky Part I—Feb. 17, 1960 Part 2—Mar. 2, 1960 Part 3—Mar. 16, 1960



Hall Generator Fluxmeter

TWO Hall generator devices in a null balance scheme are used as a fluxmeter. This scheme, in effect, compares an unknown magnetic field with a variable calibrated reference. At the null point, the fields are equal and the unknown field is related to the reference field by the calibration. Developed at Westinghouse Electric Corp. by R. J. Radus of the materials engineering department, the project was initiated to establish equipment for accurately measuring magnetic fields in small air gaps.

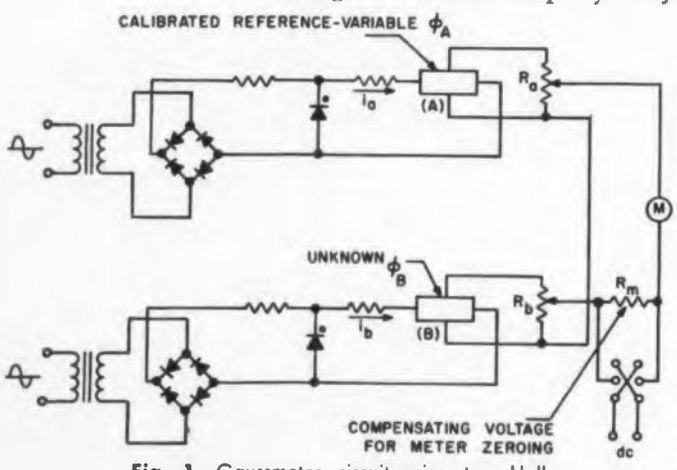


Fig. 1. Gaussmeter circuit using two Hall generators.

Circuit Description

The circuit for the null balance scheme, given in Fig. 1, shows the two Hall generators and the associated components and circuitry. The Hall generators, *A* and *B*, receive constant current signals from separate, electrical isolated sources. The outputs of the Hall generators, which are functions of the products of the current signal, i_a, and magnetic flux ϕ_a and i_b and ϕ_b, are combined in the voltage mixing resistor network. The potentiometers R_a and R_b are used to make the slopes of the output vs. $\phi \times i$ *product* identical. Differences in absolute output vs. $\phi \times i$ *product* may be balanced or compensated with an additional voltage or with spring bias in the meter. Thus, with each Hall generator being subjected to identical flux and identical current, the deflection of the meter is zero. The currents are made as identical as possible and are regulated by means of Zener diodes.

The operation of this circuit requires a variable calibrated reference, ϕ. Hence, if the Hall generators are placed, one in the reference and one in the unknown, then the reference field can be varied to obtain a balance on the meter. If the currents are identical, the balance on the meter indicates that the unknown flux has the same value as the reference flux.

A simple form of this type of circuit uses one Hall generator. This scheme shown in Fig. 2 requires that the Hall generator output from the unknown field be balanced against a variable voltage reference. The Hall generator is then put into the reference field and the reference is varied to obtain a balance. Thus, the unknown field is known to be the same as the reference field.

A model of this later type of circuit has been built and operated as a laboratory instrument. The variable reference was constructed using an XE-69 C-core with a 0.07 in. air gap. The relationship between air gap flux density and dc current in the reference coil was established

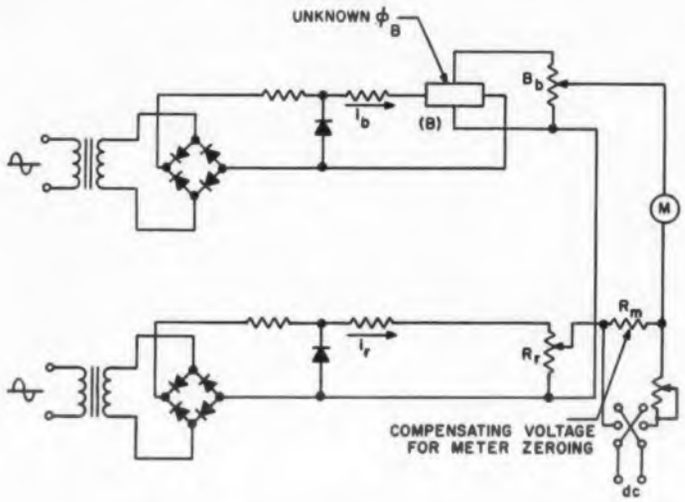


Fig. 2. Gaussmeter circuit using one Hall generator.

using a rotating coil Rawson fluxmeter type. This calibration curve is linear to approximately 7,000 gauss and extends to 9,000 gauss. Increasing beyond 9,000 gauss causes excessive heating in the coil without appreciable increase in gap flux. This upper range limit can be extended with a reference designed to minimize leakage flux. For the given core size, a reduction of leakage will mean fewer turns (re: smaller coil) and greater current. An obvious alternate solution is to design the core to take advantage of the increase in flux density that results when the cross section area is decreased. In this particular case, a reduction in area by a factor of four and the consequent increase in flux density by a factor of four is not unreasonable. This design procedure should produce a flux density in excess of 20,000 gauss in a 0.07 in. gap with a dc current of roughly 100 ma.

Application

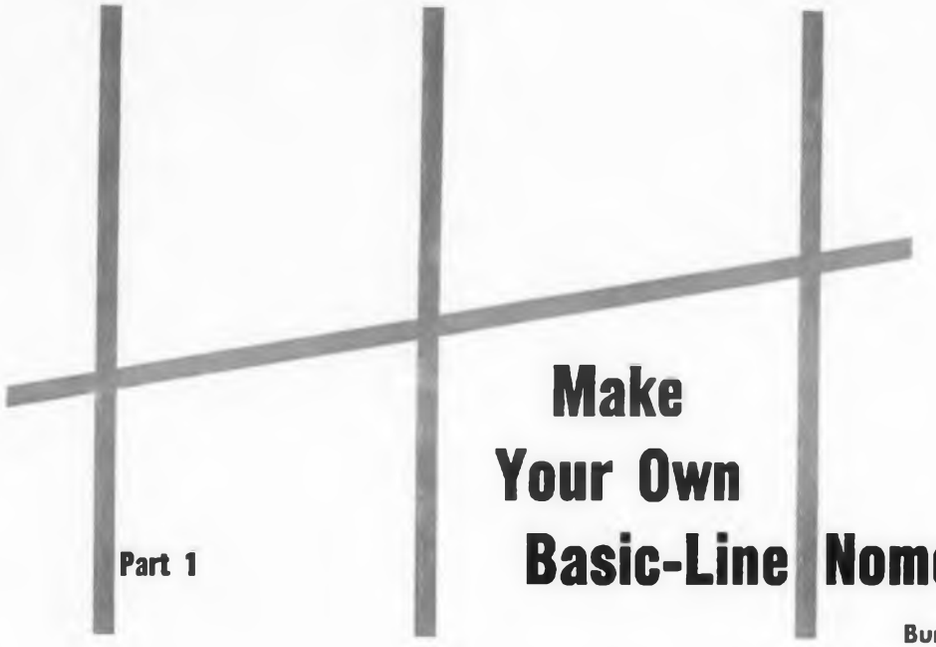
These devices are directly applicable for measuring flux densities to a maximum of 7,000 gauss. This maximum is a limit of the existing reference. Modification of the reference could readily change this maximum value to 24,000 gauss.

The single unit device functions as memory link between the unknown and a reference. The nominal error contributed by the performance of this memory link function is ±1 per cent. Extra attention to provide more precise measurements could probably reduce the error to ±0.5 per cent. Hence, the overall accuracy is roughly ±0.5 per cent in addition to the calibration accuracy of the reference.

In addition to direct application for measuring magnetic flux density, this device has been applied to take advantage of the 0.03 in. thickness in both magnetic field plotting and position detection. An existing field plotting problem concerns the uniformity of magnetic field in a small disc of barium ferrite permanent magnet. In this evaluation, the essential change of flux was produced by rotating the permanent magnet in the near vicinity of the Hall generator. Variations in the uniformity are observed on the display of a cathode ray tube.

The application to position-detection uses the symmetry of field around a bar magnet. Since the Hall generator responds only to that field which is normal to its active surface, the Hall generator can be positioned to produce either maximum output or zero output. Minimum output occurs with the probe perpendicular to the pole face. Maximum output occurs with the probe parallel with the pole face. The 0.03 in. thickness is the prime advantage in the precision of positioning. The advantage is a direct result of the small volume of flux that is sampled, instantaneously. The positioning of the Hall generator parallel with the axis of symmetry of the field is more sensitive and consequently more precise.

For flux density measurement and magnetic field plotting, the cost of the Hall Generator would not be prohibitive. ■ ■



Make Your Own Basic-Line Nomograms

Part 1

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Convair
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San Diego, Calif.

"The trouble with nomograms," according to many engineers, "is that you can't find the one you need when you need it." In this article, Burrell Hatcher supplies a simple solution to this problem—"Make your own."

Here, in the first part of a two-part article, Mr. Hatcher shows how to make addition and multiplication nomograms.

NOBODY questions the value of a nomogram in eliminating tedious, repetitive calculations. But few engineers recognize how easy it is to construct a nomogram, and fewer still realize that a nomogram can save more time than it takes to make one.

This article shows how to make nomograms for several general forms of equations. In the article, symbols like $F(x)$, $G(y)$, and $f(x)$ represent arbitrary functions of the variables in parentheses. S denotes a scale, and subscripts refer to a function. Symbols like $\overline{AD}$ refer to the straight line distance between points A and D.

The scale factor m, is defined as the length of line along an axis or scale which represents a change of one unit in the function of the variable. To illustrate, we can take two specific examples. In each case, x is allowed to vary between 10 and 150, and the desired scale length is 14 in.

Case 1. $F(x) = x$

$$m_F = \frac{14}{150 - 10} = 0.1 \text{ in.}$$

Hence, the scale $S_F = 0.1\,x$ would be laid off along the x-axis.

Case 2. $F(x) = x^{\frac{1}{2}} + 0.1x + 1$

$$m_F = \frac{14}{[150^{\frac{1}{2}}+0.1\,(150)+1] - [10^{\frac{1}{2}}+0.1\,(10)+1]}$$

$$= 0.606 \text{ in.}$$

One unit change in $F(x)$ is represented by 0.606 in. on the scale. The scale itself is given by $S_F = 0.606\,(x^{1/2} + 0.1x + 1)$. The evaluation of this expression at discrete intervals of x locates the points on the x-axis representing $F(x)$.

We may conclude that a scale factor, m_F, of a function, $F(x)$, is determined by the highest and lowest values which $F(x)$ will assume, and is given by the equation

$$m_F = \frac{L}{F_u\,(x) - F_l\,(x)}$$

where L is the desired scale length, and $F_u(x)$ and $F_l(x)$ are the upper and lower limits of $F(x)$.

Frequently the zero point for measuring scale distances does not have a convenient location, or is actually inaccessible. When this is the case, the quantities involved must be reduced by some constant so that an artificial, but more convenient, zero point may be used.

Let $S'_{F(x_l)}$ be the distance of the graduation x_l above the base line of the chart. Then the adjusted scale is

$$S'_F = m_F\,[F(x) - F(x_l)]$$

where l denotes the lowest value x will assume.

As an example of this process, assume $F(x) = 3(\log x) + 2$, where x varies between $x_l = 13$ and $x_u = 20$, and assume a scale length of 10 in. The steps involved are as follows:

$$F(x) = 3(\log x) + 2$$

$$F_u = 3(\log 20) + 2 = 3(1.3010) + 2$$

$$F_l = 3(\log 13) + 2 = 3(1.1139) + 2$$

$$m_F = \frac{10}{3\,(1.3010 - 1.1139)} = 17.82$$

$$S_F = 17.82\,[3(\log x) + 2]$$

$$S'_F = S_F - S_{F_l} = m_f\,[F(x) - F(x_l)]$$

$$S'_F = 17.82\,[3(\log x) + 2 - 3(\log 13) + 2]$$

$$S'_F = 53.46\,(\log x - 1.1139)$$

The last expression gives the distance above a base line on the x-axis which represents $F(x)$ at any value of x between 13 and 20.

In general, there are four basic types of line

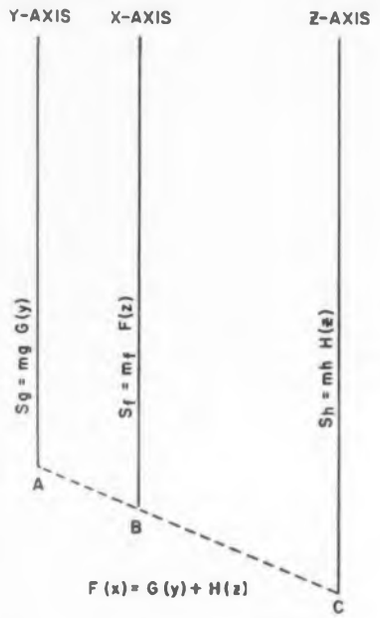

Fig. 1. Basic form of the addition nomogram.

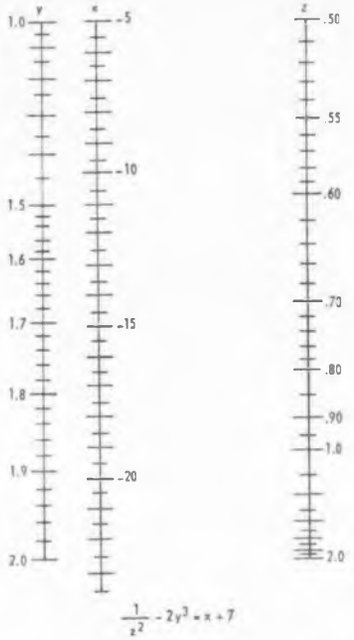

Fig. 2. Addition by nomogram. Details are in Chart 1.

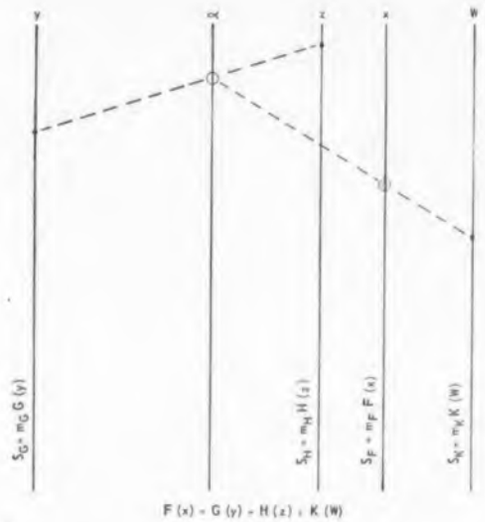

Fig. 3. Nomogram form for the addition of three terms.

nomograms. These are for addition, logarithmic multiplication, non-logarithmic multiplication, and recurring variable equations—and of course, for combinations of these.

Addition

$$F(x) = G(y) + H(z) \quad \text{(Fig. 1)}$$

On parallel y- and z-axes, one constructs the scales $S_G = m_G G(y)$, and $S_H = m_H H(z)$, starting from any base line $\overline{AC}$, and choosing convenient scale factors. $\overline{AC}$ is usually chosen so that the axes are either centered on a common horizontal line, or start on a common horizontal line. Parallel to these axes, the x-axis is spaced so that $\overline{AB}/\overline{BC} = m_G/m_H$. The scale factor for the $F(x)$ scale is given by:

$$m_F = \frac{m_G m_H}{m_G + m_H}$$

The $F(x)$ scale is then given by $S_F = m_F F(x)$.

For addition, the $H(z)$ and $G(y)$ scales increase in the same direction. For subtraction, $F(x) = G(y) - H(z)$, they increase in opposite directions.

An addition nomogram is shown in Fig. 2. It has been constructed for the equation $1/z^2 - 2y^3 = x + 7$. The variable "y" has the range 1 to 2 and "z" varies between 1/2 and 2. Chart 1 gives the computations in detail for an assumed scale length of 6 in.

A nomogram of an equation of the form $F(x) = G(y) + H(z) + K(w)$ can easily be made by superimposing two addition charts. First, one constructs a chart for $\alpha = G(y)$ and $H(z)$. The α-scale need not be calibrated. Then one constructs a chart for $F(x) = \alpha + K(w)$, as shown in Fig. 3. Appropriate scale factors are given by:

$$m_\alpha = \frac{m_G m_H}{m_G + m_H} \quad \text{and} \quad m_F = \frac{m_\alpha m_K}{m_\alpha + m_K}$$

A special case of the addition nomogram arises when the equation is of the form

$$\frac{1}{F(x)} = \frac{1}{G(y)} + \frac{1}{H(w)}$$

This equation may be charter in the usual manner, using three parallel axes with reciprocal scales, and letting

$$F'(x) = 1/F(x), G'(y) = 1/G(y), \text{ and } H'(z) = 1/H(z).$$

However, it is often more convenient to use the chart with three concurrent axes as shown in Fig. 4. Here $\overline{AB} = m_G G(y)$, $\overline{AD} = m_H H(z)$, and $\overline{AE}/\overline{EC} = m_H/m_G$. $\overline{EC}$ is measured along a line parallel to the y-axis, $\overline{AC}$ then becomes the x-axis. An auxiliary scale, $\overline{AE} = m_H F(x)$, is laid off along the z-axis, and projected to the x-axis by lines parallel to $\overline{CE}$. The auxiliary scale may then be erased.

When the angle between the y- and the z-axes, $(\alpha + \beta)$, is chosen to be 120 deg, and is bisected by the x-axis, the three scales may all be calibrated directly, using $S_G = m_G G(y)$, $S_H = m_H H(z)$ and $S_F = m_F F(x)$. The scale factors are deter-

$\frac{1}{z^2} - 2y^3 = x + 7$

$M_H = \frac{6}{\left(\frac{1}{5}\right)^2 \left(\frac{1}{2}\right)^2}$

$M_H = 1.60$ IN.

$H = \frac{1}{2} = .25$

$S'_H = 1.6 \frac{1}{2} = .25$

$M_F = \frac{1.60 \quad .428}{1.60 + .428} = 0.338$

$F_x = -22.75 - 7$

$S'_F = .338 (x - 22.75)$

$\frac{AB}{BC} = \frac{M_G}{M_H} = \frac{.428}{1.60}$

$AB + BC = 3$

$\therefore AB = 0.633$ IN.

L = 6" W = 3"

$0.5 \le z \le 2.0$

$1.0 \le y \le 2.0$

$M_G = \frac{6}{-2 + 2\,(2)^3}$

$M_G = 0.428$ IN.

$G_x = 2\,(2)^3 = 16$

$S'_G = 0.428\,(16 - 2y^3)$

$S'_G = 0.856\,(8 - y^3)$

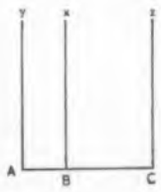

Chart 1. Detailed Computations and Assumptions for Nomogram of Fig. 2.

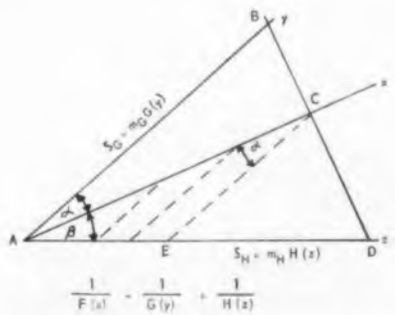

Fig. 4. A convenient nomogram for adding reciprocals.

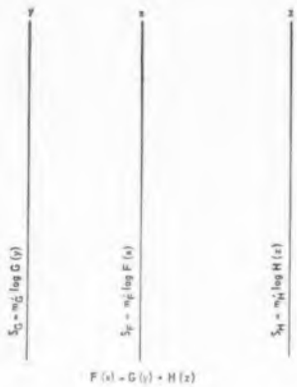

Fig. 5. Basic form of the logarithmic multiplication nomogram.

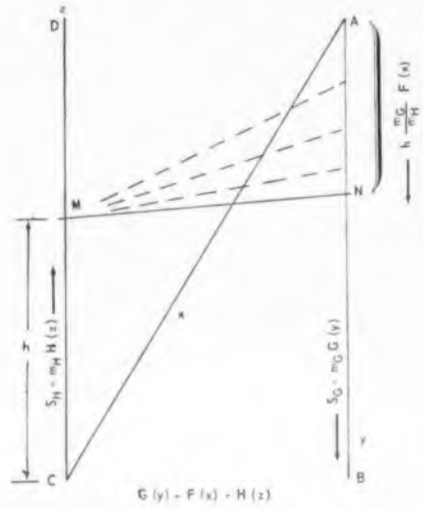

Fig. 6. Basic nomogram form for non-logarithmic multiplication.

mined in the usual manner.

When the angle $(\alpha + \beta)$ is chosen to be 90 deg, the scales may also be calibrated directly, determining m_H and m_G in the usual manner and determining m_F from the relation $m_F = m_G^2 + m_H^2)^{1/2}$. The x-axis is located by the relationship

$$\tan \beta = \frac{m_G}{m_H}.$$

Logarithmic Multiplication

$$F(x) = G(y) \cdot H(z) \quad \text{(Fig. 5)}$$

The multiplication indicated may be converted into an addition problem by taking logarithms

$$\log F(x) = \log G(y) + \log H(z).$$

The three parallel axes then bear the scales $S_G = m'_G \log G(y)$, $S_F = m'_F \log F(x)$, and $S_H = m'_H \log H(z)$ respectively. The scale factors and spacing are determined exactly as in the addition case, taking as new variables $F'(x) = \log F(x)$, etc.

For multiplication, the $G(y)$ and the $H(z)$ scales increase in the same direction, as do the C and D scales on a common sliderule. For division, they increase in opposite directions, as do the D and CI scales on a slide rule. As before, the product of three functions, $F(x) = G(y) \cdot H(z) \cdot K(w)$, is simply a matter of superposition of two additional logarithm charts.

Non-Logarithmic Multiplication

$$F(x) \cdot H(z) = G(y) \quad \text{(Fig. 6)}$$

Although slightly more difficult to prepare, multiplication charts not involving logarithms, present the advantage that they may more easily be combined with other types of charts.

On parallel axes, the scales $S_G = m_G G(y)$ and $S_H = m_H H(z)$ are laid out in opposite directions.

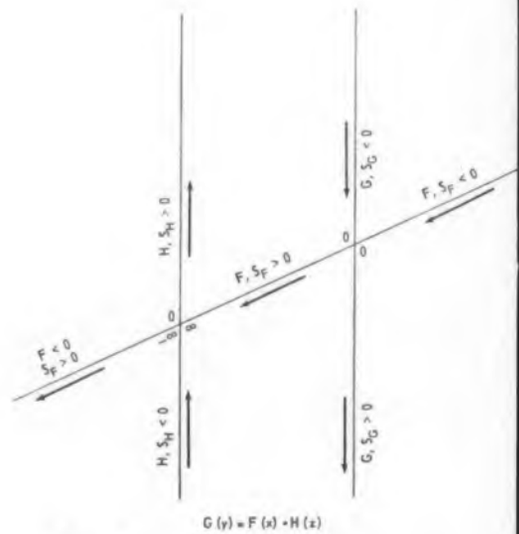

Fig. 7. Scales can be extended for negative values of functions.

The zero points, A and C, of the functions $G(y)$ and $H(z)$ respectively, are connected to form the x-axis. A point M is then chosen on the z-axis, a distance h above the zero point of $H(z)$.

The auxiliary scale

$$\overline{AN} = h \frac{m_G}{m_H} F(x)$$

is constructed on the y-axis, starting at the zero point of $G(y)$. The $F(x)$ scale is then constructed on the x-axis by projecting the auxiliary scale from the point M as shown by the dashed lines in Fig. 6. The auxiliary scale can then be removed.

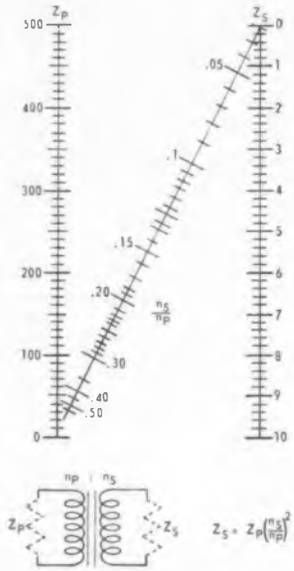

Fig. 8. Nomogram for non-logarithmic multiplication. Details are in Chart 2.

$$z_S = z_p \left(\frac{n_S}{n_p}\right)^2$$

$0 \le z_S \le 10$

$0 \le z_p \le 500$

$L = 10$

$W = 5$

$m_p = \frac{10}{500} = .02$ $\qquad$ $m_S = \frac{10}{100} = .1$

$S_p = .02\, z_p$ $\qquad$ $S_S = .1\, z_S$

$K = \sqrt{10^2 + 5^2} = 11.18$

$$S_n = \frac{11.18\left(\frac{n_S}{n_p}\right)^2}{\frac{.02}{.1} + \left(\frac{n_S}{n_p}\right)^2} = \frac{11.18\,N^2}{.02 + N^2}$$

OR $\overline{AN} = 5\,\frac{.1}{.02}\,N^2$ $\qquad$ $(h = 5)$

$\overline{AN} = 25\,N^2$

Chart 2. Detailed Computations and Assumptions for Nomogram of Fig. 8.

If desired, the x-axis may be calibrated directly, the equation for the scale being

$$S_F = \frac{K \cdot F(x)}{\frac{m_H}{m_G} + F(x)}$$

where K is the length of the diagonal and S_F is measured along the diagonal starting at point A.

The usefulness of this type of diagram may be extended to the use of negative values, as shown in Fig. 7. An example of the non-logarithmic multiplication chart is shown in Fig. 8, the calculations for which are in Chart 2. ■ ■

Infrared Transmitting Materials

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Author Tom Lusk is an authority on infrared transmitting materials. To prove it, he sat down and in one evening wrote the up-to-date information contained in this article. Here, he discusses all of the material presently available to the IR design engineer.

ALMOST EVERY device which employs infrared radiation, whether it's a Sidewinder missile or a laboratory spectrometer, requires that the infrared radiation pass *through* some solid component of the system. In a laboratory spectrometer, the window protects the detector or the prism which disperses the radiation into its component wavelength. For a missile, the infrared transparent material could be the dome which encloses the system, the lenses, filters, windows, chopping reticles, or any combination of these.

The one basic, common requirement for all these components is that they transmit as much incident radiation as possible of wavelengths at which the system operates. Of the many materials which transmit significant amounts of infrared radiation, most of them are suitable only for laboratory use in normal or controlled environments. There are few materials available in the necessary sizes or with the physical characteristics required for field or military applications where elevated temperatures, mechanical abrasion and shock, moisture, thermal stresses, and so forth, are encountered.

Required Properties

A few of the properties to be considered when selecting infrared transmitting material are given in the accompanying chart which lists the more common materials. If the material is to be used for the more mundane applications such as spectrometer prisms and windows, dispersion and transmission are the most important characteristics. For example, sodium chloride and calcium fluoride are commonly used as prisms, because they transmit a high percentage of the incident radiation, possess good dispersive qualities, and have no absorption bands in their useful wavelength region. They are soft and hydroscopic, and are unsuitable for field work where they are exposed to abrasive particles and moist atmosphere.

For more exact applications, such as the nose dome of a supersonic missile which protects the missile's infrared guidance system, materials must meet much higher requirements. The material is often required to withstand elevated temperatures and still retain its shape, rigidity and optical properties. It cannot lose its transmission qualities at high temperatures such as germanium does at about 250 C, nor can it emit too much radiation of its own when it is heated. Such self-emission of infrared radiation would effectively blind the system behind the material. A desirable trait is that the material transmit a constant and high percentage of the incident radiation in the wavelength region in which the system works. That is, it should not absorb radiation at any wavelength in the working range.

The material for a missile or aircraft dome must be as hard as possible so that at high speeds it will not be scratched by the dirt and ice particles through which the craft may pass. Scratches on the surface can scatter the incident radiation to such an extent that very little of it will pass through the dome to the detector.

Some materials, such as salts, will absorb moisture from the atmosphere to such an extent that they become cloudy and lose their ability to transmit radiation. This, of course, is intolerable in a material that must be exposed to rain, humid atmospheres or salt water spray. Generally, it may be said that a solubility greater than 10^{-4} gm/100 gm of water cannot be tolerated.

Thermal shock characteristics are important in selecting an infrared transparent material for airborne domes. Often a dome, heated to high temperatures by air friction, will be suddenly cooled many degrees in a few seconds. The material must remain undamaged in any way by such a change in temperature. Both sapphire and quartz stand up well under thermal shock.

Size Limitations

The maximum available size often is an im-

ortant design consideration. Optical grade magesium oxide, for example, is obtainable in crysls only two inches in diameter. This is obviously o small for an application which calls for a six ch diameter dome. Small pieces can often be ined together to form larger pieces, but the terfaces usually block and scatter the incident diation to such an extent that a segmented dome nnot be used, unless the individual pieces are rge enough so that only a few are required. lso, from an optical point of view, it is better at the dome be constant radius of curviture nd not composed of flat segments.

The cost of such materials is usually of great nportance. For instance, silicon has many derable properties, but one 6-in. hemispherical ome may cost about $2000, and sometimes more. n equivalent quartz dome is less expensive, but uartz does not have the long wavelength transission of silicon. Less costly domes may be made f amorphous glass such as Corning #0160 or yrex, but at the expense of transmission and hysical properties.

Reflection Losses

Many of the infrared transmitting materials hich are suitable for military applications transit less than 80 per cent of the incident radiation. n most cases the loss is primarily due to Fresnel eflection at the surface of the material. For wavengths in the micron region, for normal angles of cidence and a single surface, the reflection from e surface of a transparent material is approxiately given by:

$$r = (n_2-n_1)^2/(n_2+n_1^2) \quad (1)$$

here n_1 and n_2 are the index of refraction of wo adjacent media. When the first medium is r, the equation becomes:

$$r = (n_2-1)^2/(n_2+1)^2 \quad (2)$$

When radiant energy passes completely through media, Fresnel reflection occurs at both surces, but due to multiple internal reflections, the otal reflection is not twice Eq. 1. However, the otal reflection may be approximated by:

$$R = 2r(r+1) \quad (3)$$

From Eq. 1 it may be seen that a materal like germanium which has a high refractive ndex (about 4) has very high reflection losses. In he case of germanium, this accounts for about a 3 per cent drop in transmission.

Fortunately, such reflection losses can be reatly reduced by applying the appropriate oating to the material. For maximum reflection eduction, the refractive index of such an antieflection coating should be equal to the square oot of the substrate index. Since the index of ubstances varies with wavelength, an anti-reflecion coating can be optimized for one wavelength nly. However, this is usually sufficient to give an appreciable increase in total transmission over a region several microns wide. Combinations of coatings can increase the width of this region somewhat.

As an example, 1/4 inch thick germanium of 34.6 ohm-cm resistivity, has 50 per cent transmission at 4 microns. With the appropriate coating, the transmission can be raised to about 93 per cent at 4 microns. Over the region of 3 to 5 microns this raises the transmission from 50 per cent to more than 80 per cent.

Silicon monoxide and zinc sulfide provide good coatings for germanium while tungsten oxide and aluminum fluoride are suitable for arsenic trisulfide and magnesium fluoride.

Filter Materials

The requirements for infrared transparent materials for applications other than domes or windows are not as severe as previously noted. Filters, for example, even if used in supersonic missiles, are not subjected to abrasive atmospheres and therefore need not be particularly hard. Also, filters, in most applications, are less than an inch in diameter. These two properties alone allow the use of many materials which are not suitable for domes.

Filters can be deposited on most of the infrared transmitting materials; CaF_2, MgO, As_2S_3, mica, calcium aluminate and so forth. The substrate of most filters is merely glass. Very thin pieces such as microscope cover glass, will transmit well beyond 4.5 microns. For the far infrared, calcium chloride and silver chloride are usually used as a substrate. Sapphire is used, but is not recommended because of the difficulty in obtaining good adhesion of the films. Germanium and silicon are usually not employed as substrates because of the unfavorable effect on present filter design of their high refractive indexes.

There are two general classes of filters: band pass and long-wavelength pass filters. Band-pass filters transmit a band of wavelengths sharply bounded on each side by an extended region of high reflectance and hence, low transmittance. They are usually designed to pass a wavelength region one micron or less in width.

Long-wavelength pass filters transmit radiation of all wavelengths above the cut-off region of the filter. The short wavelength transmission limit is determined by the infrared absorption of the substrate on which the filter coatings are deposited. Below the filter cut-off, there is an extended background region of high reflectance which may merge with the absorption region of the filming materials.

In some applications it is desirable to eliminate from the system the infrared radiation of the sun. Since 93 per cent of the solar radiation lies below 1.8 microns, a piece of anti-reflective coated germanium may be used as a blocking filter, since germanium has a sharp short-wavelength cutoff at this wavelength. Silicon might also be employed for this purpose, but its shortwave cutoff, although sharp, is at 1.2 microns. Indium arsenide, with a short-wavelength cutoff at about 3.5 microns may be used for similar applications.

The selection of any particular material depends on the proposed use. Arsenic trisulfide has fairly good transmission properties, but is rather soft and starts to deform at 195 C. Sapphire is excellent where the physical requirements are severe, but it is not commercially available in domes over 4-1/2 inches in diameter and is somewhat expensive. Silicon has good physical characteristics and transmits well to 20 microns. However, it loses most of its transmissive qualities at 350 C. Quartz is also a good dome material, but it has a long wavelength cut-off at approximately four microns. Silver chloride deteriorates when exposed to ultraviolet radiation, although it can be coated to reduce this effect. Sodium and potassium chloride and calcium fluoride are much too soft and hydroscopic.

In short, a material is needed with the transmission of potassium chloride or KRS-5 and the physical properties of sapphire at the cost of glass.

Typical Useful Materials

Following are brief accounts on some of the more interesting aspects of several infrared transmitting materials which find military and field applications. These comments by no means cover all the important properties of the material nor do they cover all the materials available.

Arsenic trisulfide ***(As_2S_3).*** Arsenic trisulfide in its solid form is a true glass. It is a supercooled liquid of high viscosity. It is manufactured by purifying As_2S_3 by distillation; the powder is heated in a large boat which is tipped in such a way that the condensed liquid leaves the hot zone of the furnace solidifying it into a block of glass. A slow stream of H_2S is passed through the distilling furnace. Since the coefficient of expansion of As_2S_3 is rather high (210^{-5} per deg C at room temperatures), the melt does not stick to certain glasses or quartz and the solidified block can be easily removed from a mold after cooling.

Because the index of refraction of this material is high (2.4 at 3.3 microns), it is necessary to employ anti-reflective coatings. The American Optical Company has done considerable work with such coatings for As_2S_3, and has made measurements and calculations of the transmission of this material coated with various materials ($ThOF_2$, SiO) at different angles of incident radiation.

The absorption of this material is somewhat dependent upon the method of manufacture and

Infrared Transmitting Materials *continued*

MATERIAL		TRANSMISSION: THICKNESS MM	TRANSMISSION: UNCOATED-ROOM TEMPERATURE WAVELENGTH MICRONS 2 4 6 8	TEMPERATURE °C: MELTING	TEMPERATURE °C: SOFTENING OR DEFORMATION	HARDNESS: MOH	WATER ABSORPTION: ROOM TEMPERATURE	INDEX OF REFRACTION: WAVELENGTH MICRONS 2	INDEX OF REFRACTION: 6	INDEX OF REFRACTION: 10	DENSITY gm/cc	COEFFICIENT OF LINEAR THERMAL EXPANSION: TEMPERATURE RANGE °C	COEFFICIENT OF LINEAR THERMAL EXPANSION: x 10⁻⁶/°C	YOUNG'S MODULUS x10¹¹ DYNES/cm²	MAXIMUM DIAMETERS AVAILABLE AS OF 1/59
As_2S_3	ARSENIC TRISULFIDE	4	12μ →	300	195	2	LOW	2.423	2.398	2.380	3.20	24	26	1.6	DOMES - 12"
Al_2O_3	SAPPHIRE	2		2030		9	0	1.750	1.746		3.98	50	5.0-6.7	34.4	DOMES - 3 1/2" DISKS - 5 1/4"
Si	SILICON (1)	6.4		1420	1300	7	0	3.452	3.420	3.418	2.33	10-50	4.2	1.09	DOMES - 6" DISKS - 6"
SiO_2	QUARTZ (2)	10		1750	1585	7	0	1.438			2.20	20-320	0.56	0.68	DOMES - 14" DISKS - 18 1/2"
	CORNING #0160	2			610	2-3	0	1.56			3.05				PLATES - 6 1/2" x 6 1/2" x 11/32"
$SiO_2 \cdot B_2O_3 - Na_2O \cdot Al_2O_3$	PYREX CORNING #7780	5			820	6	0	1.46			2.23	0-300	3.2	6.76	LARGE SIZES
MgO	PERICLASE	5.4		2800	2000	5	LOW	1.709	1.597		3.58	0-1000	13.9	25.1	DISKS - 2"
CaF_2	FLUORITE	3.3		1360		4	MODERATE	1.424	1.386	1.300	3.18	0-100	19.5	7.6-14.5	CRYSTALS - 6" x 5" HIGH
Tl Br-I	KRS-5 (3)	2	70μ →	414.5		2	HIGH	2.396	2.379	2.376	7.37	20-200	58	1.6-2.5	CRYSTALS - 5" x 3 1/2"
CF_2 - CFCl	KEL-F	6.3			260	~1 (4)	0	1.43			2.12	20-150	54.5		A PLASTIC AVAILABLE IN LARGE SIZES
KCl	SYLVITE	12	20μ →	776		0.5	HIGH	1.475	1.468	1.457	1.98	(-50)-200	37	3.5	CRYSTALS - 7 1/2" x 5" HIGH
TiO_2	TITANIA	6		1825		7	0	2.4			4.25	40	7.1-9.2		CRYSTALS - 5/8" x 1 1/2" HIGH
Ag Cl	SILVER CHLORIDE (5)	12.7	25μ →	475		1.3	HIGH	2.006	1.994	1.980	5.56	(-50)-100	3.1	1.6-2.0	CRYSTALS - 3 3/4" x 5 HIGH
Ge	GERMANIUM	6.4	~30μ →	958	500	6	0	4.116	4.012	4.005	5.3	20-100	7		DISKS - ~6" DOMES - 4 1/2"
$CaAl_2O_4$	CALCIUM ALUMINATE	4		1600	790	6	HIGH	1.635			3.67	20-400	8.4	10.5	DOMES - 10"
MgF_2	MAGNESIUM FLUORIDE (EASTMAN KODAK)	2.5		1396		6	VERY LOW	1.371	1.300		3.18	0-649	18.7		DOMES - 2.6"

(1). 10 OHM-CENTIMETER (2). GENERAL ELECTRIC (3). TOXIC WHEN WORKED (4). ROCKWELL R-SCALE = 111-115 (5). AFFECTED BY UV

The transmission curves on this chart are based on 100% transmission as the full height of the line. The numbers inserted in some of the curves indicate the long wavelength cutoff.

Hardness is given in the MOH scale, diamond = 10, sapphire = 9, topaz = 8, quartz = 7, fieldspar = 6, apatice = 5, fluorspar = 4, calcite = 3, gypsum = 2 and graphite = 1. Each can be scratched by the materials with higher numbers.

When water is absorbed by a material, the infrared transmission is reduced. The effect is an over-all transmission loss and the appearance of water absorption bands at the appropriate wavelengths, such as the one shown at 3-microns for calcium aluminate. Usually, materials can be coated to prevent or reduce the effect. The notations in this column apply to the glass or crystalline form of the material.

The last column gives the maximum diameters of disks and hemispherical domes available from various suppliers as of January, 1959. Some materials such as pyrex and IR-2 glass are restricted mainly by the manufacturers current equipment size. Others, such as silicon and germanium are restricted by the manufacturing process and may, eventually, be available in larger sizes.

the sulfur content, and can vary from melt to melt. The absorption beyond 8.5 microns is due almost entirely to sulfur.

Thermal shock characteristics of As_2S_3 are good. A 1/4 in. thick disk at room temperature has withstood a 500 C air blast on one side for more than 30 seconds without damage.

Synthetic sapphire (Al_2O_3). Synthetic sapphire is produced by dropping fine particles of aluminum oxide onto a small pedestal in a furnace. A stalagmite-like crystal is built up as the droplets solidify on the cooler parts of the furnace. The boule thus produced is cut into synthetic gems or fabricated by diamond grinding.

Sapphire withstands thermal shock extremely well. A large sapphire shape has withstood heating to 400 C in 100 seconds without damage. A disk 1/8 in. thick can withstand the thermal shock of being placed into a 1000 C argon atmosphere furnace. Annealed pieces can be cooled in air from 500 C.

Domes and windows of sapphire 4-1/2 in. and 5-1/2 in. respectively are now being produced commercially. This size somewhat limits the applications of this material. However, it is possible to bond or weld together small pieces to form large shapes. But since the sapphire crystal is anisotropic, the orientation of the crystal axis must be considered, and it is difficult to obtain large pieces with a specific orientation. This means that properly orientated pieces must be cut from disks about 1 in. in diameter. As many as 150 pieces must be cut and joined to form a meniscu dome 6 in. in diameter, making the cost of such a dome almost prohibitive. It also introduce many interfaces which effectively reduce the tota transmission of the shape.

Silicon (Si). Silicon is available as an infrare radiation transmitting material in two forms: sin gle and poly-crystal. Physical properties an transmission characteristics are nearly identica for both types. The difference is in the method o fabrication of elements. The size of elements tha can be gouged and ground from a single-crysta material is limited by the size of crystal that ca be grown about 10 in. in diameter, while, i theory, polycrystalline silicon can be cast int almost any size and shape desired. Hemispherica

polycrystalline domes approximately 5 in. in diameter have recently been produced. Both forms of this material are rather expensive, but the price is dropping fairly rapidly.

The infrared transmission of silicon is somewhat dependent upon the purity of the material and the operating temperature of the silicon element. It has been found that a purity equivalent to about 5 to 10 ohm-cm resistivity is the most practical level for transmitting semiconductor-grade single crystal silicon. Any increase in purity above this value does not appreciably increase the transmission, but does increase the cost.

Silicon begins to lose its transmissive ability at elevated temperatures, until at about 350 C, the percent of transmitted infrared radiation has dropped below the useable level. This somewhat precludes its application to supersonic, extended flight vehicles.

Germanium (Ge). The transmission of germanium in the 3 to 11 micron region is less than 50 per cent, although it is fairly constant in this range. This low transmission is due primarily to Fresnel reflection losses and can be increased to better than 90 per cent by appropriate coatings, such as selenium. Beyond 11 microns true lattice absorption is predominate and the transmission curve falls off fairly rapidly toward 28 microns. Polycrystalline germanium, like polycrystalline silicon, has approximately the same transmission characteristics than single crystal material. Also like silicon, the transmission of germanium is profoundly effected by elevated temperatures so that at 260 C the material has almost ceased to be useful.

Purity has a definite effect on the transmission of germanium. And again like silicon, there is an approximate upper purity limit above which there is no appreciable increase of transmission with increasing purity. But this limit is high, being equivalent to a resistivity of about 35 ohm-cm.

Germanium is grown primarily for use in electrical components and is therefore made in fairly small crystals. It can, however, be grown in larger crystals from which disks 4 to 4-1/2 in. in diameter can be cut. It is entirely feasible to produce crystals 6 to 6-1/2 in. in diameter from which domes could be formed. Technology is rapidly proceeding in that direction.

Calcium aluminate ($CaAl_4O_7$). The transmission of calcium aluminate varies considerably depending upon the method of manufacture. This accounts for the discrepancies among the transmission curves of the various manufacturers. A large water absorption band at about 2.9 microns also effects the transmission considerably, although it has been reported that this band can be removed or considerably reduced. Because of this water absorption band of this material, $CaAl_2O_4$ finds limited application in military uses and will probably be replaced in the near future by certain infrared transmitting glasses.

Quartz (SiO_2). From the standpoint of terminology, "fused quartz" and "fused silica" are identical. Quartz is the mineralogical derivation and silica is the chemical derivation. Usually, fused quartz refers to the transparent form, while fused silica is used as the basic description for translucent or opaque forms. Silica glass, vitreous silica and vitreous quartz are other terms frequently employed.

Chemically, fused silica is silicon dioxide (SiO_2) in the order of 99 per cent purity. It is non-crystalline, homogeneous and most commonly produced from Brazilian rock crystal (for the transparent material) or pure silica sand (for translucent or opaque material).

Fused quartz may be subjected to sudden and extreme temperature changes or shock without danger of breakage. This is primarily due to its very small coefficient of expansion. It may be dipped in cold water while still red hot. Fused quartz is also virtually free from thermal hysteresis and does not suffer permanent deformation when subjected to a temperature cycle. It may be also subjected to radiation of 10^9 roentgens of cobalt 60 without effect, although a slight bluish tint, together with a loss of transmission in the ultraviolet occurs at 1.4×10^{10} roentgens.

Because of its high softening temperature, resistance to thermal shock and hardness, quartz finds many applications. Its infrared uses are somewhat limited by a long wavelength cutoff at about 4 microns. However, its low refractive index (low reflection losses) and negligible absorption give it good transmission below this wavelength. Meniscus domes 14 inches in diameter and 18-1/2 inch disks can be formed of crystal quartz.

Magnesium Fluoride (MgG_2). Magnesium fluoride may be compacted to form a very good infrared transmitting material. It transmits well past 8 microns with a long wave-length cutoff at about 10. Because of its ceramic-type composition there is excessive scattering in the visable region. This scattering decreases rapidly toward longer wavelengths and is reported to be negligible beyond approximately 1 micron. The 2.6 inch maximum diameter domes that can currently be produced limit somewhat the application of this material, but work is being done to produce domes up to 5 inches in diameter.

Silver chloride (AgCl). Silver chloride finds its main application in laboratory work, as an infrared optical material in the 3 to 20 micron range it is readily shaped under pressure, and is available either as a powder or in large sheets. In the above spectral region its dispersion is very low and its absorption is negligible. It is very soft, reacts chemically with many of the common metals and alloys and breaks down into its compounds when exposed to wavelengths shorter than 0.45 microns.

In order to reduce the effect of ultraviolet radiation (i.e. to prevent the absorption of ultraviolet radiation by AgCl) a coating of antimony trisulfide (Sb_2S_3) may be evaporated onto the silver chloride at a pressure of 10^{-4} millimeters of mercury. At an optical thickness of 7/4 wavelengths at 0.625 microns, such a layer absorbs all radiation completely below 0.470 microns. Therefore, it allows no photochemically active light to penetrate the silver chloride and darken it. A test made with a sample coated in this way, in which a General Electric S-1 sunlamp was placed 7 inches from the sample, showed that after 456 hours of exposure the transmission in the 1 to 13 micron region had dropped about 9 per cent, whereas an uncoated sample was completely opaque in this region after only 72 hours. Gilsonite may also be used for coating where stibnite might be impractical.

However, the application of such a protective coating reduces the overall transmission by approximately 4 per cent. It is necessary to apply an antireflection coating to raise the transmission to about the original values. A satisfactory antireflection coating is hydrogenated polystyrene, which transmits well at all wavelengths except 3.4 to 3.5 and 6.9 to 7.0 microns. It can be applied by pouring a solution of this plastic onto a rapidly rotating silver chloride disk. This method gives a coating of uniform thickness. The thickness of the coating depends on the rate of spin, viscosity of the solution and vapor pressure of the solvent. This coating also provides a good protection for the rather hydroscopic AgCl.

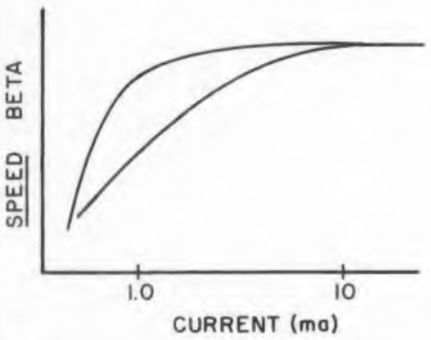
Silver chloride finds limited application outside the laboratory.

Other New Materials

Technology is proceeding rapidly toward larger sizes of existing materials, and toward some entirely new infrared transmitting materials. For example, in the past few months silicon domes have increased in size from 6 to 10 in. in diameter. Sapphire, until recently restricted to 3-1/2 in. commercially available domes (5-1/2 in. in the laboratory) is now readily obtainable in 4-1/2 in. domes, and should, within a year, be available in 7-in. hemispheres.

Magnesium fluoride is a recent breakthrough in new materials. Two new infrared transmitting amorphous glasses are well developed in the laboratory and research-development is underway on infrared transmitting ceramics. At least three promising materials have been produced experimentally by General Electric laboratories and others are being explored. The field is still wide open for new and better infrared transmitting materials. The need is great. ■ ■

Micro-Energy Transistor Switches Even Low Power—Fast

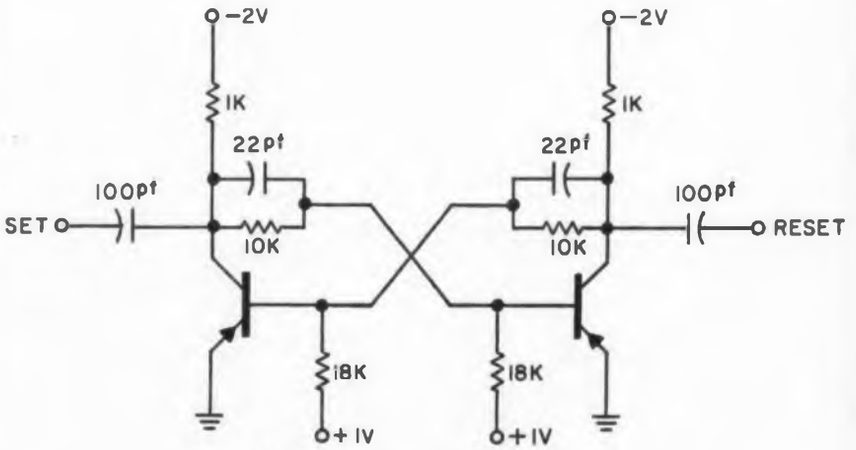


Beta and rise time both fall off rapidly below about 10 ma with conventional switching transistors (solid line). With micro-energy switch, they stay up to about 1.0 ma.

ANSWERING a need for high-speed low-current switches, a new transistor offers high switching speeds at voltages as low as 1 v and currents as low at 1 ma.

Where most high-speed switching transistors require collector voltages of from 6 to 10 v, and currents of 10 ma, the new device, though it can handle these levels, can also switch at low voltage and current levels bordering on those associated with the tunnel diode.

Developed by the Lansdale Div. of Philco Corp., this micro-energy switch allows high-speed logic circuits to consume a third of the power required with conventional switching transistors. This



Typical flip-flop dissipates less than 6 mw using micro-energy transistor switch. Voltage drop across transistor when conducting does not exceed 120 mv.

reduced power requirement allows for much denser computer packaging than has heretofore been possible with conventional techniques. Total dissipation of the transistor is only about 200 μw.

The new switch has a gain-bandwidth product greater than 125 mc at a collector voltage of 1 v and a collector current of 1 ma. Its minimum saturation-current-gain is 25 at a 2-ma collector current.

The unit has a 5-mil collector diameter, a 3-mil emitter diameter, and a collector-to-emitter capacitance of no more than 7 pf (about half that of conventional switching transistors). Its rise time, which depends on the particular circuit configuration, is about 5 nsec per unit gain when the transistor switches 2 ma at 2 v. Thus, if a flip-flop, for example, were to be used to drive five other circuits, its rise time would be 25 nsec.

Priced at less than $6, this relatively low-cost germanium transistor can dissipate up to 35 mw at 25 C. It can be stored at 100 C. Not designed for power-handling applications, it should find its largest use in logic circuitry.

First of the micro-energy switches to be supplied by Philco will be packaged in the TO-18 case, but Philco plans to offer the device in a considerably smaller, hermetically-sealed package in the near future.

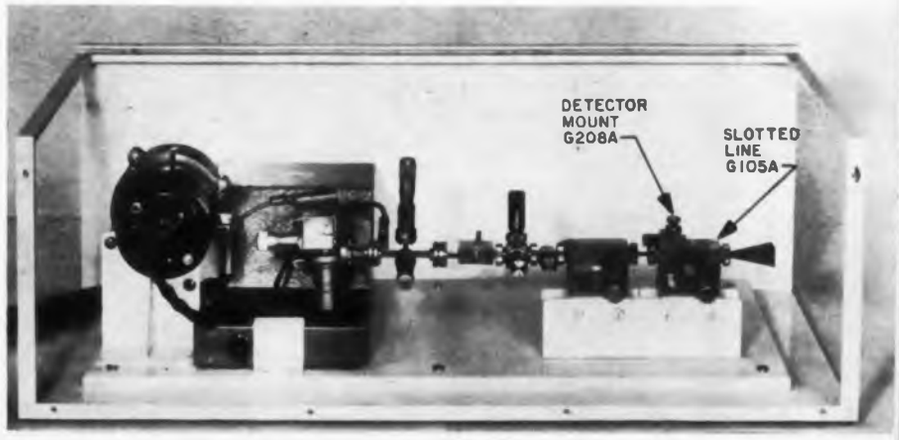
For more information on this micro-energy transistor switch, turn to the Reader-Service Card and circle 250.

2-Mm Slotted Section Shifts Standing Waves Past Fixed Probe

EMPLOYING a principle of operation new in commercial units, the type G105A is said to be the first commercially available slotted section operating in the 2-mm range. The unit, designed and manufactured by FXR Inc., 22-12 Borough Place, Woodside, N.Y., employs an integral phase shifter. The phase shifter moves the standing wave past the probe, instead of the usual method of moving the probe along the standing wave, to make vswr measurements.

The employment of this unconventional principle of operation, together with machining tolerances of ±0.0025 in. made possible the development of this component. The slotted section will measure vswr or impedance in the 140- to 220 kmc frequency range. The fundamental waveguide tolerances and attenuation restrictions made it impractical to merely scale down a slotted section operating at lower frequencies.

A fixed short is supplied with each unit. In measuring high vswr, the losses in the waveguide section itself, nominally 3 db per ft at the lower frequencies, become important. When the short is in-



Operating test set up includes unique slotted section (with horn attached) and other units of the 2-mm line.

Unconventional approach of moving the standing wave past the probe makes this 2-mm slotted section unique in commercial test equipment.

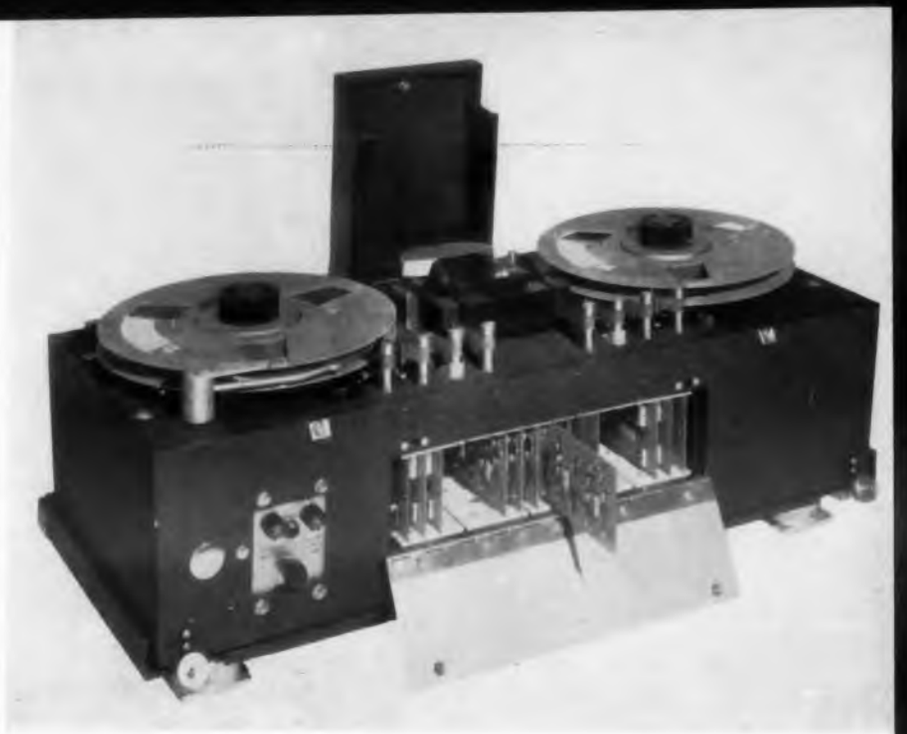
perted, infinite vswr should theoretically be measured. Comparison of the actual vswr obtained with this theoretical value allows calculation of the loss in the line, so that compensation can be made. The calculation is accomplished by use of nomographs, furnished with each component, of a type described in ELECTRONIC DESIGN (Nov. 1955, p 44).

The phase shifter has a range of 180 deg at the lowest waveguide frequency. It can be calibrated in degrees at any frequency of interest in the operating range. The standard unit is calibrated for the 150-kmc or 2-mm range, currently of most interest.

The unit is one of a complete line of waveguide test equipment designed for the Atomic Energy Commission, for use in microwave diagnostics of the highly ionized plazma produced in controlled fusion research. Other important applications of these short wavelengths are in the field of space radar, communications and telemetry.

Introduction of this complete line of test equipment which includes phase shifters, harmonic generators, frequency meters, tuners, power dividers, etc., makes practical, for the first time, the commercial exploitation of the frequency range.

For more information on these products, turn to the Reader-Service card and circle number 251.



Operating tape speeds are adjustable from 1/2 to 45 in. per second.

Digital Tape Transport Has 5-Msec Start-Stop Time

HAVING start-stop times under 5 msec, the DT series of digital tape systems is designed for all mobile, shipboard and airborne applications. Operating speeds are adjustable from 1/2 to 45 in. per second.

Made by Shepard Industries (103 Park Ave., Nutley 10, N.J.), model DT 01 is a "write" unit, model DT 02 is a "read" unit, and model DT 03 is a "read/write" unit. The machine is capable of handling seven or eight tracks (read/write) on 1/2-in. tape in one package weighing under 80 lb. The addition of an auxiliary printed-card package permits expansion of up to 16 tracks (read/write) on 1/2-in. tape or from 14 to 32 tracks (read/write) on 1-in. tape. Heads are available for all formats including IBM 704 and 705 formats. Precise speed control is maintained, the company reports, even during wide swings of voltage in an airplane power system.

Full servo control of supply and take-up reels permits fast start-stop bi-directional tape control as well as fast-forward or fast-rewind of tape, the company adds. Special tape guides and uniform tension control minimize skew and tape flap, permitting packing densities of up to 1000 phase modulation bits per inch or a transfer rate of 45,000 eight-bit characters per second for eight tracks on 1/2-in. tape at 45 in. per second.

Read or write amplifiers, as well as power supplies, are completely transistorized. Transport dimensions are 29-7/8 x 13-1/3 x 11-1/4 in., including shock mount base.

Power required is 117 v, 400 cps, 100 w, single phase and 28 v dc ±4 v, 30 w; converters are available.

Manual controls of the transport include: power, right, left, standby, fast forward, and fast rewind. Provisions are made for remote operation of the machine.

For more information on this digital tape system, turn to the Reader-Service card and circle number 252.

Weighing only 0.9 oz, the sequence programer operates in a temperature range of —40 to +165 F.

Sequence Programer Measures Less Than 1¾ In. Long

A LENGTH of 1-3/4 in. and a weight of 0.9 oz makes a new sequence programer ideal for inclusion in airborne and missile equipment. Designed for operation with solid-state circuitry over a wide range of input rates, the unit uses an interchangeable coded disk to determine or sense the sequence of events.

The solenoid-actuated switching device, made by Elgin National Watch Co. (Elgin Micronics Div., 366 Bluff City Blvd., Elgin, Ill.), is engineered to both encode and decode events in a sequence. The company reports that the unit has wide general applications in complex automatic control operations and includes "highly precise" indexing action. This precision, it adds, permits division of the program disk for sequences requiring up to 100 switch positions.

The complete programer, including the coded disk, measures less than 1-3/4 in. long. The unit is rated for 4 to 8 v and will operate with input pulses as short as 11 msec up to 70 indexing motions per second.

A temperature range of —40 to +165 F can be tolerated by the switching unit. It also stands a vibration of 10 g from 5 to 55 cps. In accordance with MIL-E-5272, it will take 15 g of shock for 11 msec.

For more information on this miniature sequence programer, turn to the Reader-Service card and circle number 253.

NEW PRODUCTS

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

Frequency Standard Provides 400 Cps Sine Or Square Wave 257

Designed to provide a stable secondary frequency source of 400 cps, the type L frequency standard is available for both commercial and military applications. Measuring 1.5 x 1.5 x 2.25 in., the unit weighs 4.5 oz and delivers a sine or square wave output. It uses silicon transistors throughout and the entire assembly is dip-potted for sealing and rigidity. Operating on 400 mw, the unit's output does not vary more than ±0.015% from —55 to +100 C. Distortion is 10% max. The input can vary from 25 to 31 v dc and the unit can stand a vibration of 15 g from 5 to 2000 cps. It meets Mil specifications.

Designers For Industry, Inc., Dept. ED, 4241 Fulton Parkway, Cleveland 9, Ohio.
Availability: *Available in limited quantities at present.*

Tunnel Diode Has Low Series Resistance, Inductance 255

This tunnel diode has a typical series inductance of 1 mh and a typical series resistance of 1 ohm. The peak current is 1 ma ±2.5%, with most units within 1%; peak to valley current ratios are 5 to 1 and 10 to 1. Typical performance shows a peak voltage of 55 mv and a valley voltage of 320 mv. It operates with a typical capacitance of 5 μf and a typical negative resistance of 120 ohms. The measured frequency oscillation is over 1500 mc. The diode is packaged in a shortened, hermetically sealed transistor case having a thin base and small alloy contact. It is designed for applications in radar, microwave radio relay, satellite communications and computer systems.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.
Price & Availability: *Available in prototype quantities at $10 per unit.*

Transistorized Decade Counter Can Add And Subtract 259

This transistorized, 100-kc Add-Subtract decade counter has a simple switching control: grounding one of two control lines determines whether it will add or subtract. Model 1303, a single-voltage unit, requires +110 v at 40 ma. Model 1203, a dual-voltage unit, requires +30 v at 35 ma and 60 v ac at 1 ma. The unit has a 10-number display, electrical zero reset, and an optional coincidence output. It plugs into standard, 10-pin, printed circuit connector. The counter measures 3-9/16 in. in height, 1 in. in width, and 3-3/4 in. in diameter. Weight is 3 oz.

Robotomics, Inc., Dept. ED, 4624 E. Garfield, Phoenix, Ariz.

Price & Availability: *Available two to four weeks after receipt of order in quantities of 1 to 24. Model 1203 is priced at $63 in production quantities of 100 and up. Model 1303 is priced at $73 in production quantities of 100 and up.*

Oscilloscope Provides Sensitivity Of 1 Mv Per Cm 258

Type 503 differential-input, X-Y oscilloscope has a sensitivity of 1 mv per cm in the dc to 450-kc range. Vertical and horizontal amplifiers are identical. Characteristics include: input stages electronically regulated; calibrated steps to 20 v per cm, adjustable between 14 steps and to over 50 v per cm uncalibrated; differential input and constant input impedance at all sensitivities. The unit has an 8 x 10 cm viewing area, 21 calibrated sweep rates with 5 degrees of magnification, electronically regulated power supplies, and adaptable trigger facilities.

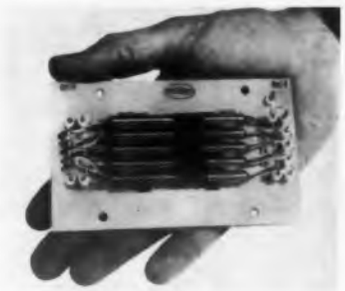
Tektronix, Inc., Dept. ED, P.O. Box 831, Portland 7, Ore.

Price & Availability: *Immediately available. Type 503 priced at $625. Type RM503, rack mounted, $640.*

NEW PRODUCTS

Bandpass Filters 667

Range is 45 to 50 kc



These magnetostrictive bandpass filters permit the construction of parallel bandpass filter arrays having center frequencies spaced one bandwidth apart from 45 to 50 kc. They provide a half-power bandwidth of 3 cps. At a center frequency of 50 kc, the filter can be adjusted to within 0.3 cps. These units are designed for applications requiring multiple, narrow-band filter channels for frequency analysis or as frequency determining elements. Typical uses are in shock and vibration equipment, spectrum analyzers, and telemetering equipment. A band of ten filters mounts on a 7 x 3 in. panel and weighs 12 oz.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton, Mass.

Discriminator 668

Selects any of 23 channels

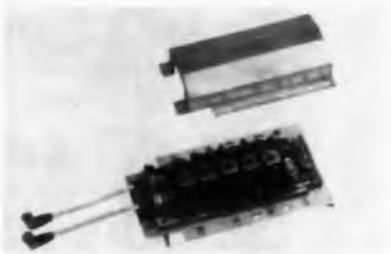
Model 0169B bandswitched discriminator uses the phase-lock technique to obtain good selectivity on each of 23 standard channels. Sensitivity is 10 mv rms to 14.5 kc and 70 mv rms at 70 kc. Stability is ±0.5% of bandwidth; linearity is 0.1% of bandwidth. Input is usually supplied by a tape reproducer. Dimensions of the unit are 12 x 7.75 x 10.5 in. It can be rack mounted.

Hallamore Electronics Co., Dept. ED, 714 N. Brookhurst St., Anaheim, Calif.

Price & Availability: *Price is $5900 for the 23-channel unit or $1300 plus $200 per channel. Units can be delivered in 60 days.*

IF Amplifier 746

Center frequency is 30 mc



These transistorized, if amplifiers are for use where minimum size and low power drain are required. Models 83003H and 83003D, shown, operate with a center frequency of 30 mc and a bandwidth of 3 mc. Model 83003H has a gain of 100 db and uses one miniature tube in the input for minimum noise. Model 83003D, completely transistorized, has a gain of 60 db. Silicon transistors are used in both units.

R S Electronics Corp., Dept. ED, P. O. Box 368, Station A, Palto Alto, Calif.

Availability: *The units are available on customer order or may be modified to meet specific requirements.*

Vibration Test System 664

Is compact and portable

Completely self-contained within a small and portable console, model 1200 vibration test system has a horizontally moving shaketable. Designed primarily for production testing of small components such as transistors, vacuum tubes, and relays, this system may also be furnished for research and development or for the calibration of accelerometers. Having a 50-lb force rated output, the system can be supplied with one of these ranges: 5 cps to 5 kc or 20 cps to 20 kc. It may also be modified to customer requirements. Operation is semi-automatic. Requirements of MIL-STD-202A, method 204 are met.

LCM Engineering, Dept. ED, 5005 E. Slauson Ave., Los Angeles 22, Calif.

NEW PRODUCTS

TV Camera 677

Stands environmental extremes

Model RGS-10 TV camera and control can be operated at an altitude of 2000 ft and are built to stand weather, shock, vibration, noise, salt spray, and dust. The system is transistorized and is of modular construction. The camera weighs 15 lb and measures 16 in. in length and 6-7/8 in. in diameter. The control weighs about 15 lb and measures 7 x 19 in. Mil specs are met.

Dage Television Div., Thompson Ramo Wooldridge, Inc., Dept. ED, Michigan City, Ind.

Price & Availability: *Price is $3900; delivery time is 30 days.*

Acceleration Switch 679

For missile and aircraft systems

Model AS-15 acceleration switch, weighing less than 3 oz and having 0.25-amp contact ratings, is for use in missile and aircraft systems. The switch point, which is adjusted by the manufacturer, can be from 0.5 to 50 g. An externally adjustable switch can be supplied. The unit is equipped to stand shock and vibration.

Era Engineering, Inc., Dept. ED, 1009 Montana Ave., Santa Monica, Calif.

Price & Availability: *Adjustable units are priced at $145 ea for 1 to 9; non-adjustable units, $115 ea. Delivery time is one week.*

TV Picture Tube Cap 680

Diffuses 75% of reflected light

This TV picture tube cap diffuses 75% of reflected light without perceptible loss in picture resolution. The tube cap is an outgrowth of the development of the laminated TV tube. The surface is abrasion-resistant.

Corning Glass Works, Dept. ED, Corning, N.Y.

Availability: *From stock.*

BOURNS TRIMPOT®

Schweber

FOR IMMEDIATE LARGE QUANTITY DELIVERY AT FACTORY PRICES 2000

Yes! Schweber can sell to 2000 pieces of any model of BOURNS TRIMPOT® at factory prices. Sizeable quantities are available for immediate shipment from stock from Schweber's warehouse.

Schweber ELECTRONICS

60 HERRICKS ROAD, MINEOLA, L. I., N.Y.

PIONEER 6-6520 TWX G-CY-NY-580U

CIRCLE 64 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 65 ON READER-SERVICE CARD

NEW PRODUCTS

Ferrite Circulator 748

Isolation is 20 db from 380 to 420 mc

Model X-127 ferrite circultar, a three-port device, has a 6.5 in. diameter and weighs 1.5 lb. The isolation is at least 20 db from 380 to 420 mc; over this bandwidth the insertion loss is less than 1 db. Type N female connectors are used. The circulator can be provided with an electromagnet for applications requiring a switchable unit. It can also be designed for use at frequencies to 1000 mc.

Melabs, Dept. ED, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif.

Availability: *The standard unit can be immediately delivered in sample quantities. For other than the specified frequency, a 30 to 45-day delivery time is required.*

Microammeter 749

Has 20 measuring ranges

Designed for a wide variety of applications, the Microva microammeter has 20 measuring ranges. The instrument combines the advantages of a galvanometer with those of a sensitive, vacuum-tube voltmeter. The input resistance is 500 ohms per volt on the voltage range. Resistance is low on the current ranges. Sensitivity is high and linearity is better than 0.3% of full scale deflection. The galvanometer is shock-proof and needs no clamping.

James G. Biddle Co., Dept. ED, 1316 Arch St., Philadelphia 7, Pa.

Glass Laminate 671

For printed circuit and microwave use

This glass laminate, designated No. 6098 Lamicoid, is suitable for printed circuit and microwave applications at temperatures to 200 C. It is made from Teflon resin and a fine-weave, 0.002 glass fabric. Dielectric strength, parallel to lamination is 45 kv, step by step. Density is 2.2 g per cc. Tensile strength is 26,000 psi and flexural strength, cut lengthwise, is 16,000 psi. Arc resistance is 185 sec. Standard sheets measure 17 x 37 in. and are from 0.006 to 0.25 in. thick.

Mica Insulator, Div. of Minnesota Mining & Mfg. Co., Dept. ED, Schenectady 1, N.Y.

Price & Availability: *Price ranges from $25.65 to $241.62 per sheet, depending on thickness. It is made on order.*

Power Supply 672

For radar modulators

Able to provide an output of 4000 v dc at 100 ma from an input of 115 v at 60 cps, model 11/4C power supply is designed for a line-type, radar pulse modulator. Regulation is 10% from no load to full load. Efficiency is 80% at 100% power output. Silicon-diode rectifiers are used. Mil specs are met. Weighing 55 lb, the unit measures 12-3/8 x 8-3/8 x 8-3/4 in.

Prototype Transformer Corp., Dept. ED, 1 Henry St., Bloomfield, N.J.

Price: *$565.*

Cases 673

Made of magnesium

These cases are made of magnesium to insure strength and stiffness with minimum weight for a variety of applications. Examples of cases available are: transit cases, teleprinter covers, module cases, and radar computer housings. They are made as welded assemblies.

Brooks & Perkins, Inc., Dept. ED, 1950 W. Fort St., Detroit 16, Mich.

Availability: *Cases are made to customer requirements.*

CIRCLE 67 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Binary-to-Decimal Converter 734

For use with computer readouts

Designed as companion equipment for computer readouts requiring decimal display for any number of 4-bit code inputs, model 260 binary-to-decimal converter provides illuminated numerical displays. The following codes can be used: binary code decimal (*1-2-4-8*), decade counter code (*1-2-2-4*) or (*1-2-4-2*), gray code, binary complement coded decimal, binary two-out-of-five code, and binary (*1-2-4-7*). This unit is compatible with a cold-cathode decimal readout or a filamentary projected readout.

Hermes Electronics Co., Dept. ED, 75 Cambridge Parkway, Cambridge 42, Mass.

Price: *$95 ea for 1 to 49 units.*

DC Power Supply 745

Rf-type

Model 2045 ruggedly-built, rf-type, dc power supply is designed for such uses as condenser charging, electrostatic paint spraying, insulation testing, and electrostatic flocking. It can also be used for spot knocking in TV manufacture. The output is −40 kv or +40 kv; voltage range is about 12 to 45 kv. The unit measures 19 x 12.5 x 13 in.

Spellman High Voltage Co., Dept. ED, 3029 Webster Ave., Bronx 67, N.Y.

Price: *Price is $165 for the standard unit; for units with high-voltage meter, $215.*

Strain Gage Indicator 740

Has three-wire hook-up

Model C22 digital strain indicator is a self-balancing servo instrument for reading the output of strain gages in μin. per in. Three return wires from a single gage provide temperature compensation for the lead-in wires. Temperature stability is 20 ppm. The instrument accepts a single strain gage in a two or three-wire system and a half or full bridge. Maximum reading is 100,000 μin. strain for a multiplier setting of 100 or 50 mv per v for full scale.

Automation Industries, Inc., Dept. ED, 3613 Aviation Blvd., Manhattan Beach, Calif.

Price & Availability: $1495; from stock.

Oscillator-Amplifier 744

For instrument-type tape recorders

Designed for use in the direct-record mode of instrument-type tape recorders, model DO-70 transistorized, plug-in bias oscillator, direct-record amplifier has a power consumption of 100 ma at 24 v dc. The bias oscillator section operates at a nominal frequency of 70 kc and provides an output of 10 ma. Amplifier input impedance is 100,000 ohms, unbalanced to ground; frequency response is 50 to 8000 cps within 2 db. The amplifier, which provides an output of 1 ma, requires 0.7 v rms input. The packaged unit measures 1-7/8 x 1-7/8 x 3-3/4 in.

Applied Magnetics Corp., Dept. ED, P.O. Box 768, Santa Barbara Municipal Airport, Goleta, Calif.

Availability: Delivery time is 30 days.

Distributed constant delay lines • Lumped-constant delay lines • Variable delay networks • Continuously variable delay lines • Pushbutton decade delay lines • Shift registers •

ESC EXTRA

Pulse transformers • Medium and low-power transformers • Filters of all types • Pulse-forming networks • Miniature plug-in encapsulated circuit assemblies

ESC DEVELOPS DELAY LINE WITH 170 to 1 DELAY TIME/RISE TIME RATIO

Model 61-34 Perfected For Specialized Communications Application

PALISADES PARK, N. J.—An entirely new Lumped-Constant Delay Line, with a proven 170 to 1 delay time/rise time ratio, has been announced by the ESC Corporation, Palisades Park, N. J. The new delay line, known as Model 61-34, was specifically designed for a specialized communications application calling for the exceptionally high delay time/rise time ratio.

ESC, the world's leading manufacturer of custom built and stock delay lines, is already widely recognized in the electronics industry for its exceptional engineering advances. In October, 1958, ESC broke through an existing design barrier and produced a delay line with a 145 to 1 delay time/rise time ratio. It had been thought, prior to the announcement of the Model 61-34, that ESC had reached the ultimate in this type of delay line.

SPECIFICATIONS OF NEW DELAY LINE MODEL 61-34

Delay time/rise time ratio: 170/1
Delay: 200 usec.
Rise time: 1.16 usec.
Attenuation: less than 2 db
Frequency response: 3 db = 325 KC
50 taps with an accuracy of ±0.2 usec. at each tap.

Complete technical data on the new unit can be obtained by writing to

ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.

CIRCLE 69 ON READER-SERVICE CARD

NEW PRODUCTS

Epoxy Resin 583

Dielectric constant is 3.2

Type TC-447 two-part transparent epoxy resin is for high reliability applications in data transmission cabling. Specific uses are: potting electrical connectors, harness junction molding, repair of cable jackets, manufacture of ground support cables, and instrument case sealing. Electrical properties are: dielectric constant, 3.2; dielectric strength, 1500 v per mil; insulation resistance, 10^{12} to 10^{14} ohms; arc resistance, 80 sec. The temperature range is —65 to +250 F without change in dielectric properties. The material adheres to metal, wood, ceramic, rubber, paper and plastic.

Electronic Production & Development, Inc., Dept. ED, 501 N. Prairie Ave., Hawthorne, Calif.

Tester 584

For measuring lifetime of semiconductor material

Contained in a single package, this test equipment measures the lifetime of semiconductor material. Lifetimes from 1 μsec can be sensed. The tester is shielded to eliminate extraneous noise. For production use, the unit offers fast operation.

Electro Impulse Laboratory, Dept. ED, 208 River St., Red Bank, N.J.

Power Amplifiers 591

Power ratings are 50 w to 5 kw

These modular power amplifiers have output power ratings from 50 w to 5 kw per phase, with three-phase ratings extending to 15 kw. Output power control range is 20:1 and response time is 50 μsec for 8 cps of the power line. Units can be 60 or 400 cps types. Models offered are: SPAQ pure transistor type, SPAM self-saturating magnetic type,

SPAQM transistor-driven magnetic type, SPAC controlled-rectifier type, and SPAX compensator type. Uses are in motor, generator, exciter and alternator regulating systems, also in the control of temperature, pressure, illumination, torque, and speed in industrial and military systems.

Regulators, Inc., Dept. ED, 455 Main St., Wyckoff, N.J.

Indicator 587

Audible and visual

This audible-visual indicator incorporates a buzzer and lights which are actuated when 28 v dc are applied to the terminals. The buzzer can be turned off while the fault is being corrected. By depressing a plastic lens, the holding armature is moved into contact with the solenoid, the buzzer and the holding contacts are closed, and the buzzer stops. The dual lamps stay on until the unit is de-energized. The indicator can be used in aircraft-missile computer checking systems, commercial computer applications, automation control panels and electromechanical annunciator systems.

Carma Manufacturing Co., Dept. ED, 1879 Mullin Ave., Torrance, Calif.

Silver-Zinc Battery 676

Has multiple output

For operating missile instrumentation and control, model P75A silver-zinc battery provides five power combinations: four outputs at 28 v at 0.5 to 14 amp, and one at 6.5 v with a current of 6 amp. Activation time is 0.8 sec; the signal required is 28 v at 4 amp. The unit has a dry shelf life of 5 yr. It stands temperatures from −65 to +165 F, shock to 50 g, acceleration to 20 g, and vibration to 10 g, along all three major axes. Weight of the battery is 45 lb.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Availability: *Made on order.*

◀ CIRCLE 70 ON READER-SERVICE CARD

Authorized

CANNON PLUG DISTRIBUTORS

COAST TO COAST

CANNON PLUGS
AUTHORIZED DISTRIBUTORS

Each of the authorized Cannon Distributors listed below, and many more, have a complete selection of the most popular Cannon Plugs—*plus*, he gives you prompt service and immediate delivery...*at factory prices!*
Let these distributors help with your plug requirements...and watch future ads for further listings.

LOS ANGELES

RICHEY Air Sales INC

With RICHEY it's the *service* that counts! Our experienced *Staff* and huge *Shelf Stock* assures you prompt delivery.

10816 Burbank Boulevard
North Hollywood, Calif.
Phone: TRiangle 7-2651,
POplar 1-6133

CIRCLE 850 ON READER-SERVICE CARD

SALT LAKE CITY

KIMBALL DISTRIBUTING COMPANY

KIMBALL'S trained staff provides the type of service you need! You get immediate quotes and prompt delivery from our huge stock of Cannon Plugs.

350 Pierpont Avenue
Salt Lake City 1, Utah
Phone: EMpire 3-5813
Branch: 621 17th Street
Denver 2, Colorado
Phone: AComa 2-6208

CIRCLE 851 ON READER-SERVICE CARD

MILWAUKEE

Taylor ELECTRIC COMPANY

Our trained connector *specialist* services your inquiry from a daily inventory of over 5000 Cannon Plugs. We can give immediate quotes at factory prices on exact stock quantities on standards and specials.

4080 N. Port Washington Rd.
Milwaukee 12, Wisconsin
Phone: WO 4-4321

CIRCLE 852 ON READER-SERVICE CARD

NEW YORK

Time Electronic Sales

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

373 Broadway
New York 13, New York
Phone: BArclay 7-3922

CIRCLE 853 ON READER-SERVICE CARD

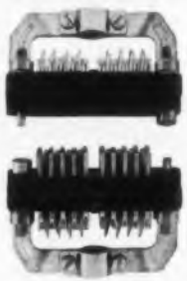
NEW FROM CANNON

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

MEET morpho*

* trademark pat. pend.

THE SYMBOL OF A MOST UNUSUAL NEW DEVELOPMENT BY CANNON

Meet MORPHO—he represents the most versatile plug you ever saw! MORPHO is Cannon Electric Company's unusual *new* development for meeting many industrial and military requirements *inexpensively*. Check these features! ▪ Crimp-type contacts supplied loose for crimping with a simple hand tool, or in belts for crimping with a semi-automatic tool ▪ Easiest installation ever, just snap into insulators, module insulators designed for alternate positioning for maximum adaptability ▪ Hermaphrodite design, contacts and insulators can be used in either plug or receptacle! MORPHO plugs have been tested to severe requirements, are available in different configurations with a wide range of contact layouts. Write for Catalog MH-1 *today* and meet MORPHO for yourself...another reason why you should always consult the *first* name in plugs — why you should *consult Cannon for all your plug requirements.*

CANNON PLUGS

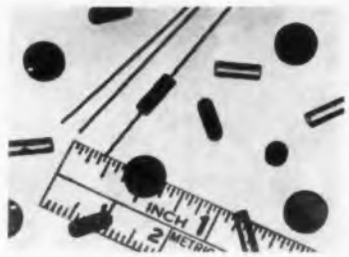
CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif.

CIRCLE 857 ON READER-SERVICE CARD

NEW PRODUCTS

Sintered Glass 743

For glass-to-metal sealing



Clearform sintered glass can be used for sealing to Dumet, Kovar, molybdenum, platinum, and other metals. The glass is made by pressing small glass particles to shape and firing the piece at a high temperature. The particles are consolidated by fusion into a non-porous, vacuum-tight structure. The material retains thermal endurance, corrosion resistance, and dielectric strength. A variety of shapes and sizes with close tolreances can be produced.

Corning Glass Works, Dept. ED, Corning, N.Y.

Availability: *Delivery time is 14 days.*

Rotary Drive Actuator 738

High-speed type

Made to drive safe-arm mechanisms, this high-speed rotary-drive actuator uses a compact 28-dc slip-clutch gear motor. Designed to replace bulky rotary solenoids, the actuator is suitable for applications requiring quickly applied torque with high reliability. The unit can be designed into equipment requiring any angular motion. It develops a minimum of 1 lb-in. or torque over a wide range of ambient conditions. Under normal conditions, it drives a 1.5 lb-in. load 90 deg in 5 msec. The unit weighs 8.5 lb and measures 1-3/16 x 1-3/16 x 3 in.

Bendix-Pacific Div., Bendix Aviation Corp., Dept. ED, 11600 Sherman Way, N. Hollywood, Calif.

Availability: *Delivery time is 90 days.*

DC Wideband Amplifiers 742

Fixed gain is 10 to 1000

Model 1000A dc wideband amplifiers offer standard and special-order fixed gains of 10 to 1000. The vernier gain control is removable. The units are plug-in type. A three-position input selection switch shorts the amplifier input in one spring-loaded position, isolating the source and permitting easy check of noise level. Another position on the switch removes external input, isolates the source, and introduces a 10-mv dc source. Bandwidth is dc to 50,000 cps, drift is less than 2 μv in 500 hr, input impedance is 100 meg shunted by 0.001 μf, output impedance is 40 milliohms, and linearity is 0.01%.

Cubic Corp., Dept. ED, 5575 Kearny Villa Road, San Diego 11, Calif.

Price & Availability: *$715; from stock by June 1st.*

Pushbutton Light Assembly 666

For airborne or ground support equipment

For airborne or ground support equipment use, this magnetically held, illuminated, push-button light assembly combines visual indication with displacement. Solenoid-actuated, the unit has simple and positive operation. Panel depth is 3.57 in. and diameter is 0.65 in. Weight is 3 oz.

Radar Relay, Inc., Dept. ED, Santa Monica, Calif.

Availability: *Prototype quantities can now be furnished.*

NEW PRODUCTS

Controlling Multimeter 739

Guards any critical voltage

Able to guard virtually any critical voltage, this controlling multimeter is a combination of a conventional multimeter and a continuous reading meter-relay with adjustable points. The unit is suitable for both laboratory and industrial use. Ranges are: dc-voltage, 2.5, 10, 50, 250, and 1000 to 5000 v; ac-voltage, 2.5, 10, 50, 250 and 1000 to 5000 v; current 0 to 100 μa, 0 to 10 ma, 0 to 100 ma, and 0 to 10 amp; and resistance to 20 meg in three scales with center scale values of 12, 1200 and 120,000 ohms.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

Price & Availability: *$230; delivery in 6 to 8 weeks.*

Recorder 735

Has two pens

Model 480 all-transistorized, two-pen X-Y recorder has plug-in input modules for general purpose, computer, low-level, differential, time base, curve following, and other functions. The paper size is 11 x 17 in. or 8.5 x 11 in. with a recording size of 10 x 15 in. The slewing speed on all axes is 30 in. per sec.

Electro Instruments, Inc., Dept. ED, 3540 Aero Court, San Diego 11, Calif.

Price & Availability: *Price is $2800; delivery is 30 to 45 days.*

Oui, General Transistor offre des transistors MIL/SPEC

GERMANIUM PNP

2N43A	MIL T 19500/18
2N44A	MIL T 19500/6
2N331	MIL T 19500/4A
2N404	MIL T 19500/20
2N416	MIL T 19500/56
2N417	MIL T 19500/57
2N425	MIL T 19500/45
2N426	MIL T 19500/42
2N427	MIL T 19500/43
2N428	MIL T 19500/44
2N464	MIL T 19500/49
2N465	MIL T 19500/50
2N466	MIL T 19500/51
2N467	MIL T 19500/45

GERMANIUM NPN

2N358A	MIL T 19500/63
2N388	MIL T 19500/65
2N1310	Guidance

SILICON PNP

2N327A	
2N328A	Guidance
2N329A	Guidance
2N1026	Guidance

DIODES

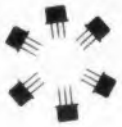
General Transistor also produces high-reliability gold-bonded diodes, three of which are designed to meet MIL requirements: 1N198, 1N277, and 1N281. The spec numbers are, respectively: MIL E 1/700, 1/993A, and 1/961.

The semiconductors listed on this page are all designed to meet MIL specs.

GENERAL TRANSISTOR CORP.

91-27 138th Place / Jamaica 35, New York

These NPN Germanium Types



As witness the deployment of General Transistors on projects such as:


BMEWS


MINUTEMAN


POLARIS


HAWK

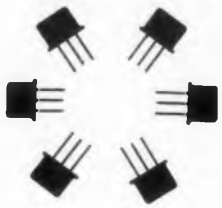
And many other military programs. Why? *Reliability.*

General Transistor is now in its fourth year of production on *quality* NPN germanium transistors. We were one of the earliest suppliers of germanium NPN transistors, and have from the beginning maintained an excellent reputation for highly reliable products. Listed are some characteristically fine types.

Type No.	Collector-Base Breakdown V_{CBO} (Volts)	Punch thru V_{pt} (Volts)	Collector Cutoff Current I_{CO} (μa)	D.C. Current Gain h_{FE}	Alpha Cutoff Frequency $f_{\alpha b}$ (mc)
2N356A	40	40	3	35	3
2N357A	40	40	3	40	6
2N439	40	35	3	60	8
2N440	40	30	3	100	12
2N446A	30	35	2	100	8
2N447A	30	25	2	150	12
2N595	35	30	2	50	5
2N596	35	30	2	70	8
2N1012	50	50	2	60	5

Typical values

Also on Military Duty



...and here's a flight of high voltage types:

		2N1310			2N1311			2N1312		
DISSIPATION RATINGS:		NPN GE Alloy Junction			NPN GE Alloy Junction			NPN GE Alloy Junction		
TOTAL TRANSISTOR DISSIPATION AT 25°C		120 MW			120 MW			120 MW		
DERATING FACTOR		2 MW/°C			2 MW/°C			2 MW/°C		
STORAGE TEMPERATURE		−65°C to 85°C			−65°C to 85°C			−65°C to 85°C		
CUT-OFF RATINGS:	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
COLLECTOR BASE VOLTAGE (V_{CBO})	I_C=25 μa	90 v			75 v			50 v		
EMITTER-BASE VOLTAGE (V_{EBO})	I_E=25 μa	20 v	50 v		20 v	50 v		20 v	40 v	
COLLECTOR-EMITTER VOLTAGE (V_{PT}) (PUNCH-THRU)	I_E=25 μa	90 v			75 v			50 v		
COLLECTOR CUT-OFF CURRENT (I_{CO})	V_{CBO}=5 v		3 μa	7 μa		3 μa	7 μa			7 μa
EMITTER CUT-OFF CURRENT (I_{EO})	V_{EBO}=5 v		3 μa	7 μa		3 μa	7 μa			7 μa
D.C. AND SWITCHING RATINGS:										
D.C. CURRENT GAIN (h_{FE})	I_C=5 ma V_{CE}=0.25 v	20			15					
	I_C=20 ma V_{CE}=0.25 v					25		20	30	
D.C. BASE VOLTAGE (V_{BE})	I_C=5 ma V_{CE}=0.25 v			0.5 v			0.5 v			
	I_C=20 ma V_{CE}=0.25 v								0.3 v	
D.C. COLLECTOR VOLTAGE (V_{CE})	I_B=10 ma I_C=100 ma		0.2 v			0.2 v			0.2 v	
SMALL SIGNAL RATINGS:										
CURRENT GAIN COMMON EMITTER (h_{fe})	V_{CE}=5 v I_E=1 ma f=1 kc		35			30			40	
ALPHA CUT-OFF FREQUENCY (f_{ab})	V_{CB}=5 v I_E=1 ma		1 mc			1.5 mc			2 mc	
COLLECTOR CAPACITY (C_{ob})	I_E=1 ma V_{CB}=5 v f=1 mc		11 μμf			11 μμf			11 μμf	
INPUT IMPEDANCE (h_{ib})	V_{CB}=5 v I_E=1 ma f=1 kc		35 Ω			35 Ω			35 Ω	
REVERSE TRANSFER RATIO (h_{rb}) (X 10⁻⁴)	V_{CB}=5 v I_E=1 ma f=1 kc			15			15			15
OUTPUT ADMITTANCE (h_{ob})	V_{CB}=5 v I_E=1 ma f=1 kc			2 μ℧			2 μ℧			2 μ℧
NOISE FIGURE (NF)	V_{CB}=5 v I_E=1 ma f=1 kc BW=100-		10 db			10 db			10 db	

Because of the relative newness of these transistors, data is presented in detail.

GENERAL TRANSISTOR CORP.

Speaking of Services: GT Hi/Scope Service

100% Lot Preconditioning

Let's assume you have equipment which must undergo severe environmental conditions...be subjected to high mechanical shock and vibration. To be certain that all the transistors you intend to use will withstand this type of exposure, we will set up a preconditioning program that will test out every single unit before we ship to you.

Special Electrical Parameter Testing

Certain transistor applications are so unusual that they cannot be completely described by standard parameters. If you are in such a position, we will design a test fixture to closely approximate actual circuit performance. This procedure will provide assurance that 100% of the transistors delivered to you will perform satisfactorily.

Special Reliability Testing Programs

Must your completed systems meet a high reliability requirement? If so, you may wish special procedures to be established with regard to your reliability programs. This is another GT service. When necessary, we will build such transistors on a specially designed production line, check them exhaustively to hold tight parameter tolerances, and subject large lots to specific and unique life tests. In many cases, we have established a program so that we ship those units which have high survival probability in your application. These things we have done, and will do again, at your request. Sound helpful?

High and Low Temperature Testing

Standard transistor parameters are generally controlled at room temperature. Yet many systems must function at other ambients. If you have a problem specifying electrical parameters at room temperature in a manner that will be valid at high or low temperatures, we are ready to assist. General Transistor is prepared to run any measurements you dictate, at any specified ambient. We can do this on complete production lots if you feel it essential.

Cost Economies Through Parameter Modifications

Yield has a strong influence on transistor cost. To give you the best economies and at the same time give you the most desirable quality, we offer this working arrangement. At your request, General Transistor will suggest slight modifications of your specifications which will allow us to ship the major portion of a production run. We will make the necessary measurements and indicate what the various parameters should be and what proportions of the run will fall into preselected types. If you then design your system to use this production mix, you will benefit from some genuine economies.

Circuit Design

If you are starting on a new program, you may want some information on what performance you can expect from state-of-the-art circuits. We will provide you with such typical circuits at your request, together with data on the performance of our transistor types within these circuits.

Special Selection on Standard Catalog Types

In many instances you may find that a standard catalog transistor is about 90% acceptable, but still needs improvement in a few parameters. In such a case, please ask us about the possibility of getting these improvements. We can tell you what increase in specifications is feasible, and produce the units to this spec. Thus, you get the desired parameters without having to redesign or wait for a custom-built semiconductor.

Qualification Approvals

Let's consider the case where you want to design a certain transistor into a system for the government, yet a government specification does not exist for the transistor. You must be ready to substantiate your use of the non-standard part. Here's what GT can do to help your case. We will run a qualification approval procedure in the same format we would for a military type. Then we'll provide you with this necessary data. This will greatly accelerate your approval for use of this transistor type.

Special Coatings or Encapsulations

In your manufacturing process, do you expose transistors to any kinds of solvents or potting materials? If so, just let us know. By using special highly resistant coatings, we'll make sure that the transistor case and markings are not vulnerable to solvent attacks.

Samples with Parameter Measurements

Assume you want to check out the margins in a design. You require upper and lower limit samples of a certain transistor type. We'll be happy to supply you with sufficient samples to cover the spread in one or two significant parameters. Thus, you can experimentally determine the performance of your circuit.

Special Production Runs

Assume that your transistor application is so unusual that units are not available from standard production. What can be done? We will analyze your requirements and decide whether it would be feasible to make a special production run of transistors to meet your needs.

What More?

This is our HI/SCOPE service...or a large part of it. Our customers have found it to be extremely useful. We think you will, too. If there is something still further that interests you, why not get in touch with us? Space precludes our going into too great detail here, but we feel sure you'll find any assistance you need at GT. Write or give us a phone call.

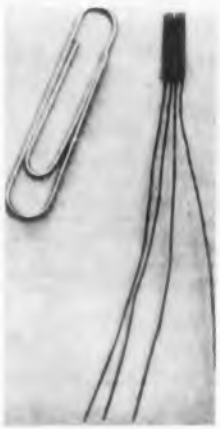
GENERAL TRANSISTOR CORP.

91-27 138th Place / Jamaica 35, New York

1056/3.08/2CM

Hall-Effect Generator 631

Uses indium arsenide for the active element



Designated HP-310, this Hall-effect generator uses indium arsenide for the active element. It operates from −35 to +85 C and has a temperature coefficient of about −0.1% per deg C. With a control current of 100 ma and a density flux of 10 kg, the nominal open circuit Hall output voltage is 100 mv. Linearities of 1% or better can be achieved when input or output circuit is properly loaded.

Ohio Semiconductors, Inc., Dept. ED, 1035 W. Third Ave., Columbus 12, Ohio.

Price & Availability: *Currently available in quantity. Sample quantities of 1 through 4 units are priced at $37.50 each. Quantity discounts available.*

Resolver Test Set 576

For semi-automatic operation

Model MST-5RSA resolver test set is designed for semi-automatic operation by unskilled personnel. It measures electrical error, electrical zero, phasing, fundamental null and total null on transmitter, differential and control resolvers. Accuracy is better than 30 sec of arc. The instrument meets SAE specs ARP-461A. Dimensions are 24 x 25 x 16 in.

Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

Price & Availability: *Price is $4500; delivery is from stock.*

CIRCLE 74 ON READER-SERVICE CARD ▶

◀ CIRCLE 73 ON READER-SERVICE CARD

NEW PRODUCTS

Event Indicator 535

Records 1000 events

Designed to meet or exceed all requirements of MIL-E-5272B, this event indicator records 1000 events on the instrument dial in 1-event increments. Any event that is initiated or indicated electrically can be registered. The unit, which is activated at 115 v, 400 cps, 1 w, weighs 1.3 oz and measures 0.68 in. in diameter and 1.42 in. in length.

Elgin Micronics, Dept. ED, 368 Bluff City Blvd., Elgin, Ill.

Price & Availability: *Sample quantities are now available at $125 ea. Full production is scheduled for later this year.*

Frequency Source 536

Generates 400 cps, 3200 cps, and 25.6 kc

Model R-2 reference frequency supply generates crystal-controlled output frequencies of 400 cps, 3200 cps, and 25.6 kc with a tolerance of ±0.005%. The 400-cps square wave output is 20 v peak-to-peak, the 3.2-kc sine wave is 3.4 v rms, and the 25.6-kc sine wave is 10 v rms. The unit supplies bias, timing, and capstan reference signals for airborne tape recorders. Silicon semiconductor elements allow for operation from −55 to +75 C. The unit measures 3 x 3 x 4 in. and weighs 24 oz. It meets MIL-E-5411 and MIL-E-5272A.

Kennedy Co., Dept. ED, 2487 E. Washington St., Pasadena, Calif.

Price & Availability: *1 to 9 units, $1075; 10 to 20 units, $985. Sample delivery is 30 days.*

Ten standard value metallized glass inductances ranging from .05 uh. to 1.30 uh. Unexcelled for high frequency tuning applications requiring temperature stability and low loss. Operating temperature range −55°C to +125°C. Temperature coefficient zero to plus 20ppm/°C. Tolerance ±10%.

Now . . . low cost inductors off-the-shelf from distributors

Determine the exact inductance values you need quickly and inexpensively with this handy new test kit available only from Corning distributors. The kit consists of 10 standard value glass inductors which you can modify to specific odd values with four different types of cores.

These glass inductors are ruggedly built to take repeated handling in test labs or on production lines. The only inductors made without wires, the coil consists of a silver oxide film fired to the glass, then copper-plated and tin-dipped. It can't shift or work loose.

See your Corning distributor now for this new cost-cutting, time-saving Standard Inductor Kit. Low price is only $24.95 (net) including mounting hardware and complete technical data book.

Two each of these four different types of cores: 1) red dot, 5.0 permeability; 2) blue dot, 9.2 permeability; 3) ¼" brass; 4) 3/32" brass.

CORNING
ELECTRONIC COMPONENTS
Distributed exclusively by
ERIE DISTRIBUTOR DIVISION

CIRCLE 76 ON READER-SERVICE CARD

CORNING STANDARD INDUCTOR KIT

Immediate delivery from these distributors

ARIZONA, Phoenix
Radio Specialties & Appliance Corp.
917 North 7th Street

ARIZONA, Tucson
Standard Radio Parts Inc
827 South Park Avenue

CALIFORNIA, Glendale 1
R. V. Weatherford Company
5921 San Fernando Road

CALIFORNIA, Inglewood
Newark Electronics Corp
2747 West Century Blvd

CALIFORNIA, Los Angeles 15
Universal Radio Supply Company
1729 South Los Angeles Street

CALIFORNIA, Oakland 1
Elmar Electronics, Inc.
110 11th Street

CALIFORNIA, Palo Alto
Zack Electronics
844 High Street

CALIFORNIA, San Diego 1
Western Radio & TV Supply Co.
1415 India Street

CALIFORNIA, San Francisco 1
Pacific Wholesale Company
1946 Mission Street

CALIFORNIA, San Francisco 2
Zack Electronics
1422 Market Street

COLORADO, Denver
Inter-State Radio & Supply Company
2100 Stout Street

WASHINGTON 9, D.C.
Capitol Radio Wholesalers, Inc.
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WASHINGTON 1, D.C.
Electronic Industrial Sales, Inc.
2345 Sherman Avenue, N.W.

FLORIDA, Miami
Eisenson Supply
P. O. Box 1655
[illegible]

FLORIDA, Miami 37
Electronic Supply
[illegible]

ILLINOIS, Chicago 6
Newark Electronics Corporation
223 West Madison Street

INDIANA, Ft. Wayne 1
Ft. Wayne Electronic Supply, Inc.
[illegible]

INDIANA, Indianapolis 25
Graham Electronics Supply, Inc.
122 South Senate Avenue

IOWA, Cedar Rapids
Deeco, Inc
619 First Street N. W.

LOUISIANA, New Orleans 19
Electronic Parts Corp
[illegible]

MARYLAND, Baltimore 1
Kann-Ellert Electronics, Inc
Howard & Redwood Streets

MARYLAND, Baltimore 1
Wholesale Radio Parts Co. Inc
[illegible]

MASSACHUSETTS, Boston 16
Cramer Electronics, Inc.
811 Boylston Street

MASSACHUSETTS, Boston 17
Radio Shack Corporation
730 Commonwealth Avenue

MICHIGAN, Detroit 35
Ferguson Electronic Supply
2306 Puritan Ave

MINNESOTA, St. Paul 3
Stark Electronics
[illegible]

NEW JERSEY, Camden 2
General Radio Supply Co. Inc
600 Penn Avenue

NEW JERSEY, Mountainside
Federated Purchaser, Inc.
[illegible]

NEW MEXICO, Alamogordo
Radio Specialties Co., Inc.
[illegible]

NEW MEXICO, Albuquerque
Radio Specialties Co., Inc.
[illegible]

NEW YORK, Binghamton
Federal Electronics, Inc.
P. O. Box 309

NEW YORK, Buffalo 3
Radio Equipment Corporation
317 Elm Street

NEW YORK, Hempstead
Davis Electronics Corporation
[illegible]

NEW YORK, New York 23
Hudson Radio & TV Corp.
[illegible]

NEW YORK, New York 7
Interstate Electronics, Inc.
[illegible]

NEW YORK, New York 6
Murray Electronics, Inc
136 Liberty Street
Room 420

NEW YORK, New York 13
[illegible]
506 Canal Street

NEW YORK, New York 11
Terminal Electronics, Inc.
[illegible]

NEW YORK, Poughkeepsie
[illegible]
[illegible]

NEW YORK, Rochester 5
Rochester Radio Supply Co., Inc.
[illegible]

NEW YORK, Syracuse 4
Morris Distributing Co., Inc.
[illegible]

NEW YORK, Utica 1
[illegible]
[illegible]

NORTH CAROLINA, Winston-Salem
Dalton Hege Radio Supply Co., Inc.
[illegible]

OHIO, Akron 8
Main Sun Radio Company
[illegible]

OHIO, Cincinnati 10
Hughes-Peters, Inc.
[illegible]

OHIO, Columbus 15
Hughes-Peters, Inc.
[illegible]

OHIO, Cincinnati 15
Pasco Electronic Parts Corp.
[illegible]

OHIO, Dayton 4
Stacpo, Inc.
[illegible]

OKLAHOMA, Tulsa 16
Oil Capital Electronics Corp.
Admiral Station Box GG
[illegible]

OREGON, Portland 9
United Radio Supply, Inc.
[illegible]

PENNSYLVANIA, Philadelphia 7
Almo Radio Company
913 Arch Street

PENNSYLVANIA, Philadelphia 7
Herbach & Rademan, Inc.
[illegible]

PENNSYLVANIA, Pittsburgh 22
Cameradio Company
[illegible]

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Fred P. Purcell
[illegible]

TENNESSEE, Nashville 4
Electra Distributing Company
1914 West End Avenue

TEXAS, Dallas 35
Engineering Supply
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TEXAS, Houston 19
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Priest Electronics, Inc.
[illegible]

WASHINGTON, Seattle 1
Seattle Radio Supply, Inc.
[illegible]

ERIE
DISTRIBUTOR DIVISION
ERIE, PENNSYLVANIA

NEW PRODUCTS

Time Delays 537

Range covers 0.1 to 300 sec

Designed for prototype and general purpose use, types 401 and 404 transistorized time delays have a delay interval that is adjustable over a 10:1 range. Five overlapping ranges cover 0.1 to 300 sec. The time delay is determined by a resistor connected between two external terminals. Designed for nominal 28-v dc operation, the units have a ±1% repeatability under constant operating conditions. The contacts are dpdt and are rated for 100,000 operations at 3 amp, 30 v dc or 115 v ac.

G-V Controls Inc., Dept. ED, Okner Parkway, Livingston, N.J.

Price & Availability: *Units are in stock. Price varies from $145 to $400.*

Synchronous Motor 538

Speed is 3000 rpm

Measuring 1 in. in diameter and 1-13/74 in. in length, model SM-1, 400-cps synchronous motor has an operating speed of 3000 rpm. The unit operates at 115 v with a maximum power input of 2-1/2 w and has a power factor of 0.9. It weighs 1.7 oz. Jewel bearings are used. Rotation is reversible. The unit meets MIL-E-5272B requirements for temperature, altitude, vibration and shock.

Waltham Precision Instrument Co., Dept. ED, 221 Crescent St., Waltham 54, Mass.

Price & Availability: *Price is under $40. Delivery time is one week.*

Infrared Detector 539

Responds to 5:7 microns

Model J-02 infrared detector has a range of response from the visible region of 5.7 microns with a time constant of less than 1 μsec. The unit occupies 0.1 x 0.1 mm². Using the photovoltaic effect in indium antimonide at liquid nitrogen, the detector has typical NEP values of 2×10^{-12} w at 5 microns and 7×10^{-12} w for a 500 K black body. Having an impedance of 1000 to 40,000 ohms, the unit can be efficiently coupled to transistor and vacuum-tube preamplifiers. It is suitable for use in the design of infrared systems having high optical gain, high resolution, and very rapid scanning rates.

Radiation Electronics Co., Dept. ED, 5600 Jarvis Ave., Chicago 48, Ill.

Price & Availability: *Price is $700. Units are made on order and can be delivered in 30 days.*

DC-DC Amplifier 540

Gain is 25,000

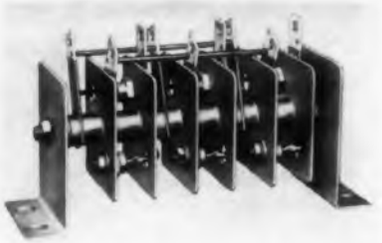
Consisting of an input mechanical modulator, a high-gain ac amplifier, and an electrical demodulator output, type A3700-01 dc-dc amplifier has a gain of 25,000. Input impedance is 100,000 ohms, output voltage is ±10 v dc, and signal frequency is 400 ±2.5 cps.

Kearfott, Div. of General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

NEW PRODUCTS

Silicon Rectifier Stacks 541

Have cell voltages to 600 piv



These silicon power rectifier stacks have cell voltages up to 600 piv. They use either style 21 or style 33 diodes. Bridge assemblies using style 21 diodes are rated at up to 39 amp, single-phase, and 58 amp, three-phase; bridge assemblies with style 33 diodes are rated at up to 75 amp, single-phase, and 112 amp, three- phase.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.

***Availability:** Delivery time is 7 to 10 days.*

Portable Hot-Cold Chamber 542

Temperature range is —100 to +400 F

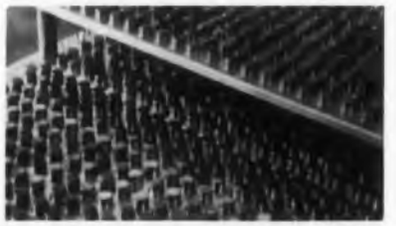
This hot-cold chamber provides temperatures from —100 to +400 F regulated to ±1 F. The controls include an indicating-controlling thermostat and a high-low wattage selector. The interior is stainless steel.

The Electric Hotpack Co., Inc., Dept. ED, 5065 Cottman St., Philadelphia 35, Pa.

***Availability:** Delivery time is 30 days.*

Silicon Mesa Transistors 543

Current rating is 1 amp



Having a current capability of 1 amp, types RT5001 through RT5004 are rated at up to 100 v.

The saturation resistance is typically less than 3 ohms at 500 ma. A wide range of applications is possible due to controlled beta linearity. Typical dc current gain is within 75% of the maximum value from 100 ma to 1 amp. Fast-switching units, these transistors have applications in magnetic memory drivers, hf oscillators, dc-dc converters, servo motor drives, choppers, and solenoid drivers.

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

Price & Availability: *Price ranges from $38.70 to $49.50. Units are immediately available.*

Photoconductive Cells 544

Continuous power ratings are 0.5 and 0.25 w

Types 504 and 505 photoconductive cells are cadmium selenide and cadmium sulphide types, respectively. The peak spectral response for the 504 is 5500 A and for the 505, 6900 A. The cells are rated at 250 v dc or peak ac. The units measure 1/2 in. in diameter and 1/2 in. in length.

Clairex Corp., Dept. ED, 19 W. 26th St., New York, N.Y.

Price: *Range is from $1.25 to $4.*

Incremental Voltmeter 545

Range is 10 mv to 500 v

Model 130 incremental dc voltmeter, incorporating an offset voltage source variable from 0 to 509 v and accurate to 0.1%, reads dc voltages from 10 mv to 500 v. The error of indication is 0.2% or less. Both positive and negative voltages can be read. The unit measures 13 x 7-1/2 x 6-1/8 in. and weighs 11 lb with batteries.

Belleville-Hexem Corp., Dept. ED, 638 University Ave., Los Gatos, Calif.

Price: *$625.*

NEW PRODUCTS

Moisture Getters 546

For semiconductors

These semiconductor moisture getters are mad of porous 7930 glass. Discs with or without holes and having thicknesses from 0.03 in. can be supplied. The material has mechanical strength to permit easy handling and mounting of the getters in transistor and diode enclosures.

Corning Glass Works, Dept. ED, Corning, N.Y.
Availability: *Large quantities can be supplied in three weeks.*

Polycrystalline Silicone Rods 57

For floating zone crystal growing

For floating zone crystal growing, these poly crystalline silicon rods are uniform in diamet have a boron content of 1 ppb, and have a v high density. Standard diameters of the rods a 3/4 to 7/8 in. with tolerances of ±0.005 in. Nor inal length is 10 in. Diameters of 3/8 to 1 in are available on special order.

Trancoa Chemical Corp., Dept. ED, Reading, Mass.
Price: *$1 per gram.*

Vacuum Oven 547

Double pass-through type

This twin pass-through oven is designed fo accelerated drying and baking of semiconductors. Pull-down is to 1 micron. A three-heat switch provides for wattage control. An overtemperature device is optional with the unit.

The Electric Hotpack Co., Inc., Dept. ED, 5065 Cottman St., Philadelphia 35, Pa.
Price & Availability: *Delivery time is 45 to 60 days.*

CIRCLE 80 ON READER SERVICE CARD

Miniature Switch 617

Measures 1/2 in. in diameter

Available in switching modes from one-pole, 10 positions to five-pole, two positions, this series BJ switch measures 1/2 in. in diameter and 1/2-in. in depth. Current switching capacity is 350 ma, 100 v dc with an inductive load of 2.8 h. The dielectric strength of the unit is 1000 v rms for 1 min at sea level; insulation resistance is 10,000 meg, minimum. Units come as either limited or continuous rotation, and in the latter design, may be motor driven for automatic-programming systems.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

Availability: Made on order only.

Ceramic Capacitors 397

Range is 47 to 56,000 μμf

Available in parallel lead, axial or feedthrough combinations, type EC ceramic capacitors range from 47 to 56,000 μμf. Their temperature range is −55 to +150 C; capacity variations are limited to ±10% of room temperature capacitance. Tolerances are 5%, 10%, 20%, or with GMV −0% and +100%. The units are rated at 200 wvdc and have a power factor of 2.5% at 1 kc or 1% at 10 kc. They stand environmental extremes and are suited for blocking and bypass applications where compactness is necessary.

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

CIRCLE 83 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Potting Compound 400

Has very low initial viscosity

For laminating, casting and potting, Epocast type 3 is basically an epoxy resin having a very low initial viscosity. The compound gels in the temperature range of 150 to 200 F. It has a high heat distortion temperature and long pot life. It has good electrical and adhesive properties, with thermal and mechanical shock-resistant characteristics.

Furane Plastics, Inc., Dept. ED, 4516 Brazil St., Los Angeles, Calif. ***Price & Availability:*** *Price is $2.25 per lb in 4-lb quantities. Delivery is 48 hr after receipt of order.*

Hysteresis Motor 401

High-torque

This hysteresis motor, called Supersyn, provides high-torque capabilities, fast acceleration, and good damping. A 12-pole motor is about 1/4 the size of conventional models but is able to develop the same output.

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

Ultrasonic Cleaner 694

With barium titanate transducers

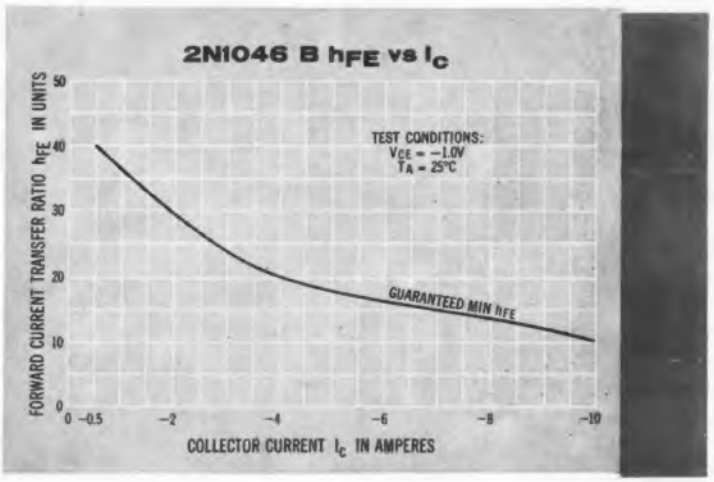
Model CB125 solid, stainless steel basket with barium titanate transducers sealed in the bottom is connected to model PG125 generator. Operating frequency for the basket is 40 kc. It may be used in the warm liquid rinse of a standard liquid-liquid vapor degreaser, in hot or cold solution tanks, or in the precleaning of tanks of plating systems. The basket weighs 16.5 lb and measures 9.5 x 9.5 x 33 in. The generator has an output of 125 w avg, 250 w peak and measures 14 x 10 x 10.25 in.

Circo Ultrasonic Corp., Dept. ED, 51 Terminal Ave., Clark, N.J. ***Price & Availability:*** *$350 for the generator; $250 for the basket. Delivery time is 14 days.*

ANIUM POWER TRANSISTORS

New high current 2N1046-A-B give you high frequency/dissipation/voltage with high beta!

New TI 2N1046B germanium power transistors give you 10 amp I_C with typical 18 mc f_T* . . . 130 volt BV_{CBO} . . . guaranteed beta of 10 at 10 amp I_C . . . 30 watt dissipation . . . high frequency/high current operating characteristics. The 2N1046 series alloy-diffused P-N-P transistors provides maximum reliability for your core driving, hi-fi amplification, and other high frequency power applications.



f_T* *Frequency at which common emitter current gain of the device is unity.*

Call on your nearest TI distributor or sales office for immediate delivery of TI germanium power transistors including the 1-amp 2N1038 series and the 3-amp 2N1042 series power transistors.

TI GERMANIUM POWER TRANSISTOR CHARACTERISTICS AT 25°C

Type	Dissipation at 25°C watts	Collector to Base Voltage-v max	Collector to Emitter Voltage min BV_{CEO}	Emitter to Base Voltage-v min BV_{EBO}	Collector Current Amps max	h_{FE} @ I_c min	h_{FE} @ I_c max	Collector Reverse Current I_{CO} max ma	Collector Reverse Current I_{CO} max v	Typ R_{CS} @ I_C ohms	Internal Cutoff Frequency avg f_T
2N456A	50	−40	−20	−20	−7	30 @ 5a	90	−0.5	−20	0.040 @ 5a	430 kc
2N457A	50	−60	−30	−20	−7	30 @ 5a	90	−0.5	−30	0.040 @ 5a	430 kc
2N458A	50	−80	−40	−20	−7	30 @ 5a	90	−0.5	−40	0.040 @ 5a	430 kc
2N1021	50	−100	−50	−20	−7	30 @ 5a	90	−0.5	−50	0.040 @ 5a	430 kc
2N1022	50	−120	−50	−20	−7	30 @ 5a	90	−0.5	−60	0.040 @ 5a	430 kc
2N511	80	−40	−20	−30	−25	20 @ 10a	60	−2	−20	0.025 @ 10a	260 kc
2N511A	80	−60	−30	−30	−25	20 @ 10a	60	−2	−30	0.025 @ 10a	260 kc
2N511B	80	−80	−40	−30	−25	20 @ 10a	60	−2	−40	0.025 @ 10a	260 kc
2N512	80	−40	−20	−30	−25	20 @ 15a	60	−2	−20	0.033 @ 15a	280 kc
2N512A	80	−60	−30	−30	−25	20 @ 15a	60	−2	−30	0.033 @ 15a	280 kc
2N512B	80	−80	−40	−30	−25	20 @ 15a	60	−2	−40	0.033 @ 15a	280 kc
2N513	80	−40	−20	−30	−25	20 @ 20a	60	−2	−20	0.038 @ 20a	300 kc
2N513A	80	−60	−30	−30	−25	20 @ 20a	60	−2	−30	0.038 @ 20a	300 kc
2N513B	80	−80	−40	−30	−25	20 @ 20a	60	−2	−40	0.038 @ 20a	300 kc
2N514	80	−40	−20	−30	−25	20 @ 25a	60	−2	−20	0.040 @ 25a	350 kc
2N514A	80	−60	−30	−30	−25	20 @ 25a	60	−2	−30	0.040 @ 25a	350 kc
2N514B	80	−80	−40	−30	−25	20 @ 25a	60	−2	−40	0.040 @ 25a	350 kc
2N1038	20	−40	−30	−20	−3	20 @ 1a	60	−125μa	−20	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1039	20	−60	−40	−20	−3	20 @ 1a	60	−125μa	−30	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1040	20	−80	−50	−20	−3	20 @ 1a	60	−125μa	−40	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1041	20	−100	−60	−20	−3	20 @ 1a	60	−125μa	−50	0.150 @ 1a	8.0 kc $f_{\alpha e}$ min
2N1042	20	−40	−30	−20	−3	20 @ 3a	60	−125μa	−20	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1043	20	−60	−40	−20	−3	20 @ 3a	60	−125μa	−30	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1044	20	−80	−50	−20	−3	20 @ 3a	60	−125μa	−40	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1045	20	−100	−60	−20	−3	20 @ 3a	60	−125μa	−50	0.167 @ 3a	8.0 kc $f_{\alpha e}$ min
2N1046	30	−100	−50	−1.5	−10	40 @ 0.5a		−1	−40	0.500 @ 1a	15 mc min
2N1046A	30	−140	−50	−1.5	−10	20 @ 4a		−1	−40	0.125 @ 4a	15 mc min
2N1046B	30	−140	−50	−1.5	−10	10 @ 10a		−1	−40	0.050 @ 10a	15 mc min

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CIRCLE 85 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Digital Meter 565

Measures ac, dc, and ohms

Model 500 A digital meter is a laboratory instrument for measuring ac, dc, and ohms. The top scale is 1200 v ac and dc. Accuracy is ±0.1% on dc ranges and ±0.5% on ac ranges. Resistance range is 1 meg at an accuracy of ±0.2%. Input resistance on the 1200-v dc range is 20 meg. An output is provided for direct operation of digital printers for data processing systems. The instrument is suited for laboratory use.

Franklin Electronics Inc., Dept. ED, Bridgeport, Pa.

Price & Availability: $1850; from stock.

Tape Transport 560

Handles 5, 6, 7, and 8-level codes

Model 81 tape transport permits the interchangeable use of plug-in photoelectric or magnetic head assemblies, and accommodation of standard printed circuit models of control logic and read-and-write amplifiers. The photoelectric reading head system handles 5, 6, 7, and 8-level codes. Integral adjustable tape guides will handle 11/16, 13/16, 7/8, and 1-in. wide tapes. Metered tape speeds of up to 75 ips in either direction can be furnished. The unit is capable of moderate stop-start times and can be controlled remotely or locally. Solid-state circuitry is used throughout. Requirements of MIL-E-4158 B are met.

Cook Electric Co., Data-Stor Div., Dept. ED, 8100 N. Monticello Ave., Skokie, Ill.

Availability: From stock after May 1, 1960.

Crystal Ovens 561

Temperature setting is +50 to +125 C

The KCO series of crystal ovens offers a temperature setting of +50 to +125 C, a voltage range of 6.3 to 117 v ac or dc, a warm up time of as low as 2 min, and an ambient temperature range of −65 to +120 C. The units are constructed to have a maximum life expectancy with minimum temperature deviation or shift. Units for high shock and vibration environments can also be supplied.

Keystone Electronics Co., Dept. ED, 65 Seventh Ave., Newark 4, N.J.

Availability: *Immediate delivery on prototype quantities.*

Constant-Current Power Supply 552

Regulation is better than 1%

Designed for powering solid-state equipment, model UCS-200 power supply provides up to 400 ma at 30 v max. Regulation is better than 1% against line and no load to full load variations; the unit is transistor and Zener-diode regulated. Ripple is less than 5 mv. The output, continuously monitored by a voltmeter and a milliameter, is isolated from input line and chassis ground. Up to three units can be mounted in a rack panel 5.25 in. high.

Matthew Laboratories, Dept. ED, 3344 Fort Independence St., New York 63, N.Y.

Price & Availability: *$109.50; from stock.*

NEW PRODUCTS

Airborne Pressure Transducer 6

Accuracy is 0.25%

Model 181 miniature press transducer is designed for airbo applications whose measureme of 0.25% accuracy are required o a wide temperature range. Press ranges are: 0 to 250, 0 to 300, 0 350, 0 to 500, 0 to 750, and 0 1000 psi. The unit is able to sta three times rated full-scale pr sure. It has a low sensitivity vibration, a virtually infinite reso tion, and a pressure-cavity clean- feature. The unit can be used w either a constant voltage or const current system.

Taber Instruments Corp., De ED, N. Tonawanda, N.Y.
Price: $350 for standard unit.

Laboratory Standard Console 3

For ac and dc instruments

Designed to check ac ammet ac voltmeters, dc ammeters, dc vo meters, and wattmeters, this labo tory standard console has an ac racy of 0.05%. Ranges are 0 to 15 v and 0 to 50 amp for ac, 0 to 750 150 mv, 1.5 to 30 ma, and 0 to amp for dc. The unit operates o the temperature range of 40 to 1 F. It requires 110 to 120 v at 60 c measures 5 x 7 x 2 in., and nee only one non-skilled operator.

Weston Instruments, Daystro Inc., Dept. ED, 614 Frelinghuys Ave., Newark 12, N.J.

Microwave Wattmeter 3

Has self-balancing bolometer brid

This microwave wattmeter, d signed for highly accurate bolom ric power measurements up to ma dc, is made up of two ba units: model 1493 self-balanci bolometer bridge and model 14 reference-current generator. T bridge automatically adjusts the

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bias power dissipated in the external bolometer by circuitry that keeps the dc resistance of the bolometer constant. The bridge comprised the resistance with which a bolometer is combined to form a bridge circuit, a dc amplifier, and a regulated plate-voltage supply. The dc amplifier is connected in a feedback circuit. The bridge alone is capable of high-power measurements. Used with the reference current generator, it can measure power in the milliwatt range.

Weston Instruments, Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Duplexer 681

Covers 225 to 400 mc

Type T428V1D duplexer covers from 225 to 400 mc and is capable of reliable operation at 1 kw peak power input or 400 w avg. Construction is of rigid coaxial line. The rf output connections have type N or 7/8-in. coaxial fittings. The vswr is held to 1.5 on transmit and 1.7 on receive. Insertion loss is a maximum of 0.6 db. The tubes utilize electronic deionization technique instead of the water vapor and rare gas mixture commonly used.

Tucor, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

Price & Availability: *The complete unit is priced at $1000. It is made on order.*

Motor-Alternator Sets 416

Provide ac line power at 60 or 400 cps

This line of motor-alternators packages from 5 to 40 kw (6.25 kva to 50 kva) provides ac line power at either 60 or 400 cps, single or three phase. A total of 120 different standard sets are included in the line. They are specifically intended for use with electronic computers, missile-ground systems, telemetry and guidance systems and other large electronic systems. All regulating circuitry is solid-state.

Electric Specialty Co., Dept. ED, 206 South St., Stamford, Conn.

Availability: *Made on order only.*

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NEW PRODUCTS

Differential Transformer Indicator 604

Displays values on a 10-in. panel meter

Indication and recording of static and dynamic values of linear motion, acceleration, force, pressure, and other quantities measurable by differential transformer transducers are possible with model 300BF indicator. All values are displayed on a 10-in. panel meter. A demodulated output, flat to 500 cps, is available for operation of cathode ray and recording oscillographs. The instrument is accurate to 1% with maximum resolution of 0.000005 in. of core displacement.

Daytronic Corp., Dept. ED, 225 S. Jefferson St., Dayton 2, Ohio.
Price & Availability: *Delivered 10 days after order received. Price is $395.*

Semiconductor Preforms 421

Melting point is 1800 F

These silver-arsenic alloy preforms have a melting point of 1800 F. For use in forming alloy junctions in silicon transistors in spherical shapes, the preforms are 99% silver and 1% arsenic. Diameters range from 0.001 to 0.125 in. Tolerance is ±0.0001 in.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

Oscilloscope Recording Camera 417

Modular design

This oscilloscope recording camera, called Minute Man Oscillotron, has a polaroid, Land back providing either 60-sec prints or transparencies. Of modular design, it can be converted to record a wide range of object-to-image ratios. It can be attached to any 5"-in. oscilloscope.

Beattie-Coleman, Inc., Dept. ED, 1042 N. Olive St., Anaheim, Calif.

Welder 443

Operates by ultrasonics

This rotary, tip foil welder operates on the principle of ultrasonics. Materials as thin as 0.00025 and up to 0.006 in. can be welded through high-frequency sound alone. The unit can be used with metals such as aluminum foil, where surface oxidation or welding heat presents a deterrent to standard welders, and metals with high electrical conductivity, such as copper. Production models measure 23-3/8 x 15-1/4 x 21-3/4 in.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

Price & Availability: *Available from stock. Price is $3850 per unit; quantity discounts available.*

Ceramic Capacitor 418

For operation from —55 to +150 C

The VK-U series of ceramic capacitors are for operation from —55 to +150 C at 200 v dc without derating. Values to 10,000 μμf are offered; maximum size is 0.265 x 0.07 in. All units are guaranteed to have a minimum life of 1000 hr at maximum temperature and at 200% of rated voltage. Dielectric strength is guaranteed to 400% of rated voltage and maximum capacitance change with temperature is typically ±10%.

Vitramon, Inc., Dept. ED, Box 544, Bridgeport 1, Conn.

Epoxy 360

Has built-in dielectric

Available in thin sheets or in roll or die-cut form, Filmex epoxy permits bonding of metal parts and achieves insulation with a pre-determined dielectric strength. It can also be used for sealing. The material is heat-cured at temperatures from 200 to 450 F in 5 to 20 min. It is supplied ready to use.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.

Availability: *From stock.*

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NEW PRODUCTS

Wire Cutter 405

Cuts in increments from 1 to 6 in.

Model Ses-Matic wire feed, a self contained unit that measures, feeds and cuts wire with an accuracy of 0.002, is adjustable to cut off wire in increments from 1 to 6 in. in length. Units for wire sizes up to 3/16 in. and stroke lengths from 1 to 24 in. are also available. Electrical controls provide stop and start. No adjustment is necessary when changing from one wire size to another within the range of the unit.

Special Engineering Service, Inc., Dept. ED, 7630 Wyoming, Dearborn, Mich.

Availability: *Made on order only. Can be delivered 48 days after order received.*

Servo Amplifiers 402

Have outputs of 2.5 and 9 w

Types A 7220 and A 7200 servo amplifiers are encapsulated units that drive a size 8 servo motor and a size 18 servo motor, respectively. The A 7220 requires a power input of either 26 or 115 v, 400 cps rms, and has an output of either 13 or 26 v rms at 2.5 w. The A 7200 requires 115 v rms, ±10%, and has a power output of 9 w. Both units withstand shock, vibration, and environmental requirements as specified in MIL-E-5272B.

Control Data Corp., Cedar Engineering Div., Dept. ED, 5806 W. 36th St., Minneapolis 16, Minn.

Availability: *Delivered 45 to 60 days after order received.*

Ultrasonic Cleaner 597

Combines production and cleaning operations

By processing machined and sheet metal parts as they come off automatic fabricators, this ultrasonic cleaner, called AutoSonex, combines the separate operations of production and cleaning. As parts move through the machine, they are immersed in a degreasing solution,

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lowered by ultrasonics, rinsed, then rained and passed through an iso- ated solvent drying chamber be- ore being discharged. The solvent rocess removes oils, drawing lu- ricants and smut, chips, and abra- ives and dust.

Metalclean Equipment Co., Dept. D, Box 177, Bala Cynwyd, Pa.

rice & Availability: Available om stock by April 1, 1960. Deliv- red 8 weeks after order is re- eived. Price is under $3000 per nit. Water drying facilities between 250 and $400 depending on hether gas or electricity is used.

esistor Alloy 410

Made of 74% nickel and 20% chromium

Called Chromel-R, this resistor lloy consists of 74% nickel and 20% hromium plus small percentages of ther alloying materials. Specific roperties include an electrical re- istivity of 800 ohm-cmf at 20 C, nd a temperature coefficient of re- istance within 0 ±10 ppm per deg C over the operating range from -65 to +150 C. The material omes in drawn wire sizes from .0031 in. down to 0.0004 in. in iameter, bare or enameled.

Hoskins Manufacturing Co., Dept. D, 4445 Lawton Ave., Detroit 8, Mich.

vailability: Available from stock.

nduction Heater 590

For processing semiconductors

This 3-mc induction heater, de- igned for the processing of semi- onductors and other miniature omponents, permits instantaneous, in-point heat with no contamina- ion and no preheating. The unit perates on 220 or 440 v. Other eatures are instant change coils, nd a built-in current transformer. The unit is shockproof and is housed n a welded, formed steel cabinet. Automatic production units can be uilt to meet individual require- nents.

Sherman Industrial Electronics, Dept. ED, State College, Pa.

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NEW PRODUCTS

Power Supplies 557

Output current is 25 ma

Model RS-473 power supply provides two outputs of positive 300 to 400 v and negative 300 to 400 v, or a single output of 600 to 800 v. Current range is to 25 ma. Ripple and noise are 7 mv peak-to-peak max. Recovery time is less than 25 μsec, load regulation is 0.03%, and line regulation is 0.02%. Internal impedance is less than 1 ohm. Required input is 105 to 125 v ac at 60 to 400 cps. The unit is available as a bench model for laboratory use or as a flat plate module for installation into original equipment.

Trans Electronics, Inc., Dept. ED, 7349 Canoga Ave., Canoga Park, Calif.

Price & Availability: *Bench model, $120; plate module, $115. Delivery is from stock.*

Amplifier Demodulator 564

Variable gain type

This amplifier demodulator is designed to amplify and convert phase-sensitive suppressed-carrier ac input signals to phase-sensitive dc signals. The gain is adjustable to a maximum of 100 by varying the feedback resistor. The output voltage is ±2.5 v dc and can have a zero offset. Input impedance is 500 K min; output impedance is 2 K at a voltage gain of 25. Linearity is 1% over the temperature range of −55 to +85 C. Size of the unit is 1 x 1 x 2 in.

Natel Engineering Co., Inc., Dept. ED, 15922 Strathern St., Van Nuys, Calif.

Price & Availability: *$65 to $150. Standard units are furnished from stock.*

SILICON RECTIFIERS

		P.R.V.	Max. DC Current at T°C Resistive Load	Max. One Cycle 60 C.P.S. Surge Full Load	Max. Rev. Peak Current @ Max. Temp. & P.I.V.
LOW POWER RECT.	1N1217 SERIES	50-1000 V.	500 MA @ 110°C. AMB.	15 AMPS.	1.5 MA @ 150°C. JUNCTION
	1N1227 SERIES	50-1000 V.	1.6 A @ 140°C. CASE	15 AMPS.	
MEDIUM POWER RECT.	1N1341 SERIES	50-600 V.	6 A @ 150°C. CASE	160 AMPS.	10 MA @ 190°C. JUNCTION
	1N1199 SERIES	50-600 V.	12 A @ 150°C. CASE	200 AMPS.	
	1N1191 SERIES	50-600 V.	18 A @ 140°C. CASE	220 AMPS.	
	1N1183 SERIES	50-600 V.	35 A @ 140°C. CASE	220 AMPS.	
HIGH POWER RECT.	1N1396 SERIES	50-500 V.	70 A @ 150°C. CASE	1200 AMPS.	30 MA @ 190°C. JUNCTION
	1N1660 SERIES	50-500 V.	160 A @ 125°C. CASE	2000 AMPS.	40 MA @ 190°C. JUNCTION
	1N1670 SERIES	50-500 V.	240 A @ 125°C. CASE	3000 AMPS.	50 MA @ 190°C. JUNCTION
	439 SERIES	50-600 V.	240 A @ 125°C. CASE	3000 AMPS.	

GERMANIUM TRANSISTORS

	Class	Typical Operation			Maximum Ratings			
		I_{CBO} μa	h_{FE}	f mc/s	V_{CE} V	I_C ma	P_C mw	T_J °C
2N59	AUDIO-PNP	10	100	1.2	20	200	180	85
2N60	AUDIO-PNP	10	70	1.1	20	200	180	85
2N403	AUDIO-PNP	10	33	0.85	20	200	180	85
2N614	IF -PNP	3	5	3	20	150	125	85
2N616	IF -PNP	3	20	9	20	150	125	85
2N617	IF -PNP	3	14	7	20	150	125	85

SILICON POWER TRANSISTORS

	Type	h_{fe} or h_{FE}	$f_{\alpha mc}$	V_{CEX} Volts	I_C Amps	T_J °C
2N1015 SERIES—2 AMP.	NPN	10 (V_{CE}=4 V I_C=2 A)	ALPHA CUTOFF .300	30-200	7.5a	150
2N1016 SERIES—5 AMP.	NPN	10 (V_{CE}=4 V I_C=5 A)	ALPHA CUTOFF .300	30-200	7.5a	150

50 AMPERE SILICON "TRINISTOR"* CONTROLLED RECTIFIER

Breakover Voltage @ 125°C T_J	Reverse Blocking Voltage @ 125°C T_J	Turn-on Time	Turn-off Time
TYPICAL			
50-200 VOLTS	50-200 VOLTS	1.0 μ SEC.	15-20 μ SEC.

RECTIFIER ASSEMBLIES

Standard rectifier assemblies are available in all types of circuit configurations, and are designed for either forced air or natural convection cooling with a wide range of ratings. Nickel-plated copper plates and other materials used in these assemblies have been chosen to insure satisfactory performance in corrosive atmospheres and high ambient temperatures.

THERMOELECTRIC COOLING DEVICES

Two types are available in commercial quantities: WX814 (2.5 oz.) and WX816 (3.0 oz.). Both types measure about an inch and a half square and will find immediate application in cooling germanium transistors, infrared detectors, optical systems, mechanical and electric instruments, laboratory and portable medical equipment, and related fields where spot cooling below ambient is necessary.

INFRARED DETECTORS

Type	Noise Equivalent Power (NEP) Watts		Wave-length Response, Microns	Time Constant, μ SEC.	
	TYPICAL	LIMIT		TYPICAL	LIMIT
812	5×10^{-11}	10^{-10} MAX.	1-12	0.1	0.2 MAX.

The types listed are just a small sampling of the complete line which can be supplied in volume quantities for prompt deliveries.

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Clock Timers 562

Come in 4 and 5-digit models

Available in 4 and 5-digit models, types HTCcZ4E and HTCeZ5E electromechanical timers indicate time when pulsed each minute, second, 1/5 sec, or 1/10 sec by an impulse transmitter. The units have an instantaneous mechanical toggle type zero reset; remote electric resets can also be furnished. Typical maximum readings are: for the 5-digit unit, 11 hr 50 min 59 sec and 99 min 59 sec 9/10 sec; and for the 4-digit unit, 99 min 59 sec. The 4-digit unit occupies 1-3/8 x 1-1/4 x 4-1/16 in. Power requirements are 1.6 x at 24 v dc.

Landis & Gyr, Inc., Dept. ED, 45 W. 45th St., New York 36, N.Y.

Price & Availability: *Prices range from $32 to $38.50. Delivery time for small quantities is 8 to 10 days.*

Relay Tester 556

For go/no-go testing

Model RT-905 relay tester measures pull-in and drop-out voltage and current simultaneously. Coil voltage is continuously variable. An on-off control is provided with neon lights to indicate the contact position. Automatic relay-driving circuitry provides three repetition rates for go/no-go testing. The standard rack-mounting unit measures 8.75 x 19 in. The enclosed chassis assembly is 17 x 8.25 x 8 in.

Electronic Engineering Co. of Calif., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: *$870 fob Santa Ana.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN

NEW PRODUCTS

Ohmmeters 404

Have 0 to 3 and 0 to 3000 ranges

The Vibroground series of ohmmeters includes three models, all of which provide direct reading of ohms resistance to an earth ground. Direct reading ranges down to 0 to 3 ohms, and as high as 0 to 3000 ohms are available. Hand cranking and leveling adjustments have been eliminated in these models. The units contain battery-operated, vibrator power supplies.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Price & Availability: *Some models available from stock; other models delivered 30 days after order received. When ordered in quantities of 1 to 10, price is between $120 and $575.*

Vhf Pulse Transmitter 408

Gives a peak pulse power of 1000 w

Model 200A vhf pulse transmitter operates over a frequency range of 152 to 174 mc, and delivers a peak pulse power of 1000 w at a maximum duty cycle of 50% into a nominal load impedance of 50 ohms. The input modulation requirement is 1 to 4 v peak into a 100-ohm termination. The transmitter's rf output signal between modulation pulses is 60 db or more below the 1-kw output signal. The unit operates from a 208-v, 60-cps, three-phase, 4-wire input.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Drive, Menlo Park, Calif.

Availability: *Made on order only.*

Switches 403

Have leaf and roller leaf actuators

The 5300 series subminiature switches are available with integral leaf and roller leaf actuators. Their electrical ratings are: 5-amp resistance and 3-amp inductance at 30 v dc and 125 v dc. Terminal styles are solder hole, turret, and double tur-

ret. The basic switch meets the requirements of MIL-S-6743 and vibration per Procedure II of MIL-E-5272A. The units are suited for ganging in cam-actuated and limit-switch applications when multiple pole switching is desired.

Haydon Switch, Inc., Dept. ED, Waterbury 20, Conn.

Price & Availability: *Delivered 20 days after order received. List prices are between $1.75 and $2.10. Quantity discounts available.*

Insulating Tubing 414

For high-temperature closures

Designed for closures that must submit to high-temperature conditions, this zipper type closure is offered on the firm's Alas and Alsr, high-temperature and chemical-resistant tubing, and on the all-Teflon jackets. The jackets have the Z-Trac sewn with Teflon-coated, glass thread to a 6 or 10 mil sheet material of Teflon-impregnated, glass cloth. A pressure sensitive tape can be heat-processed over the stitching to seal needle holes.

The Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles, Calif.

Availability: *Usually available from stock.*

Electronic Mounts 407

Come in two designs

Used to isolate airborne equipment from high-intensity environments, these two designs of electronic mountings together compose 35 variations. Model 2310 is a center-of-gravity system designed to accommodate the smaller ATR configurations. Natural frequency is in the 6 to 10-cps range with a transmissibility at resonance of less than 3. Model 2311 is a base type system for larger ATR equipments. Each system uses stainless steel resilient elements, and meets the requirements of MIL-C-172B.

Robinson Technical Products, Inc., Dept. ED, Teterboro Air Terminal, Teterboro, N.J.

Availability: *Made on order only.*

NEW PRODUCTS

Variable Resistance Transducer 423

Controls to 1/4 kw of power

The Regohm variable resistance transducer controls up to 1/4 kw of power and responds to less than 0.0001 in. of mechanical displacement. Any process or machine quantity which appears as a change in position can move the actuator of the unit to initiate control. Input motion causes a stepless change of resistance in the output circuit. The unit is compact and is rated conservatively for a life of 50,000 hr with no need for cleaning, lubricating, or adjustment.

Electric Regulator Corp., Dept. ED, Pearl St., Norwalk, Conn.

Annunciator 415

Gives sequence of alarms

This digital sequential annunciator instantly identifies the sequence in which a group of alarms occur. Any number of total alarm points can be handled. Three variations are available in which up to 7, 15 or 31 off-normal points may be sequentially identified by clear binary readout, with resolution between points in milliseconds. Alarms are audible as well as sequentially visible.

Panellit, Inc., Panalarm Div. Dept. ED, 7401 N. Hamlin Ave. Skokie, Ill.

Price & Availability: Made on order only; will be available in early second quarter, 1960. Price is less than $100 per point.

Accelerometer 427

Weighs 3/4 g

Type A-3109 self-generating accelerometer, measuring less than 0.1 in. high and 0.5 in. in diam. weighs 3/4 g. It has an acceleration range of 0.5 to 500 g, a useful frequency range of 3 to 4000 cps, and a sensitivity of 2 mv per g min. The operating temperature range is —65 to +250 F. Resonant frequency i

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12 kc min. The unit is particularly suited for use in wind tunnel testing of simulated aircraft; it can also be built into many types of electronic equipment as a permanent installation. The unit is housed in aluminum. Model A-3108, also offered, is enclosed in brass housing, has greater sensitivity, and has a broader frequency response.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.
Price & Availability: *Price is $285; quantity discounts are available. Delivery is within two weeks.*

Analog-to-Digital Converter 412

Output is 10,000 bits per sec

This solid-state, analog-to-digital converter, called the Multiverter M3, has an output of 10,000 pits per sec at an accuracy of 0.05%. Either 11-bit binary or 3-digit binary coded decimal plus sign is available on standard units. On special order 4-decimal digits plus sign can be furnished. The input impedance is 10,000 ohms per v. Power requirement is 115 or 230 v ac, 50 or 400 cps, with a maximum consumption of 35 w.

Packard Bell Computer, Div. of Packard Bell Electronics, Dept. ED, 12333 W. Olympic Blvd., Los Angeles 64, Calif.
Price: *$4,500.*

Dual Potentiometers 588

Resistance range is 500 ohms to 10 meg

This assembly of two potentiometers, welded back-to-back, is for channel balancing applications in stereo systems, limited space applications, and unitized chassis construction. The units are furnished in a resistance range from 500 ohms to 10 meg. The 0.5-w composition element controls to 2 w. Wirewound element controls are rated at 2 to 4 w. The back-to-back arrangement permits positioning the terminals of each control in virtually any position in relation to each other.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

CIRCLE 97 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Punched Tape Programmer 555

Handles 80 bits

Able to handle 80 bits of information, model TP-201A bi-directional punched tape programer is for use in automatic test equipment and digital data processing systems. It can be used for the design of automatic pre-flight checkout equipment or automatic process control equipment with random or sequential access to 3000 discrete tests. A bi-directional electrical drive system uses positive detent action for positioning the tape. The unit uses 2-in. tape with 1-in. for punched information and 1 in. for printed information. Storage reels for up to 250 ft of tape are self-contained in the unit. The panel measures 6 x 11.75 in. with 5.75 in. below-the-panel depth. Models handling 160 and 240 bits of information can also be furnished.

Electronic Engineering Co. of Calif., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

Price: $1160 fob Santa Ana.

Coaxial Directional Couplers 554

Range is 250 to 4000 mc

This series of coaxial, directional couplers covers the range of 250 to 4000 mc. Directivity is 20 db min. Coupling variation is less than ±1 db over a 2:1 frequency range. Standard units are furnished with type N connectors and 10-, 20-, and 30-db coupling. Model 5-30 is shown here.

Radar Design Corp., Dept. ED, 1006 Pickard Drive, Syracuse 11, N.Y.

Price & Availability: *Price ranges from $100 to $200, depending on coupling and frequency range. Units are available for immediate delivery.*

Adhesive Tapes 608

Coated with adhesives on both sides, this tape is precision cut to meet specific product requirements. The pre-cut tape is available in microthin form for use where space is limited, in polyester films where high dielectric strength is needed, and in other forms with special physical properties. Typical uses are to attach diecast nameplates or trademarks to product surface, and to secure small electronic parts in radio, TV, and appliances.

W. H. Brady Co., Dept. ED, 727 W. Glendale Ave., Milwaukee 9, Wis.

Price & Availability: *Made to order items. Delivered 3 to 4 weeks after order received. Price depends on customer specifications.*

Ferrite Circulator 439

Model V-FC 1, a four-port device uses polarization rotation. A non-reciprocal 45-deg rotator and dual-mode transducers are included in the unit. Peak power, unpressurized, is 10 kw; average power is 2 w.

T. R. G., Microwave Component and Antenna Dept., Dept. ED, 9 Union Square, Somerville 43, Mass.

Price & Availability: *Price is $2500 ea. The unit is made on order and can be delivered in 60 to 90 days.*

Instrument Dials 433

This shadow-free, electroluminescent dial has an operating life of thousands of hours. The dial face is backed by a lamp base which is a vitreous enameled steel sheet coated with phosphor. It operates on 115-v, 60-cps power.

Weston Instruments, Daystrom, Inc., Dept. ED. 614 Frelinghuysen Ave., Newark 12, N.J.

Potentiometer 434

Type WPS 1/2 is a precision version of type APS 1/S. The unit has sealed construction, servo-type mounting, and a behind-the-panel length of 1/2 in.

Waters Manufacturing, Inc., Dept. ED, Boston Post Road, Wayland, Mass.

Calorimetric Test Set 435

Model 290 includes model 290A calorimeter, an ac wattmeter, and a closed-circuit heat exchanger. The calorimeter includes liquid flow controls, calibration sources, and metering circuits. Accuracy is 1%.

Sierra Electronic Corp., Dept. ED, 3885 Bohannon Drive, Menlo Park, Calif.

Silver Solder Preform Rings 501

Designed for soldering at 1150 to 1800 F, these rings can be supplied with an overlap, a gap, or with ends butted in diameters of 0.003 to 0.375 in. and with a wide range of inside diameters.

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

NEW PRODUCTS

Impregnator 444

Uses centrifugal impregnation

This machine impregnates in minutes such parts as capacitors, armatures, electrical coils, and other porous and semi-porous objects. It uses centrifugal impregnation by developing a pressure variance from 100 psi at the periphery to zero at the center of the chamber. Saturants such as varnish, wax, asphalt, oil, or others are pushed into the objects while air and other contaminants are being pushed out. Special models allow the use of volatile, electrolytic and hot saturants.

Leon J. Barrett Co., Dept. ED, Box 378, Worcester 1, Mass.

***Price & Availability:** Made on order only; can be delivered 60 to 120 days after order received. Prices range from $4000 to $15,000, depending on size, type, and arrangement.*

Ceramic Tooling 359

For use in soldering

Made for use in soldering diodes, rectifiers, and electrical connectors, type M120F-T ceramic tooling is heat resistant to 1100 C and will not oxidize or spall in the soldering range. Low thermal expansion permits very close tolerances to be achieved. A wide variety of sizes, from 10 x 10 in. boats to inserts 0.062 in. in diameter, can be supplied. The tooling is suitable for use with any heating method.

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

***Availability:** Delivery time is two to four weeks.*

Silicon Transistor 458

For use from −65 to +175 C

Made for both military and industrial applications, type 2N1069 high-power silicon transistor operates over the temperature range of −65 to +175 C. Typical applications are as a relay replacement and control, solenoid actuator, power converter, dc amplifier, power supply regulator, and class A and B power amplifiers. The unit has a low saturation resistance. At 25 C mounting flange temperature, the power dissipation is 50 w; at 100 C, it is 25 w. An npn transistor, the unit is hermetically sealed in a welded metal case and conforms to JEDEC TO-3 outline.

Silicon Transistor Corp., Dept. ED, Carle Place, L.I., N.Y.

***Price:** For quantities under 100, $60.40 ea; for over 100 $40.25.*

Mercury Relays 440

Come in three groups

These 30-amp, 115-v, ac mercury relays come in three groups: one designed for ordinary temperature requirements; a second that will operate at temperatures up to 500 F; and an ultra high and ultra low temperature group that will operate up to 1200 F. All units are hermetically sealed and have 3-way wiring connections. The line of relays gives various time delays for ac relays without using thermal delay mechanisms.

Sorrels-Johnson Corp., Dept. ED, 363 Rantoul St., Beverly, Mass.

***Price & Availability:** Made on order only. Samples available from stock; units available from stock by March 20. Custom units delivered in 60 days. Price for Class No. 1 is $15 per unit; $9 when ordered in quantities of 100, and $6 when ordered in quantities of 500.*

Relays 43[illegible]

Contact rating is 0 to 10 v at 1 ma

The Micro-Scan relays are for dc asynchronous, and synchronous switching of low mv level to moderate level signal circuits in digital analog, and measurement applications. Both dpdt and spdt types are available with a contact rating of 0 to 10 v at 1 ma. Operating time is less than 750 μsec and the driving system requires less than 500 mw to the polarized center-tapped coil

Thermal noise is less than 3 μv. Contacts are arranged to make-before-break or break-before-make with center position off.

James Electronics, Inc., Dept. ED, 1050 N. Rockwell St., Chicago 18, Ill.

Price & Availability: Sample quantities are available from stock; production quantities can be delivered in four to five weeks. Price is furnished on request.

Printed Circuit Motors 406

Come in two sizes

Electric motors for servo and instrument use employing a flat printed circuit instead of the conventional wirewound armature are available in two sizes: the model PMI-PM368, which measures 4-1/4 in. in diameter and 2-1/4 in. in length, and the larger model PMI-PM488, 5-5/8 in. in diameter and 3 in. in length. The motors have low armature inductance, not exceeding a few microhenries. The low inductance eliminates the sparking normally associated with commutating.

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

Price & Availability: Available from stock after April 15. Prices are $190 for PMI-PM 368, and $240 for PMI-PM 488. Quantity discounts available.

Magnetic Tape 352

Heavy-duty

Scotch magnetic instrumentation tape has a long-wearing coating that minimizes oxide rub-off, reduces build-up of electrostatic charges, and resists high temperatures. The binder is similar to that used in video tapes. Applications include airborne and missile recording. Type 398 has a 1.5-mil backing and type 399 has a 1-mil backing. Both have a 0.45-mil black oxide coating.

Minnesota Mining & Mfg. Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

Availability: Standard sizes are in stock. Non-standard sizes can be delivered in 30 days.

Digital Test Equipment 413

Flip-flop and clock

This digital test equipment consists of type 202 flip-flop and type 403 clock. The static flip-flop has built-in output amplifiers, an indicator, a source for counting carry pulses, a complement input, and two transistor gates. Delay is 60 mμsec. This unit can also be used for all general purpose logical operations. The highly stable crystal clock produces a 40-mμsec, 2.5-v pulse every 100 mμsec. This output can be used to drive the flip-flop, as a time pulse distributor, or in other logical applications. Both units have graphic front panels and patchcord logical interconnections.

Digital Equipment Corp., Dept. ED, Maynard, Mass.

Price & Availability: Models 202 and 403 are priced at $160 ea. They can be delivered in about two weeks.

Tunnel Diodes 351

Peak-to-valley ratios are 3:1 and 7:1

These tunnel diodes have peak-to-valley ratios of 3:1 and 7:1 or higher. Germanium, pn junction units, they are particularly suited to microwave applications where low power and high frequency are needed. The TO-9 package is used.

General Transistor Corp., Dept. ED, 91-27 138th Place, Jamaica 35, N.Y.

Price: $8 and $10, depending on the unit.

Gear Tester 353

Uses recorder

This electronic gear tester uses a recorder which can be calibrated to any ratio within the limit of recording tape. Gears can be checked in pairs or against a master gear. A master gear for each pitch is required together with a driving gear of the same pitch for the driving motor.

Scherr-Tumico Co., Dept. ED, 200 Lafayette St., New York 12, N.Y.

NEW PRODUCTS

Transistor Tester 559

Battery-powered

Model K & K transistor tester is powered by two 6-v batteries and weighs 2.5 lb. It is well suited for matching transistors in push-pull, audio circuits. Power and general purpose types may be tested to determine if the transistor is open, shorted, noisy or has high leakage.

Kierulff & Co., Dept. ED, 6303 Corsair St., Los Angeles 22, Calif.

Price & Availability: *$19.95; from stock.*

Electroplater 470

Comes in three models

Models K-50, K-100 and K-250 tool room electroplaters have an attachment that cuts set-up and stop-off time. It consists of a hoist which raises and lowers a plastic-coated table into a hard chrome-plating solution. The table holds the parts to be plated. It also acts as a current deflector preventing buildup on ends and edges of the parts being plated.

National File Co., Krome-King Div., Dept. ED, 530 N. Cedar St., Lansing 12, Mich.

Price & Availability: *Delivered about 10 days after order received. Prices are: K-50, $875; K-100, $1500; K-250, $2990.*

Pressure Transducers 464

Available with 1000 to 5000 psi

Available in pressure ranges between 1000 and 5000 psi, type H-143 pressure transducer weighs 6 oz and measures 2.5 x 1 in. It meets a total dynamic error band of $\pm 2\%$ which includes linearity, hysteresis, resolution, static friction, sinusoidal vibration of 20 g from 50 to 2000 cps, and Gaussian random vibration of 0.6 g^2 per cps. All welded construction is used.

Servonic Instruments, Inc., Dept. ED, 640 Terminal Way, Costa Mesa, Calif.

Availability: *Units are made on order and can be delivered in 30 to 60 days.*

Electric Heaters 553

Have 3/4 in. diam

These electric heaters, measuring 3/4 in. in diam and 0.15 in. thick, have a center hole for mounting with a No. 2 screw. Units are enclosed in flat-bottomed, metal cases. Operating at 115 v ac or dc, the unit has wattage ratings of 2, 5, and 10 w. Heater internal temperatures to 500 F are permissible.

Minco Products, Inc., Dept. ED, 740 Washington Ave., N., Minneapolis 1, Minn.

Price & Availability: *Price is $10 each for one or two units; $8.50 ea for three units. Units are in stock.*

Threaded Terminals 469

With Teflon insulation

Type TF-300 Teflon-insulated, threaded terminals can be subjected to soldering operations without burning, charring, or chacking of insulation. They are female-type, with an over-all height of 0.468 in. above the chassis and a lug height of 0.156 in. Able to stand extreme vibration, the units are mounted with screws and are made of brass, gold flash over silver.

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

Availability: *Delivery time is 30 days.*

Plug 471

Has four isolated terminals

Model MDP-X is a 3/4-in. spaced molded double-plug with four terminals isolated from each other. Each terminal connects to a solder turret. The banana plugs have a one-piece beryllium copper spring to increase expected life. The plug body is molded of unbreakable plastic. Its standard color is red.

Pomona Electronics Co., Inc., Dept. ED, 1126 W. Fifth Ave., Pomona, Calif.

Price & Availability: *Available from stock. Can be delivered 2 days after order received. Price is $3.25 per unit; $2.85 in quantities of 7 to 12; $2.40 in quantities of 50 to 99.*

NEW PRODUCTS

Voltage-to-Frequency Converter 669

Long-term accuracy is 0.1%

This transistorized voltage-to-frequency converter has a long-term accuracy of 0.1%. The frequency range is 0 to 100 kc and full-scale sensitivity can be switched from 0.1 to 1000 v in five steps. Input polarity is indicated automatically. Typical applications include analog-to-digital conversion, integration, and telemetry. In addition to the cabinet design shown, a rack-mount unit and a module suitable for multi-channel installations are offered.

Vidar Corporation, Dept. ED, 2107 El Camino Real, Palo Alto, Calif.

***Price & Availability:** $700; 90-day delivery time.*

Servo Motor 563

Size 8

Type 5009-09 size 8 servo motor has an ambient temperature range of —55 to +125 C. Designed for small space applications, the unit measures 0.863 in. long and weighs 1.2 oz. Stall torque is 0.2 oz-in., no load speed is 6200 rpm at rated voltages of 26 v fixed phase and 40 v control phase, and rotor inertia is 0.47 g-cm². Impedances are 230 deg, 190 + j131 for the 26-v winding and 339 + j332 for the 40-v winding.

John Oster Manufacturing Co., Avionic Div., Dept. ED, 1 Main St., Racine, Wis.

***Availability:** Delivery time is 90 days after receipt of order.*

NEW!

ADVANCED DESIGN POWER TRANSISTORS FROM CLEVITE

Three new lines of germanium power transistors by Clevite feature new advances in controlled gain spread, fully specified collector-to-emitter voltage characteristics and low current leakage — even at maximum voltages and high temperatures.

The new 8 ampere switching series can be used to replace the older, more costly ring-emitter types in 3 to 8 ampere service.

The new 25 ampere switching type offers exceptionally low saturation voltage and is available with either pin terminals or solder lugs.

The new Spacesaver design not only affords important savings in space and weight, but its significantly improved frequency response means higher audio fidelity, faster switching and better performance in regulated power supply applications. Its low base resistance gives lower input impedance for equal power gain and lower saturation resistance, resulting in lower "switched-on" voltage drop. Lower cut off current results in better temperature stability in direct coupled circuits and a higher "switched-off" impedance.

CLEVITE NOW OFFERS THESE COMPLETE LINES

Switching Types	Amplifier Types
5 ampere	2 watt
8 ampere	4 watt
15 ampere	2 watt Spacesaver
25 ampere	
3 ampere Spacesaver	

All Clevite germanium power transistors are designed for low thermal resistance, low base input voltage, low saturation voltage and superior current gain.

For latest data and prices or application assistance, write for Bulletin 60 . . .

A DIVISION OF CLEVITE CORPORATION

Reliability in volume . . .

CLEVITE TRANSISTOR

254 Crescent Street Waltham 54, Mass. Tel: TWinbrook 4-9330

Silicon Rectifiers 662

PIV range is 100 to 400 v

These four silicon power rectifiers offer a piv range of 100 to 400 v. The single-cycle, peak-surge current rating is 20 amp for all units. Type 10 is designed for general purpose applications up to 1.6 amp and is mounted in an axial-lead, top hat, all-welded case. Type 11 has very low reverse leakage currents with the same current ratings and mechanical configuration as type 10. Types 22 and 23 are stud-mounted versions having a 7/16 in. hexagonal base.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.

Price & Availability: *Units are in stock. Prices range from $0.51 to $11.05.*

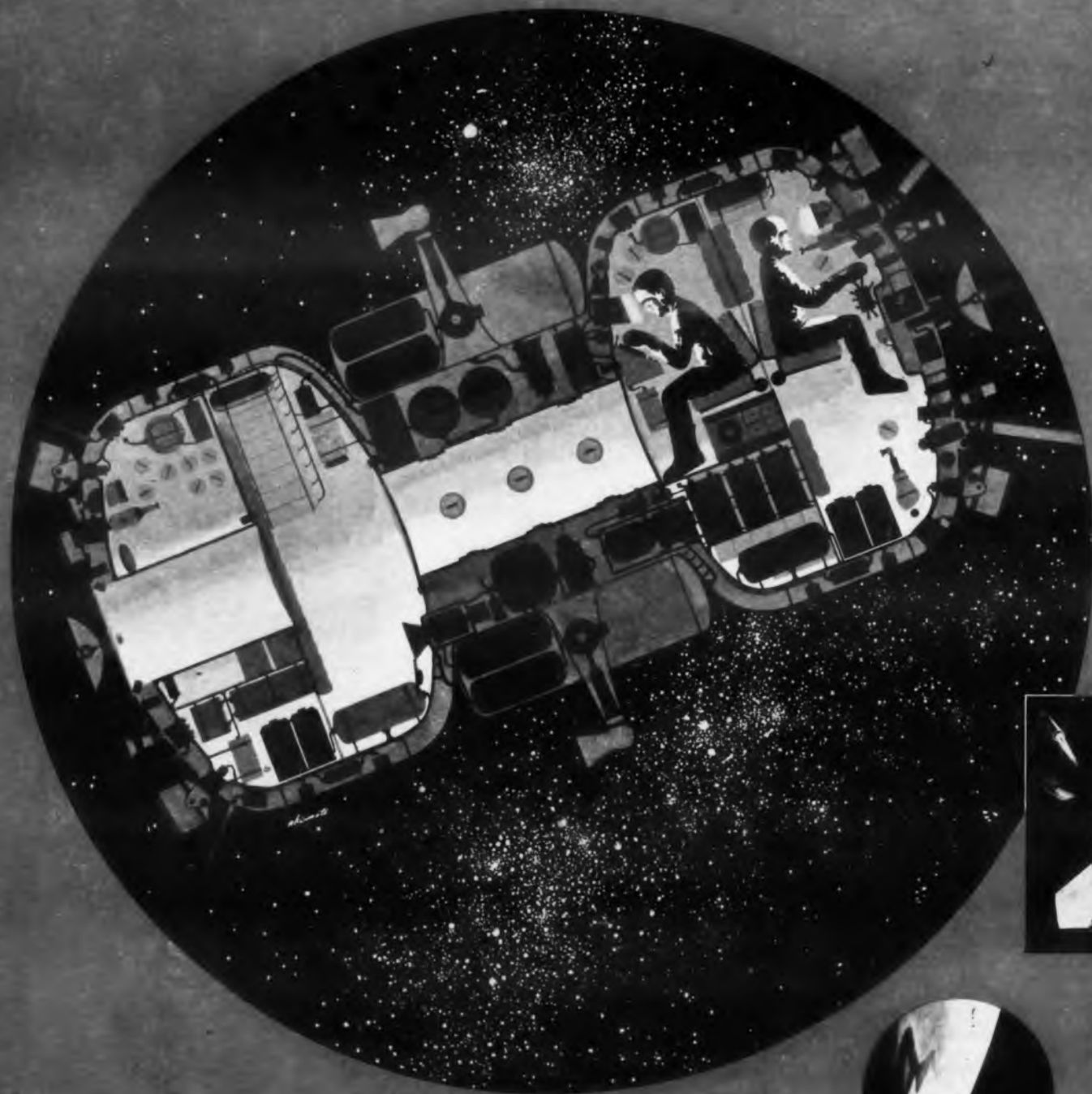
Indicator Lamp 661

Life is 3000 to 5000 hr

This electronic indicator lamp has a rated life of 3000 to 5000 hr. Particularly suited for use in data processing equipment, the lamp also has applications in photocell activation scanning devices, as lighted push buttons, and in aircraft instrumentation. Units are offered in 4, 6, 10, 12, 16, 24, and 28-v sizes; other voltages can be made to order. Standard current ratings are 35 to 45 ma. End foot-candle illumination ranges from 200 for the 4-v unit to 1285 for the 28-v type.

Sylvania Electric Products, Inc., Dept. ED, 730 Third Ave., New York, N.Y.

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY



THE ASTROTUG

Tugboat for Space: Spaceborne scientific laboratories and platforms for further exploration into space are an accepted concept based on established engineering techniques. Components would be fired as individual units into space, on precalculated orbits, and there assembled. To solve the major problems of how men are to live and work in space during the assembly process, Lockheed has prepared a detailed engineering design of an astrotug—a manned vehicle housing a crew of two or three. Missile-launched, the astrotug will be capable of supporting its crew for a number of days in an environment of suitable atmosphere, artificial gravity, and with provisions for exercise, relaxation, bathing facilities, medical care, illumination and adequate food and water.

The Lockheed astrotug is a completely independent working vehicle. Personnel need not leave it in space suits in order to work on the project of assembling the space station components. As shown in the diagram, the tug consists of two double-walled pressure vessels approximately 20 feet long overall and 9 feet in inside diameter. Swivelling rocket nozzles are arranged for maneuvering. On the forward end, extending out are four mechanical manipulator arms with interchangeable "hands" for such specialized functions as gripping, welding, hammering, cutting, running screws, etc. "Hands" can be changed by remote control from inside. Viewing ports provide uninterrupted observation. Radar antennas, searchlights, and other equipment necessary to the tug's work are mounted externally. Main controls and instruments including radar, radio, infrared, computers and navigation consoles are duplicated in each of the two major compartments as a safety measure.

Men working in single units afloat in space suits would have little applicable force and could work for very limited periods of time. With the Lockheed astrotug, personnel could carry on the work in relative safety and comfort with maximum efficiency. A special reentry vehicle, separate from the astrotug, has been conceived for ferrying to and from earth. Tugs themselves would remain floating in orbit indefinitely, being reprovisioned and refurbished as fresh crews arrive in relief.

Space vehicle development is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology—from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

Engineers and Scientists: Such programs reach far into the future and deal with unknown and stimulating environments. It is a rewarding future with a company that has an outstanding record of progress and achievement. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. E-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 Program and the MIDAS and SAMOS Satellites; Air Force X-7, and Army KINGFISHER

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CIRCLE 902 ON CAREER INQUIRY FORM, PAGE 261

NEW PRODUCTS

Constant-Current Power Supplies 551

Supply 1 μa to 500 ma

This series of programable constant-current power supplies covers the range of 1 μa to 500 ma. They are designed for applications such as semiconductor diode testing, transistor production testing, ampere-turn control, capacitor-forming, and gyro compensation. A multi-step range selector and continuous vernier control permit adjustment from zero current to the range selector setting. Voltage compliance ranges from 100 v at maximum current output to 260 v in one model. Other features are modulation input and simple external reconnection for constant-voltage output.

Electronic Measurements Co., Inc., Eatontown, N.J.

Price & Availability: *Price is $289. Units are in stock and can be delivered in two weeks.*

Image Orthicon 689

Tube face has 4.5-in. diam

Model 7389-A image orthicon, unilaterally interchangeable with the 7389, offers a high signal-to-noise ratio, greater resolution, and a higher-capacitance target. It has a tube face with a 4.5-in. diam, but uses the same optics and optical image sizes as required with 3-in. tubes.

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

Sub-Fractional DC Motor 462

For instrument use

Model RDB-25 sub-fractional dc motor is for use in instruments, control apparatus, and timing devices. Gear reductions are 3:1 to 3600:1, basic motor speeds are 3600 to 900 rpm, and voltage ratings are 24 to 115 v dc. The standard unit is shunt-wound with 115-v dc field excitation, and armature voltage from 0 to 115 v dc for speed control. The output torque is 1.5 oz-in. at 1600 rpm and with an armature voltage of 115 v.

National Pneumatic Co., Inc., Dept. ED, 125 Amory St., Boston, Mass.

Price & Availability: *Price is $50 ea for orders of 1 to 9 units; $43.75 ea for 25 to 49. Small quantities are furnished from stock.*

◀ CIRCLE 114 ON READER-SERVICE CARD

CIRCLE 115 ON READER-SERVICE CARD

Transistor Transformer 586

Are mu-shielded

The use of mu metal in these miniature transistor transformers provides a hum pick-up reduction of about 20 to 30 db. These units are furnished in MIL-AF construction, 3/4 x 3/4 x 1-1/8 in., or in cylindrical design with a diameter of 15/16 in. and a height of 15/16 in. Supplied with either high-compression glass or ceramic terminals, the units conform to MIL-T-27A, grade 4, class R, and have a life of 10,000 hr.

Microtran Co., Inc., Dept. ED, 145 E. Mineola Ave., Valley Stream, N.Y.

Aircraft Tester 585

For control panels and constant speed drive controls

Model T170 ac-generator control tester is for inspection of control panels and constant speed drive controls used on 115 to 200 v, 400 cps, three-phase aircraft electrical power systems. The unit contains power supplies, special switching, and metering to test and calibrate switching relays, time delay relays, and power supplies. It can measure dc and ac volts, frequency, and time interval over a wide range with high accuracy and is programed by a test card.

Avtron Manufacturing, Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.

Controlled Rectifier Housing 589

Stands to 1435 F

These hermetically-sealed, controlled-rectifier housings use a braze material able to stand temperatures above 1435 F so that subsequent welding or brazing can be performed. Tapered seals are used. Five seals to dissimilar materials are possible.

Mitronics, Inc., Dept. ED, Central Ave., Hillside, N.J.

CIRCLE 116 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Instrumentation Amplifiers 558

Compact

Up to 16 of these instrumentation amplifiers fit into a rack space measuring 3.5 x 19 in. Units have completely solid state circuitry. Some units in the 1600 series use chopper stabilization; others have differential circuitry. Typical open loop gains are 10,000,000 for chopper stabilized combinations and 10,000 for differential units. Outputs are ±10 v at 2 to 20 ma.

Burr-Brown Research Corp., Dept. ED, Box 6444, Tucson, Ariz.

Price & Availability: *Prices range from $140 to $190 per module. Delivery is from stock to 60 days after receipt of order.*

Rotary Switches 468

Has many applications

Type SG-270 rotary switch is suited for circuit sampling, sequencing, programming, and many other uses. Precious metal rings and brushes provide smooth, low-torque action with either make-before-break or break-before-make contacts. Multiple gangs can be assembled. Cased in plastic, the unit is fungus resistant and can be used at high temperatures.

The Gamewell Co., Dept. ED, Chestnut St., Newton Upper Falls 64, Mass.

Availability: *Delivery time is 35 to 45 days.*

Accelerometers 467

For low frequency measurement

Models 7-54 and 7-55 linear accelerometers are for low-frequency acceleration measurement in missile and aircraft airborne instrumentation, telemetry, control, and inertial platforms. Model 7-55 differential transformer type, made for long-term use, has a self-contained oscillator-demodulator to accept dc inputs. Its output is 0 to 5 v dc. Model 7-54 potentiometer pick-off transducer type offers excellent resolution while maintaining good frequency response. Available with a wide choice of symmetrical and non-symmetrical ranges, both

units can be hermetically-sealed and are oil-damped.

Edcliff Instruments, Dept. ED, 1711 S. Mountain Ave., Monrovia, Calif.

Price & Availability: *Model 7-54 is priced from $150 to $200; model 7-55, $171 to $228. Delivery time is six to eight weeks.*

Rotary Switch 475

Is rated at 10 amp

Made for rapid wiring with snap-on connectors, type P rotary snap switch is rated at 10 amp. The male-type quick-disconnect terminals are integral with the stationary contacts and can be furnished on any of the side-connected switches having make-before-break or break-before-make contacts.

Electro Switch Corp., Dept. ED, King Ave., Weymouth, Boston 88, Mass.

Dual-Output Battery 510

Provides 3 and 8 amp

Model P68A dual-output battery is designed for missile and space applications. One section provides 8 amp at 28 v, has a maximum current of 25 amp, and a discharge time of 40 min at 8 amp. Capacity is 5.5 amp-hr. The other section supplies 3 amp at 6.3 v, has a maximum current of 25 amp, a discharge time of 40 min, and a capacity of 5.5 amp-hr. Both sections are automatically activated in 1 sec; required signal is 2 amp at 28 v. The battery stands shock to 50 g, acceleration to 20 g, and vibration to 10 g, along all major axes. Temperature range is −65 to +165 F. The unit is hermetically sealed and weighs 13 lb.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Availability: *The unit is made on order.*

NEW PRODUCTS

Voltage Regulator 477

For 400-cps line voltage

This 400-cps voltage regulator has a rapid response due to the use of an ac-reference. It corrects line changes of ±5 v to a total error of ±0.25 v. The standard unit has three channels for three-phase regulation. Since each channel is independent, the unit can regulate three loads on one phase. One channel has a maximum load of 300 w; the two others, 200 w each. Suitable for military applications, the unit conforms to MIL-E-4158. It comes in a rack mounting design with a panel measuring 8.75 x 19 x 20 in.

Amelco, Inc., Dept. ED, 12964 Panama St., Los Angeles 66, Calif.

Pushbutton Gang Switch 499

Life is 100,000 cycles

Supplied in contact ratings up to 5 amp at 28 v dc, this panel-mounted, pushbutton gang switch has a reliable life of 100,000 cycles at rated load. Contacts can be spdt, 6 pdt, or any combination of these. The unit can have from 2 to 10 switches, locked and interlocked. No two switches can be operated at the same time. The pushbuttons have a snap-in feature for rebulbing from the front of the panel. Standard buttons measure 0.75 in. square and have 1-in. centers.

Pendar, Inc., Switch Div., Dept. ED, 14744 Arminta St., Van Nuys, Calif.

Price & Availability: *Units are made on order and can be delivered in 30 to 60 days. Price is $10.*

Telescoping Antenna 678

For rocket and missile use

These explosive-actuated, expandable telescoping antennas are for use in rockets and missiles. Prior to actuation, the sections are stored in recessed compartments parallel to the longitudinal axis of the missile. Explosive-actuated caterpillar motors unlatch the door coverings, allowing the antennas to be raised by helical springs to a position perpendicular to the longitudinal axis of the rocket. An electrically-operated explosive gas cartridge extends the antenna from a stored length of 18 in. to as long as 10 ft 4 in.

Raymond Engineering Laboratory, Inc., Dept. ED, Smith St., Middletown, Conn.

Availability: Ten weeks.

Inductor 489

For tuning vhf-uhf circuits

Type 81AM1 inductor is for tuning vhf-uhf circuits over a frequency range of 50 to 400 mc with a 2:1 tuning ratio. The unit has applications in missiles and telemetry and is about 1/4 the size of the firm's previous models. At 250 mc the nominal Q-factor is 60, maximum control current is 70 ma, maximum average control current is 35 ma, and maximum bias current is 5 ma. The dc resistance is 300 ohms max for the control winding and 300 ohms for the bias winding. Units to meet MIL-T-27-A specs are furnished on special order.

CGS Laboratories, Inc., Dept. ED, Wilton, Conn.

Availability: The unit will be available in small quantities by May.

NEW PRODUCTS

Pushbutton Switch 473

For low-current use

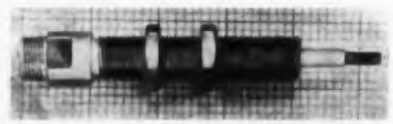
Designed for low-current use, this pushbutton switch can be supplied with dpdt, double-break, positive action, either with momentary contacts or with a push-on, push-off mechanism. With special gold contacts and increased contact pressure, it is possible to make and break a current as low as 1/4 ma. The unit has a life of 200,000 cycles. The button measures 3/4 sq in.

Pendar, Inc., Dept. ED, 14744 Arminta St., Van Nuys, Calif.

Price & Availability: *Price is $9.96 ea. Delivery time is two days.*

Differential Transformer 478

Operates over — 65 to + 450 F



Model H101A linear variable differential transducer, with an excitation voltage of 10 v rms and a carrier frequency of 400 cps to 3 kc, will operate over the range of —65 to +450 F under rapid environmental changes. In the linear range of 1 to 4 in., nonlinearity is 0.5% or less. Output sensitivity is 1 mv per v input per 0.001 in. for the smaller model and 0.25 mv for the larger model. Resolution is continuous and repeatability is 0.01% or better. Construction is of stainless steel.

Pacific ElectroKinetics, Dept. ED, 329 S. Vermont Ave., Glendora, Calif.

Converter-Amplifier 463

For closed circuit testing

This rf converter-amplifier is for closed circuit testing of missile, telemetering, and data transmission systems. The unit consists of the rf amplifier and converter section, a crystal-controlled oscillator and multiplier section, and an if ampli-

fier. The rf amplifier accepts any one of four pre-set frequencies in the 200-mc range. These frequencies are amplified to the final output level of 5 v at an impedance of 200 ohms. Over-all voltage gain is 500,000 from the 50-ohm input to the 200-ohm output. Bandwidth is 200 kc at the −1 db points. Gain adjustment is over a 40-db range. Over-all gain stability is better than ±1 db over 10 hr of operation.

The Daven Co., Dept. ED, Livingston, N.J.

Price & Availability: *Units are made on order and can be delivered in 60 days. Price ranges from $1000 to $2000.*

Rotary Multi-Pole Switch 474

Has solder-lug terminals

Type A rotary multi-pole switch has solder-lug terminals which are silver-plated and have elongated holes that accommodate up to three No. 16 wires. Maximum interrupting rating is 5 amp at 125 v ac and continuous-current rating is 10 amp. The unit can be furnished with a variety of contact arrangements with from 1 to 10 sections. Designed for single-hole panel mounting, switch measures 2-7/32 in. in diam and extends from 1-1/16 to 5-1/4 in. behind the panel.

Electro Switch Corp., Dept. ED, King Ave., Weymouth, Boston 88, Mass.

Elapsed Time Controller 436

For batch type operations

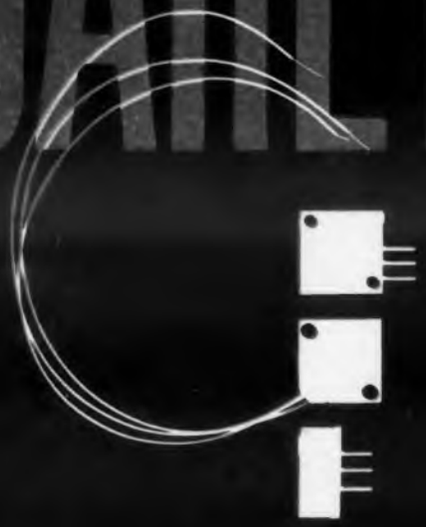
Installed in the circuit of a batch type operation, model 7003 elapsed time controller provides timed, automatic regulation of temperature or pressure. Ranges are 100 F to 1000 F and 30 in. mercury vacuum to 7500 psig. Time ranges are 1, 5, 12, and 24 hr; minimum setting of each timer is equal to 4% of its range. A 12-in. circular chart is used to record data. The controller case is dust- and moisture-resistant. Front of panel dimensions are 14-3/16 x 18-3/4 in.

Weston Instruments Div., Daystrom, Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Price & Availability: *Price is about $525. Delivery time is 60 days.*

CIRCLE 123 ON READER-SERVICE CARD ➤

SQUARETRIM



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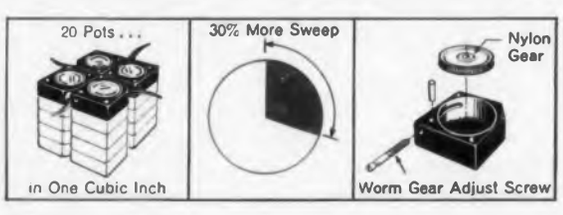
For full specifications on the complete line of SQUARETRIM potentiometers, contact the Daystrom representative serving your area, or write the factory direct. Ask for Data File ED-1112-1.



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CIRCLE 125 ON READER-SERVICE CARD

NEW PRODUCTS

Potentiometer 487

Unit includes two switches

This assembly consists of a molded carbon potentiometer, series 53M, a switch activated by end-rotation of potentiometer, and a second switch that may be activated at any point of rotation of the potentiometer by push-pull action of the shaft. Resistive rating of the switches is 7 v dc, 7 amp. The entire assembly is encapsulated in a high dielectric plastic compound.

Clarostat Manufacturing Co., Inc., Dept. ED, Dover, N.H.

Environmental Chamber 465

For processing metal alloys

Model WT-54-125 environmental chamber is for processing and stabilizing of metal alloys such as stainless steel, molybdenum, and tantalum. It provides an ambient temperature range down to −140 F. Refrigeration capacity is sufficient to lower the temperature of 300 lb of steel from +80 F to −125 F in 1 hr. Inside dimensions are 72 x 36 x 36 in. The interior is constructed of 16-gage stainless steel and the bottom is reinforced to take 1000 lb per sq ft. The chamber is available with 220 or 440 v, 60 cps, three-phase power.

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

Availability: *Delivery time is 45 days.*

Solderless Terminals 466

For high vibration equipment

The Vibrakrimp solderless terminals are for use where high vibration is encountered. A seamless, annealed, tin-plated brass sleeve is permanently attached over the terminal barrel. Barrel length is 1/4 in. Ring, hook, spade, flanged spade, and rectangular types can be furnished. Sizes 22-16, 16-14, and 12-10 AWG are standard.

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

Price & Availability: *Price is $27 to $46 for 10,000. Units are in stock.*

NEW PRODUCTS

UHF Bandpass Filters 506

Passband is 870 to 1150 mc

Model HFF-T(B)-5 uhf bandpass filter uses distributed parameter multi-pole tuned elements. The unit shown has a center frequency of 1010 mc and a passband of 870 to 1150 mc. Attenuation at 575 and 1740 mc is better than 40 db. The filter uses five inductively coupled resonant sections. It operates out of and into a 50-ohm impedance. Insertion loss is less than 0.3 db and vswr is less than 1.2:1 throughout the passband. Dimensions are 7-5/8 x 5-3/4 x 2-9/16 in. and weight is 3-1/4 lb.

Applied Research, Inc., Dept. ED, 76 S. Bayles Ave., Port Washington, N.Y.

Price & Availability: *$350; delivery time is 30 days.*

Microwave Calibrator 472

Has a range from + 10 to — 100 dbm

This microwave calibrator has a variable output range from +10 to —100 dbm and provides a read-out scale which shows transponder output directly in dbm. The system includes: a crystal mixer holder; matching network; filter; hybrid; cross-guide coupler; precision waveguide; and level set and variable coaxial attenuators. These components may be integrated into other systems. The calibrator measures 8 x 18 x 21 in.

Transco Products, Inc., Dept. ED, 12210 Nebraska Ave., Los Angeles 25, Calif.

Price & Availability: *Made on order only. Can be delivered 90 days after order received. Price is between $8000 and $10,000, depending on specifications.*

Insulation Tubing 430

For high temperature use

Made of coated Dacron, this insulation envelope is for use on wires, cables, and pipes that are subjected to high temperatures. Suitable for military applications, it stands up to 300 F for 100 hr or more and 400 to 450 F for 10 min.

Zippertubing Co., Dept. ED, 752 S. San Pedro St., Los Angeles, Calif.

Availability: *from stock.*

Silver-Zinc Battery 509

For missiles and space vehicles

Designed for missiles and space vehicles, model 42A silver-zinc battery is intended for applications where standby capacity is required, or where one circuit must meet a heavy peak current demand, while the other has a steady, non-fluctuating load. Each 19-cell section provides 3 amp at 26.5 v. Maximum current is 15 amp, discharge time is 40 min at 3 amp, and capacity is 2 amp-hr. Time for automatic activation is 0.5 sec; the required signal is 4 amp at 28 v. Operating over the temperature range of —40 to +80 F, the unit stands shock to 100 g, acceleration to 50 g, and vibration to 8 g, along all three major axes. Size of the unit is 5 x 5 x 7 in.

Cook Batteries, Dept. ED, 3850 Olive St., Denver 7, Colo.

Availability: *The unit is made on order.*

Magnetic Storage Drum 659

Speed is 900 to 6000 rpm

Able to meet MIL-E-4158A and MIL-E-5400B, model 7508 magnetic storage drum has a speed range of 900 to 6000 rpm. Standard operating parameters include bit repetition rates of over 300 kc, return to bias, and over 600 kc, non-return to bias. The unit has 250 tracks, a bit capacity of 460,800, and 3072 bits per track. Design life at 6000 rpm is rated at more than three years.

Bryant Computer Products, Dept. ED, P.O. Box 620, Springfield, Vt.

Availability: *Delivery time is 90 to 150 days.*

NEW PRODUCTS

Potentiometers 495

Designed for linear functions, the MTF series of film potentiometers include three types which are alike in size and shape, differing only in the number of turns necessary to transverse the resistance element. Three-, five-, and ten-turn models afford infinite resolution.

Technology Instrument Corp., Dept. ED, Main St., Acton, Mass.

Microwave Equipment 496

The Macrawave line of microwave test equipment and components includes: adapters, test horns, attenuators, signal samplers, switches, tuners, wave meters, and others. They come in the following EIA designated tubing sizes. WR77, WR975, WR1150, WR1500, WR1800, WR2100, and WR2300.

Douglas Microwave Co., Inc., Dept. ED, 252 E. Third St., Mount Vernon, N.Y.

Nuts 497

Made of heat-treated spring steel, these nuts are available cadmium-plated, nickel-plated, black-phosphate, and plain. Their dimensions are 1/8 in. 27 NPS, hex width 9/16 in., and washer diameter of 7/8 in.

Crest Products, Inc., Dept. ED, Box 64, Union, N.J.

Microphones 455

The 330 series of microphones includes two dynamic models, high and low impedance, and two ceramic high impedance models. The model numbers are 335H, 335L, 333 and 331.

Astatic Corp., Dept. ED, Conneaut, Ohio.

Price: Prices are: 335H, $26.50; 335L, $23.50; 333, $17.90; 331, $17.90.

Solvents 456

These solvents include Electronic Grade Acetone, Trichloroethylene and Methyl Alcohol. Each solvent is ready to use as a bath to remove water, grease, grit and other materials.

Fisher Scientific Co., Dept. ED, 717 Fisher Building, Pittsburgh 19, Pa.

Price: Prices are: acetone, $4.20 per gal; trichloroethylene, $7.05 per gal; methyl alcohol, $4.10 per gal. All solvents come in a 4-gal pack.

Wireways and Fittings 457

Made of heavy gage steel, these wireways and fittings include elbows, connectors, panel adapters, and combination drop and bracket hangers. The units come in various stock sizes up to 8 x 8 in., in lengths from 1 to 5 ft.

Keystone Manufacturing Co., Dept. ED, 23328 Sherwood Road, Warren, Mich.

Availability: Units can be delivered from stock.

Signal Generator 658

Produces 4 types of TV test signals

Model PSX-1 signal generator produces the following types of TV test signals: video pulses, cw, pulsed cw, and audio-modulated cw signals. The instrument is suitable for the design and testing of precision if-amplifiers such as those used in radar system; it can also be of use in general laboratory applications. The unit contains a complete video pulse generator section and an rf section. Phantastrons and comparators produce video pulses with a repetition rate adjustable from 50 to 5000 cps. Pulse widths are variable from 0.05 to 10 μsec and have a rise and fall time of less than 0.02 μsec. A cw oscillator and buffer circuits produce a signal adjustable from 25 to 75 mc. For cw operation the output of the generator is 1 v rms into 50 v.

Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Price & Availability: *Price is $1695; delivery time is 45 days.*

Coaxial Ignitron 424

For control use in resistance welding

Type GL-7670 coaxial ignitron is for control of high-peak currents in resistance welding and other uses. Other applications include capacitor discharge circuits. It can handle peak currents as high as 1300 amp at 1800 v. Standard size B welder ratings are met.

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

Availability: *from stock.*

Infrared Transmission Glass 429

For missile and optical uses

Code 9752 infrared transmission glass, in a thickness of 2 mm, will transmit 77% of the infrared at 4 microns and 38% at 5.5 microns. At 600 C, there is no transmission loss at 4 microns and only 13% at 5.5 microns. The glass is suitable for use in missiles and in optical instruments. It comes in hollow shapes and flat pieces up to 12 sq in. and 0.5 in. thick.

Corning Glass Works, Dept. ED, Corning, N.Y.

NEW PRODUCTS

Counter-Timer 670

Has Nixie in-line readout

Suitable for both laboratory and industrial applications, model 361 counter-timer has six-digit Nixie in-line readout. When used with sine wave inputs, the unit has a frequency range of 10 cps to 1 mc with pulse inputs in the range of 0 to 1 mc. Time intervals cover 1 μsec to 10 sec in 10-decade steps. Accuracy is ±1 count ±3 parts in 10^7 per week. Display times are adjustable from 0.2 to 10 sec. Solid-state circuitry is used throughout.

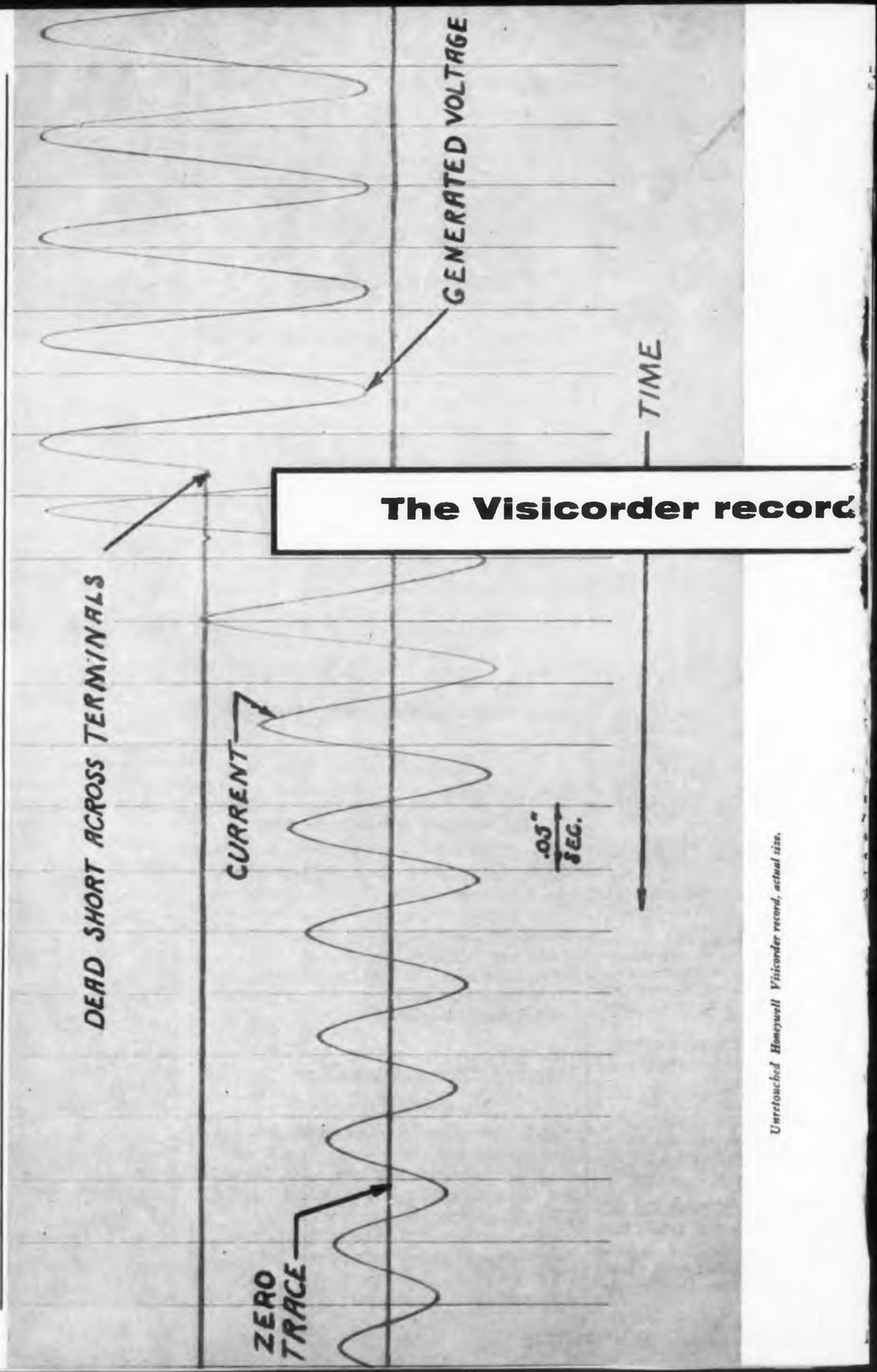
Transistor Specialties, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.
Price: $1450.

Tape Simulator 660

Handles 80 bits

Model 0359 tape simulator, for manual entry of data into punched-tape systems, has a capacity of 80 bits of information. When used with perforated tape systems, the unit substitutes for the tape reader and can be used to perform checkout and verification functions in both laboratory and production-line applications. In systems where punched tape is used, the unit can act as a second signal source. It is portable and is packaged in a steel case measuring 16 x 14.5 x 5 in.

Hallamore Electronics Corp., Dept. ED, 8352 Brookhurst, Anaheim, Calif.
Availability: *Units are in stock.*



s study of the drop in voltage load on an Allis-.lmers alternating current generator was directly orded by a Model 906 Honeywell Visicorder.

this transient reactance test, made by design ineers at the Allis-Chalmers Norwood Works, generator was operated at full voltage, and then ad short was applied to the terminals. When a sudden load is thrown upon a generator, the age drops because of the inherent character-s of the generator. This voltage "nosedive" is pid that a voltage regulator cannot immediately ct the voltage and bring it up to normal. Be-e of this time delay while the regulator is hing up, motor contacts and other devices on ine may drop out, lights may blink objection-and electronic devices may function erratic-For these reasons, these studies of time as ed to generator characteristics are very im-nt to better generator design. The Visicorder's of operation, calibration, and immediate read-nade it ideal for these studies.

N. O. Risch and F. R. Manning, design engineers at Allis-Chalmers Norwood Works, study a Visicorder chart of voltage-drop tests on a generator.

Stand-Off Terminal 505

For high-vibration use

Type TM-301TUR stud-type, threaded stand-off terminal is for high-vibration applications. Dual turret design permits two terminal positions for wiring or components. Teflon insulation is used between the terminal and the brass ferrule base. The unit has an over-all height of 41/64 in. above the chassis and a stud length of 1/4 in. The two turrets measure 0.125 and 0.12 in. high.

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

Availability: Delivery time is 30 days.

Radio Antenna Reel 425

For supersonic aircraft

Designed specifically for supersonic aircraft, this radio antenna reel releases a cable antenna which enables messages to be transmitted with 95% of power. The weighted antenna can be extended as much as 150 ft from the reel. Unreeling can be halted at any point by means of a brake with a holding force of 500 lb-in. The cable can be rewound at 3 ft per sec when the 115-v, 400-cps, three-phase motor is actuated. The gear train, brake, and motor are enclosed in the reel. Dimensions are 4.06 in. in diameter and 5.4 in. in length. Weight is less than 6.5 lb.

General Controls Co., Aircraft Electronic Controls Div., Dept. ED, 1320 S. Flower St., Burbank, Calif.

Temperature and Voltage Controllers 602

Variety of types offered

The FXC varistors and thermistors can be used for controlling temperature and voltage and for compensation in any electronic circuit requiring precise control. The varistors, including rod and disk types, have a negative voltage coefficient of resistance that decreases as applied voltage increases. The thermistors are offered in a full line of values and in miniature, bead, rod, vacuum and disk types.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N.Y.

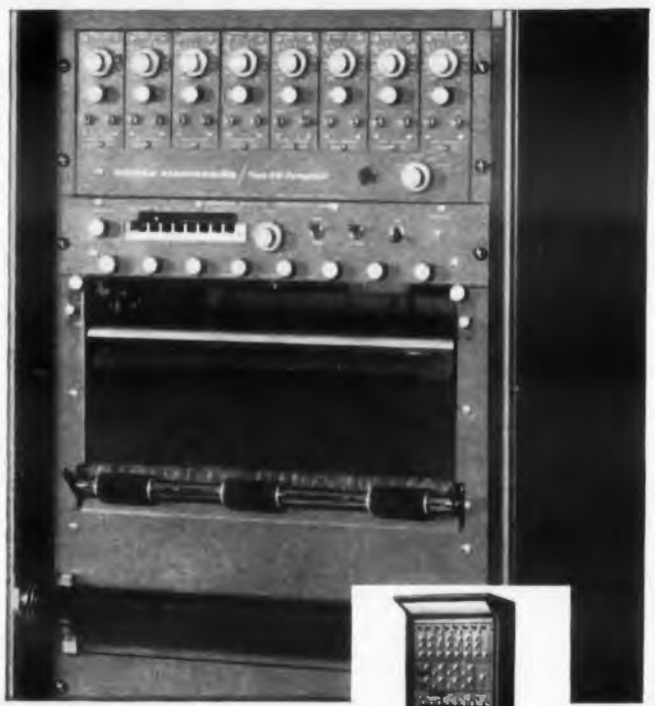
Availability: Sample quantities are immediately available.

THE OFFNER TYPE *all transistor* RD DYNOGRAPH

simpler
more economical

same performance
same versatility

for your low — and medium gain applications



The Type RD is available in a variety of mountings, including the BMR rack. The Type R (illustrated above in the BMR rack) should be specified where microvolt sensitivity and greatest versatility are required.

The Offner Type RD Dynograph provides the same performance, the same convenience as the Type RC, (the Type R without pre-amplifiers). Economies in design were made possible by eliminating circuit components necessary only when preamplifiers are employed.

In the Type RD each amplifier is *completely* replaceable; only the power supply is common.

The Type 473 Amplifiers are all-transistor in construction, and provide advantages of high reliability and instant operation with no stabilizing warm-up. Sensitivity is 10 MV per cm. to 100 volts per cm., with a zero drift of less than 0.2 MV per hour at highest sensitivity.

The Type RD Dynograph assemblies are ideal for systems applications, telemetering, and other uses not requiring the greater versatility and sensitivity of the Type R. It is available in a variety of mountings, including the BMR rack, or for mounting in standard racks.

SPECIFICATIONS

Sensitivity: 10 MV per cm. to 100 volts per cm.

Drift: 0.2 MV per hour at max. sensitivity[1].

Frequency Response: To beyond 200 cps, ± 10%[2].

Zero Suppression: 40 cm., plus and minus.

Recording Media: Ink or electric curvilinear; heat or electric rectilinear. Recording media interchangeable.

Number of Channels: One to eight standard with Type 504A rack-mounted paper drive (illustrated). Up to 24 on other mountings.

1. From low resistance source at normal ambients.
2. Ink or electric recording. Heat sensitive limited by capability of medium.

OFFNER ELECTRONICS INC.
3938 River Road, Schiller Park, Illinois (Suburb of Chicago)

Magnetic Amplifier 61

Has servo drive

Model 1339 magnetic amplifier with a servo drive controller, requires an excitation voltage of 115 v ac at 400 cps. The amplifier's signal input impedance is 20 K min. Signal voltages are: ±0.01 v ac to obtain null, ±0.015 v ac to obtain 3 v, and ±0.15 v ac to obtain 30 v. The amplifier's saturation voltage is about 40 v ac. With zero input signal, the output for dynamic braking is 0.08 to 0.12 amp dc. Temperature range of the unit is −55 to +100 C. Dimensions are 2 x 2-1/4 x 3-1/8 in.

Lumen, Inc., Dept. ED, Moen Ave., P.O., Box 905, Joliet, Ill.

Coaxial Terminations 357

For microwave applications

Designed for microwave applications, these mismatched coaxial terminations present a constant, known vswr value to a 50-ohm line for rapid calibration of vswr measuring equipment. Specific applications are: calibration of microwave reflectometers, including scope-trace types; over-all accuracy check of slotted line equipment; and as a dummy load in microwave network development. Furnished with N, BNC, and TNC connectors, the units cover 0 to 3 kmc. Units with LT connectors cover 0 to 1.5 kmc. Standard vswr values are 1.5, 2, 2.5 and 3.

Radar Design Corp., Dept. ED, Pickard Dr., Syracuse, N.Y.

Price & Availability: *Price ranges from $35 to $75. Delivery is from stock.*

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PHOENIX 2727 North Central Avenue ..... CRestwood 7-3358
SAN FRANCISCO 535 Middlefield Rd., Palo Alto, ... DAvenport 1-2064
SEATTLE 3466 E. Marginal Way ..... MAin 4-0783
ST. PAUL 1821 University Avenue ..... MIdway 6-1891
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WINSTON-SALEM 310 W. Fourth Street ..... PArk 3-0363

Transitron electronic corporation
wakefield, massachusetts

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U. S. A.
CABLE ADDRESS: TRELCO

CIRCLE 134 ON READER-SERVICE CARD

CIRCLE 135 ON READER-SERVICE CARD ➤

FROM **Transitron**...INDUSTRY'S BROADEST LINE OF

MICRO-DIODES

MICRO-MINIATURIZATION POSSIBLE NOW!

YES — FASTEST DIFFUSED SILICON MICRO-DIODES AVAILABLE. They combine advanced diffusion techniques with extremely small size, to provide milli-micro-second switching speeds, excellent static, forward and inverse characteristics.

YES — ONLY SERIES OF HIGH QUALITY MICRO-REGULATORS. Series of 8 diffused-silicon micro-regulators provides stable voltage regulation and reference sources previously found only in considerably larger devices. Excellent dynamic resistance characteristics.

YES — BASIC FAMILY OF MULTI-PURPOSE MICRO-DIODES. Series of 3 high quality diffused-silicon micro-diodes provides voltage ratings up to 200 volts, current rating up to 50 milliamperes. May be considered for switching applications. Exceptional static, forward and inverse characteristics.

YES — EVEN A MICRO-STABISTOR.
This diffused-silicon stabistor is the micro-counterpart of Transitron's universally-known SG-22.

All of these new micro-diodes are COMPLETELY COMPATIBLE with present circuitry . . . provide the same excellent performance as larger Transitron diodes in 1/10th the space! Here is your chance to micro-miniaturize circuits TODAY!

VERY FAST SWITCHING MICRO-DIODE			
TYPE	PIV	Ef @ 5 MA	RECOVERY TIME
TMD-50	50V	0.75V	4 mμsec

FAST SWITCHING MICRO-DIODE			
TYPE	PIV	Ef @ 20 MA	RECOVERY TIME
TMD-24	50V	0.85V	0.3 μsec
TMD-25	100V	0.85V	0.3 μsec
TMD-27	200V	0.85V	0.3 μsec

SILICON MICRO-REGULATOR		
TYPE	VOLTAGE @ 5 MA	POWER RATING @ 25°C
TMD-01	5.1V	100 MW
TMD-03	6.2V	100 MW
TMD-07	9.1V	100 MW

HIGH CONDUCTANCE MICRO-DIODE			
TYPE	PIV	Ef @ 100 MA	POWER RATING @ 25°C
TMD-41	50V	1.0V	100 MW
TMD-42	100V	1.0V	100 MW
TMD-45	200V	1.0V	100 MW

SILICON MICRO-STABISTOR		
TYPE	Ef @ 1 MA	DYNAMIC RESISTANCE
TMD-40	0.55V	60 OHMS

For further information, write for Bulletins:

PB-71A (High Conductance). PB-71B (Fast Switching). PB-71C (Very Fast Switching). PB-71D (Stabistor). PB-71E (Regulators); AN 1358A Application Notes.

See Transitron at the AFCEA Show, Booths 157-158

Transitron electronic corporation • wakefield, massachusetts

"Leadership in Semiconductors" SEE YOUR LOCAL AUTHORIZED TRANSITRON DISTRIBUTOR FOR QUANTITIES FROM 1-999.

NEW PRODUCTS

Epoxy Coating 492

Empcote is a flexible epoxy coating for circuit boards. It meets the requirements of MIL-5272-A and MIL-E-5400. It has been compounded to permit a faulty circuit board component to be cut out with a heated knife blade, replaced, and spot patched before returning to service.

Empcor Co., Dept. ED, 101 W. Verdugo Ave., Burbank, Calif.

Fluxing Additive 493

This fluxing additive, called Wes-X 501, acts as an adhesive to keep the flux close to the base metal. Through this adhesive action, the critical time between fluxing and hot dipping can be eliminated. The additive can be used in any aqueous flux bath. Westinghouse Electric Corp., Dept. ED, Box 2099, Pittsburgh 30, Pa.

Plastic Potentiometers 494

Potentiometers of the P series come in 1-1/4-, 1-5/8-, and 3-in. diam molded plastic units designed for instrument usage where low residual inductance and capacitance are important factors. They may be ganged up to six cups per single shaft with each unit phased independently.

Technology Instrument Corp., Dept. ED, Main St., Acton, Mass.

Cable Clamps and Clips 459

Called Plastic Strap, these clamps and clips will not rust or corrode from wet or acid conditions. They have rounded edges and are supplied with a flat opening for standard double-wire cables or a round, larger opening for triple-wire types.

Commercial Plastics Co., Dept. ED., 941 George St., Chicago 14, Ill.

Spring Tester 460

Made to test instrument hairsprings for torque, the unit operates on the balance principle with the spring zeroed in then loaded to 100 deg. Direct reading is made on a millimeter scale. No spring master is needed.

Gerbet Hairspring Co., Dept. ED, Thomaston, Conn.

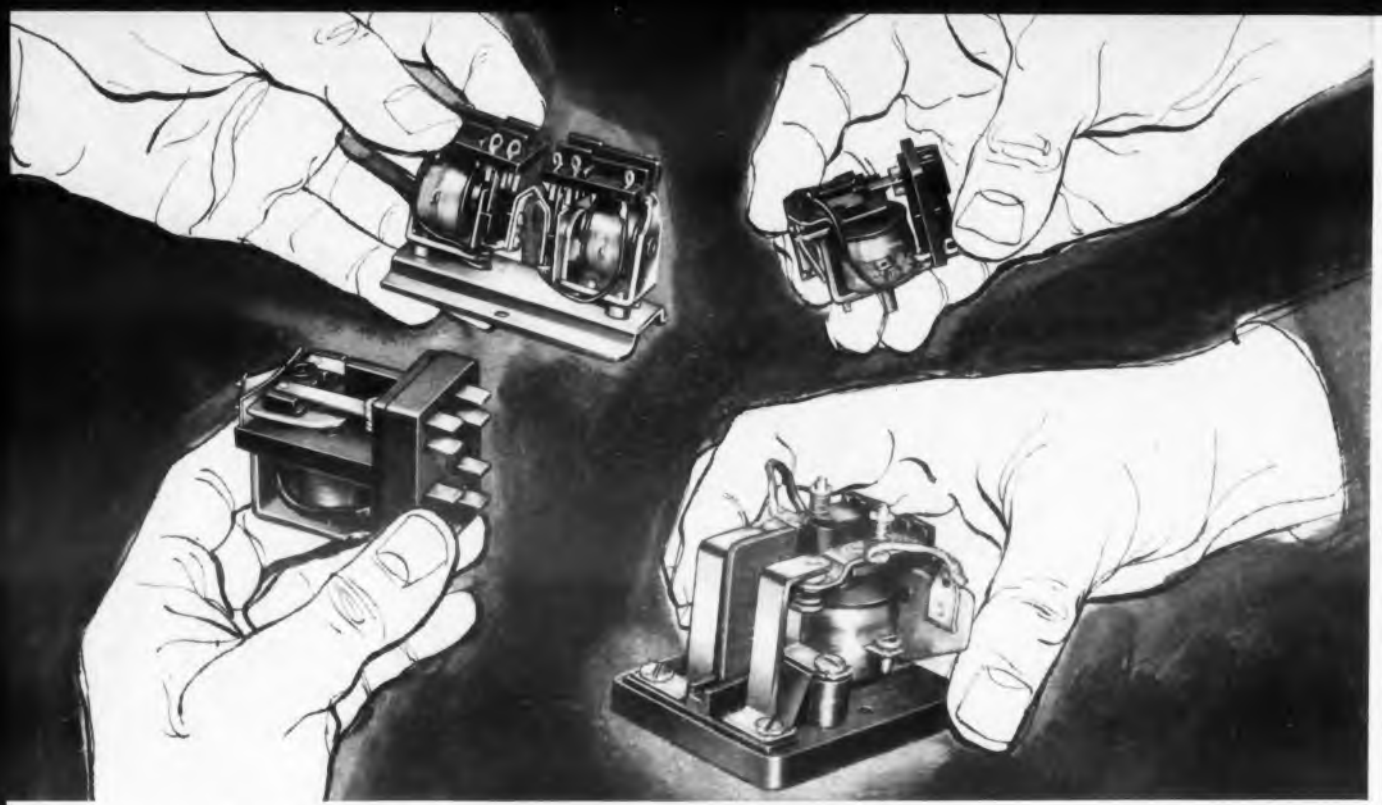
Opposed-Head Electronic Micrometer 461

Model VDR permits pressureless measurement from two sides to the centerline of a fragile or compressible part. It automatically displays measurements to 20 millionth of an inch.

J. W. Dice Co., Dept. ED, Englewood, N.J.
***Price & Availability:** $2250; delivery time is 10 days.*

Correction Notice

The C & H Supply Co. is located in Inglewood, Calif., not Inglewood, N.J. (as reported on page 112 of the 2/17/60 issue of ELECTRONIC DESIGN).



KB Series
Latching Relay

save time! save money! call your parts distributor for P&B RELAYS

These important savings are yours when you order—from your Electronic Parts Distributor—P&B relays listed with Underwriters' Laboratories, Inc. and Canadian Standards Association:

SAVE TIME. You get fast, off-the-shelf delivery. Usually your order is shipped the day after it is received. And no waiting for U/L or CSA clearance . . . this has been done for you. Thus you get your project—and your product—off to a fast start!

SAVE MONEY. You save the cost of getting relays listed with U/L or CSA . . . and you need have no big investment in shelf inventory, either. Remember, you pay no premium over factory prices in quantities to 249.

More than 40 different standard P&B relays in 450 different coil voltages and contact arrangements are available from the leading Electronic Part Distributors in your area. For special applications, call your nearest P&B sales engineer.

PR Series

Type	Contact Arrangement*	Type	Contact Arrangement*
PR1AY	SPST-NO	PR5AY	SPDT
PR3AY	SPDT-NO-DM	PR7AY	DPST-NO
		PR11AY	DPDT

These relays are available in any of the following operating voltages: 6, 12, 24, 115, 230 volts 50/60 cycles AC.

Contacts are rated at: 25 amps, 115/230 V. AC 1 phase. 1 hp for 115/230 volt AC motors 1 phase.

*Read: NO normally open, NC normally closed, DB double break, DM double make.

U/L File E22575 CSA File 15734

AB Series

U/L File E29244 CSA File 15734

For appliance and general purpose operations requiring long life and quiet operation. Quick connect terminals. Screw terminal adapters also furnished with each relay. Contact arrangement: DPDT. Rated at 10 amps, 115 V., 5 amps, 230 AC non-inductive by U/L and CSA.

ABC Series

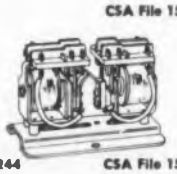
U/L File E29244 CSA File 15734

Medium duty power relay in dust cover. For small motors, industrial controls and similar applications. Contact arrangement: DPDT. Rated at 10 amps, 115 V., 5 amps, 230 AC non-inductive by U/L and CSA.

KA Series

U/L File E29244 CSA File 15734

Small, low cost, general purpose relay for handling automation work, small motors, solenoids, other relays. Contact arrangements: SPDT, DPDT and 3PDT. Rated at 5 amps, at 115 V., AC non-inductive by U/L and CSA.



KB Series

U/L File E29244 CSA File 15734

Compact latch relay ideal for memory work and overload applications. Operates on momentary impulse to either coil. Contact arrangements: 4PDT and 6PDT. Rated at 5 amps at 115 V., AC non-inductive by U/L and CSA.

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

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We're Relay Specialists—Over 400 types of P&B relays are available right off of our shelves.

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Factory Prices—You pay no premium for Newark's super-service. Newark offers Quantity O.E.M. Prices that are competitive with Potter & Brumfield's own selling price!

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Princeton, Indiana

CIRCLE 137 ON READER-SERVICE CARD

CIRCLE 138 ON READER-SERVICE CARD

NEW PRODUCTS

Electrical Insulating Resins 682

For continuous duty to 400 F

Types 17-A and 17-B electric insulating resins are for continuous duty at up to 400 F and intermittent duty to 500 F. Type 17-A is for impregnation and type 17-B is for casting and potting. Both types require a hardener and will gel in 10 to 15 min at 300 to 320 F.

Furane Plastics, Dept. ED, 4517 Brazil St., Los Angeles, Calif.

***Price & Availability:** Type 17-B is priced at $1.95 per lb for orders of less than 10 lb. Quantity discounts are offered. Delivery is 48 hr after receipt of order.*

Laminated Material 355

For printed circuit boards

Designated Enrad II, this strong, peel-back resisting material is for use in the construction of printed circuit boards. Boards laminated with this material and with Fiberglas cloth are suitable for vhf and uhf applications, stand a 20-sec solder dip test, and have excellent temperature, moisture, and dielectric strength characteristics. The boards can be made as thin as 0.01 in.

Enflo Corp., Dept. ED, Fellowship Rd. & Route 73, Maple Shade, N.J.

Molding Compound 354

Heat distortion point is over 500 F

Having a heat distortion point of over 500 F, the RX 495 asbestos-reinforced phenolic molding compound is made for gears, electrical switchgear, and control parts. The average impact strength is 2.5 ft-lb per in. of notch with a compressive strength of 12,000 psi. Tensile strength is 6000 psi and compressive strength is 22,000 psi avg. Arc resistance is 165 sec and average ignition time is 340 sec.

Rogers Corp., Dept. ED, Rogers, Conn.

◀ CIRCLE 133 ON READER-SERVICE CARD

CIRCLE 141 ON READER-SERVICE CARD ▶

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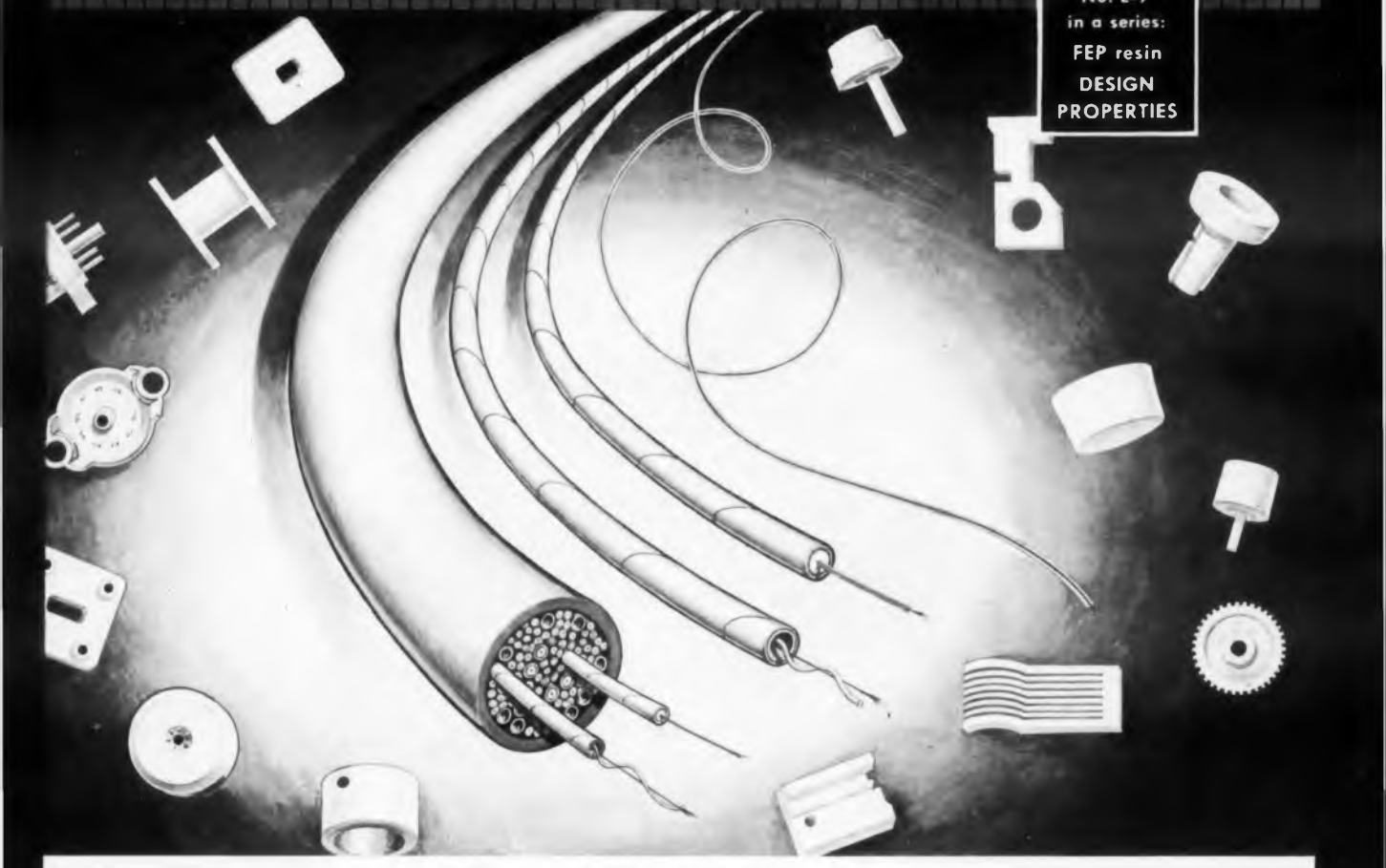
ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

No. E-9
in a series:
FEP resin
DESIGN
PROPERTIES



NOW COMMERCIALLY AVAILABLE . . .

New TEFLON® FEP resin . . . for a new wide range of improved electrical designs

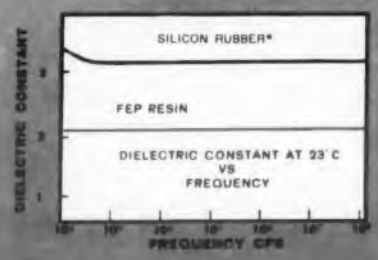
With the commercial availability of TEFLON 100 FEP resin—a new, melt-processible fluorocarbon resin—the family of TEFLON fluorocarbon resins now offers an outstanding combination of properties for use in a wider range of electrical equipment than ever before. TEFLON 100 FEP resin can be molded and extruded by techniques commonly used with thermoplastic polymers. FEP resin has excellent electrical properties over a wide range of temperature and frequencies. Parts fabricated from FEP resin have excellent heat resistance . . . are capable of continuous service at temperatures up to 400°F., and higher under certain conditions. They are inert to virtually all chemicals and solvents. They have a very low coefficient of friction. They are tough, strong, and display excellent weatherability.

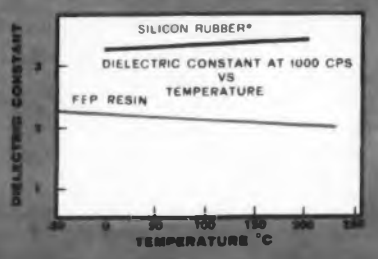
And because TEFLON 100 FEP resin is melt-processible, it can be extruded as jackets for wire and cable . . . as long, continuous lengths of wire insulation . . . and rapidly fabricated into complex shapes.

On the following page, you will find more information on the electrical, mechanical and thermal properties of TEFLON 100 FEP resin, plus examples of the improved designs now made possible by this new addition to the family of TEFLON resins.

OVER

Now... melt-processible FEP resin for jacketing ...extrudable wire insulation... complex shapes





*TYPICAL LOW MOISTURE ABSORBTION COMPOUNDS

Table 1. Thermal properties (typical values)

Property	FEP Resin
Melt point, °F.	545-565
Cut-through temperature, °F. (32-mil wire, 8-10 mil film, 340 gm. load)	522
Low-temperature brittleness, °F. (ASTM D746)	−140
Coefficient of linear thermal expansion, −100°F. to +160°F., in./in./°F.	4.6-5.9 x 10^{-5}

Table 2. Mechanical properties

Property	FEP Resin
Coefficient of Friction	
Inclined plane against steel, 77°F.	0.09
Tensile Strength, lb./sq.in.	
−321°F.	16,000
73°F.	3,080
392°F.	650
Elongation, %	
−321°F.	4-5%
73°F.	250-330%
392°F.	200-250%
Flexural Modulus, lb./sq.in.	
73°F.	50,000-60,000
392°F.	6,000-8,000
Cold Mandrel Bend	
MIL-W-16878C (−85°F.)	passes

The exceptionally low dielectric constant of TEFLON 100 FEP resin over a wide range of frequencies and over a wide range of temperatures is shown in the charts at left. The dissipation factor of FEP resin is less than 0.0003 at 100 cycles, to a maximum of 0.0007 at 1 megacycle. These outstanding insulating properties are not affected by heat aging.

The tables at left illustrate typical values of thermal properties of TEFLON FEP resin and the excellent mechanical properties offered by this resin.

Cable jacketing of FEP resin offers the outstanding insulating properties of this resin, plus mechanical toughness, abrasion resistance and smooth-sliding qualities. It is economical to make because FEP resin is easily extruded, at temperatures that do not affect primary insulation. Long, continuous lengths of insulation for hook-up wire are also easily fabricated.

Because FEP resin is heat bondable to itself and to many other materials, including TFE resins and copper, it now makes possible improved design of printed circuits, both flexible and rigid. Film of FEP resin is an excellent cement for bonding copper to TFE resins and other materials because laminates so bonded will have the excellent surface electrical properties of the FEP resin plus the special properties – such as rigidity or economy – of the base material. And both the dielectric constant and dissipation factor of FEP and TFE resins are essentially invariant over wide ranges of temperature and frequency.

A variety of tiny electronic components such as feed-throughs, stand-offs, tube and diode sockets, and terminations like the missile connector right, utilize the dielectric properties of TEFLON FEP-fluorocarbon resin. Over a measured temperature range from −40°F. to 400°F., its volume resistivity exceeds 10^{18} ohm-cm, and its surface resistivity exceeds 10^{14} ohms/sq., over the widest range of frequencies. Complex shapes are readily injection-molded in one piece.

Have you seen Volume 1, No. 1, of the new "Journal of TEFLON"? This regular publication contains articles of interest to all users and designers of electrical components, wire and cable. Put yourself on the mailing list for this up-to-date, informative journal. Simply write to the address below.

FOR MORE INFORMATION... about the properties and applications of TEFLON fluorocarbon resins—in particular, the new FEP resin—just drop us a line, mentioning your area of interest. Address: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department T-164, Room 2526, Wilmington 98, Delaware. IN CANADA: Du Pont of Canada Ltd., P.O. Box 660, Montreal, Que.

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TEFLON®
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Frequency Monitoring Relay 674

Miniature

The Tinymag frequency monitoring relay protects electronic equipment from high or low power line frequencies over a wide range of voltage and temperature. It uses the line to be monitored for excitation. The magnetic amplifier insures snap action on pickup and dropout. The relay coil operates at twice the minimum closing voltage for positive seating of the contacts; it operates without shock mounts to 40 g.

Torwico Electronics, Inc., Dept. ED, 1090 Morris Ave., Union, N.J.

Price & Availability: *Prices range from $93 to $215. Delivery time is 60 to 90 days.*

Multiplex Carrier 432

Handles 600 channels

This transistorized multiplex carrier system handles up to 600 voice-frequency channels on a single radio beam. Power requirement is only 700 w. About 1/3 the size of conventional equipment with tubes, this modular unit makes it possible to house 120 channels in an 8-ft. rack space.

General Electric Co., Communication Products Dept., Dept. ED, Lynchburg, Va.

Availability: *The unit will be in stock by about September of 1960.*

Multitester 600

Pocket size

This pocket size multitester is suitable for a wide range of servicing applications. It features 10,000 ohms per v ac-dc meter having a 3.5-in. meter face and 1% precision resistors. Ranges are: 0 to 6, 0 to 30, 0 to 120, 0 to 600, and 0 to 1200 v dc; 0 to 6, 0 to 30, 0 to 600, and 0 to 1200 v ac; 0 to 120 μa; 0 to 3 ma, and 0 to 300 ma dc; 0 to 30 K and 0 to 3 meg resistance; and −20 to +63 db in five scales. Capacity range is 50 μμf to 0.01 μf and 0.001 to 0.15 μf. The full capacity range requires 120 v ac; the second range, 6 v ac.

Lafayette Radio, Dept. ED, 165-08 Liberty Ave., Jamaica 33, N.Y.

Price: *$8.95.*

◀ CIRCLE 141 ON READER-SERVICE CARD

NEW PRODUCTS

Coaxial Connector 613

Has a constant impedance of 125 ohms

Type E5642/13 coaxial connector has a constant impedance of 125 ohms. The voltage reflection coefficient, resulting from a mismatch at the connector, is a maximum of 1% for a 10^{-9} sec rise-time signal. Good shielding is provided from external electrostatic fields and currents flowing on external cable surfaces. The female receptacle or male plug may be used with or without the cable clamping sleeve. All contacts are gold-plated.

Ecco Components Corp., Dept. ED, 578 Nepperhan Ave., Yonkers, N.Y.

Potentiometers 636

Two types are epoxy encapsulated

Types 768 and 769 trimmer potentiometers are epoxy encapsulated to meet the requirements of MIL-STD-202A, Method 106A, or MIL-E-5272A, Procedure 1. They are designed for applications where infinite resolution and high temperature characteristics are needed. Both types come in resistance ranges from 50 to 25,000 ohms with a nominal linearity of ±5%. Adjustments are made with a 28-1/2 turn screw.

Fairchild Controls Corp., Dept. ED, 225 Park Ave., Hicksville, N.Y.

Price & Availability: *Quantities up to 2500 in certain resistance ranges available from stock. Price is $15 per unit in quantities of 1 to 5. Prices scaled down to $8.30 for quantities of 1000 or more.*

Trimmer Capacitors 606

Dielectric strength is 600 v dc

These miniature trimmer capacitors have a Q-rating of better than 1000 at 1000 cps, an operating temperature range of −55 to +125 C, an insulating resistance of 10,000 ohms, and a dielectric strength of 600 v dc at sea level. The units have a non-rotating piston fitted into a glass cylinder. There is no air gap between the piston and the cylinder wall. The adjusting screw stays flush with the face of the bushing. The linear travel of the piston bears a direct and positive relationship to the angular rotation of the screw, clockwise or counterclockwise, resulting in reported absolute retrace characteristics. There is no backlash. Wear of the screw threads is automatically compensated.

Atlee Corp., Dept. ED, 47 Prospect St., Woburn, Mass.

Precision Dials 610

Five models available

Series 1360 precision dials provide accurate and reliable performance due to these characteristics: absence of noise, lack of jumping or stepping action, and few ambiguities in reading and setting. Contoured brake arms lock settings in place without interfering with reading or setting. The series includes five models in various color combinations.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

NEW PRODUCTS

Miniature, Plug-In Relays 615

Ratings are 5 and 10 amp

These miniature, plug-in relays are offered in the following types: spdt, rated at 5 amp; dpdt, 10 amp; and 6 pdt, 10 amp. All units meet the requirements of MIL-R-25018, MIL-R-6106C, and MIL-E-5272. They are hermetically sealed and have snap-action construction. Gold contacts can be furnished. Sockets are designed for top or bottom chassis mounting and provisions are made for locking the plug-in relay to the socket and the chassis.

Electronic Specialty Co., Dept. ED, 5121 San Fernando Rd., Los Angeles 29, Calif.

Metalized Ceramic Housings 616

For resistors

These metalized steatite and alumina ceramic housings are for carbon-fixed, wirewound and film-type resistors. Each housing has a metallic band about 3/16 in. wide on each of the inner ends of a tubular ceramic shell. This band is a silver-fired coating that has been hot-tin coated for easy soldering. The housings are offered in various sizes.

Metalizing Industries, Inc., Dept. ED, 338 Hudson St., Hackensack, N.J.

Price & Availability: *In quantities of 1000 to 5000, prices range from $75 to $100 per 1000 for steatite shells and from $155 to $230 per 1000 for alumina shells. Prototype lots are available in three weeks; production quantities, in six weeks.*

Hermetically-Sealed Switch 619

Weighs 1/28 oz

The Klixon AT1-1 precision, hermetically-sealed switch weighs less than 1/28 oz and has envelope dimensions of 0.32 in. in diameter and 0.44 in. in length. It is designed for applications where high reliability is required such as in aircraft and missile uses. The current capacity is 3 amp at 28 v dc, resistive. The contact arrangement is spdt and the life expectancy is 10,000 cycles. The unit stands 40 g vibration, 100 g shock, and temperatures from −65 to +275.

Texas Instruments, Inc., Metals & Controls Div., Dept. ED, 34 Forest St., Attleboro, Mass.

Price & Availability: *Price is $18 ea for 1 to 9 units; $10 for production quantities. Delivery time is two weeks.*

Digital Recorder 634

Is a 16-track model

Having standard tape speeds from 1-7/8 to 60 ips, this 16-track portable digital recorder, model PS 216-D, is furnished with 1 in. wide tape and weighs 100 lb. It has modular construction and printed circuit boards which provide NRZ digital read and write amplifiers in solid-state form. The unit includes a tape magazine for replacement of tape or to interchange with a continuous loop magazine. Reels are standard 10-1/2 in. and can be used with acetate or mylar tapes of any thickness from 1 mil up.

Precision Instrument Co., Dept. ED, 1011 Commercial St., San Carlos, Calif.

NEW PRODUCTS

Photometer 428

Measures fluorescence and phosphorescence

Designed for measuring such phenomena as fluorescence, phosphorescence and luminescence, model 210 photometer measures the intensity difference between two light sources or measures and records the intensities of the light sources independently. Using a meter scale with a 50-amp per lumen photomultiplier tube, each scale division can represent as little as 2 micromicrolumens. Accuracy is ±0.5% for each channel and ±1% differential at the recorder output. Meter accuracy is ±1%, stability is ±0.1% per channel per day, range is 1, 10, and 100 mμamp and 1 and 10 μamp. Full scale deflection can be obtained with 1% change of either input from equal input conditions.

Eldorado Electronics, Dept. ED, 2821 Tenth St., Berkeley 10, Calif.
Price: $985.

Voltage References 633

Provide 0.01% absolute accuracy

These three secondary standard voltage reference sources have front panel null meters and provide 0.01% absolute accuracy. Constant fixed voltages of ±100 v dc can be provided. The selectable range of portable or rack mounting decimal unit is ±111.112 v, in 1 mv steps. A 17-switch portable binary unit has a selectable range of ±100.008 v dc, selectable in 0.8 mv steps. As voltage dividers, the instruments provide any percentage of dc or low frequency ac external reference voltage.

Epsco, Inc., Equipment Div., Dept. ED, 275 Massachusetts Ave., Cambridge 39, Mass.

Quadrature Rejection Circuit 601

For use at altitudes to 100,000 ft

Able to meet environmental specs of MIL-E-5272, this transistorized quadrature rejection circuit operates at altitudes to 100,000 ft and over

the temperature range of −55 to +115 C. It operates from a preamplifier or gain-controlled amplifier source into a transistor servo-amplifier. It rejects the component of the input wave which is 90 deg from the reference input. The quadrature component is 5000 ohms and signal frequency is 400 ±60 cps.

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

Scanners 607

For automatic data logging systems

Designed for operation in automatic data logging systems, these transistorized input scanners are offered in three models. Model 260 sequentially connects up to 100 single-pole channels to a digital voltmeter for measurement. Model 261 is for 200 single-pole channels and model 262 is for 100 double-pole channels. All three provide channel identification for a data recorder. All logic functions are performed by semiconductors; control functions are by transistors, diodes, and relays. Heavy-duty stepping switches with gold-plated contacts are used. The scanners can be controlled remotely or manually with front panel controls.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

Voltage Detector 624

Input sensitivity is less than 20 μa

Model PT-3 transistorized voltage detector has an input sensitivity of less than 20 μa and an output response time of 10 μsec. Each of the two outputs can supply 200 ma into a load. The unit is designed for airborne and ground applications. The output is push-pull. Housed in a MIL-T-27 can, the unit measures 1-5/8 x 2-5/8 x 2-3/8 in.

Anadex Instruments, Inc., Dept. ED, 14734 Arminta St., Van Nuys, Calif.

Price & Availability: $148; from stock.

NEW PRODUCTS

Transducer 599

Position-sensitive

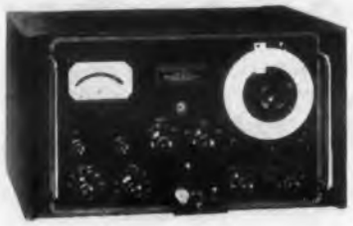
Type DP position-sensitive transducer detects static or dynamic mechanical displacement. The basic sensing element is a linear variable differential transformer. The device is suitable for a variety of remote detection applications including the measurement of beam deflection, thickness, strain and elongation, surface quality of materials in motion and thermal expansion of metals. Linearity is 1% full scale, operating temperature range is −65 to +222 F, and output voltage with an input of 6.3 v is 0.25 v at 60 cps to 1.6 v at 20,000 cps. The unit weighs 12 oz and has a volume of less than 12 cu in.

Schaevitz Engineering, Dept. ED, P.O. Box 505, Camden, N.J.

Price & Availability: *Price is $200. Units can be delivered in three to four weeks.*

Transistor Tester 626

Measures alpha, beta, and input resistance



Type 275-A transistor test set measures alpha, beta, and input resistance parameters. Direct readings are provided. Able to test both npn and pnp transistors, the unit can also measure the characteristics of diodes and other semiconductor devices. The instrument handles up to 5 amp emitter current.

Boonton Radio Corp., Dept. ED, Boonton, N.J.

Price & Availability: *$935; after June 1960.*

Gyro Wheel Supply 603

Frequency stability is 0.005%

Furnished with either tuning fork or crystal frequency reference, model WS303 transistorized gyro wheel supply has a frequency stability of 0.005% when internal reference is used. Standard voltage stability is 0.5 v or better from zero to full load and from −55 to +71 C. Output has less than 3% harmonic content. The unit meets military environmental specs.

Harrel, Inc., Dept. ED, 1788 First Ave., New York 28, N.Y.

Availability: *Delivery time is about four weeks.*

DC Power Supply 625

For missile checkout and launching equipment

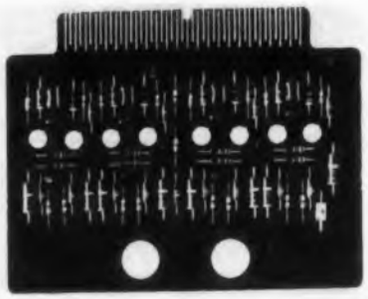
Model M-1520 power supply is for driving transistorized circuits in missile checkout and launching equipment. Measuring 10.5 x 7.125 x 6 in., the supply has a line static regulation of ±0.1% for changes from 27.5 to 31.5 v and line dynamic regulation of ±0.05 v for input transients of 70 v dc lasting 0.2 sec. Static load regulation is ±0.4% for changes from no load to full load, load dynamic regulation is ±0.125 v for step changes from no load to full load and full load to no load. Outputs are 8, 10, and 12 v dc, adjustable from 0 to 5 amp. Input is 27.5 to 31.5 at 8 amp max. Ripple is held to less than 1 mv rms.

Perkin Engineering Corp., Dept. ED, El Segundo, Calif.

Price: $1362.

Flip-Flops 629

Operating speed is 300 kc max



Model MF-4 flip-flop module contains four RS flip-flops for use in any asynchronous or single-phase-clock digital system. The flip-flops can be connected to form binary counters, decimal counters, or shift registers without the use of external gating. Maximum operating speed is 300 kc but can be increased to 500 kc with special transistors. Each flip-flop has a pulse input and a dc input on both the set and reset sides. The module is made of an epoxy glass board and has a 47-pin connector.

Abacus, Inc., Dept. ED, 3040 Overland Ave., Los Angeles 34, Calif.

***Price & Availability:** Prices range from $90 to $125. Delivery is from stock.*

NEW PRODUCTS

Magnetic Memory Drum 630

With true flux responsive readout

This digital, magnetic memory drum has true flux responsive readout. The drum is intended to provide a variable delay for the master control of automatic inspection devices, conveyors and materials handling equipment, program control for automatic machine tools, and synchronous conversion of binary codes from parallel to serial and reverse. The readout is claimed to be independent of drum speed. Two types of direct output from the read heads are offered. For operation into transistor circuitry, the output is rectified and matched for low impedance. The one-output is 1.5 v dc into 1000 ohms and the zero-output is less than 30 mv. For operation into a cold-cathode matrix, the one-output is 65 v ac and the zero-output is less than 2 v.

Consolidated Controls Corp., Dept. ED, Bethel, Conn.

Price & Availability: *Price is $162. Delivery time is 45 days after receipt of order.*

Digital-to-Analog Converter 595

Overall accuracy is ±0.01%

Model 43 transistorized digital-to-analog converter has an over-all accuracy of ±0.1%. The standard unit accepts two channels of 12-bit straight binary data. One, three, and four-channel units are also available; variations may be made in the number of bits per channel. The converter may be used to drive a number of voltage sensitive devices and, with additional circuitry, will drive X-Y recorders. The front panel contains an illuminated display indicating the contents of the storage registers for visual monitoring, testing, or calibration. The unit occupies 7 in. of relay rack space.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price & Availability: *$450; three weeks delivery time.*

Crystal Mixers 623

For microwave signals

These balanced crystal mixers heterodyne two microwave frequencies in the same band to obtain an if difference frequency at the push-pull or push-push outputs. The mixers suppress local oscillator noise. Applications are in the front end of radar receivers and in laboratory instrumentation. Sizes range from 2.5 to 90 kmc.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: *Prices range from $275 to $435. Units can be furnished 30 days from receipt of order.*

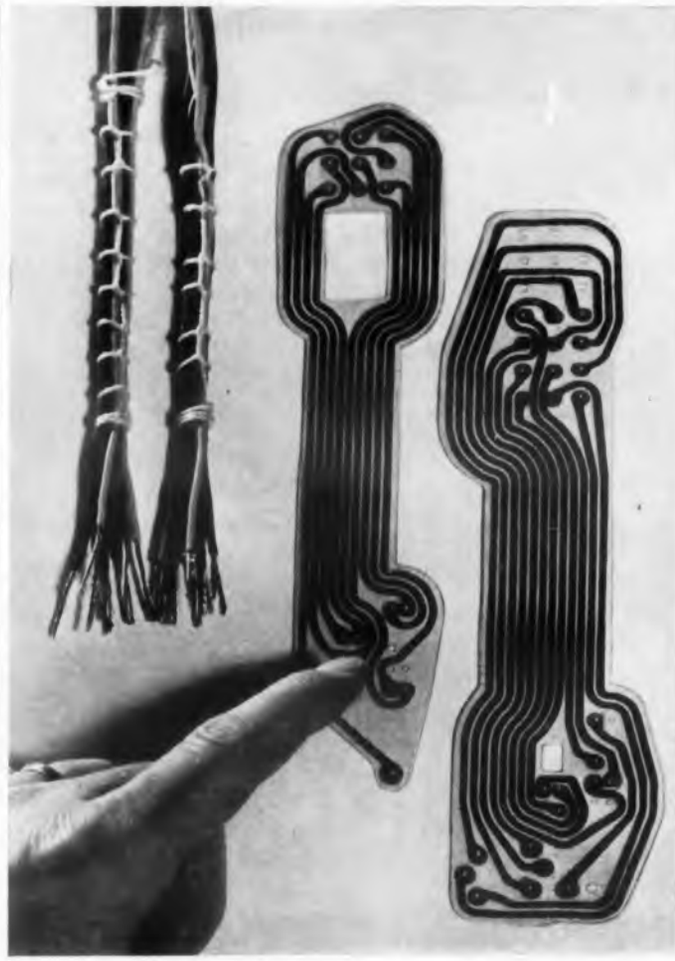
DC Accelerometer 605

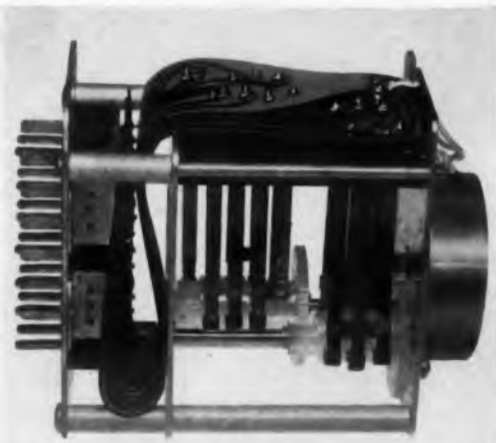
Measures 1.5 x 0.8 x 0.8 in.

Model 24155 dc accelerometer weighs 2.5 oz and measures 1.5 x 0.8 x 0.8 in. The unit can be supplied with a potentiometer resistance of 2000 to 5000 ohms. Standard range is ±2 to ±25 g. The unit is fluid-damped to provide linearity, hysteresis, and repeatability of ±1%. Natural frequency is 20 to 72 cps making the unit suitable for telemetry applications. It stands shock of 50 g for 11 msec and is hermetically sealed.

Giannini Controls Corp., Dept. ED, 918 E. Green St., Pasadena, Calif.

Don't miss an issue of ELECTRONIC DESIGN; return your renewal card today.





A. W. Haydon interrupter timer

Western Electric Call Director telephone

NEW PRODUCTS

DC Power Supply 594

Measures 2-5/16 x 3 x 4-1/4 in.

Model 1501 power supply measures 2-5/16 x 3 x 4-1/4 in. It delivers 5000 v dc at up to 5 ma. Ripple is 1%. Required input is 115 v ac at 60 cps. Also available are 1100 and 15,000-v, 5-ma supplies.

Atlas Transformer Co., Dept. ED, 1839 Moore St., San Diego 1, Calif.

Price & Availability: *$203; three weeks delivery time.*

DC Power Supply 618

Provides 0 to 36 v at 0 to 500 ma

Model 860 power supply provides an adjustable output of 0 to 36 v at 0 to 500 ma. An octal plug is used for all input and output connections to the supply, including remote programing and remote sensing. Regulation is better than 3 mv and ripple is less than 500 μv for any combination of line or load. The unit measures 6-1/2 x 3-7/16 x 6 in.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N.J.

Price: *$197.*

Line Follower 596

For use with strip chart recorder

Model F-2 line follower, consisting of a light source, a scanning mirror, and a photocell pick-up, is designed primarily for use with the firm's model 80-A strip chart recorder. Typical applications are in graphic data analysis, process control, and in other areas where arbitrary functions of time must be generated in a simple manner. Length of the record is up to 120 ft. The line does not have to be specially prepared and may be the product of a previous recording on the recorder.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Price: *About $750.*

Soft-Solder Preforms 598

Purity is 99.999% plus

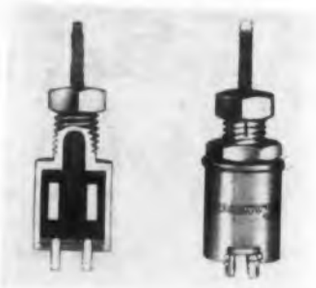
These soft-solder preforms with alloying elements are held to a purity of better than 99.999%. The vacuum casting technique used in the production of these preforms assures consistent flow characteristics and joint strength. Alloying elements are lead and tin. Melting points range from 361 to 689 F. Flat washers, discs, and pellets are offered; the parts are packaged in argon or other protective atmospheres.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

Availability: Large quantities can be delivered three weeks after receipt of order.

Shielded Coils 628

Cover 25 mc to 250 kc



The LS9 shielded coils are available in 10 different operating ranges covering a span from 0.5 μh at 25 mc to 1 mh at 250 kc. All have a breakdown rating of 500 v dc and are wound on polypenco forms. The main housing and mounted hardware are nickel-plated brass. Height of the coil housing, including terminals, is 39/64 in.; diameter is 7/16 in. From 2 to 6 solder terminals are available.

Cambridge Thermionic Corp., Dept. ED, 445 Concord Ave., Cambridge 38, Mass.

Availability: From stock.

Miniature Transmission 637

Has up to 15 exact speeds

Utilizing gears made of Delrin, this miniature transmission has a range of 15 speeds, from 3.3 to 7812 rpm. Speeds are electronically controlled through magnetic clutches. At 7812 rpm, the transmission develops over 1/3 hp. Torque developed is over 100 oz in., depending upon speed. Case dimensions, excluding power source and control panel, are 4-1/14 x 7-1/4 x 3-5/8 in. It operates on 115 v, 60 cps.

Dynamic Gear Co., Inc., Dept. ED, Dixon Ave., Amityville, N.Y.

NEW PRODUCTS

Explosive-Actuated Switch 620

Breaks 6 circuits simultaneously

Type XM-9 explosive-actuated switch, designed for military and commercial applications, breaks 6 circuits simultaneously. It has 6 pairs of normally closed contacts, touching conducting rings on a cylindrical shaft. The switch is made to operate in 35 msec max; actual function time is 4 to 5 msec. Resistance between closed contacts and housing or between adjacent pairs of contacts is at least 100 meg when 500 v dc are applied. The unit measures about 2 in. in length, 1 in. in height, and 9/16 in. in width; it weighs 1.5 oz. It operates from —65 to +160 F and stands centrifugal acceleration of 1000 g.

Dial Service and Manufacturing, Inc., Dept. ED, 1741 Rockwell Ave., Cleveland 14, Ohio.

Price & Availability: *Price is $15 ea for 10 to 1000 units. They will be in stock by August 1960.*

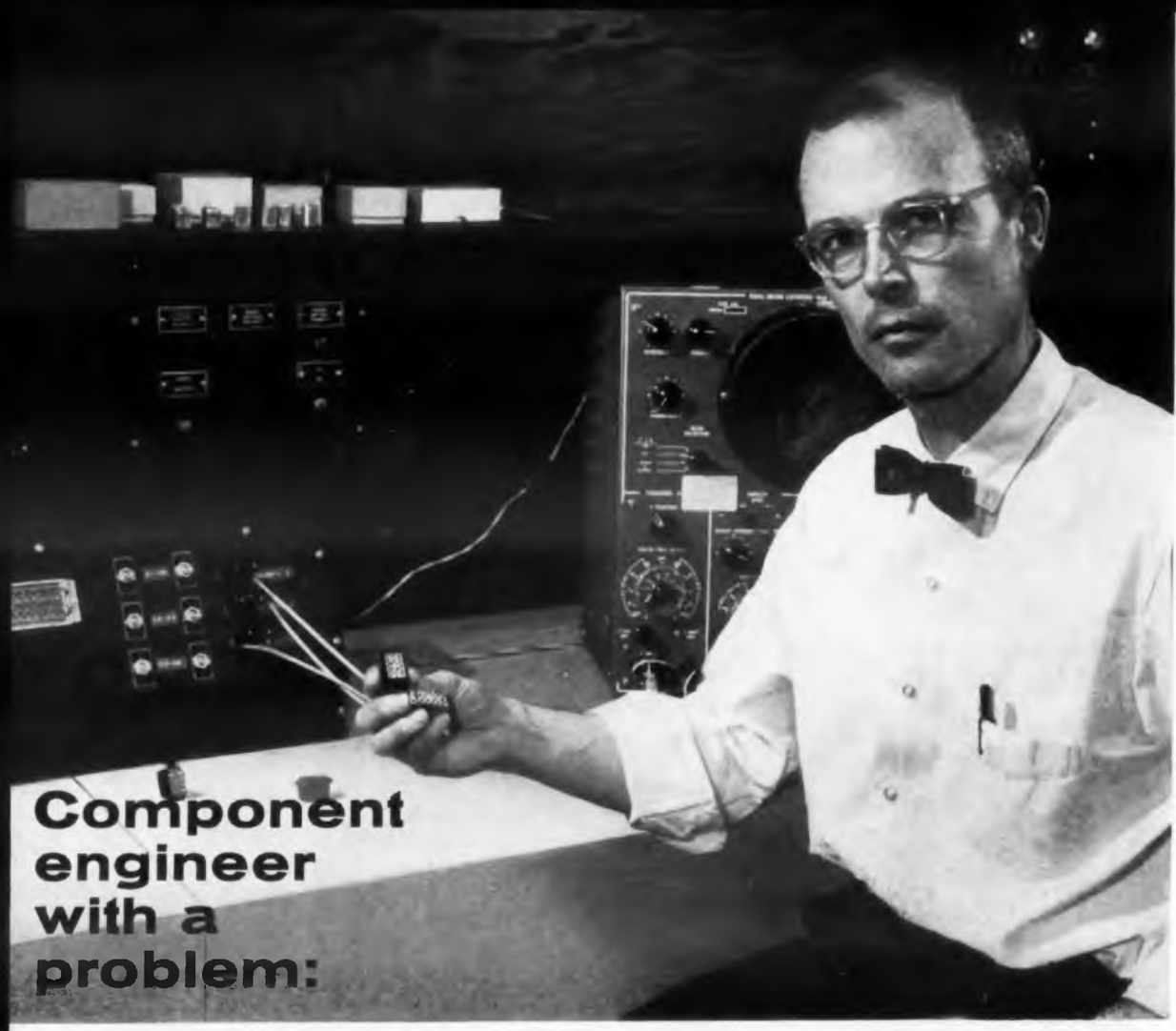
Coaxial Filters 632

For frequencies from 100 to 10,000 mc

These coaxial filters come in frequencies from 100 to 10,000 mc and in high power or miniaturized versions as well as standard sizes. Low pass filters in the standard model have a power rating of 10 to 50 w; in the high power model they are rated at 500 w. All filters are supplied with one male and one female connector in either the N, BNC, TNC, C, or HN series. They meet the requirements of MIL-E-5272B.

Microlab, Dept. ED, 570 W. Mount Pleasant Ave., Livingston, N.J.

Price & Availability: *Immediate delivery is made from stock. Prices range from $30 to $65.*



"The relay I need must not fail!"

Perhaps the relay is a key element in a missile guidance system . . . the fire-control system of a supersonic fighter . . . the rocket-launching mechanism for a nuclear sub . . . *and, it must not fail!*

That's where General Electric comes in. Though *absolute* reliability is impossible, making "super-reliable" sealed relays is a way of life at General Electric. But, we don't make industry's most reliable sealed relays with good intentions alone. It all stems from GE's advanced technology, manufacturing technique, and testing procedure.

For reliability—advanced technology

G-E technological leadership is best exemplified by the application of inert arc welding in sealing Unimite and 4-pole micro-miniature relays. Solder and solder flux—long a major source of contamination—are completely eliminated . . . reliability is boosted!

For reliability—superior manufacturing

Automatic wash-cycles . . . 3-unit console to automatically check 12 electrical characteristics in one setup . . . 100% contact resistance checks by the scope method . . . these are but a few of the manufacturing techniques General Electric employs to minimize the human factor in relay assembly.

And, in the General Electric Micro White Room—perhaps the most exacting relay assembly facility ever conceived—relays are built in an atmosphere a hundred times more pure than that in which we live. What's more, operators are judged primarily on *quality*. So, the incentive to achieve perfection is paramount!

For reliability—exhaustive testing

Before a G-E relay qualifies for production, it must withstand a battery of excrutiating tests. It's never tested to arbitrary specifications . . . *but to the limits of its capability!* Once the relay is accepted, these same exhaustive testing procedures—simulating actual operating and atmospheric conditions—are repeated . . . continually . . . to verify its high level of reliability.

For reliability—call General Electric

When you need a sealed relay that *has* to operate, you can't afford anything less than the best! Call your General Electric Apparatus Sales Engineer today. *Specialty Control Department, Waynesboro, Virginia.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

GENERAL ELECTRIC SEALED RELAYS—UNMATCHED FOR RELIABILITY

CIRCLE 161 ON READER-SERVICE CARD

General Electric sealed relays for the '60's

4-POLE MICRO-MINIATURE

New grid-space, 4-pole double-throw micro-miniature relay features all-welded construction to eliminate flux contaminants. Knife-edge armature bearing and other design features provide structure capable of mechanical life in excess of 10 million operations. Rated 2 amps at 28 volts DC, or 115 volts AC resistive; requires only 100 milliwatts per pole. Other specifications are:

Operating sensitivity: 400 milliwatts at pickup voltages: continuous duty.

Vibration: 55 to 2000 cps at 30G's with 0.195" max. excursion 10 to 55 cps.

Shock: 50G's for 11 ms operating.

Temperature range: 125 C to −65 C.

Operating time: 6 milliseconds max. including bounce.

Insulation resistance: 1000 megohms min.

Dielectric strength: 1000 volts rms except 600 volts across contact gap.

Contact resistance: 0.050 ohms maximum (0.1 ohms max. after life).

Release time: 5 milliseconds maximum including bounce.

MINIATURE: Long-life type; rated 5 amps at 28 volts DC; in 2- or 4-pole double-throw and 6PNO forms. Ideal for ground jobs.

MICRO-MINIATURE: Crystal can type, all popular coils and mounting forms; 2 amps, 28 v DC or 115 v AC. Grid-spaced terminals available.

UNIMITE: World's smallest 1-amp sealed relay! Operates in 1.5 millisecond, releases in 3.5 milliseconds. Isolated contact chamber; all-welded construction.

General Electric Company
Section A792-16
Schenectady, New York

Please send me a free copy of the 1959–60 Sealed Relay Catalog.

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GENERAL ELECTRIC

NEW PRODUCTS

Diffusion Furnace 638

Has a 1200 C max operating temperature

This diffusion furnace for semiconductor manufacturers has a maximum operating temperature of 1200 C. The constant temperature work zone is made longer by dividing the diffusion zone heating elements into three electrically independent sections, each separately adjustable. Contamination is minimized through the use of high-purity impervious alumina muffles. The unit measures 22 x 24 x 48 in. and has a power requirement of 120/240 v, single phase.

Pitt Precision Products, Inc., Dept. ED, 261 Madison Ave., New York 16, N.Y.

Availability: *Units are adapted to meet specific customer requirements.*

Printing Timer 635

Has a capacity of 99,999.9 hr

Developed for use in ballistic missile programs, this printing timer has a capacity of 99,999.9 hr. It can be permanently or temporarily connected to the machine to be checked. Preprinted cards are used to record the time. The left side of the timer accumulates running time in hours and tenths of minutes. The right side is a time stamp, recording the year, date, hour, and hundredths of a minute. Power requirement is 110 v ac for both input and machine connector.

Cincinnati Time Recorder Co., Dept. ED, 1733 Central Ave., Cincinnati 14, Ohio.

Miniature Relay 643

Operates on 5 mw

The BR-1S relay has a coil sensitivity of 5 mw and will handle up to 2 amp resistive at 32 v dc or 110 v ac. It can withstand 25 g (11 msec) shock, and 0.06 in. of vibration at 10 to 55 cps. Having a temperature range from −65 to +85 C, the 1-1/4 oz relay will operate in 10 msec with 100 mw power to the coil and can be adjusted to drop-out at 90% of pull-in. The BR-1S comes in a

variety of terminal and mounting combinations, all with spst Form C contacts.

Babcock Relays, Inc., Dept. ED, 1640 Monrovia Ave., Costa Mesa, Calif.

Price & Availability: *Single unit orders filled within 3 weeks at an individual unit price of $10 each.*

Integrating Accelerometer 621

Dynamic range is 10^5

This integrating accelerometer is for velocity and distance information furnished in pulse digital form. Each output pulse indicates a calibrated distance traveled along the vector axis of the device. Dynamic range is 10^5. Maximum input is ±100 g and maximum velocities are 10,000 ft per sec. Accuracy of the distance output is 0.1%. Operating voltage is 28 ±4 v dc; total power consumption is 5 w. The unit meets MIL-E-5272B.

Globe Industries, Inc., Dept. ED, 711 San Mateo Blvd., S. E., Albuquerque, N. Mex.

Price & Availability: *Prices range from $900 to $2200. Some units are in stock.*

DC Amplifier 609

Portable

The Fitgo dc amplifier, designed for laboratory and small data system applications, is portable and weighs less than 24 lb. Model RP-1 mounting module houses both the amplifier and the power supply. All power supply components are mounted in a plug-in circuit board measuring 5 x 10 in. The supply handles any amplifier with a bandwidth under 300 cps. Power dissipation is about 5 w. Power requirements are 105 to 125 v ac at 50 or 400 cps. The mounting module can also be furnished for rack mounting.

Beckman Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

NEW PRODUCTS

Delay Lines 710

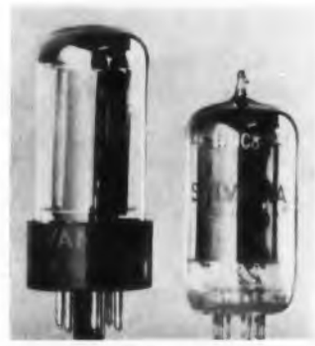
Come in 36 different types

These lumped constant delay lines come in 36 different types, varying in delay time, rise time and impedance. Using powdered iron toroidal inductors, they have a delay tolerance within ±3%, and are rated at 200 v dc. Characteristic impedance is within ±5%. The units meet environmental tests from −55 to +105 C. They are encapsulated in epoxy resin and are hermetically sealed in metal cases.

IMC Magnetics Corp., Gray & Kuhn Div., Dept. ED, 570 Main St., Westbury, N.Y.

Receiving Tubes 711

For printed circuitry



These tubes are designed with straight-sided T-9 bulbs using a 9-pin miniature circle of leads in place of the conventional octal base. The tubes suitable for printed circuitry use, include: 17HC8, a medium mu triode pentode; 6EW7, a double triode; and 10EW7, similar to the 6EW7 except for higher heater power requirements.

Sylvania Electric Products Inc., Electronic Tubes Div., Dept. ED, Seneca Falls, N.Y.

Zener Diodes 639

Have 5% standard tolerance

These 10-w Zener diodes in standard 7/16 in hex stud package come with 5% standard tolerance. Reverse breakdown voltages range from

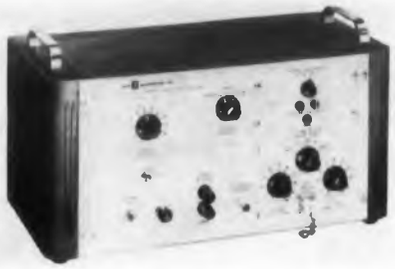
7.5 to 100 v. Included are the following series: 1N1351A-1N1375A; 1N1806A-1N1808A; 1N1816A-1N1836A; 1N2008A; 1N2498A-1N2500A. Their uses include voltage reference or regulation, clipping, surge and under or over-voltage protection, meter protection and other applications.

U.S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.

Availability: *Immediate shipment, up to 999 pieces, is from stock.*

Pulse Generator 708

Gives pulse widths from 10 to 100 μsec



Model 1051 pulse generator provides positive or negative pulses in any one of four fixed widths: 10, 20, 50, or 100 μsec. Pulse repetition frequencies range from 50 to 5000 pps, continuously variable through two ranges. The unit can generate current amplitudes up to 4 amp, and has a rise time less than 5 μsec. It measures 16-1/2 x 8-1/4 x 8 in.; requires 75 w from a 115 v, 50 to 60 cps line; and is forced air-cooled.

Rese Engineering, Inc., Dept. ED, 731 Arch St., Philadelphia 6, Pa.

Availability: *Available from stock. Can be delivered 3 days after order received.*

Resin Compounds 648

Come in three types

These resin compounds include the Isochemterge 1401, 1405, and Safety Gel. They are intended for use in plant and laboratory clean-ups and in the removal of uncured epoxy and similar resins. They solubilize resin wastes and offer low viscosity plus 100% epoxy solids without the use of reactive or other dilutents. The Isochemterges may be used to remove polyesters, vinyl resins, acetates, inks and other industrial or laboratory stains on equipment or person.

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

Price & Availability: *Delivery made from stock. Prices are: 1401, $5.50; 1405, $7; Safety Gel, $8, when ordered in gallon cans. Price per lb for 55 gallon drums is: 1401, $0.50; 1405, $0.65; Safety Gel, $0.75. All prices fob plant in Providence, R.I.*

NEW PRODUCTS

Induction Heater 642

For semiconductor materials

Designed for research and development work and for production of semiconductor and other conductive materials, model LI-10D-1 induction heater operates at about 400 kc and 4 mc. The unit has an output of 10 kw. Outside dimensions of the cabinet are 40 x 40 x 76 in. with a 30 x 30 x 16 in. cubicle mounted on top for dual frequency requirement. Net weight of the entire unit is approximately 2150 lb. Power consumption is 20 kva max at 90% power factor.

Lindberg Engineering Co., Dept. ED, 2450 W. Hubbard St., Chicago 12, Ill.

Price & Availability: *Made on order only and delivered 8 to 10 weeks after order received. Price is between $7500 and $10,000.*

Standard Cell 707

Is temperature-stabilized

Model 811 unsaturated standard cell, a Weston-type secondary reference, potential standard, can be incorporated into digital voltmeters, digital-to-analog converters, precision power supplies, and other bridge and potentiometric instruments. A thermostat is used to eliminate temperature errors; cell temperature is held to within ±1 C over a 50 C range, of ambient temperature variations. Output is 1.019 to 1.0198 v dc and drift is less than 3 ppm per year. Internal resistance is 1250 ohms. Dimensions of the unit are 1-1/8 x 1-3/8 x 2-11/16 in.

Winslow Co., Dept. ED, 701 Lehigh Ave., Union, N.J.

Readout Devices 641

Include drive and decoding circuitry

Designed for operation directly from binary codes, the TND-BCD series of transistorized Nixie tube drivers are completely self-contained including drive and decoding circuitry. Models are available for 1-2-4-8, excess —3, tertiary, biquinary, or other 4-level binary codes. A 180-v

external voltage source is required. Standard units for the 1-in. Nixie tube are packaged in a metal body 1-1/4 in. square and about 4-1/2 in. long. Tube may be mounted flush or extended.

Transistor Electronics Corp., Dept. ED, 3357 Republic Ave., Minneapolis 26, Minn.

Price & Availability: *Units for 1-in. Nixie tube are standard. Available for the miniature and jumbo size tubes on special order. Prices range from $100 to $150.*

DC Power Supply 709

Has 0.05% line and load regulation

Designed for laboratory applications, this transistorized dc power supply furnishes 0 to 36 v at 0 to 600 ma, and 0 to 18 v at 0 to 1 amp, with 0.05% line and load regulation. The unit has less than 1 mv ripple. Automatic short circuit protection is provided with variable current limiting provisions. Turn-on and turn-off transients have been eliminated. The use of electrolytic capacitors allow an operating ambient temperature up to 50 C.

Trygon Electronics Inc., Dept. ED, 111 Pleasant Ave., Roosevelt, Long Island, N.Y.

Price & Availability: *Delivery is 4 weeks after order received. Price is $199.50.*

Film Capacitors 646

Have a 0.1% tolerance

Polystyrene and Mylar film capacitors with a 0.1% capacitance tolerance come in all capacities from 1 to 50 μf, and in voltages from 10 to 15,000 wvdc. They can be supplied in hermetically sealed metal tubes or cans, in all mounting and case styles, with glass-to-metal seals. Both polystyrene and Mylar types come uncased or in Mylar-wrap with epoxy end seals, if desired.

Capcon, Inc., Dept. ED, 61 Stanton St., New York 2, N.Y.

Availability: *Most ratings ordered by customer. Can be supplied from stock or to order. Delivery is from 7 to 10 weeks.*

NEW PRODUCTS

Continuously Variable Delay Line 706

Delay is 0.5 μsec

Designed for printed board mounting, model 72-17 continuously variable delay line has a delay of 0.5 μsec. Other typical characteristics are: impedance, 1000 ohms; rise time, 0.1 μsec; maximum attenuation, 10%; maximum voltage, 500 v peak; and resolution, less than 0.001 μsec. Terminals and holding tabs are provided.

ESC Corp., Dept. ED, 534 Bergen Blvd., Palisades Park, N.J.

Accelerometer 704

Frequency response is 2 to 4000 cps

Model 2211 ring-shape accelerometer provides a frequency response from 2 to 4000 cps ±5% with an output of 1000 meg and less than 5% cross-axis sensitivity. The operating temperature range is −40 to +230 F with a maximum sensitivity change of ±10%. The first resonant frequency is 25 kc. Sensitivity is 5 mv peak-to-peak per g.

Endevco Corp., Dept. ED, 161 E. California Blvd., Pasadena, Calif.

Digital Module Cabinet 698

Holds 32 modules

Able to hold 32 digital modules, type BL-11 T-block has a taper-pin plugboard panel for

making signal connections. A hold-down bar retains the modules in the chassis. Notched for rack mounting, the cabinet measures 5.25 x 19 x 8 in.

Computer Control Company, Inc., Dept. ED. 983 Concord St., Framingham, Mass.

Cable Connectors 703

Life is 1000 hr at 200 C

These miniature cable connectors have an operating life of 1000 hr at 200 C. Able to meet MIL-C-26500, they resist thermal shock of +260 to −55 C and will support 1500 v rms at altitudes to 350,000 ft. They stand vibration of 0 to 2000 cps, 15 g. Contacts are crimp type.

Amphenol-Borg Electronics Corp., Amphenol Connector Div., Dept. ED, 1830 S. 54th Ave., Chicago 50, Ill.

Strip Chart Recorder 702

Monitors 10 to 100 mv dc

Operating from 105 to 125 v of 50 to 60 cps power, this strip chart recorder monitors dc signals in the range of 10 to 100 mv and provides 5-in. pen travel. Repeatibility is better than 0.35%. Pen response is 1 sec, full scale. Operation is pushbutton. The unit measures 11 x 14 x 4.75 in. and can be placed on a laboratory bench or mounted on a wall. Designed for laboratory use, it can be used with a variety of sensing elements for measuring temperature, frequency, solution conductivity, light intensity, and other variables.

Beckman Scientific and Process Instruments Div., Dept. ED, Fullerton, Calif.

NEW PRODUCTS

Tube Tester 699

Dimensions are 6-3/4 x 5-1/4 x 2-1/4 in.

Measuring only 6-3/4 x 5-1/4 x 2-1/4 in., model 211 tube tester checks all octal, loctal, 9-prong, and miniature tubes for shorts, leakages, opens and intermittents as well as for quality. Shorts or leakages between any two elements in the tube can be detected; each section of the multipurpose tubes are checked separately.

Electronic Measurements Corp., Dept. ED, 625 Broadway, New York 12, N.Y.

Price: *$22.90, wired; $14.90, in kit form.*

Diode Tube Mounts 622

Sizes are 2.6 to 40 kmc

Furnished in sizes covering the frequency range of 2.6 to 40 kmc, type 140 tube mounts provide a means for coupling a gas diode noise source to a standard size waveguide. Mismatch will not exceed 1.15 vswr. Noise output is 16 db for all sizes. The mount is supplied with a 4-ft. cable. Units are equipped with a waveguide terminated in a matched load.

DeMornay-Bonardi, Dept. ED, 780 Arroyo Parkway, Pasadena, Calif.

Price & Availability: *$220 to $306; 2 weeks to 30 days.*

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

Printed Circuit Board Holder 567

This printed circuit and terminal board holder can be set up without the use of tools. Universal coupling provides adjustment in any plane.

J. G. Dorsey & Associates, Dept. ED, P.O. Box 45793, Los Angeles 45, Calif.
Price: $12.50

Flat Cables 580

These vinyl-insulated, hook-up wires are up to 2 in. wide. From 20 to 30 conductors may be fabricated into one ribbon.

Times Wire & Cable Co., Inc., Dept. ED, 358 Hall Ave., Wallingford, Conn.

Scope Cart 581

Designed to fit all popular oscilloscopes, the cart has large, full-swivel casters, a bottom tray, and a pull-out leaf for use as a writing desk. A 6-ft. retractable power cord with a dual outlet, mounting provisions for two extra amplifiers, and snap clips for storing probes are provided.

Hughes Industrial Systems, Dept. ED, International Airport Station, P. O. Box 90427, Los Angeles 45, Calif.

Gold Alloy 582

These strips are rolled to tolerances down to ±0.0001 in. Thickness is down to 0.0005 in. and maximum width is 4 in. Excellent conductivity, solderability, and ductility are offered.

Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

Heavy-Duty Differentials 570

Type V7 units are available in both precision ball bearings and oil-less bearings. They are balanced with interchangeable end spur clamp rings. Pitch ranges are 48 to 120. Both aluminum and stainless steel are offered.

PIC Design Corp., Dept. ED, 377 Atlantic Ave., E. Rockaway, L.I., N.Y.
Price & Availability: from $45 to $75; in stock.

Latches for Black Boxes 571

These flush type latches offer the following claimed advantages: quick opening, secure over-the-center locking, use of close button as a handle with latch open, tight sealing, and light weight.

U. S. Chemical Milling Corp., Dept. ED, 1700 Rosecrans Ave., Manhattan Beach, Calif.
Price & Availability: Price ranges from $2.50 to $3.25 ea for quantities from 1 to 24. Units are in stock.

Correction Notice

The metalized ceramic components described on p. 216 of the March 16, 1960 issue are made by Metallizing Industries Inc., of Hackensack, N.J.

NEW PRODUCTS

Silicon Transistors 644

Come in two types

These silicon transistors include the NS200, for switching applications in computer circuitry, and the NS300, for high-frequency amplification in video amplifiers, if strips, telemetering, and other applications. Leakage current for the NS200 is 3 μa at 150 C, and 5 μa for the NS300 at the same temperature. Guaranteed minimum gain-bandwidth product for both components is 200 mc. Beta fall-off from 1 to 100 ma is less than 35% of peak value.

National Semiconductor Corp., Dept. ED, Danbury, Conn.

Availability: *Quantities are available for immediate delivery.*

Digital-to-Analog Converter 700

Accuracy is 0.1%

Able to accept virtually any kind of digital data and provide an analog output plus control signals, model 42 digital-to-analog converter has a 0.1% conversion accuracy. It permits automatic operation of X-Y recorders and is compatible with IBM summary punches and card readers; it can also be driven by mechanical punched tape readers. The translater is supplied with a 10-key serial keyboard for manual input. The instrument accepts four digits and signs per axis and provides a front panel display of matrix contents.

F. L. Moseley Co., Dept. ED, 409 N. Fair Oaks Ave., Pasadena, Calif.

Tape Recorder 649

For facsimile communications

Intended for use at relay stations handling facsimile transmissions, model D-944 tape recorder can store a received signal simultaneously with its reception on a normal receiver. It can also be used to store picture signals. Tape speed is controlled by recording a 1000-cps standard frequency on the lower tape track at the same time as recording the facsimile signal on the upper tape track. On replay, the replayed 1000 cps signal is compared with the standard. Phase variations between them are used to control the tape speed.

Muirhead Instruments Inc., Dept. ED, 441 Lexington Ave., New York 17, N.Y.

Radar Beacon 437

Model SRT-3081 has a frequency range of 2750 to 2950 mc and can be used at altitudes to 60,000 ft. The receiver weighs 1.25 lb and measures 1-1/4 x 2-7/8 x 5-3/4 in. The transmitter weighs 3.45 lb and measures 2 x 3-5/8 x 7-9/16 in.

Telerad Manufacturing Corp., Dept. ED, 1440 Broadway, New York 18, N.Y.

Pressure Sensitive Adhesive 441

Type 17, covered with silicone-coated release paper, holds parts to components during assembly in blind spots or hard to reach areas. It can be used to back washers and other insulating pads. Thickness is 1/32 in. or more.

Spaulding Fibre Co., Ind., Dept. ED, 310 Wheeler St., Tonawanda, N.Y.

Availability: *The product is made on order.*

Pushbutton Switches 442

Type 9231 has specially recessed, knurled face nuts. It accommodates 6-, 12-, and 24-volt systems. Over-all dimensions are 2 x 1-1/8 in. and diameter of the mounting stem measures 3/4 in. Weight is 0.18 lb.

Cole-Herse Co., Dept. ED, 20 Old Colony Ave., Boston 27, Mass.

Availability: *from stock.*

Glass For Glass-To-Metal Seals 446

Available in 10,000 shapes and sizes, these glass beads meet the exact fabricating and operational temperatures of the finished seal. Color coding is offered.

Mansol Ceramics Co., Dept. ED, 140 Little St., Belleville, N.J.

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

Marking Enamel 447

For use on program boards and printed circuit boards, Uni-Glaxe enamels provide good adhesion and stability under stress. They can be cured without heat or baked at 250 to 325 F for 5 to 10 min.

Union Ink Co., Inc., Dept. ED, Ridgefield, N.J.

Price & Availability: *Delivery is from stock. Price is from $18.50 to $24 per gallon.*

Capacitor Standard 454

This absolute standard of low capacitance is made to a value of 10 μμf. The instrument avoids use of substitution methods of measurements with National Bureau of Standards calibrated sub-standards of lower impedance which may vary after the calibration date.

Wayne Kerr Corp., Dept. ED, 1633 Race St., Philadelphia 3, Pa.

Price & Availability: *Can be delivered 7 to 10 days after order received. Price is $850.*

NEW PRODUCTS

Logic Element 640

Is a multimode inverter-shifter

Type MM-2A logic element includes two independent inverter amplifiers, two independent polarity inverters, a set-reset flip-flop and a noninverting amplifier. It has an operating temperature range from −55 to +85 C, is epoxy encapsulated, and measures 1 x 0.8 x 0.5 in. All resistors and capacitors have ±10% tolerances; all units are capable of conservative operation over the frequency range of 0 to 200 kc. The unit weighs 10 g and uses a −12 v power supply.

Universal Data Systems, Inc., Dept. ED, Becker Electronics Manufacturing Corp., Valley Stream, Long Island, N.Y.

Rotary Switch 705

Has adjustable segment

This rotary switch can be externally adjusted to open or close at any point from 0 to 355 deg. Ambient temperature range is −50 to +150 C, voltage breakdown is at 1000 v ac, and life expectancy is 50,000,000 cycles. The unit is housed in anodized aluminum. Switches having a range of 0 to 180 deg can also be furnished.

Precision Line, Inc., Dept. ED, 63 Main St., Maynard, Mass.

Counter-Timer 647

Has nixie in-line readout

Model 1039 counter-timer is fully transistorized and provides nixie in-line readout. Its frequency measurement range is from 0 to 10 mc. Measurements of time intervals and periods from 0.3 μsec to 10^8 sec, frequency ratios to 10^7 and phase measurements direct to 0.1 deg, are also provided. Using plug-in printed circuit boards, the unit has a panel height of 5-1/4 in. Power consumption is 50 w.

Systron Corp., Dept. ED, 950 Galindo St., Concord, Calif.

Price & Availability: Delivery is 30 to 60 days. Price is $2900.

Semiconductor Desiccants 448

These molecular sieve desiccants offer good absorption qualities by having a large surface area for collection of moisture.

Mansol Ceramics Co., Dept ED, 140 Little St., Belleville, N.J.

Availability: Made on order, the product can be delivered 30 days after receipt of order.

Soldering Pencil 449

This device is equipped with a 1/4-in. tip, rated at 60 w, and weighing 2 oz. Designed for constant duty, it operates on ac or dc, any frequency.

Hexacon Electric Co., Dept. ED, 299 W. Clay Ave., Roselle Park, N.J.

Precision Bearings 450

Types available include separable type bearings for gyro spin axes, stable platform gimbals, gyro precision axes, and others with an OD from 0.3125 to 4.5 in.

Kearfott, Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Flat Multi-Conductor Cable 566

Plyo-Duct is suitable for light, compact, reliable harnessing of complex circuits. Advantages include complete conductor encapsulation, reduction of wiring errors, and flexibility.

Methode Manufacturing Corp., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

Availability: Delivery time is 21 to 30 days.

Laminated Heating Elements 452

Heetstrip, a dielectrically-heated glass cloth using a heat dissipating film to provide a uniformly heated surface, weighs less than 2 oz per sq ft. It is 0.025 in. thick.

Thermolab Corp., Dept. ED, 6940 Farmdale Ave., N. Hollywood, Calif.

Magnetic Tape Reels 453

These reels have wide-hub shoulders in die-cast aluminum. Larger mating surface with the tape deck hub makes for better alignment with the machine. Stabilized tapered flange reduces interference.

Tapac Corp., Dept. ED, 411 W. Maple Ave., Monrovia, Calif.

Socket Head Screws 657

The 1960 series socket-head cap screws have a head diameter 1-1/2 times the body diameter of the screws. This is said to increase bearing surface, while eliminating indentation of the surface on which the screw bears.

The Bristol Co., Dept. ED, Waterbury 20, Conn.

Availability: Available from stock.

NEW PRODUCTS

Swaging Machine 728

For printed wiring and conventional boards

Model TSM-11 swaging machine is used for both printed wiring and conventional type circuit boards. It is equipped with a transistorized electronic timer. Swaging time is adjustable at a control head of the machine, allowing the operator to set up the correct pressure duration. Semi-automatic in operation, the machine works with preloaded circuit boards. It requires 117 v, 60 cps, 15 w, and externally controlled, compressed air to 100 psi max.

Delbert Blinn Co., Dept. ED, 440 W. Monterey Ave., Pomona, Calif.

Price & Availability: *Delivery made in 30 to 45 days. Price is $545 with one set of tools, fob Pomona, Calif.*

Rheostat 701

Is rated at 5 w

This 5-w rheostat has a diameter of 0.5 in. and is smaller than a dime. The operating temperature is 340 C. The unit has a built-in safety factor and has excellent heat dissipating characteristics.

Hardwicke Hindle, Inc., 40 Hermon St., Newark 5, N.J.

High-Speed Printer 727

Operates at 600 lines a minute

Called the Univac compatible high-speed printer, this unit operates at 600 lines a minute. It consists of a tape reader, a control unit and a printer. It prints entire lines of data at once rather than individual words or letters; each of the lines may contain up to 130 characters, alphabetical or numerical. Any error detected by the system's internal checking circuits will cause the printer to stop.

Sperry Rand Corp., Remington Rand Div., Dept. ED, 315 Park Ave. S., New York 10, N.Y.

Price & Availability: *Deliveries will begin in several months. The printer will rent for $3500 a month, or it may be purchased at $195,000.*

Receiving Tube 656

Designated type 7687, this tube is a nine-pin triode pentode that combines a coil heater, a rigid mount structure and a cool operating cathode. It is designed for hi-fi systems.

Sylvania Electric Products Inc., Electronic Tube Div., Dept. ED, Seneca Falls, N.Y.

Scope Dollies 655

These scope dollies include four models: No. 32957, 17 x 23 in. with a 20 deg viewing angle; No. 32957D, with identical features but equipped with a single drawer and storage area; No. 61056, with adjustable brackets; and No. 41157, a tilt-top model which permits scope adjustment to 20 deg, front or rear.

PER Manufacturing Co., Dept. ED, 861 E. Luzerne St., Philadelphia 24, Pa.

Price: No. 32957, $62.95; No. 32957D, $67.50; No. 61056, $59.95; No. 41157, $76.75 with drawer, $72.50 without drawer.

Ceramic Microphone 654

Designed for communications service applications, model 715 SR ceramic microphone has an output level of −55 db and a response range of 60° to 10,000 cps. The case is made of diecast zinc.

Electro-Voice, Inc., Dept. ED, Buchanan, Mich.

Audio Amplifiers 653

These 8-w audio amplifiers, the 138 series, include a self-contained power supply, four interchangeable input panels, and output transformer taps for matching 4, 8, 16, 150, and 600 ohms. Units are furnished with receptacles and plug-in type connectors.

W. L. Maxson Corp., Langevin Div., Dept. ED, 475 Tenth Ave., New York 18, N.Y.

Graph Stamp 652

This rubber graph stamp gives a 3-in. square graph pattern. Design and development engineers may use it for plotting various curves from analytical data and mathematical formulas, drawing curves obtained from oscilloscope data and mathematical formulas, and others The graph pattern is 100 blocks per square inch.

Edmund Scientific Co., Dept. ED, Barrington, N.J.

Price & Availability: Available on direct order. Price is $3 postpaid, stamp pad not included.

Junction Block 651

This J type junction block has a terminal bar with six No. 6-32 screws, and can handle a maximum incoming current of 30 amp. It is rated at 300 v.

Curtis Development & Manufacturing Co., Dept. ED, 3250 N. 33rd St., Milwaukee 16, Wis.

Price & Availability: Made on order only. Can be delivered 5 to 10 days after order received. Prices range from $0.43 for a one terminal unit, to $4.83 for a 12 terminal unit.

NEW PRODUCTS

Analog Computer 645

Is a desk-top model

Designated the AD-1 electronic differential analyzer, this analog computer is a desk-top model. It is built on a modular system, facilitating the addition of more complex components to suit customer requirements. By expanding the basic desk-top model to a complex floor model, it is possible to add such components as a pre-programed, removable patchboard system, up to 64 amplifiers, electronic multipliers and diode function generators.

Bowmar Instrument Corp., Dept. ED, 8000 Bluffton Road, Fort Wayne, Ind.

Price: *The basic model is priced to sell as low as $2000.*

Insulating Material 721

For dry-type transformer coils

For use in dry-tape transformer coils, this insulating material is made of vegetable parchment paper. Called Patapar, the material is furnished in rolls 22 in. in diameter and 18 in. wide or in sheets 24 x 36 in. Thickness is from 1.25 to 5 mils. The average minimum dielectric strength is 321 v per mil.

Paterson Parchment Paper Co., Dept. ED, Bristol, Pa.

Command Receiver 725

For missile use

This command receiver can be used in missiles as a safety device. Equipped with four channels that accept four separate radio commands, the unit weighs only 3 lb. Combinations of commands can be executed without mechanical relays. The unit operates in multi-signal environments and is immune to other radio interference. It stands 100 g shock and acceleration, vibration levels of 10 to 2000 cps, and operates in the temperature range of −40 to +71 C.

Avco Corp., Crosley Div., Dept. ED, 1329 Arlington St., Cincinnati 25, Ohio.

Availability: *For military use only.*

Thermocouple Connection Head 715

For high temperature use

Called Mini-head, this industrial thermocouple connection-head is suitable for high temperature use and has a silicone paint coating for weather protection. Made of semi-steel, the device contains a high-temperature refractory terminal block

which fits 7-gage or smaller T/C wires and 12-gage or smaller extension wires. The device accommodates both conventional thermocouple wire-elements and metal-sheathed thermocouples in sizes of 1/16, 1/8, 3/16, and 1/4 in. It is pressure tight to 125 psi.

E. C. Smith Manufacturing Co., Inc., Dept. ED, Forrest & Hector St., Conshohocken, Pa.

Silicon Power Rectifier 726

Is rated at 30 amp avg at 25 C

Style 33 silicon power rectifier is rated at 30 amp avg at 25 C ambient temperature on a 5 x 5 x 1/16 in. copper heat sink. Peak inverse voltages range from 50 to 600 v, in 50 v steps. A typical forward dynamic resistance of 0.0035 ohm is achieved through conductivity modulation. The double-diffused diode is available with both standard and reverse polarity.

Syntron Co., Dept. ED, 283 Lexington Ave., Homer City, Pa.

Price & Availability: *Available from stock. Delivery made in 3 to 5 days for reasonable quantities. Price ranges from $54.60 each to $3.25 each, depending on quantity and PIV rating.*

Electric Furnaces 724

Have molybdenum-wound elements

Type M-Y furnaces with molybdenum-wound elements, can be used in a variety of non-oxidizing, reducing, or inert atmospheres. They are suitable for ceramic metallizing, special sintering, silicon depositing and diffusing, and for developing new heat treating techniques. The water-jacketed cooling sections have precise temperature regulators.

C. I. Hayes, Inc., Dept. ED, 896 Wellington Ave., Cranston 10, R.I.

Liquid Level Sensing System 716

Temperature range is −420 to +1100 F

This miniature, capacitance-type liquid level sensing system is for use on aircraft, missiles, and ground support equipment. Composed of a control unit and a capacitance sensor, the system weighs 5.5 oz. Sensors operate over a broad temperature range, from liquid hydrogen at −420 to +1100 F. Flange-mounted, bulkhead mounted, and in-line sensors can be furnished. Response time is 10 msec to 4 sec with an accuracy of ±0.05 in. Power consumption is 0.33 w on dc systems and 0.5 w on ac systems.

Minneapolis-Honeywell Regulator Co., Aeronautical Div., Dept. ED, 2600 Ridgeway Road, Minneapolis 15, Minn.

IMPULSE

A DIGEST OF NEW DEVELOPMENTS IN ELECTRONICS AND AUTOMATION

PUBLISHED BY ROME CABLE DIV. OF ALCOA, ROME, N. Y.
PIONEERS IN INSTRUMENTATION CABLE ENGINEERING

SAGE MOVE? If possible, the Government will give serious attention to the prospect of converting the SAGE System to air traffic control. Motive for such a move is the statement by the USSR that it will build no more bombers. If this be the case, a new use for SAGE will have to be found, or our huge investment will have to be scrapped.

BIG BOUNCE. The Navy recently demonstrated a new communications system using the moon as a relay for radio signals. With the moon serving as a passive reflector, photographs have been transmitted from Pearl Harbor to Washington, D. C. Signals are received about 2½ seconds after transmission. This new system can only be used between points which have the moon above the horizon at the same time.

VOLT GETS A JOLT. Amplifiers using voltage may be in for competition from a non-electric device referred to as a fluid amplifier. Essentially such a device is a block of hard material with passages for the flow of a fluid. Elements include a power jet input which corresponds to a tube cathode, output jets which correspond to plates, and control jets which correspond to control grids. Amplification of 10 to 100 has been accomplished with pure fluid amplifiers. Priced lower than tubes or transistors, these amplifiers have no moving parts and are virtually invulnerable to the effects of extreme heat or cold, humidity, and shock.

BIG VOICE FROM LITTLE PACKAGE. It looks like the United States' Pioneer V will be sending signals from 50 million miles away come August. The 26-inch payload is outstanding from an electronic standpoint in that it includes an ultra-long-distance communications system built around two miniature transmitters—one 5-watt, the other 150-watt capacity. The power supply consists of 4,400 solar cells and rechargeable nickel cadmium batteries. Parametric amplifiers are being used for the first time in the front part of two of the ground receivers.

CABLEMAN'S CORNER. The subject of cable testing is an important one. This is the phase of production that determines whether or not the cable you are purchasing is in accordance with your standards and requirements. In the field of electronics and automation, cables are required to suit various stringent electrical, mechanical, and/or chemical environments. Many years of study and testing have gone into the design of test equipment to be used for these critical tests. It is not enough to know that a cable has been tested in a manner that is "essentially" the same as the required standard. Slight variations in equipment design or methods of tests can mean the difference between conformance and non-conformance. Make sure the test data you receive gives a true picture of the performance of your cable. When you need cable, call on a cable specialist. Phone Rome 3000, or write: Rome Cable Division of Alcoa, Dept. 1150, Rome, New York.

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

CIRCLE 192 ON READER-SERVICE CARD

NEW PRODUCTS

Photocell 713

Spectral response is 0.3 to 3.5 microns

Type 61SV photoconductive cell has a spectral response range of 0.3 to 3.5 microns. Sensitivity with tungsten light is 3 ma per lumen at 2700 K with 200 v applied to the cell. Black body sensitivity at 200 C is 180 v rms per w, peak-to-peak and signal-to-noise ratio is 150:1. Minimum detectable power is 5 x 10^{-9} w. Increasing the black body source temperature from 200 to 500 C increases the sensitivity of the cell over 100 times. Maximum voltage to the cell can be 250 v and ambient temperature range is −10 to +50 C.

International Electronics Corp., Dept. ED, 8 Spring St., New York 12, N.Y.

Instrument Counters 723

Two types offered

Developed for use in military inertial guidance navigation systems, these two counters are suitable for any application requiring low torque, reliability, high speeds, and a minimum of space and weight. The three-digit counter, able to operate at 1500 rpm, has turned-aluminum wheels measuring 0.5 in. in diameter. The tandem counter, having a shutter which is actuated in either direction when a transfer point is reached, can be used as a straight six-wheel counter, has a maximum torque of 1-1/2 oz-in.

Veeder-Root, Inc., Dept. ED, Hartford 2, Conn.

Silicon Rectifiers 722

Forward-current rating is 750 ma dc

Made for use in both industrial equipment and consumer products, these diffused-junction silicon rectifiers have a maximum dc forward-current rating of 750 ma for resistive or inductive loads, and 500 ma for capacitive loads at temperatures to 75 C. Designated types 1N2858 through 1N2861, they have a range of piv ratings from 50 to 600 v.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Digital-to-Analog Converter 71

Weighs 30 g

Model DAC-94 digital-to-analog converter, a constant current generator, delivers 0.01 μa per pulse per sec when used with a supply of 12 v dc. Suited for computer applications and pulse-repetition rate monitoring in laboratory instruments, the unit is of modular construction and weigh

30 g. Over the temperature range of −20 to +140 F, linearity of the unit is ±2% for output voltages to 20 mv. Models delivering 0.1 μa can also be furnished.

Transformer-Electronics Co., Dept. ED, Industrial Park, Boulder, Colo.

Price & Availability: *$150; 30-day delivery time.*

Rotary Switches 718

Life is 40,000 operations

Made in accordance with MIL-S-21604, type JK rotary switch has an electrical life of 40,000 operations, make and break. The unit provides 16 positions, 15 on and 1 off, for 3, 5, and 10 ganged sections from 1 to 10. It has an interrupting rating of 5 amp at 125 v ac and unity power factor. Contacts are non-shorting. Screw terminals are provided. Designed for mounting behind a panel 1/4 in. thick, the switch has a body diameter of 2-27/32 to 6 in. Weight is from 19 to 44 oz.

Electro Switch Corp., Dept. ED, King Ave., Weymouth, Boston 88, Mass.

Insulation Fabrics and Tapes 720

Are polyester-treated

These polyester-treated fabrics and tapes are for use as intermediates in rolling insulating tubes and in forming or molding shapes or contours for electrical equipment. A wide variety of bases, including glass and synthetic fabrics, asbestos, and asbestos-glass mats, are employed. Grades TT-9451 and M-41524-BV have high moisture resistance and stable physical properties at high temperatures. Grade TT-9453 is for barrier tube rolling and general low-pressure banding applications. Grade M-41424-FA is for insulating field coils requiring class B performance.

Westinghouse Electric Corp., Micarta Div., Dept. ED, Trafford, Pa.

Damping Material 712

Reduces structural response to white noise

This damping material called Dyna-damp, reduces structural response to white noise. Designed to protect missile components from vibration, shock and noise, the material can also be used to reduce the resonant response of electronic equipment chassis and other secondary structures. Structural sections damped with this material have a resonant amplification of 3:1 to 5:1. Weight of a typical panel is 1.01 lb per sq ft, which is comparable to the weight of aluminum sheets. Panels can be punched, sheared, and formed by stretch forming techniques. Various structural shapes can be supplied.

Lord Manufacturing Co., Dept. ED, Erie, Pa.

NEW PRODUCTS

Insulation Material 7

Has low thermal conductivity to 2200 F

Resistotherm, a compact of fibrous potassium titanate, has low thermal conductivity at temperatures to 2200 F. It has an average bulk density of 16 lb per cu ft and a high refractive index. Shapes that can be supplied are: rectangular and curved pads and solids, both flat and arched; uniform rectangular pipe shapes; uniform circular pipe shapes; discs; and bowls.

Resisto Chemical, Inc., Dept. ED, P.O. Box 1945, Wilmington 99, Del.

Digital Readout 39

Depth is 1.5 in.

These digital readouts can be instantly snapped in and out of their mountings. Available in four-, five- and six-window models, these readouts are only 1.5 in. deep. Each window section consists of 12 transparent lucite panels. Applications include use in computer and telemetering consoles and racks, precision measuring instruments, airborne equipment, process control panels, automatic test installations, and monitoring remote operations.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.

Laminates 73

Come in three types

These three laminates are: a melamine resin impregnated glass cloth laminate for use where high humidity is a problem; graphite fabric and asbestos base laminates designed for short-time applications at 5000 F; and a new grade of XXXP material, copper clad for printed circuit use.

Continental-Diamond Fibre Corp., Dept. EL, Newark, Del.

Rotary Switches 71

Modular design

Designed for switching multiple circuits in TV broadcasting operations, series VSD modular rotary switches are remotely controlled and adaptable to various methods of control within TV

installations of all sizes. Switching is accomplished within a 1-in. radius resulting in low cross-talk and flat frequency response. Rotation to the extreme position is in 0.05 sec.

Telecontrol Corp., Dept. ED, 1418 W. 166th St., Gardena, Calif.

Silicon Rectifiers 729

11 types are rated to 800 v

Series MA silicon rectifiers includes 11 types with voltage ratings to 800 v. In half-wave circuits with proper heat sink, they are rated at 1.6 amp, in ambients up to 150 C. Up to 5.4 amp may be safely passed in full-wave circuits. Rectifier bases are gold-plated solid copper to provide optimum heat transfer together with minimum contact resistance. Units in the series are hermetically sealed and stud mounted.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.

Axial Flow Blower 396

Develops up to 25 in. water pressure

Up to 25 in. of water pressure can be developed with this axial flow blower, having a diameter of 4 in. The unit shown operates from a 28-v dc motor; other drives can be 12 v dc, and 110 v at 60 and at 400 cps. Large numbers of thin, highly curved blades are used. Good aerodynamic performance is insured by careful control of pressure gradients.

General Turbine Corp., Dept. ED, 1338 W. Ave., Buffalo 13, N.Y.

Pressure Transducer 730

Has ranges from 0 to 100 psia or psig

Potentiometer pressure transducer series TI-P-MH has pressure range up to 100 psia or psig, and a linearity of ±0.75%. It uses a wiper arm that achieves contact pressure by an electromagnet. The wiper arm is in contact with the mandrel only on demand. Friction is about 0.5%, depending on the magnetic hold down force. The unit weighs 15 oz and measures 2-1/4 in. in diameter x 1-3/4 in.

Physical Sciences Corp., Dept. ED, 389 N. Fair Oaks Ave., Pasadena, Calif.

Bench units take wings for rack mounting.

Getting Down to Cases

Flip-Tilt case serves portable instruments like this impedance bridge.

WHEN they get down to cases, many engineers have just about lost interest in a design. After they've designed the innards of a piece of equipment, and perhaps paid some small attention to the front panel, they cope with the case design pretty much as an afterthought.

This was obviously not the case with the cases of some of General Radio's newest instruments. These cases appear to have been designed with the loving attention that many designers devote only to circuitry.

Each instrument, according to the General Radio philosophy, deserves a case which helps it perform its intended function.

The Case for Large Instruments

Fairly large instruments are designed, basically, for relay-rack mounting. But they can be supplied with different hardware for bench mounting or for stacking in a quasi-relay-rack assembly. For bench use, end frames hold a relay-rack instrument in its cabinet and serve as carrying handles and supporting feet.

The Case for Smaller Instruments

Small and medium-sized instruments—those used most often on the bench—are housed in a cabinet with carrying handles, rubber feet, a removable dust cover, and extendible legs which allow the instrument to be tilted.

Just as rack instruments can be mounted on the bench, the bench instruments can be mounted on the rack. Screws that hold the instrument sides to the panel can be used to secure panel extenders for relay-rack mounting.

The Case for Portable Instruments

Some instruments spend much of their lives in transit between a storage shelf and a lab bench. For these basically portable instruments General Radio has designed a unique Flip-Tilt case with many novel features.

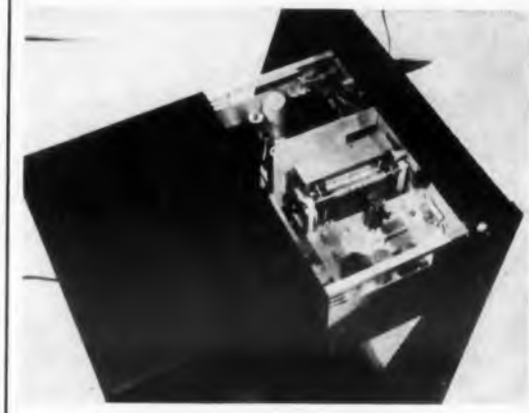
- It provides a self-contained enclosure for transport, including a convenient carrying handle.
- It provides accessory storage space in the cover which also serves as the base when the instrument is in use.
- It can be set up for use at any viewing angle.
- It can be adapted to relay-rack mounting.

The rubber gasket which seals the closed case provides friction to keep the instrument at any desired tilt angle.

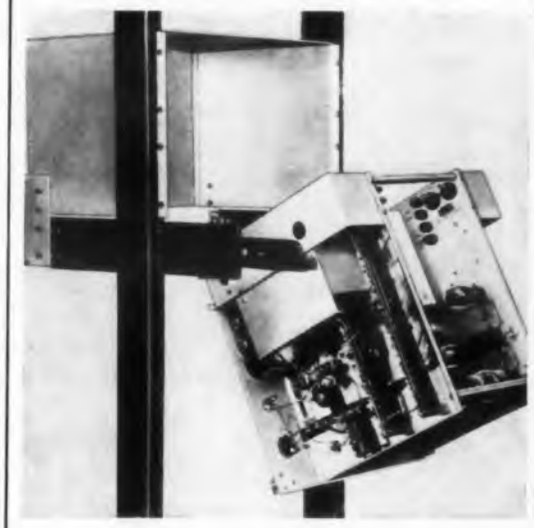
GR's standard rack-mounted instruments are accessible either from the front or rear. The cabinet can be left secured to the rack while the complete panel and chassis assembly is removed from the front. Or the panel and chassis can be

DESIGN DECISIONS

Some instruments are best approached from the rear. . . .



. . . . **others,** from the front. But many of the GR instruments can be serviced from front or rear.



left in the rack, with the panel screwed to the rack, while the cabinet is removed from the rear.

The Case for Color

Leaving no aspect of the designs to whim, GR laid particular stress on choice of color. A scale of grays represents GR's concept of color, not only for eye appeal, but as a servant of function.

Light-gray control knobs and white engraved panel markings stand out in contrast to the charcoal-gray panels.

Dials minimize eyestrain by use of black background with white markings. To avoid reflection, dials and meters behind windows reverse this, using black markings on a white background.

The cases are a medium gray, chosen to look cleaner longer. They steer a course between too

dark a gray (which shows dust easily) and too light a gray (which shows smudges).

The philosophy behind these newly designed instrument cases is well described by Henry C. Littlejohn in "The Case of the Well Designed Instrument," which appears in the March 1960 *General Radio Experimenter*.

Punched-Tape Reader Sees 80 Holes At Once

The high reading-speed inherent in punched tape combines with the large storage capacity of punched cards when 8-hole punched tape is read on a Tape-Ard Reader. This unique device reads 80 holes at a time.

Key to this unusual ability is a contact head which holds 80 bifurcated contact fingers. The head is pivoted to allow easy tape changes. In operation, it latches into accurate alignment with the tape.

The reader, a product of California Technical Industries of Belmont, Calif., takes standard 1-in. tape, with holes on 1/10-in. centers, and reads a frame of 10 rows of 8 holes each. The machine advances a frame of tape in 35 msec. It can read 6 frames per second for continuous operation and up to 15 frames per second for short periods.

Holes in punched card allow plungers in door to actuate sealed subminiature switches which program this diode function generator.

SERVICES FOR DESIGNERS

Custom Wiring Enclosures 260

The company offers complete design, engineering, and fabrication services for all types of custom wiring enclosures to meet unusual installation requirements. Made to order products include: control and instrument panels, switch-gear and switch-gear housings, cabinets and components, electronic chassis, and junction and cut-out boxes, among others. Items can be made from all types of materials and supplied with any type of protective finish desired.

The company also maintains tooling to produce openings such as rounds, rectangles, notches, clusters, etc., in any size or shape to customer specifications. For complete information, a four-page brochure, No. B-159-B, is available.

Keystone Manufacturing Co., Dept. ED, 23328 Sherwood Road, Warren, Mich.

Computer Rental 261

The General Electric Computer Dept. has announced a five-year lease plan for its miniaturized analog computer network analyzer. The instrument is a desk-top computer designed for use by consulting firms and government planning agencies, among others.

The computer carries a price tag of "just under $8600." Under the new plan, it may be leased through General Electric Credit Corp. Monthly rental will be approximately $180.

General Electric Co., Computer Dept., Dept. ED, Deer Valley Park, Phoenix, Ariz.

Component Data 262

Engineers interested in keeping abreast of the expansion in the fields of transistors, diodes and rectifiers, and microwave tubes, are now being offered a new information service in the form of a periodical tabulation.

Published twice yearly, *Characteristics Tabulations* is said to permit engineers to find out rapidly whether a particular component is available, and the manufacturer from whom it is available. Knowing only the circuit characteristics of a desired component, it is said to be possible to check according to characteristics and discover immediately what is available.

Subscription prices are $23.25 yearly for the diode and rectifier tabulation; both the transistor and microwave tube tabulations are $15.50 yearly. In addition to the two yearly issues, the transistor tabulation also includes twice-yearly supplements.

Derivation & Tabulation Associates, Inc., Dept. ED, 95 Harrison Ave., West Orange, N.J.

High-Frequency Cable Length Nomogram

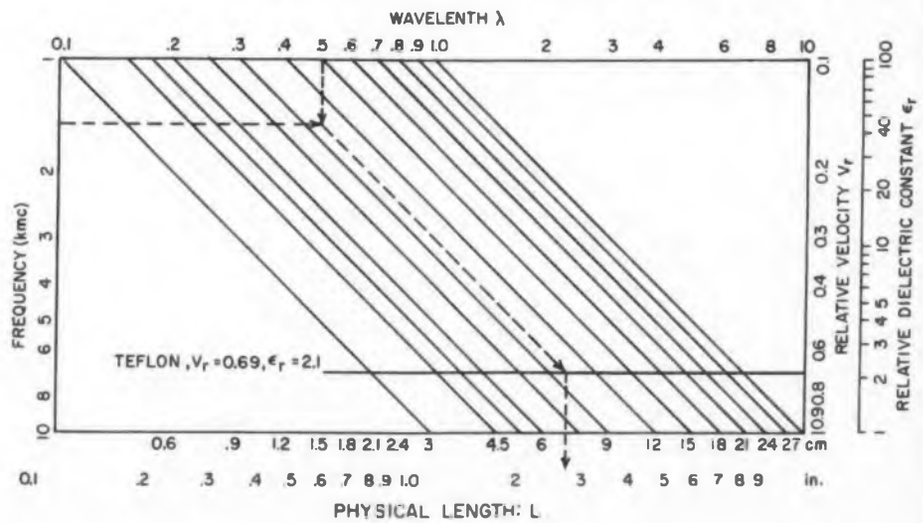
R. J. Plugge
The Martin Co.
Baltimore, Md.

LENGTHY calculations can be eliminated when converting electrical length lines to physical lengths values using the nomogram shown. Although the chart is inadequate for exact computations, the time-saving advantage should be of help when reasonable approximations are permissible.

Illustrative example: Determine the physical length of a 0.5 λ line using Teflon dielectric at 1.5 kmc.

Solution: Draw a horizontal line from 0.5 λ. At the intersection of this line with the vertical line representing 1.5 kmc, draw a plus 45 deg slope line. The intersection of the 45 deg slope line and the vertical line representing the relative dielectric constant of Teflon ($\epsilon_r = 2.1$) is projected horizontally to the physical length axis. The approximate physical length is found to be 6.9 cm or 2.72 in.

Note that the frequency range can be extended by multiplying (or dividing) the frequency scale by a multiple of 10, for example, and dividing (or multiplying) the physical scale by the same factor of 10. Thus, the spectrum can be covered with the single nomogram. ■ ■



NEW LITERATURE

Leak Detectors 263

Four-page bulletin No. 1857 contains tables of conversion factors, formulae, performance charts, hints, and other useful information for users of mass spectrometer-type leak detectors. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Stepping and Selector Switches 264

Six-page bulletin No. D-1059 supplies complete physical, performance and environmental data on Ledex hermetically-sealed stepping and selector switches. It also contains photographs and line drawings of all models. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio.

Ceramic Elements 265

This four-page bulletin describes high-temperature piezoelectric ceramic elements. The bulletin outlines the electrical and mechanical properties of these modified lead zirconium titanates. Universal Dynamics Corp., 130 Los Aguajes Ave., Santa Barbara, Calif.

Rockets

One-volume book No. ASA Y10.14-1959 gives symbols for terms and concepts frequently used in the design, manufacture and operation of rockets. Where more than one symbol is in common usage, the standard designates one as the preferred symbol, but includes others as alternates. Several hundred symbols are included. English letters are printed in italics for clarification. *Send $1.50 to American Standards Association, Dept. ED, 70 E. 45th St., New York 17, N.Y., or The American Society of Mechanical Engineers, Dept. ED, 29 W. 39th St., New York 18, N.Y.*

Round Drawn Cases 266

This four-page data sheet shows more than 200 standard sizes of round drawn cases made from aluminum, copper, steel, brass and mu metal. These cases are designed to house electronic components. The data sheet gives complete sizes and combinations available, and quantity price lists. Olympic Products Co., Inc., Alpha, N.J.

High-Temperature Transformers 267

Two-color, one-page, data sheet No. T 9-6 offers technical data on a range of small-size, high-tem-

perature transformers. The text describes the use of high-temperature wire providing a short thermal path. Also included are dimensional drawings, specifications and ordering information. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Portable and Hand Tachometers **268**

Two-page bulletin No. T-101-50 describes portable and hand tachometers. Eight standard ranges are listed. Special scales are also available. Photographs are included. The Electro-Mechano Co., 241 E. Erie St., Milwaukee, Wisc.

Miniature Connectors **269**

This six-page, two-color, abbreviated catalog describes the four basic series of the firm's miniature connectors. The catalog contains cut-away drawings, and detailed specifications, and a table showing the mating combinations of the interchangeable DM and DS series. The Deutsch Company, Municipal Airport, Banning, Calif.

Insulation Testing **270**

Simplified procedures and step-by-step diagrams for measurement of insulation resistance are incorporated in 32-page manual No. P-14556. This manual makes accurate insulation testing possible by non-technical personnel. Associated Research Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Heating Elements **271**

Catalog No. HB-3-359, 16 pages, describes a "wire mesh" heating element. It gives complete technical data as well as a visual description of the varied components. Charts, photographs, diagrams, and graphs are included. Electrofilm, Inc., 7116 Laurel Canyon Blvd., N. Hollywood, Calif.

Transformers **272**

Catalog No. TR-61, 36 pages, gives specifications and prices on the industrial transformer line and data on over 80 units for audio, pulse and transistor applications. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

Miniaturized Power Diodes **273**

Bulletin No. CDB-1 describes miniaturized power diodes. The brochure includes electrical and mechanical specifications, dimensional drawings, and performance curves. United Electronics Co., 42 Spring St., Newark 4, N.J.

NEW LITERATURE

Electronic Components 274

Forty-eight page catalog supplement shows high-fidelity, ham, records and tape, industrial and general type components. One section gives a wide selection of hi-fi and test equipment kits. Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass.

Transducers 275

Pressure instrumentation of the variable reluctance and dc-dc types is shown and described in this four-page brochure. Photographs and a chart on transducers are included. Ultradyne, Inc., 2630 San Mateo, N.E., Albuquerque, N.M.

Wire 276

This pocket brochure, four pages, illustrates and explains the applications of specially shaped round, flat, square and rectangular wire. Little Falls Alloys, Inc., 189 Caldwell Ave., Paterson, N.J.

Citizen Band Transceivers 277

This four-page brochure includes data on model TCV-273 transceiver. Photographs and specifications are included. Acton Laboratories, Inc., 533 Main St., Acton, Mass.

Potentiometers 278

This precision potentiometer selector chart, measuring 24 x 30 in. contains complete specifications including electrical, mechanical, mounting, special features, and environmental information on 37 standard models of single and multiturn precision potentiometers. The chart is suitable for wall mounting. Spectrol Electronics Corp., 1710 S. Del Mar Ave., San Gabriel, Calif.

Motors 279

Eight-page bulletin No. 198 describes and illustrates the features of the firm's Slo-Speed design, the basic types, and many modifications, as well as the universal mounting positions in which these units may be used. Sterling Electric Motors, 5401 Telegraph Road, Los Angeles 22, Calif.

Infrared Equipment 280

Four liquid nitrogen cooling systems for infrared detector devices are described in six-page folder No. F-1265. Included are illustrations of

the cooling systems, design features, performance data, and specifications. Linde Company, 30 E. 42nd St., New York 17, N.Y.

Electric Controls 281

Eight-page booklet No. P-75 describes standard, special, and custom controls used to actuate electric brakes and clutches. Included are sections on operation, dimension and selection. Warner Electric Brake & Clutch Co., Beloit, Wisc.

Modulators 282

This two-page bulletin gives specifications, applications, and response curves for six models of the Mag Mod miniaturized magnetic modulators. Photographs and a diagram are included. General Magnetics Inc., 135 Bloomfield Ave., Bloomfield, N.J.

Switches 283

Six-page bulletin No. D-1059, covering hermetically-sealed stepping and selector switches, supplies complete physical, performance, and environmental data. It also contains photographs and line drawings of all models. G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio.

Compounds 284

Six-page bulletin No. TIB 41-M1 describes the physical and electrical properties of the polycarbonate resin, Merlon, a thermoplastic for engineering applications. Charts and photographs are included. Mobay Chemical Co., 1815 Washington Road, Pittsburgh 34, Pa.

Transformers 285

This two-page, two-color data sheet describes a 120-w high temperature transformer that requires small, chassis-mounting space. The unit is 1-3/16 in. thick, and weighs 15 oz. Complete specifications, dimensional drawings, and ordering information are included. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Metal Materials 286

Two-page bulletin No. TRU-11 discusses the stacking of thermostat metal elements. Multiple element assemblies in series, in parallel and in parallel-series are also discussed. Rules for determining the thermal deflection, mechanical deflection, and force of each type of assembly, are given. Texas Instruments, Inc., 34 Forest St., Attleboro, Mass.

NEW LITERATURE

Springs **287**

The eight-page handbook, Spring Materials Digest, discusses the various spring properties of several groups of metal alloys. The catalog contains several comparison tables and charts. H. K. Porter Company, Inc., Riverside, N.J.

Metal Materials **288**

This four-page folder describes micromesh, expanded metal meshes of ductile materials for tube grids and shielding. A chart listing minimum and maximum dimensions of micromesh is included. Designers Metal Division, 650 Hoffman Street, Hammond, Ind.

Coaxial Connectors **289**

This eight-page brochure of microminiature, snap-locking coaxial connectors gives complete details including electrical, mechanical, and environmental specifications and outline drawings. Connectors for rack and panel installations, coaxial cable and accessories, and a price list are included. Electro-Physics Labs., 2065 Huntington Drive, San Marino, Calif.

Cap Screws **290**

Illustrated bulletin No. 769, six pages, describes the 1960 series socket head cap screws. Standards and dimension for cap screws with bristol multiple-spline and hex socket heads are given. The Bristol Company, Waterbury 20, Conn.

Solder **291**

This one-page bulletin describes some products used in the electronic field. A melting point chart for all soldering alloys is given. Information on high purity metals and microforms is included. Anchor Metal Co., Inc., 966 Meeker Ave., Brooklyn 22, N.Y.

Plug-In Modules **292**

Illustrated bulletin No. 59-B, four pages, describes series 2010 logic blocks, a complete and compatible set of transistorized, digital logic circuit plug-in cards. It covers the operating range, temperature range, and simple loading rules. Block diagrams, descriptions, specifications and suggested applications are shown for each of the eight plug-ins. Also included is a complete summary chart, outlining the plug-in types, their circuits, input required, output available and unit price. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Power Supplies 293

Designed for transistor-circuit applications, a series of transistorized power supplies is described in this two-page bulletin, No. PS1059. Information on transient response, ripple, stability, regulation, output impedance, controls, weight, packaging and price is provided. Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

High Purity Metals 294

Bulletin No. HP-100 describes ultra-high purity metals, including the three grades of indium ingot. Types A, B, and C cover a range of purity of 99.9+%, 99.99+% and 99.999+%. The bulletin lists various suggested applications. High Purity Metals, Inc., 340 Hudson St., Hackensack, N.J.

Shaded Pole Motors 295

Bulletin No. GED-3876, a four-page, illustrated brochure, gives electrical performance and dimensions of the unitized two-pole, 33-frame, shaded-pole motors. Two basic versions of the motors are described and applications for them in ratings of 1 through 20 mph are listed. A tentative selection guide is included. The bulletin contains charts indicating the relative sound level, sound frequency, wear-friction, and temperature effect on starting. General Electric Co., Schenectady 5, N.Y.

Magnetic Pickups 296

Four-page bulletin No. 2A, entitled "Excitation of Magnetic Pickups With Gears," describes factors to be considered in the excitation of magnetic pickups. Curves that show the change in magnetic pickup output are included. Electro Products Laboratories, Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.

Receiving and Picture Tubes 297

Form No. PINDEX-109 gives base diagrams for more than 2000 JEDEC-registered receiving tubes and picture tubes. The receiving-tube section gives triplicate presentation of base diagrams. All picture tubes are in a separate section. A third section has listings of (1) a group of receiving-type tubes, and (2) a group of foreign receiving tubes. Send $1.75 to Commercial Engineering, Electron Tube Div., RCA, Dept. ED, Harrison, N.J.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN.

NEW LITERATURE

Recording and Monitoring Systems 298

This illustrated bulletin describes and gives specifications of the MS-15A magnetic recording and monitoring system. The system is equipped with 24 broad-band, linear phase-shift seismic amplifier-fm modulator combination channels. Southwestern Industrial Electronics Co., 10201 Westheimer Road, Box 22187, Houston 27, Texas.

Precision Instrument Switches 299

This illustrated catalog, 28 pages, describes precision instrument switches. It contains terminal board reference charts, mechanical dimensions, engineering data, and product descriptions. Aerovox Corp., Cinema Engineering Div., 1100 Chestnut St., Burbank, Calif.

Switches 300

This two-page catalog sheet contains illustrations, dimensional drawings, and technical details of series TSD modular digital switches. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 15, Ill.

Rotary Switches 301

Four-page catalog No. 399, covering the firm's stock line of low-power rotary switches, lists 124 types and sizes of switches, both shorting and non-shorting. Prices and specifications are included. Oak Manufacturing Co., 1260 N. Clybourn Ave., Chicago 10, Ill.

Computing System 302

Sig-page brochure No. S-483 describes the components of the firm's type RPC-4000 fully-transistorized, electronic, stored program, general purpose computing system and applications. Photographs and illustrations are included. Royal McBee Corp., Data Processing Div., Port Chester, N.Y.

Converters 303

Four-page bulletin No. GEA-7060 describes oil-filled silicon rectifier conversion units for high-voltage power supplies. Illustrated brochure gives information on products, applications, cost savings, and reduced maintenance. It includes photographs, line and dimensional drawings, cost savings chart, ratings, and price tables. General Electric Co., Schenectady 5, N.Y.

Printed Circuit Grid Boards 304

Two-page data sheet No. CE-3.01 describes Fotoceram printed-circuit grid boards. Processing instructions and sizes are included. Corning Glass Works, Bradford, Pa.

Audio Circuits 305

This 33-page booklet contains comprehensive audio design information and a collection of amplifier circuits for design engineers. It contains treatments of overall requirements of monophonic and stereophonic systems. It includes 14 pages of schematics of monophonic and stereophonic preamplifiers and amplifiers. A tabular listing of audio tubes is included. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, Long Island, N.Y.

Precision Instrument Bearings 306

Four-page data sheet No. 60-01 is an illustrated guide for the selection of Microspin miniature precision instrument bearings. It includes available styles and sizes, specifications, applications, and installation procedures. Northfield Precision Instrument Corp., 4400 Austin Blvd., Island Park, L.I., N.Y.

Liquid Level Controls 307

This four-page brochure explains the principle of operation of liquid level controls. Details of both 2 and 3-pole controls and enclosures, information on multiple pump controls and special control panels, and a run-down of electrode fittings and electrodes are included. It also has illustrations, diagrams, and charts. Charles F. Warrick Co., 1964 W. Eleven Mile Road, Berkeley, Mich.

Precision Meters 308

Twenty-page catalog No. 5M1-60 has an all-inclusive meter master chart. It lists and displays current, voltage and high resistance meters; selective-expansion meters; and differential meters. Photographs and diagrams are included. Greibach Instruments Corp., 319 North Ave., New Rochelle, N.Y.

Semiconductors 309

This 24-page handbook lists semiconductors of 9 manufacturers in sequences by parameter and function, and by transistor and diode type number. A section of dimensioned mounting diagrams is included. Radio Shack Corp., I & G Div., Boston 17, Mass.

NEW LITERATURE

Radar Beacons 310

Four-page data sheet No. TDS-201 shows the development of radar beacons. Photographs and a diagram of the major elements of a beacon are included. Motorola Inc., Military Electronics Div., 8201 E. McDowell Road, Scottsdale, Ariz.

Fhp Motors 311

Illustrated bulletin No. GEC-1539, two pages, lists ratings and frame sizes for the open and totally-closed fhp, dc motors. It also describes applications in ratings of 1/20 to 1 hp at 3450 to 860 rpm. Features and dimensions of the motors, diagrams, and photographs are also included. General Electric Co., Schenectady 5, N.Y.

Flexible Couplings 312

This four-page brochure illustrates a flexible coupling design. It gives dimensions and weights, plus torque and flex data. Graphs of torsional and lateral deflection are included. Naugler Engineering, Inc., 19 Madison Ave., Beverly, Mass.

Electron Tubes 313

Four-page bulletin No. ICE-197 charts approximately 450 foreign tube types used in entertainment equipment. Where available, direct or similar tube types for replacement are listed. Radio Corporation of America, Commercial Engineering, Electron Tube Div., Harrison, N.J.

Converter Systems 314

Four-page data and application bulletin No. 125902 describes the firm's high-speed data link converter system. The system can be applied to standard telephone or microwave link transmission media. Diagrams on installation and timing are included. Epsco Incorporated, 275 Massachusetts Ave., Cambridge 39, Mass.

Fasteners 315

"Screw Fastening of Aluminum," a 48-page handbook, covers the various types of standard and special fasteners and fastening systems used to join aluminum assemblies. It contains 38 illustrations, 12 tables and recommended hole sizes for various types of self-tapping screws. Reynolds Metals Co., PRD-32, Richmond 18, Va.

Pressure Transducer 316

Type 4-327 pressure transducer for measuring gage and absolute pressures to 5000 psi is described in this two-page bulletin, No. 1626. An outline drawing and circuit diagram are included. Consolidated Electrodynamics Corp., Transducer Div., 360 Sierra Madre Villa, Pasadena, Calif.

Stampings 317

This seven-page booklet describes custom stampings, including those used in transistor assemblies. The illustrated booklet also contains descriptions of close tolerance stampings. August W. Holmberg & Co., Inc., 133-31 39th Ave., Flushing 54, N.Y.

Test Instruments 318

Key specifications and photos of instruments for nuclear research and process control appear in catalog No. D-100, six pages. Among the instruments described are: a current integrator, photometer, linear amplifier, decimal scaler, and time analyzer. Eldorado Electronics, 2821 Tenth St., Berkeley 10, Calif.

Diffusion Furnace 319

Bulletin No. 1081 describes and illustrates a line of gaseous and solid diffusion furnaces for the manufacture of transistors and semiconductor devices. Included is a chart of the single-zone, two-zone, and multizone types as well as application data. Lindberg Engineering Co., Pilot Plant Equipment Div., 2444 W. Hubbard St., Chicago 12, Ill.

Electric Motors 320

Geared and nongeared electric motors from 1/2000 to 25 hp are listed in this catalog, 28 pages. In addition, thyratron controllers, silicon and selenium rectifiers, and control units are described. The illustrated catalog is designated No. 108-60. B&B Electric Motor Co., 206 Lafayette St., New York, N.Y.

Power Supplies 321

Tabular specification data on more than 400 separate power supply models appear in this 32-page handbook and catalog. Included is technical data on regulated dc supplies, frequency changers, high voltage supplies, transistorized inverters and converters, and ac line-voltage regulators. The illustrated catalog also contains dimension drawings. Sorensen & Co., Richards Ave., S. Norwalk, Conn.

NEW LITERATURE

Variable Resistors 322

This two-page data sheet contains dimensional drawings, resistance range, wattage and temperature rating, voltage rating, tapers and taps available, rotation angle, specifications and optional switches, shaft dimensions and mounting styles for types 200 and QS200 5/8-in. diam variable resistors. Chicago Telephone Supply Corp., 1142 W. Beardsley Ave., Elkhart, Ind.

Microwave Reflector 323

Technical bulletin No. 6-2-5 describes a bistatic microwave reflector, model 2BS-212. Included is a chart showing radar cross section in square meters and bistatic angle. The device will reflect microwave energy into a conical volume of space about the direction from which the incident energy impinges. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

Components Catalogs 324

This 32-page catalog of electronic components has been broken down into 7 parts: catalog J-101 covers industrial and military jacks; J-102 covers telephone jacks; C-501 covers microphone, phono and rf connectors; P-201 covers the complete line of plugs; S-302 covers lever-type switches; No. 301 covers button-type switches; and No. 303 covers miscellaneous switches. Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

Control Chassis 325

The K-100 series control chassis are described in this two-page bulletin, No. 100-A. Block diagrams for two models in the series are included, in addition to a dimension drawing, general description and operation data. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Digital Logic Module 326

This four-page bulletin describes a solid-state switching circuit module for operation at input pulse repetition rates of 5 mc. Diagrams illustrate hook-ups with 4 and 8 inputs; tables give NOR and Sheffer stroke descriptions. American Bosch Arma Corp., Tele-Dynamics Div., 500 Parkside Ave., Philadelphia 31, Pa.

Servomotor 327

The size 18, velocity-damp servomotor is described in this four-page data bulletin. Included are photos of the model 18 VM 460, as well as

dimensional drawings, torque-speed curves, electrical and mechanical characteristics. Beckman Instruments Inc., Helipot Technical Information Service, 2500 Fullerton Road, Fullerton, Calif.

Random Signal Measurements 328

This four-page technical booklet is entitled "AC Voltmeters and Random Signal Measurements." It compares the relative merits of seven basic types of ac measuring devices, describes some of the properties of random signals and discusses their importance. In addition, bulletin No. 59 outlines design features to obtain accurate random signal power measurements. Flow Corp., 85 Mystic St., Arlington, Mass.

Power Supplies 329

Catalog No. B601, 24 pages, gives full descriptive data on active standard models in the transistorized, vacuum tube, magnetic and hybrid design groups of voltage regulated power supplies. The catalog is indexed by design groups and output voltage range. Kepco, Inc., 131-38 Sanford Ave., Flushing 55, N.Y.

Plastic Components 330

Chemelec Teflon, Nylon, Kel-F, Delrin and other plastic electronic components are described in illustrated bulletin No. AD-169, 24 pages. Mechanical and electrical design and environmental characteristics of the listed plastics are included. The bulletin also contains several engineering drawings on tracing paper. Garlock Packing Co., Garlock Electronic Products, 443 Main St., Palmyra, N.Y.

Ultrasonic Cleaning and Rust-Proofing 331

This brochure covers the line of products developed to meet the requirements of an integrated ultrasonic cleaning and rust-proofing system. Ultrasonic liquid cleaning concentrate 660-J is described and the factors involved in the selection of rust preventatives for use after cleaning are explained. Rust-Lick Inc., Dept. 6, 755 Boylston St., Boston 16, Mass.

Measurement Instruments 332

This short-form catalog, four pages, contains data on signal and sweep generators, frequency meters, Q meters, bridges, power meters, millimicrosecond pulse generators, wave analyzers, deviation meters, spectrum analyzers, oscilloscopes, and multichannel repeater test gear. Marconi Instruments, 111 Cedar Lane, Englewood, N.J.

NEW LITERATURE

Liquid Cooling Manual

This 170-page manual is entitled "Design Manual of Methods of Liquid Cooling Electronic Equipment." It contains descriptions of various thermal design techniques to assist electronic engineers in the design of shipboard and ground-based electronic equipment using liquid and forced air-to-liquid cooling. Section Headings include: Theory; Heat Exchangers; Pressure Losses and Their Determination; Design Considerations; and Design Examples. Designated NavShips 900, 145, the manual may be obtained by defense contractors through local Navy offices. Non-defense contractors write to the Government Printing Office, Washington 25, D.C. Price of the manual has not yet been set. *For more information, contact Cornell Aeronautical Laboratory, Inc., Dept. ED, Box 235, Buffalo 21, N.Y.*

Recording and Control Systems 333

This eight-page bulletin describes various digital recording and control systems made by the company. Also described are transistorized elements, encoders, and operational militarized equipment. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Using Epoxy Resins 334

Entitled "Specific Applications for Dolphon Epoxy Resins," this 16-page booklet outlines the successful application of various resins to specific types of equipment, such as stators, armatures, field coils, and transformers. The booklet describes both wet winding and vacuum impregnation. John C. Dolph Co., Monmouth Junction, N.J.

Test Chamber 335

This two-page bulletin describes the ValuMite low and high temperature test chamber. Data is included on the chamber, cooling assembly, heating assembly, thermal capacity, and performance data. International Radiant Corp., 577 E. 156th St., New York 55, N.Y.

Transistor Base Tabs 336

This technical data sheet, No. 107, describes the physical properties of partially coated metals used as base tabs for transistors. Specifications are also given for full coated metals. The dimensional range of base materials is included. Alpha Metals, Inc., 56 Water St., Jersey City 4, N.J.

Stunt Box Control Device 337

The Teletype 28 stunt box is described in this 20-page, four-color brochure. It is intended to provide users and potential users of Teletype model 28 equipment with data of how model 28 page printers and automatic send-receive sets can be used to maximum capabilities. The illustrated brochure describes functions and function mechanisms. Teletype Corp., Dept. SP-9, 4100 Fullerton Ave., Chicago 39, Ill.

Vacuum Gages 338

Heated thermopile vacuum gages are described in this six-page booklet. The illustrated booklet covers pressure ranges for single meter types, twin meter types, battery-operated types, and controllers. Chart and scale ranges of two types of recorders are included. The booklet also describes various accessories. Hastings-Raydist, Inc., Hampton, Va.

Printed Circuits 339

This four-page folder, No. 1159, discusses the use of printed circuits. The types of insulating materials and the current capacity in relation to width of copper conductive pattern are described. The booklet also lists the choice of metals available for the conductive pattern as well as the types of plating recommended to achieve desired results. Whitney Blake Co., Printed Circuit Div., New Haven 14, Conn.

Reference Folder 340

Prepared to be used either as a wall chart or as a desktop reference, this folder contains three tables of information: a temperature table showing conversion from Centigrade to Fahrenheit, or vice versa, from 0 to 3000 deg; a table of decimal equivalents of fractions in increments of 1/64 in., and a table giving the mechanical and electrical properties of high alumina and steatite ceramics. Centralab, Electronics Div. of Glove-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

Knobs and Handles 341

Specifications, dimension drawings and illustrations of 49 stock designs of molded plastic knobs and handles appear in this eight-page catalog. Groups include ball knobs, oval and tapered knobs, tapered handles, push-pull and lid knobs, knurled and fluted handwheels and knobs, thumb screws and terminal nuts, pointer and instrument knobs, and others. Dimco-Gray Co., 207 E. Sixth St., Dayton 2, Ohio.

NEW LITERATURE

Radar Data Transmission 343

Operation of a radar data transmission system designed to provide real time missile impact predictions is covered in this six-page bulletin. Included are a block diagram, complete specifications and principles of operation. Collins Radio Co., Western Div., 2700 W. Olive St., Burbank, Calif.

Chart Papers 344

This four-page booklet describes chart papers, writing styli and other suppliers for direct writing recording equipment. The booklet contains samples of chart papers used in thermal, electric and ink writing. Pens and styli for each model of recording are also illustrated. Clevite Corp., Brush Instruments Div., 37th and Perkins, Cleveland 14, Ohio.

Stainless Steel Chart 345

This revised data chart, Sec. A, No. 1, provides analyses specifications for 58 different types of stainless steel. It covers all 40 standard AISI grades, plus 18 others. Printed on card stock, the chart measures 8-1/2 x 11 in. Peter A. Frasse & Co., Inc., 17 Grand St., New York 13, N.Y.

Vibration and Noise Mounts 346

The Ballmount series of vibration mounts is described in this bulletin, two pages. Application notes, load ranges, and outline drawings are included in the illustrated bulletin. No. 59-04-6. Barry Controls Inc., 700 Pleasant St., Watertown 72, Mass.

Structural Adhesives

This 16-page, illustrated, file-tabbed catalog contains complete information on Scotch-Weld brand structural adhesives and structural adhesive design concepts. The catalog includes tables and line drawings dealing with types and properties of Scotch-Weld film, and proper design methods for structural adhesive bonding. Case histories illustrating how the adhesives are used to solve structural assembly problems are also included. *Write on company letterhead to Minnesota Mining and Manufacturing Co., Adhesives, Coatings, and Sealers Div., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.*

Pulse Generators 347

This two-page bulletin describes models 3450C/Y and 3450C/X pulse generators. The illustrated bulletin covers specifications including pulse delays and widths, repetition rates, and outputs. Electro-Pulse Inc., 11861 Teale St., Culver City, Calif.

Bobbins and Coil Forms 348

This 1960 catalog, 26 pages, lists stock nylon and fluorocarbon bobbins, nylon transformer bobbin for printed circuits, molded nylon switch tubing, and molded nylon switch blade lifters, among others. In addition to outline drawings, tables are included which cover available parts and sizes. American Molded Products Co., 2727 W. Chicago Ave., Chicago 22, Ill.

Relay Coils 349

This two-page bulletin details coil production with more ampere turns within a given volume, while holding resistance level. This case history illustrates and describes testing and inspection facilities for the coils. Tur-Bo Jet Products Co., 424 S. San Gabriel Blvd., San Gabriel, Calif.

Closed Circuit TV Equipment

This catalog, 112 pages, lists closed circuit TV equipment such as cameras, housings, lenses, monitors, switchers, microwave equipment and the company's television tape recorder. It is designed as an aid in planning TV systems. *Write on company letterhead to Radio Corp. of America, ITV—Dept. ED, Building 15-1, Camden 2, N.J.*

Instrument Gear Catalog 350

This instrument gear catalog lists gears, pinions and racks in a pitch range from 20 to 120. They are stocked in four grades, with a total composite tooth error of: 0.002, 0.0015, 0.001, and 0.005 and are available in five materials including stressproof steel, stainless steel, brass, aluminum, and machine steel. Franke Gear Works, Armac Gear Div., 4401 N. Ravenswood Ave., Chicago 40, Ill.

Magnetic Recording System 363

The MS-15A magnetic recording and monitoring system is described in this bulletin which includes complete specifications. The system is equipped with 24 broad-brand, linear phase-shift seismic amplifier-fm modulator combination channels. Dresser Industries, Inc., Southwestern Industrial Electronics Co., 10201 Westheimer Road, Box 22187, Houston 27, Tex.

Optical Components 364

This 14-page booklet describes the production of optical components including grinding, edging, and polishing. A glossary of terms most used in optics is also included in the illustrated booklet. Tiffen Optical Co., 71 Jane St., Roslyn Heights, L.I., N.Y.

NEW LITERATURE

Glass Molding Components 365

Properties of fifteen grades of phenolic and polyester glass molding compounds are outlined in this four-page technical bulletin, No. 64-060. Tables give data on hardness, tensile strength, heat resistance, dielectric strength, moisture resistance, and shear strength, among others. Applicable military specifications are also listed. Westinghouse Electric Corp., Micarta Div., Hampton, S.C.

Transducer 366

This four-page bulletin includes step-by-step drawings which illustrate how the Regohm transducer can change 1/10 in. of mechanical motion into stepless control of up to 1/4 kw of power. Specification sheet also available contains a procedure used to select a transducer for a specific application. Electric Regulator Corp., Pearl St., Norwalk, Conn.

Tapes and Adhesives 367

This manual provides comprehensive information on the physical characteristics and typical applications of a full line of industrial tapes, bulk adhesives, coatings, and other pressure-sensitive products. Products are cross-indexed by Armed Forces specification data, tape type, tape function and industrial application. Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39, Ill.

Ultrasonic Filter Element Cleaner 368

This 38-page technical report describes a hyperintense proximal scanning ultrasonic system which uses cavitation to clean filter elements and other equipment. Sections include data on components, operation, installation, input requirements and cleaning limitations. Aircraft Porous Media, Inc., 30 Sea Cliff Ave., Glen Cove, N.Y.

Proximity Meter 369

Booklet No. TM-951-2 contains a complete description, circuit and dimensional information, and numerous application specifics including layout and configuration details of a capacitance operated proximity meter. The 28-page manual also contains performance and adjustment figures with sufficient data to permit modification to or application for purposes that require measurement of physical displacement, dielectric constant or cyclic motion. Robertshaw-Fulton Controls Co., Aeronautical and Instrument Div., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

Process Control **370**

Instruments for process control, laboratory analysis and research are described in this 16-page catalog. Described in bulletin No. 1313 are techniques and instruments for leak detection, mass spectrometry, chromatography, moisture monitoring, and other types of analysis and control. Consolidated Electrodynamics Corp., Analytical and Control Div., 360 Sierra Madre Villa, Pasadena, Calif.

Semiconductors and Components **371**

This 14-page catalog contains a listing of silicon transistors, germanium transistors, silicon diodes and rectifiers, carbon film resistors, tantalum capacitors, silicon resistors, and sensors and materials. Also described is the SOLID CIRCUIT semiconductor network concept. Texas Instruments Inc., Semiconductor-Components Div., 13500 N. Central Expressway, Box 312, Dallas, Texas.

Plastic Stock Shapes **372**

This 12-page booklet covers the complete warehouse availabilities of Polypenco industrial plastics. The booklet contains property and application data on mill shapes of nylons, TFE fluorocarbons, polycarbonates, chlorinated polyethers and cross-linked polystyrene available from 50 stock locations in the U.S. Information on Fluorosint, a new TFE base resin, is included in the illustrated booklet. Polymer Corp. of Pennsylvania, Reading, Pa.

AC Magnetic Starters **373**

Engineering data on type CY ac magnetic starters, available in a full range of sizes from size 0 through 4, are included in this eight-page illustrated bulletin. An arc quenching principle is fully described and diagrammed. The Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.

Nylon Bobbins and Washers **374**

Complete specifications on the maximum and minimum flange and core sizes, core lengths and wall thicknesses for nylon bobbins and thrust washers appear in this four-page brochure. Cosmo Plastics Co., 3239 W. 14th St., Cleveland 9, Ohio.

Don't forget to mail your renewal form to continue receiving ELECTRONIC DESIGN

NEW LITERATURE

Motors **375**

Bulletin No. MU-245 lists motors, 1/6 through 10 hp, available with resilient mountings. The illustrated, four-page bulletin covers the mounting construction and various "whys" and "wherefores" of quiet motor operation. Horsepower ratings available at 1800 rpm are given in table form. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 33, Mo.

Self-Locking Captive Nuts **376**

Illustrations, a specifying chart, and tabulated data on thread size, insertion force and material thickness of self-locking captive nuts appear in this one-page bulletin, No. 58-2SL. National Radio Co., Inc., 37 Washington St., Melrose 76, Mass.

Temperature Potentiometer **377**

This two-page data sheet describes the 8692 single-range and the 8693 double-range portable temperature potentiometers and their advantages for making temperature or millivolt measurements in plants or research laboratories. A range-change method is described and all 24 interchangeable ranges are tabulated. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Test Equipment **378**

This short form catalog lists and describes the following instruments: an automatic hi-pot tester; frequency standard; phase shifter; null detector; phase meter; null meter; impedance comparators, and power oscillators. Industrial Test Equipment Co., 55 E. 11th St., New York 3, N.Y.

Current Pulse Generator **379**

Bulletin No. 59-G, two pages, describes the model 1051 millimicrosecond current pulse generator. The illustrated bulletin includes data on the rise time, illustrates the typical pulses available, and lists complete specifications. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Flame Spray Process **380**

This 16-page bulletin covers the metallizing process that sprays powdered metals, including tungsten carbide and self-fluxing alloys of the boron-silicone, nickel, chromium type and refractory ceramics. A plasma spray process that develops temperatures up to 30,000 F and can spray any material that can be melted without decomposition is also described in the illustrated bulletin. Tables and charts on characteristics of coatings are included. Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, L.I., N.Y.

Electronic Voltmeters 385

Panel-mounting electronic voltmeters designed for continuous monitoring of critical parameters in systems and consoles are described in a folder of data sheets. Single and multiple range units, both commercial and military, are described. Metronix, Inc., Chesterland, Ohio.

Relay Catalog 386

This 24-page catalog covers the complete line of subminiature and microminiature hermetically sealed relays. Designated as catalog No. 4, it contains data on mounting styles, available terminal types, sockets, ordering data, and dry circuit information. Outline drawings are included. Filtors Inc., Port Washington, New York.

Digital Instrumentation 381

Digital instrumentation is described in bulletin No. 100-D, a six-page flyer giving brief specifications and features of dc voltmeters, control units, preamplifiers, ac converters, ohmmeters, ratiometers, scanning systems, printer control units, chronometer and a talking meter. Cubic Corp., 5575 Kearny Villa Road, San Diego 11, Calif.

Voltage Reference Source 382

Model VR-607 voltage reference source is described in this six-page brochure. Operating and physical characteristics are given for four units in the line. Wiring diagrams show hookups for applications such as voltage comparator, attenuator for dc or ac signals, calibration of fm discriminators, and voltage reference for analog computers. Epsco, Inc., Equipment Div., 275 Massachusetts Ave., Cambridge, Mass.

Molded Rods 383

Ten grades of Micarta thermosetting-laminate molded rods are described in this technical data bulletin No. 63-360, two pages. Data includes grade selection, standard lengths, finishes, and tolerances. Westinghouse Electric Corp., Micarta Div., Hampton Plant, Hampton, S.C.

Digital Voltmeter 384

The V64 digital voltmeter is described in this four-page bulletin. No. 64-1. The booklet compares the full four-digit V64 with pointer meters and three-digit voltmeters in usefulness and price. Other sections of the booklet cover the instrument's use with accessories for ac and low-level dc measurements, applications and specifications. Non-Linear Systems, Inc., Del Mar, Calif.

NEW LITERATURE

Time Delay Relays 387

Bulletin No. 359, four pages, illustrates and describes the Economy series of time delay relays. Data on the solid state units include applications, calibration, fabrication, terminals and mounting styles. A specification guide gives contact ratings, time setting, time delay in seconds and timing accuracy. Marstan Electronics Corp., 204 Babylon Turnpike, Roosevelt, Long Island, N.Y.

Germanium Transistors 388

This four-page catalog covers 412 germanium transistor types that are either in stock or in production by the company. The catalog lists transistors for applications in computers, aircraft, missiles, military, marine, entertainment and general industry. All are manufactured to registered EIA specifications. Electronic Transistors Corp., 9226 Hudson Blvd., N. Bergen, N.J.

Photoelectric Scanner 389

Type SA-1R photoelectric scanner that contains both the light source and the pick up head in one housing is completely described in bulletin No. 260, one page. Details include photographs, dimensions, size and mounting specifications, delivery time and list price. Farmer Electric Products Co., Inc., 2300 Washington St., Newton Lower Falls, Mass.

Traveling-Wave Tubes

This 54-page booklet describes the theory of operation, design features and performance characteristics of periodically focused traveling-wave tubes. Data is included on wide-band microwave amplifier tubes, a traveling-wave tube with periodic permanent magnets, integral-package traveling-wave tubes, and electrostatic periodic focusing. The illustrated booklet gives noise, amplification and frequency and phase characteristics in table and chart form. *Send $0.50 to Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.*

High Temperature Magnet Wire 391

This seven-page technical paper, No. 60-1, is an abstract of one originally presented at the National Conference on the Application of Electrical Insulation. High temperature magnet wire is discussed and described. Data includes typical electrical and physical characteristics of Ceroc wire and insulation resistance of Ceroc ceramic coatings. Sprague Electric Co., N. Adams, Mass.

Protective Coatings 392

Insulating and protective coatings are described in this one-page data sheet, No. C30. It includes a chart that compares conventional coating with HumiSeal types 1B12, 1A27 and 1A14 coatings. Columbia Technical Corp., 61-02 31st Ave., Woodside, N.Y.

Data Processing Programing 393

A new technique for automatically preparing electronic data processing programs is discussed in this 94-page manual. Known as FACT (Fully Automatic Compiling Technique), the system is intended for use with the company's 800 data processing system. FACT is said to eliminate endless manual program coding by enabling the computer to translate simple statements in English into its own detailed machine instructions. Minneapolis-Honeywell, Datamatic Div., Wellesley Hills 81, Mass.

Digital Computer 394

The completely transistorized digital computer, model 2003, is described in this booklet, four pages. The illustrated booklet covers speed, input-output facilities, memory capacity, instruction system and physical characteristics. Other characteristics include automatic program monitoring and control, buffers and random access, indexing, and block transfers. General Mills, Inc., Mechanical Div., 1620 Central Ave., Minneapolis 13, Minn.

Relay Catalog 409

This 24-page relay catalog contains illustrations, specifications and dimensional drawings of the complete line of telephone type relays; medium size, small, miniature and subminiature. Also illustrated are a variety of hermetically sealed telephone type relays and microminiature crystal can relays to current MIL specifications. Other types of relays covered include plug-in types, power, snap action, and time delay types. Magnecraft Electric Co., 3350D W. Grand Ave., Chicago 51, Ill.

Cable 419

Various types of custom cable are illustrated in these three data sheets, one page each. Shown are: conductor cable assembly used by Air Force technicians in checking out electronic flight stabilization units; helicopter navigational system checkout harness, and cable, wiring harness and terminal board assembly used in the Atlas ground pressurization equipment. Robertshaw-Fulton Controls Co., Aeronautical and Instrument Div., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

NEW LITERATURE

Drafting Method 420

Actual experience of engineering firms who have been using the Mylar-Duralar drafting method over the past few years is described in this report. It includes demonstrations of the correct technique for drafting with duralar pencils and Mylar film, and also describes the wash and print system. J. S. Staedtler, Inc., Hackensack, N.J.

Instrument Gears 422

This handbook provides precalculated gear data and dimensions in table form. Included are instrument gear data tables of 64, 72, 80, 96, 120, 160, 180, and 200 diametral pitches for 20-degree pressure angle spur gears. Extra-fine pitch sizes were included to permit handbook use when designing for miniaturization. "Instrument Gear Data Tables" also contains data for one diametrical pitch from 10 to 400 teeth. The data conforms to AGMA 236.03. Engineering Data Supply, Box 45413, Los Angeles 45, Calif.

Precision Instrument Components

The "Precision Instrument Components Standard" book is available at no charge only to engineers who are department heads. The material is produced on reproductible tracing paper, 8-1/2 in. x 11 in. for modification drawings, inspection, standards, records, and purchasing. It has over 400 loose-leaf pages and is available in a leather bound ring binder. *Write on company letterhead to PIC Design Corp., Dept. ED, 477 Atlantic Ave., E. Rockaway, L.I., N.Y.*

Wire-Shielding Nomogram 426

This 4-page technical paper on wire-shielding values includes a nomogram to quickly find shielding parameters such as percent coverage and wires per carrier. Shielding materials, angle of braid, and production considerations are also briefly discussed. Revere Corp. of America, Subsidiary of Neptune Meter Co., Wallingford, Conn.

Printed Circuit Board Holder 479

The Little Joe No. 160 printed circuit board holder is described and illustrated in this catalog sheet. Various adjustable working positions such as horizontal, vertical, and angular, are shown. In addition to holding printed circuit boards up to 8-1/2 in. in width, the holder can be used for holding rectangular plugs. Macdonald & Co., Dept. L-1, 1324 Ethel St., Glendale 7, Calif.

Plug-In Modules 480

Bulletin 59-B describes series 2010 logic blocks, a complete and compatible set of transistorized, digital logic circuit plug-in cards for rapid, low cost "building block" design and construction of special purpose digital computers and processing equipment. The four-page illustrated bulletin includes block diagrams, descriptions, specifications, and suggested applications shown for each of the eight plug-ins. Also included is a complete summary chart, outlining the plug-in types, their circuits, input required, output available and unit price. Rese Engineering, Inc., 731 Arch St., Philadelphia 6, Pa.

Miniature Accelerometers 481

Series 200 true compression accelerometers, for use where size and weight are critical factors, is described in this bulletin. Included are data and illustrations on the crystal accelerometers. The bulletin lists complete electrical and physical specifications for models 200 and 201. Shock response and frequency response are both graphically illustrated. Columbia Research Laboratories, MacDade Blvd. and Bullens Lane, Woodlyn, Pa.

Delay Lines 482

Data sheet M-1001 gives information on the theory of operation of fixed and variable magnetostrictive delay lines. This data sheet is of special interest to those who are concerned with analog and digital computers, radar systems, aerial navigation systems, missile systems, coding devices, and range market generators. Listed are the range of design characteristics available for these delay lines. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, N.Y.

NEW LITERATURE

Memory Testers 483

The DEC memory tester type 1512 is described in this four-page, two-color folder. For testing coincident current core memories under simulated computer conditions, the 1512 will test planes up to 64 x 64 with several patterns of information in a single operation. Digital Equipment Corp., Maynard, Mass.

Relays 484

Micro-Scan relays designed for dc, asynchronous and synchronous switching of low microvolt level to moderate level signal circuits are described and illustrated in this two-page bulletin. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Electric Tachometers 485

Nine tachometer indicators and six electric generators are described in this four-page catalog. Information covering the use of this type of equipment in connection with variable speed applications is also included. A fan style, long scale, switchboard type indicator is introduced in this literature. Madison Electric Products, Inc., Madison, Ohio.

Environmental Test Equipment 486

Environmental test equipment that duplicates global climatic conditions, large and small test cabinets, baths, ovens, and steam humidity chambers are among the units described in this 41-page catalog, No. 560. It includes illustrations, descriptions, applications, and a temperature conversion chart from C to F, or F to C. American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.

Servo Amplifiers 488

Two specification sheets enumerate all applicable specifications for transistorized

servo amplifiers. These amplifiers come in power outputs of 3.5, 6 and 12 w and were designed specifically for high-temperature applications. The specification sheets also show diagrams for wiring, mounting and unit outline. Bulova Research & Development Laboratories, Inc., Woodside, N.Y.

Laminates 502

This four-page bulletin discusses some of the thousands of applications and uses for fabricated parts punched, machined, ground, drilled or turned from insurok sheet, tubes, and rods. The bulletin's contents will prove particularly interesting and beneficial to purchasing agents, design engineers, etc. working in the mechanical, chemical or electrical fields. The Richardson Co., 2753 Lake St., Melrose Park, Ill.

Solenoids and Selectors 503

An application guide to rotary solenoids, selectors, and stepping motors comprises this eight-page bulletin (No. A-1259). It is illustrated with line drawings, charts, photographs, and circuit diagrams. It also contains specific physical, performance, and enviromental data on more than 250 different models. It supplies information on how to use this data to select the proper rotary solenoid, selector or stepping motor for any application. Only half the size of ordinary units, the ledex rotary solenoid is capable of developing twice as much power as these ordinary solenoids. The stepping and selector switches require only 1/5 the space formerly taken up by ordinary relays. G.H. Leland, Inc., 123 Webster St., Dayton, Ohio.

Reliability Program 504

Designed to familiarize component, reliability, and quality control personnel with the firm's reliability assurance program, this eight-page brochure illustrates the operations involved in the manufacture and inspection of the firm's products. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

NEW LITERATURE

Transistor Choppers 507

A complete line of transistor choppers is described in bulletin No. C-61, two pages. Typical transistor chopper applications are illustrated, including their use as modulator demodulators and full-wave series, shunt and series-shunt modulators. Electrical characteristics, temperature and frequency ranges are detailed. Null outputs, phase angles, dwell times, noise levels and signal and drive voltages are also discussed. Airpax Electronics Inc., Cambridge Div., Cambridge, Md.

Air and Gas Switches 508

Four technical data sheets describe and illustrate two absolute air pressure switches and two gas density switches. These switches are employed as control and warning devices to monitor pressures or densities of gas or vapors either in sealed containers or in open systems. Leakage from electronic equipment packages is an example. Typical application, dimension drawings, specifications, and characteristics are included for each switch. Newark Controls Co., Sales Dept., 15 Ward St., Bloomfield, N.J.

Pen Recorders 511

Bulletin No. GEZ-2969, four pages, describes a line of round chart single and double pen recorders. Applications, measurable parameters, and specifications appear in addition to dimension drawings and a list of available charts and scales. General Electric Co., Schenectady 5, N.Y.

Transformers 512

This brochure describes miniature, epoxy molded transformers for use with transistors in printed circuits. It contains engineering data, electrical specifications, and mechanical dimensions. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.

DC Power Supplies 513

Complete specification data for every dc power supply in the firm's standard line are contained in this 16-page catalog. Among the 75 units described are included: modular and laboratory vacuum tube regulated supplies; modular transistorized regulated supplies; modular magamp regulated supplies, and unregulated supplies. Rack mounting kits for modular supplies are also described. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Electrical Papers 514

In the form of a file folder, this bulletin contains product information on many different categories of electrical papers including insulating, conductive, impregnated, and synthetic fiber papers. Some of the special end uses covered in the bulletin are core material, layer and turn insulation, laminating base, cable wrapping, and electro-graphic copy. The firm's production and electrical testing facilities are also described. Riegel Papers Corp., 260 Madison Ave., New York, N.Y.

Capacitors 515

Complete electrical specifications, temperature characteristic graphs, and construction details are included in this 16-page capacitor catalog. Among the units described are: kraft and foil; mylar and foil; metallized mylar; high voltage midgets; kraft-mylar and foil; film and foil; polystyrene and foil; metallized paper; and metallized teflon. Electron Products Technical Information Service, 2065 Huntington Drive, San Marino, Calif.

Positioning Controls 516

Bulletin No. J-105, 16 pages, describes and illustrates: a line of linear and rotary actuators delivering torques from a few inch ounces to 3,500 lb in.; remote positioners from relay types to power transistor units; machine tool point-to-point position and rate control; punch card formula and program control; and closed loop process control. The bulletin contains tables and outline drawings. Jordon Controls, Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.

NEW LITERATURE

Voltage Regulators 517

The four-page Bulletin 3200, "Fincor" model F-26 series, describes voltage regulators for ac generators and generator-exciters. There are four models currently available—three with selenium rectifiers and one with a sealed silicon rectifier for corrosive atmosphere. Each regulator is of the tubeless magnetic-amplifier type. A chart of the typical response curve is included. Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Pa.

Power Supplies 518

The two-page bulletin, "New From PRD," describes type 812 universal klystron power supply which has digital readout for beam and reflector voltages; dual outputs for simultaneous operation of two klystrons; and front panel arrangement for checking calibration of reflector and grid voltage readings. Performance specifications are included. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y.

Magnetic Tape Storage 519

Two brochures describe magnetic tape storage units: model 220 Datafile, a multiple-tape unit with a capacity of 50 million digits; and model 205 Datafile. Both units are used with the firm's electronic data processing systems. Burroughs Corp., ElectroData Div., 460 Sierra Madre Villa, Pasadena, Calif.

Data Logging Systems 520

The two-page Application Data Sheet N-07 (1) describes the use of a 100-channel sequential data logging system. This system records the test results of components being exposed to nuclear radiation. Complete specifications are listed. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Null Detectors 521

A description of the use of the portable, line-operated 9834 guarded dc null detector is in the two-page data sheet ED7

(2). The operation of the detector is described with the aid of a schematic diagram. Complete specifications are given with a tabular listing of the instrument sensitivities for various source resistances. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Industrial Films 522

Brief explanations of the prineipal uses, properties, and types of six industrial films are contained in this eight-page booklet "Engineering With Du Pont Industrial Films." It discusses Mylar polyester film, Teflon FEP-fluorocarbon film, Teslar PVF film, and the company's polyethylene, cellophane, and acetate films. E. I. du Pont de Nemours & Co., Film Dept., Section IF, Wilmington 98, Del.

Covers and Cases 523

Catalog No. C59 contains data on standard deep drawn magnesium boxes and covers, and military transit-combination-instrument cases. The catalog contains dimension drawings, tables giving maximum and minimum heights, and photographs of some of the units. Zero Manufacturing Co., 1121 Chestnut St., Burbank, Calif.

Adhesives and Laminates 524

This six-page booklet describes the complete line of adhesives, laminating materials, putties and sandwich core. The booklet contains a temperature chart that indicates the upper and lower service limits for each adhesive and laminating material in the line. All materials are given in table form. Narmco Resins & Coatings Co., 600 Victoria St., Costa Mesa, Calif.

Voltage References 525

Three voltage reference sources are described in this six-page brochure. The units provide 0.01% absolute accuracy with 0.0005% stability through the use of certified standard cells and oil-immersed resistors. The illustrated brochure contains wiring diagrams and complete specifications. Epsco, Inc., Equipment Div., 275 Massachusetts Ave., Cambridge, Mass.

NEW LITERATURE

Modulators 526

Three modulators, models 700, 402 and 223A, are described in detail in this literature. In addition, a checklist for design data is provided to assist the engineer in obtaining quotations on his particular equipment. Burmac Electronics Co. Inc., 142 S. Long Beach Road, Rockville Centre, N.Y.

Hi-Fi Amplifier Circuits

Included in this 27-page booklet on hi-fi amplifier circuits are schematics for 15, 30 and 50 w audio amplifier circuits. The illustrated booklet also covers complete operating characteristics of tubes used in the circuits. Performance requirements, a balancing unit for stereophonics and a parts list are included with the circuit diagrams. *Send 80.35 to Radio Corp. of America, Electron Tube Div., Dept. ED, Harrison, N.J.*

Compartment Boxes 527

Series E, F, H and N plastic utility boxes are illustrated and described in this four-page catalog folder. Diagrams of standard compartment variations in each series are given. Also included are basic box sizes, compartment dimensions, and packing and shipping weights. Gilbert Plastics, Inc., Boright Ave., Kenilworth, N.J.

Precision Comparator 528

This 14-page brochure includes detailed engineering information on the precision comparator. Twenty-one working circuits are shown which illustrate the use of the device in a variety of measurement problems. Tables cover a summary of the most popular comparator types and reference specifications. Optimized Devices, Inc., 864 Franklin Ave., Thornwood, N.Y.

Shock Testing Machines 529

Four models of Varipulse shock testing machines are described in this four-page bulletin, No. 59-07. In addition to photographs of the machines, maximum load and table capacity specifications are given. Barry Controls, Inc., 700 Pleasant St., Watertown 72, Mass.

Environment-Free Switch 530

Data sheet No. 169 describes the environment-free subminiature switch, catalog listing 1XE1. The data sheet includes full description, dimensional drawings, electrical ratings, mechanical characteristics and other information. Micro Switch, Freeport, Ill.

Pressure Indicator 531

The PI series differential pressure indicators are described in this two-page data sheet. In addition to tube and indicator characteristics, minimum and maximum ranges are given in table form. Hastings-Raydist, Inc., Hampton, Va.

Laboratory Monitor 532

This two-page data sheet covers the LM-1 laboratory monitor for use in counting, hot-cell monitoring and classroom demonstration. Specifications and probable error settings are included. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Electronic Measurements 533

"Design Ideas" is a four-page technical publication issued quarterly and dealing with instruments, techniques and applications in the electronics measurements field. The first issue is devoted to detailed discussion of voltage divider accuracy and calibration. Electro Scientific Industries, Inc., 7524 S.W. Macadam Ave., Portland 19, Ore.

Word Indicator Light 534

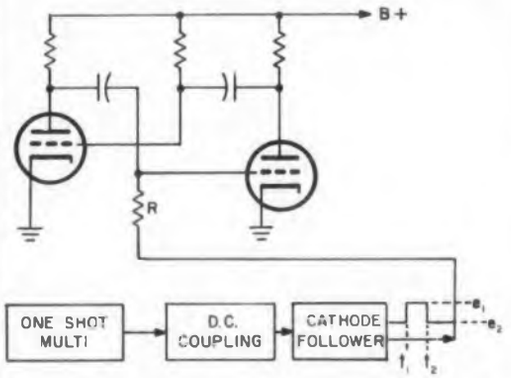
A diode-resistor circuit which reduces the 115 v ac input to drive AN-3140-327 lamps is described in this four-page brochure. Master Specialties Co., 956 E. 108th St., Los Angeles 59, Calif.

IDEAS FOR DESIGN

Adjustable Multi Bias Allows Variable Frequency Operation

By biasing a free-running multivibrator to controlled voltage levels, it can be made to have several interesting modes of operation. The additional circuitry required is indicated in the figure.

The operating frequency of a multivibrator is partly dependent on the voltage to which the grid-return resistor R is connected. Any variation in this voltage will change the frequency. Thus, instead of connecting R to a constant potential, it is returned to the coupled output of a one-shot multivibrator. With this arrangement, the free-running multi can oscillate in any one of 3 modes.



The output frequency of a free-running multivibrator can be varied by adjusting the voltage to which the grid resistor R is returned.

Mode 1—Output pulses for a fixed time interval. The cathode follower output is adjusted so that at E_2 tube T_2 is cut off and E_1 is any voltage that will cause the multi to oscillate. The magnitude of E_1 depends on the frequency desired. The free-running multi will oscillate only during the time $t_1 < t < t_2$.

Mode 2—Output pulses at varying frequencies. E_1 and E_2 are two different voltage levels. This permits the multi to oscillate at 2 different frequencies. The duration of each frequency is adjusted by varying the pulse duration and repetition rate of the output.

Mode 3—Multi-frequency oscillations. For this mode, the one-shot multivibrator is replaced by a diode storage counter of any number of steps. Each step voltage will cause the multivibrator to operate at a different frequency.

Unfortunately, the equations for the multivibrator operation (period, frequency, etc.) are involved and cumbersome. However, the ideas given here can be used as a beginning point for a laboratory breadboard design.

Irving Bayer, Design Engineer, Budd-Lewyt Electronics, Inc., Long Island City, N. Y.

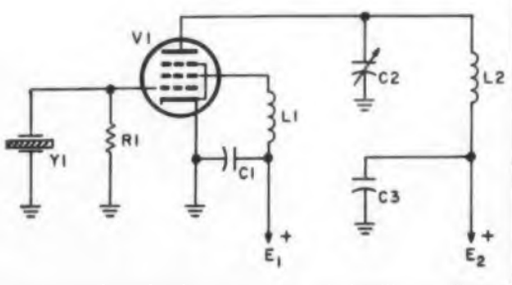
Crystal Oscillator Provides Good Load Isolation

The grounded-cathode, electron-coupled, Miller oscillator shown performs very favorably when compared with the modified Pierce and TriTet electron-coupled oscillators typical of present day designs. Its plate circuit can be designed for straight-through amplifier, or for multiplier operation. Suppressor-grid shielding provides excellent load isolation.

The cathode, grid, and screen elements of the oscillator tube function as a grounded-cathode Miller oscillator. Crystal Y_1 can be of the fundamental or overtone mode type designed for antiresonant operation. One crystal terminal is at rf-ground potential, which is an advantage if crystal switching is required. The circuit capacity must tune inductor L_1 to a frequency slightly above the crystal operating frequency to satisfy the conditions for sustained oscillation. If necessary, for proper tuning, a physical capacitor can be connected in parallel with L_1. Otherwise lower frequency applications would require impractical inductance values.

For straight-through operation of the plate circuit, L_2 can be an rf choke and C_2 can be omitted. The output must then be capacity-coupled to the following stage. For multiplier operation of the plate circuit, L_2 and C_2 tune to the desired harmonic output frequency. Capacitive or inductive output coupling can then be used. For either straight-through or harmonic operation, electrode voltage and loading conditions must prevent the instantaneous plate voltage from dropping below the instantaneous screen voltage. Load reflections may otherwise affect frequency stability.

In applying the circuit, the pentode section of a type 6U8 tube was used to provide 130 mc mixer injection for a vhf receiver converter. A type 6AG7 tube was used for a 48-mc output in a vhf transmitter-exciter. The basic circuit has a variety of transmitter and receiver applications in the hf, vhf, and lower uhf spectrum.



Grounded-cathode electron-coupled Miller oscillator has application in hf, vhf and lower uhf range.

Edwin E. Steinberg, Chicago, Ill.

IDEAS FOR DESIGN

Transistorized Neon Drivers Eliminate Reverse Leakage Glow

Transistorized neon drivers, such as the one shown in Fig. 1, are often used for visual indication of a flip-flop's state. Unfortunately, the reverse leakage current may be great enough to cause the neon lamp to glow even though the transistor is in the "off" (reset) state.

To reduce the effect of I_{co}, a resistor can be connected in parallel with the lamp and its load resistor. This forms a current divider and allows most of the leakage current to flow in the parallel resistor. This method is quite effective at room temperatures. However, I_{co} doubles for every 10 deg C temperature rise. At higher temperatures, enough reverse leakage current will flow through the lamp to cause it to glow quite brightly.

The circuit of Fig. 2 was designed for operation

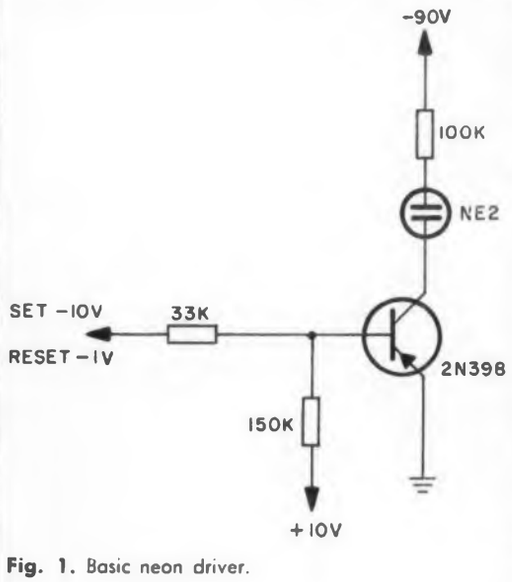


Fig. 1. Basic neon driver.

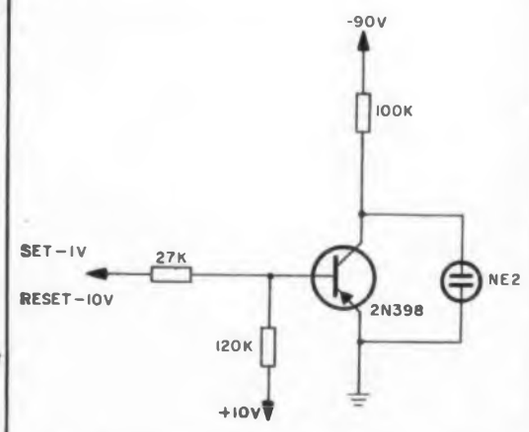


Fig. 2. A neon driver circuit which is not critical to I_{co}.

at elevated temperatures. The base of *Q1* is connected to the opposite side of the flip-flop so the input voltage is −10 v when reset, −1 v when set. *Q1* conducts when the flip-flop is reset, dropping the voltage across the neon to less than a volt and holding it dark. In the set state *Q1* is held non-conducting and current flows through the neon, lighting it brightly. Leakage currents, I_{co}, up to 200 μa may be tolerated with no degradation of performance.

Robert M. Walker, Development Engineer, Lawrence Radiation Laboratory, Livermore, Calif.

Log-Log Slide Rule Converts Voltage, Power Ratios Directly to Db

Decibels may be read directly on a log-log slide rule without any manipulations other than the initial alignment. It is necessary only to know whether you are dealing with voltage or power ratios.

For voltage ratios, the *2* on the C scale is aligned with the *10* on the LL3 scale, Fig. 1. The voltage ratio is located on the proper LL scale. Then, the corresponding value in db is read on the C scale. If the voltage ratio is located on the LL3 scale, the value in db on the C scale is multiplied by *10*; on the LL2 scale, the C scale multiplier is *1*; on the LL1 scale, the C scale multiplier is 0.1.

For power ratios, the *1* on the C scale is aligned with the *10* on the LL2 scale, Fig. 2. The LL scale multipliers are the same as with voltage ratios. In the same manner, for inverse ratios the LL03, LL02, and LL01 scales may be used.

This method of converting to db is much faster than using tables or solving $db = 20 \log_{10} V_1/V_2 = 10 \log_{10} P_1/P_2$. The slide rule is solving, without manipulation, $db = 8.68 \log_e V_1/V_2 = 4.34 \log_e P_1/P_2$.

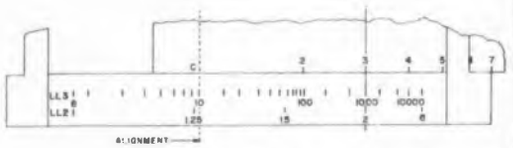


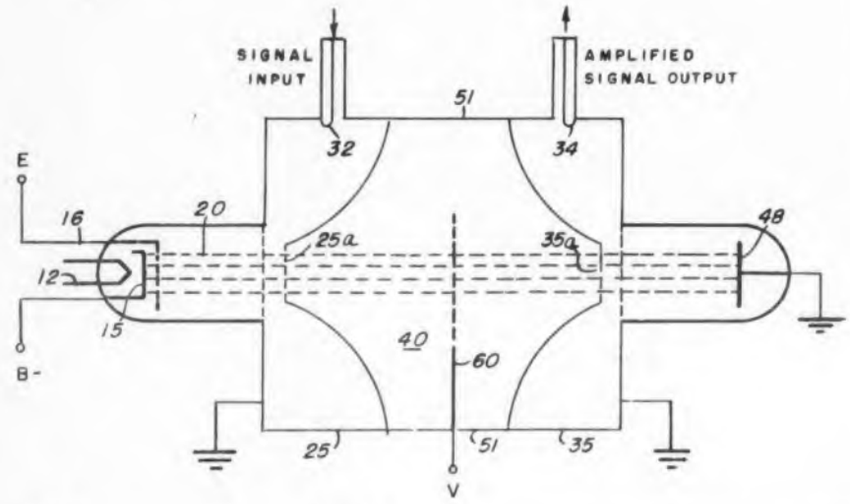
Fig. 1. For Voltage Ratios: — 2 on C scale is aligned with *10* on LL3 scale.

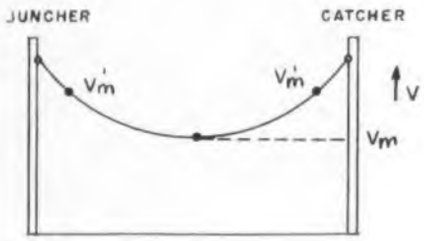
Fig. 2. For Power Ratios: — *1* on C scale is aligned with *10* on LL3 scale.

R. Wayne Crawford, Research Associate, Ohio State University, Columbus, Ohio.

PATENTS

Benjamin Bernstein





Klystron Amplifier

Patent No. 2,917,656. W. E. Waters. (Assigned to United States of America)

The power gain of a klystron is increased by as much as 16 db by using a drift tube of sufficiently large diameter so that a space charge distribution exists within the drift space. The presence of the space charge depresses the potential between the cavities. A probe is inserted in the vicinity of the potential minimum to collect positive ions which otherwise would be trapped and decrease the potential minimum.

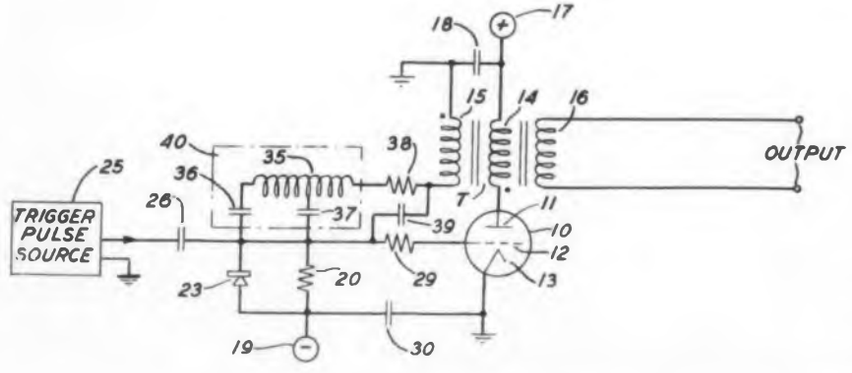
A two cavity tube with the large diameter drift space *51* is shown. The potential minimum is maintained by probe V_1.

Quick Recovery Circuit for Blocking Oscillators

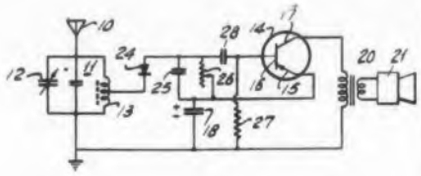
Patent No. 2,922,037. H. A. Reise. (Assigned to Bell Telephone Laboratories)

A trigger-controlled blocking oscillator has a delay line to control the pulse duration and a diode shunt path to reduce the recovery time. The recovery time can be reduced from 100 μsecs to 1/2 μsec.

A typical circuit is shown in which the feedback path is from winding *15* through delay line *40*. Capacitor *39* helps to shorten the rise time. Initially triode *10* is cut off since resistor *20* is tied to



bias supply *19*. A trigger pulse causes the triode to conduct and, when the oscillation reverses, the line charges. Diode *23* now provides a discharge path in shunt with resistor *20* and in series with the low grid-to-cathode tube impedance.



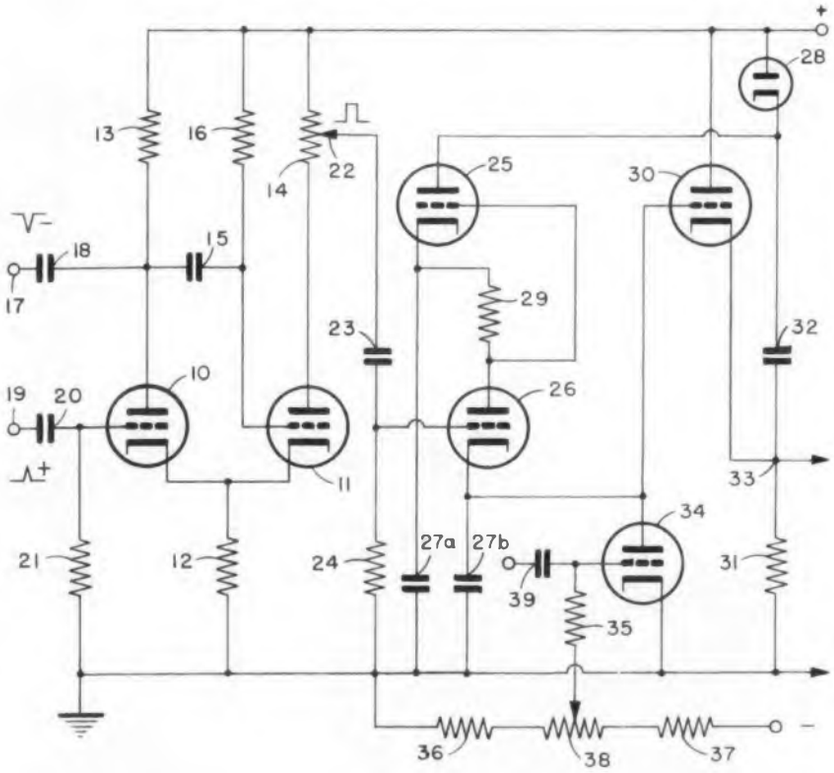
Passive Transistor Detector-Amplifier

Patent No. 2,918,573. H. E. Hollman. (Assigned to Dresser Industries, Inc.)

In a transistor broadcast receiver, the rectified rf power is used as the power source for amplifying the modulation signals.

A simple circuit is illustrated. The rf modulated carrier, rectified by diode *24*, charges capacitor *18*. This capacitor then acts as the battery supply for the detector-amplifier transistor *14*. Calculation has shown that the available power in an average case will be at least 5 mw. This is more than adequate to drive speaker *21*.

A push-pull circuit is described and also an avc circuit employing the invention is presented.



Linear Staircase Counter

Patent No. 2,922,041. Homer G. Boyle. (Assigned to Avco Manufacturing Corp.)

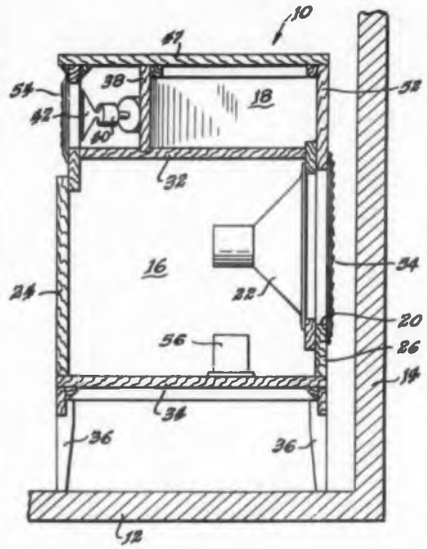
The circuit is a variation of a conventional diode step-charging counter. Triodes *10* and *11* are arranged as a cathode-coupled multivibrator to produce positive pulses at potentiometer *22* in response to either a positive pulse at *19* or a negative pulse at *17*. Initially capacitor *27a* is fully charged through triode *25* in series with diode *28*. A positive pulse drives triode *26* into conduction, discharging capacitor *27a* into capacitor *27b*. When the positive pulse terminates, capacitor *27a* again charges. Capacitor *27b* is periodically charged as the pulses to be counted are applied. The charging circuit is linearized by cathode follower *30* which increases the charging voltage by feeding back the output voltage through triode *25*. The circuit may be reset by applying a pulse to triode *34* and completely discharging capacitor *27b*.

PATENTS

Electroacoustical Device

Patent No. 2,921,135. L. S. Hoodwin. (Assigned to Electro-Voice Inc.)

Placed near a flat wall a speaker enclosure should be about 5 in. from the wall. To eliminate attenuation in the vicinity of 250 cycles, its low frequency energy should be directed rearward. The high frequency radiator, by contrast, is directed through the front of the compartment. The image of the low frequency speaker then comes closer to this source, and the transmitter is equivalent to a point source. For naturalness, it is desirable to raise the low frequency speaker enclosure about 2 ft above the floor.



Shown schematically is the low frequency speaker *22* housed in the enclosure *16*. A flaring horn effect is produced by spacing speaker *22* from wall *14*. Also shown is the mounting of the higher frequency speaker *40* in enclosure *18*. Legs *36* raise the cabinet the necessary height above the floor.

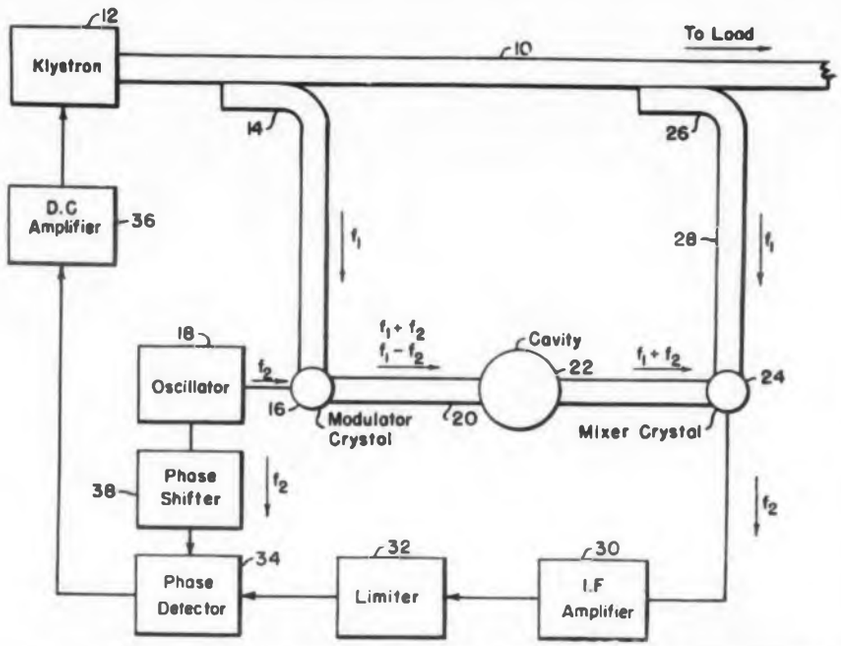
Frequency Control System

Patent No. 2,917,713. C. H. Grauling, Jr. (Assigned to Westinghouse Electric Corp.)

The frequency of an oscillator is stabilized by maintaining a constant phase shift of a reference signal mixed with the oscillator output. The device has high

noise immunity to am disturbances.

A klystron *12* produces the oscillator frequency f_1 which is balanced-mixed with the output f_2 of the reference source. Cavity *22* selects the upper sideband, which mixes with the klystron signal. This produces a phase-modulated resultant, f_2. The phase-detector output controls the klystron and adjusts for any frequency shift.



BOOKS

New Manual Collects Reliable, Well-Designed Transistor Circuits

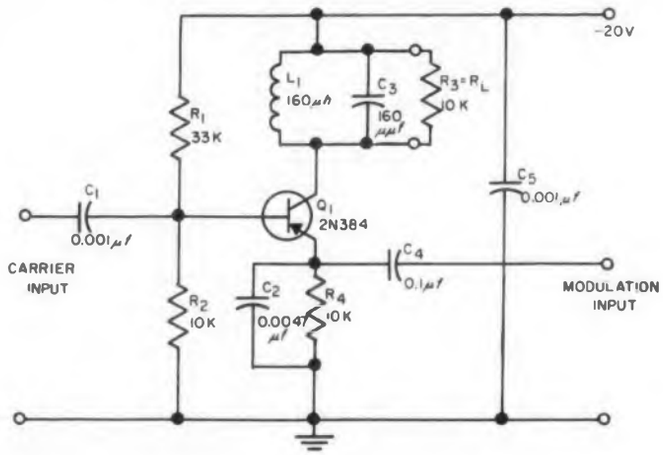


Fig. 1. Low-level modulator.

RECENTLY published, "A Handbook of Selected Semiconductor Circuits"* is a collection of a wide range of contemporary transistor circuits. Sponsored by the Bureau of Ships, the manual is a "state of the art" grouping of circuits exemplifying good design and reliability. Industrial concerns, government organizations, educational institutions and individuals working in the transistor circuit field submitted circuits for inclusion in the handbook.

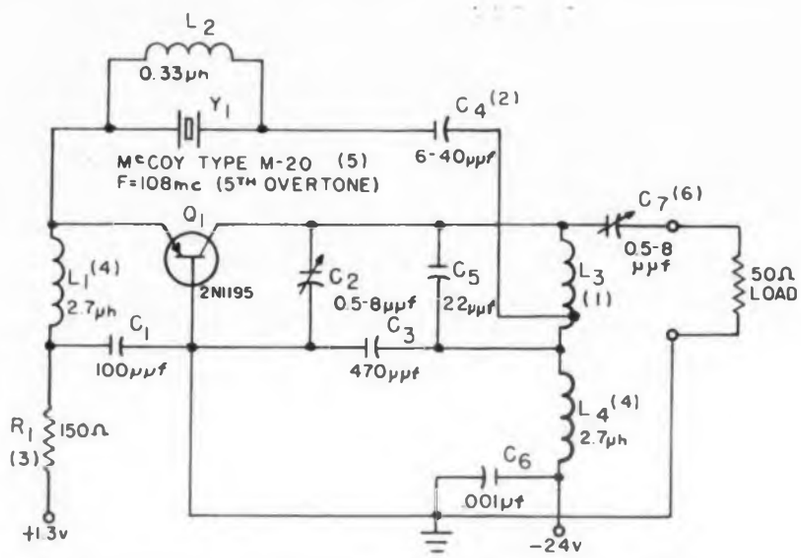
The areas of circuit design covered are:

- Direct coupled amplifiers
- Low-frequency amplifiers
- High-frequency amplifiers
- Oscillators
- Switching circuits
- Logic circuits
- Ac to dc power supplies
- Small signal nonlinear circuits

Each section presents anywhere from 7 to 24 circuits in its category. The circuits were selected on the basis of "inventiveness, reliability, or advanced state of the art design." The schematics are presented with a discussion of its operation and its special design features.

In addition, each circuit group is preceded by an informative discussion on its design philosophy. This is included to aid in the design of circuits other than those shown in the text.

* "A Handbook of Selected Semiconductor Circuits," NAVSHIPS 93484, edited by Seymour Schwartz, Superintendent of Documents, Government Printing Office, Washington 25, D. C., price, $2.75.



NOTES: 1. 3 turns #21 wire space wound ¼" dia. 2. Valve determines frequency. 3. Valve determines output. 4. L_1 & L_4 parallel resonant at 108 mc. 5. The temperature, series resistance and spurious mode response as per specifications. 6. Adjust to match 50 ohm load.

Fig. 2. 108 mc crystal oscillator.

Some examples of the circuitry and discussion in the Handbook follow.

Low-Level Modulator
Transistor Applications, Inc.

Fig. 1 is a simple, low-level modulator suitable for use in the early stages of a radio-frequency transmitter. The circuit is a common-emitter amplifier, with a fixed base bias furnished by a voltage divided, R_1 and R_2. The emitter current determined is by an emitter bias resistor, R_4. Modulation is accomplished by applying the audio signal to the emitter circuit, which varies the instantaneous emitter-base potential, thereby modulating the transconductance of the transistor.

The optimum carrier level at the base of the transistor is 0.1 v rms. To produce 100-per-cent modulation, 0.12 v rms of audio-frequency voltage must be applied to the emitter. The modulator will supply 3 v rms of carrier to a 10 K load. The envelope distortion is approximately 5 per cent at 80-per-cent modulation, and 20 per cent at 100-per-cent modulation.

With the type 2N384 transistor the

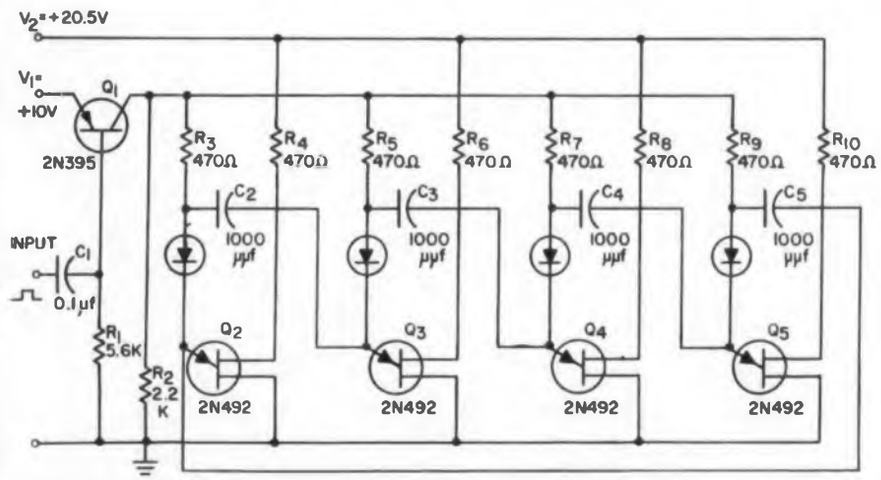


Fig. 3. Unijunction ring counter.

radio frequency response of the modulator is essentially flat up to 30 mc. The audio-frequency response is determined principally by the loading of the audio-frequency source by the 0.0047 μf emitter-bypass capacitor. This emitter-bypass capacitor is sufficiently large for carrier frequencies down to 1 mc. If lower carrier frequencies are to be used, the capacitance should be increased. If, however, this imposes too great a burden upon the audio-frequency driver, the modulator can be made push-pull as far as the radio-frequency inputs and outputs are concerned, while the emitters are driven in parallel with the modulating voltage. If balanced operation is attained, the bypass capacitor can be omitted, with a resulting improvement in high-frequency response.

108-Mc Crystal Oscillator—
Naval Research Laboratory

Fig. 2, a 108-mc crystal oscillator employing a diffused base transistor, was designed for use in Vanguard I. It also formed a portion of the telemetry transmitters for Vanguard III and Explorer IV. The crystal holder capacitance is tuned out by a shunt inductor. A small capacitor is connected in series with the crystal to compensate for the phase lag in the transistor. The use of an overtone crystal requires the use of an additional tuned circuit placed in the collector.

As shown, the oscillator has a separate emitter supply voltage. This is convenient when batteries are being used as a power source. With a suitably chosen emitter resistor this leads to practically perfect stabilization of the operating point. If a single power supply is to be used, R_1 could be connected directly across C_1, and the base could be supplied from a voltage divider connected from ground to the negative supply.

The efficiency of the oscillator is between 30 and 35 per cent when delivering 15 to 30 mw to a 50-ohm load. However, the oscillator is capable of delivering 100 mw at an efficiency of 40 to 45 per cent. With constant loading and temperature the frequency stability is approximately $\pm 1 \times 10^{-8}$ for 10 minutes.

Unijunction Ring Counter—
General Electric Company

The unijunction ring counter, Fig. 3, is characterized by a small number of components and an additional trigger input for setting and resetting control. The operation of the basic unijunction circuit (monostable) is described in Part 6—Switching Circuits, Circuit 6-15. For bistable operation the load resistor R_3, R_5, R_7, etc. must intersect the "off" region below the peak-to-breakdown voltage and the "on" region beyond the valley point of the voltage-current characteristic.

To turn the circuit "on", a positive pulse is applied at the emitter. This raises the emitter voltage above the peak point. The circuit may be turned "off" by applying a negative pulse at the emitter that lowers the emitter voltage below the valley point, V_B.

In the ring counter, assume Q_2 is "on." The collector current of Q_1 is at V_B (approximately 3 v), and the emitter voltage of the other unijunction transistors is at V_1, or 10 v. When a trigger pulse is applied, Q_1 cuts off, and the emitter current of Q_2 decreases to zero, cutting off Q_2. During the trigger pulse, capacitor C_5 discharges through R_9, R_3 and CR_1. Capacitor C_2 remains charged to $(V_1 - V_B) = 7$ v, since diode CR_2 and the emitter of Q_3 are off, preventing it from discharging. At the end of the trigger, the voltage at the collector of Q_1 rises to V_1. Since there is no voltage on C_3, C_4 and C_5, the voltages at the emitters of Q_2, Q_4, Q_5 will rise V_1. However, this is below their peak voltage, so they remain off. The voltage on C_2 is equal to $V_1 - V_B$, so that the voltage at the emitter of Q_3 rises to $2V_1 - V_B$ or about 17 v. This exceeds the peak voltage, causing Q_3 to turn "on."

The circuit is designed to work with the normal range of unijunction parameters. The coupling capacitor cannot discharge during the trigger pulse, so that the trigger pulse width can vary over a wide range. Emitter triggering is used, since it requires less current, and operating margins are at a maximum. The resistors R_4, R_6, etc. are used for peak point stabilization, if desired, and should be low resistance values.

The counter operates at rates up to 80 kc, with a temperature range of —55 C to 120 C (Q_1 not included). ■ ■

J. George Adashko

Millimicrosecond Pulse Generator

ONE OF THE most important problems in millimicrosecond technology is the generation of video pulses of high repetition rates. Recently, a portable generator was developed for positive pulses of 20, 50 and 100 mμsec. Designated the GMI-23, the generator has repetition frequencies ranging from 10 kc to 1.5 mc.

Sharp millimicrosecond pulses are produced by rapidly charging a capacitor. A large charging current should be used, since the maximum slope of the shaped wave pulse is given by

$$\frac{du}{dt} = \frac{i}{C}$$

where du/dt = rate of rise of the pulse front, I = charging current drawn during the time of pulse shaping, and C = capacitance connected in parallel with the charging device.

Commercially available low-power tubes can deliver current pulses so sharp that the capacitor voltage will increase at the rate of 20 to 30 v per mμsec. Used for this purpose, the tube conducts only during the time of pulse shaping and is cut off for the rest of the pulse time.

Schmitt-Type Circuit Triggers Blocking Oscillator Pulse Shaper

The pulse generator, Fig. 1, was designed around a delayed blocking oscillator. It consists of the following principal units:

- Broadband input stage (1).
- Schmitt-type sine-wave converter for preliminary shaping of the sinusoidal input into rectangular waves (2).
- Delayed blocking oscillator pulse shaper using a 6N6P (6J6 equiv) tube, (3).
- Stages for shaping 20, 50 and 100 mμsec pulses,

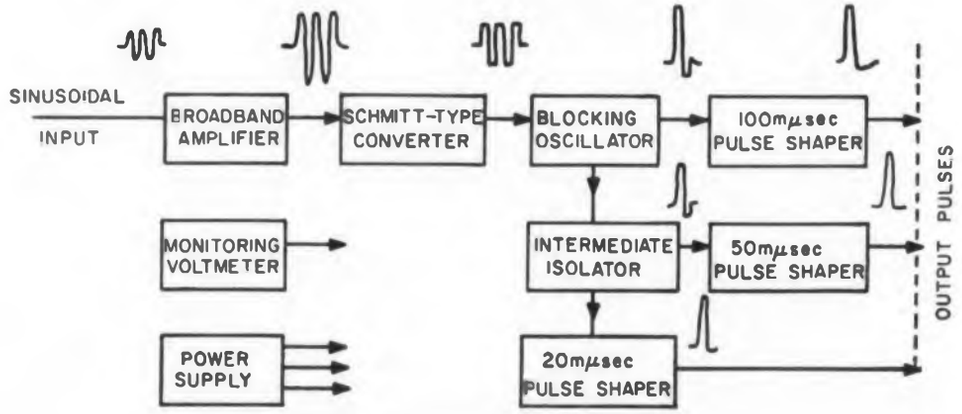
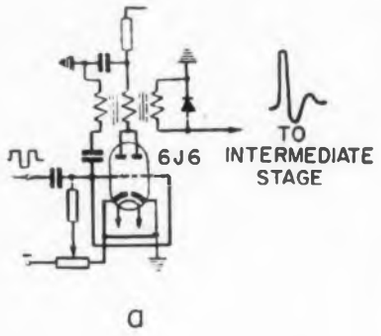
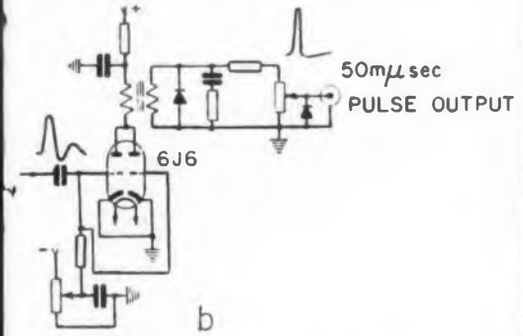


Fig. 1. Block diagram of the GMI-23 pulse generator shows separate outputs of 20, 50 and 100 mμsec.



a

Fig. 2a. Millimicrosecond pulses are produced by this blocking oscillator.



b

Fig. 2b. Output of blocking oscillator is fed to this circuit which produces a fixed-interval pulse of 50 mμsec.

(4), (6), (7). These are amplifier stages with shock-excited tuned circuits. The tubes used are 6N6P (6J6 equiv).

- Intermediate isolating stage, (5), similar in construction to the fixed video pulse-shaping stages.
- Control and indication device, essentially a peak voltmeter using a 6N5P (6V6 equiv) tube, whose output is fed to a bridge circuit using two 6P1P (6V6 equiv) tubes.
- Power supply, (9).

Fig. 2a shows the schematic of the blocking oscillator (block 3 of Fig. 1). The stage for shaping the 50-mμsec pulses (block 6 of Fig. 1) is shown in Fig. 2b.

The circuit parameters (primarily the plate loads), and the tube type are selected so that the rise time will be about 150 to 350 mμsec. The blocking oscillator is triggered by short-duration positive pulses, shaped by a differentiating RC network. If the pulse input were not differentiated, at low repetition rates (less than 100 kc) there would be repeated triggering of the blocking oscillator. This is because the oscillators control grid would still be at a positive potential after the initial output pulse had been generated.

The tube for the blocking oscillator operates under overdriven conditions, with the simultaneous

RUSSIAN TRANSLATIONS

use of pulsed emission. The tube should have low interelectrode capacitances which tend to increase the pulse rise time. Also, the tube should have electrodes with the highest possible dissipation rating. This allowable dissipation limits the maximum repetition rate for given pulse parameters. The 6N6P (6J6 equiv) tube was found to satisfy these requirements.

The transformer core used in the blocking oscillator was made of material which retains its initial permeability without considerably increased losses up to approximately 5 mc.

The diode in the load winding improves the shape of the pulse by clamping the negative overshoot.

The wave forms of the pulses obtained at the outputs of the GMI-23 are shown in Figs. 3a, 3b, and 3c. The data on the pulses are gathered in Table 1. The lower line on the oscillogram serves as a time marker.

Figure Number	Pulse Duration μsec	Oscilloscope sweep duration μsec	Repetition frequency, mc
3a	20	150	1.0
3b	50	200	1.0
3c	100	300	1.0

Pulses shaped by a Schmitt trigger do not have constant rise times over a wide range of repetition frequencies. This results in a variation of the rise times of the input pulses to the blocking oscillator. However, the blocking oscillator serves as a rise time "equalizer," so that its output pulses have nearly equal rise times over a wide repetition frequency range.

Pulse-Interval Shaping Stages Have Shock-Excited Tuned Plate Loads

The shaping stages, 4, 6, 7, Fig. 1, are essentially amplifiers with shock-excited tank circuits. The tube requirements in such circuits are similar to those of the blocking oscillator tubes. Forced grid bias is used to cut off these stages. The tank-circuit transformers are wound on the same magnetic material used in the blocking oscillator transformer. The number of turns in the primary and load windings are identical and depend on the desired pulse duration. With the load winding, any pulse polarity can be obtained at the generator output. However, to simplify the construction only positive pulses are shaped in GMI-23.

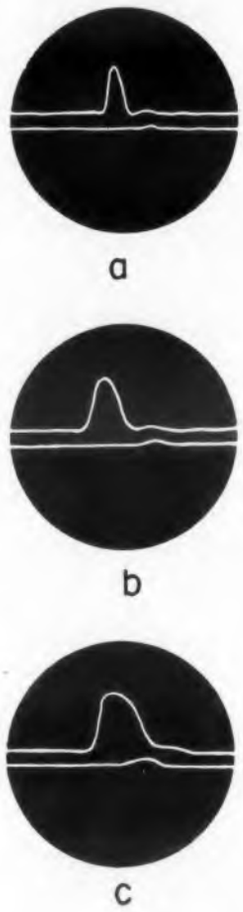


Fig. 3. Pulse waveforms of (a) 20 μsec, (b) 50 μsec, (c) 100 μsec, outputs.

The amplitude and duration of the pulses shaped by the tank circuit depend both on the parameters of the tank circuit and on the exciting-current rise times. The diode across the transformer winding performs the same role as the diode connected in the load winding of the blocking oscillator. The amplitude of the output pulse is regulated by a 460-ohm potentiometer shunted by a correcting RC network and by an additional diode. The 100 μsec stage is triggered by pulses shaped by the blocking oscillator. The 50 and 20 μsec pulses should not be directly triggered by the blocking generator. Fluctuations in the pulse rise times over the range of the repetition frequency will lead to noticeable fluctuations in the duration of the shaped pulses. The intermediate stage, serves as an additional "equalizer" for the rise times of the triggering pulses.

Abstracted from "GMI-23 Millimicrosecond Pulse Generator" by V. S. Chilikin, Electrosvyaz', *January 1960, pp 40-44.*

GERMAN ABSTRACTS

E. Brenner

Frequency Stable Oscillators

THE DEFINITION of frequency stability can be refined to include relevant criteria for performance. For small time intervals, t, it is meaningful to define the quotient $S_t = \Delta f/ft$. In general, it is necessary to specify both the relative frequency deviation $\Delta f/f$, and t, the time interval in which the relative frequency deviation must be kept within prescribed limits.

In Doppler radar applications the velocity error Δv is given by $\Delta v = c \Delta f/2f$, where c is the velocity of light. If a 2-per-cent error is tolerated in measuring the velocity, the allowed frequency fluctuation is $\Delta f/f = 2 \times 10^{-8}$ for f 5.4 kmc, target distance 6 km, velocity 500 km/hr. With a specified time interval of 40 μsec S is 5×10^{-4}/sec. Time interval t is smaller, but $\Delta f/f$ is of the order 4×10^{-9}.

While crystal or atomic clocks can be used for very accurate frequency control (of the order of 10^{-9} and 10^{-10} per day, respectively) such installa-

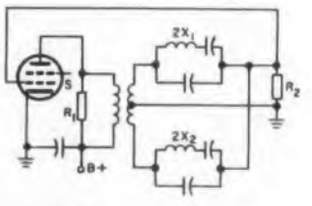


Fig. 1. Differential bridge circuit using two quartz crystals.

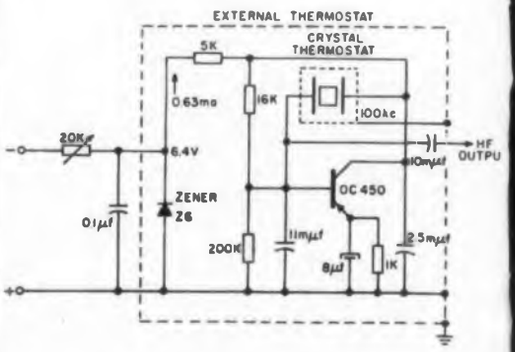


Fig. 2. Quartz crystal stabilized, transistor oscillator.

ions are elaborate, costly and not portable. For some applications, comparatively simple oscillators, using either one or two crystals, are suitable. Two crystals, with different resonant frequencies, are used in a differential bridge oscillator circuit, Fig. 1, or in a phase shift oscillator. A simple crystal-controlled transistor oscillator is shown in Fig. 2.

Superficially it appears that transistor oscillators are inferior to vacuum tube circuits. However, the former can be used advantageously because the small size and small amount of heat generated by transistors make it possible to use a small, thermostatically controlled crystal. Operating conditions are regulated with Zener diodes. The circuit of Fig. 2 uses a high quality 100-kc quartz crystal with a special thermostat and a silicon OC 450 transistor Frequency comparison using a standard 200-kc atomic clock-controlled transmitter revealed that frequency variation of the transistor oscillator was below 1.5×10^{-8} per day with $\Delta f/f$ below 1.4×10^{-8}. The radar frequencies are generated by frequency multiplication.

Abstracted from an article by W. Herzog, Nachrichtentechnische Zeitschrift, Vol. 13, No. 1, nuary 1960, pp 29-33.

Distortion in RC Oscillators

WHEN THE purity of the sinusoidal output waveform for RC oscillators is a principal design criterion, the values of the linear feedback elements can be adjusted to reduce harmonic content at the expense of circuit symmetry.

In the Wien bridge, Fig. 1, if the bridge is ap-

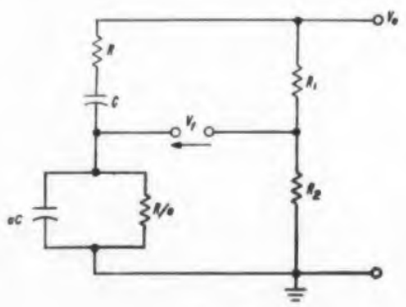


Fig. 1. Wien bridge.

GERMAN ABSTRACTS

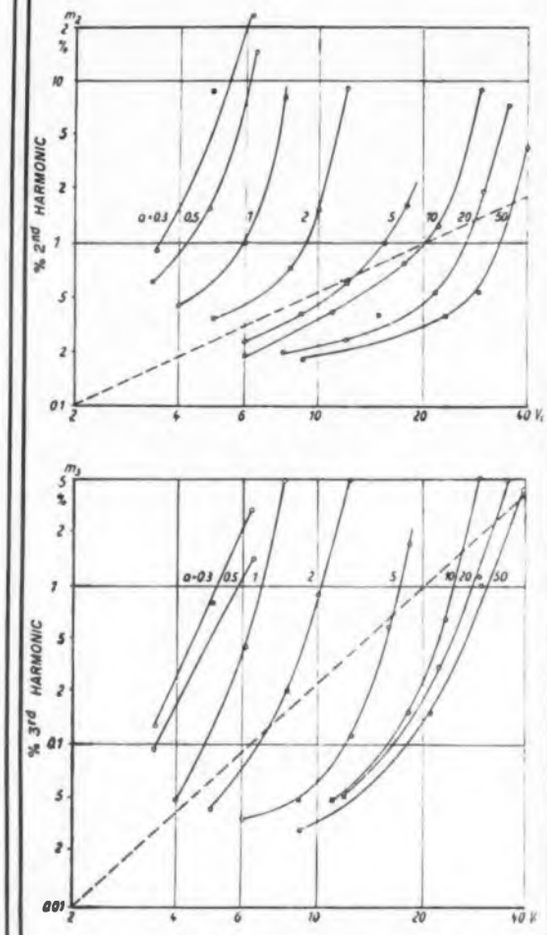


Fig. 2. Per cent harmonic content (second and third harmonic) as a function of output voltage for a Wien bridge oscillator with a as a parameter.

proximately balanced $[R_2/(R_1+R_2)\approx 1/(2a+1)]$, increasing values of a reduce the harmonic content of the output. The upper limit on the value of a is determined by the available amplifier gain. Quantitatively, the second and third harmonic distortions as functions of output voltage, with a as a parameter, are shown in Fig. 2.

For the two possible (three-section) phase-shift oscillators, Fig. 3, the C-R arrangement, Fig. 3a, has a higher attenuation for harmonics and consequently the output has less harmonic content. From the viewpoint of harmonic distortion, values of a below unity are favorable as is verified by the experimental curves, Fig. 4. However, the ex-

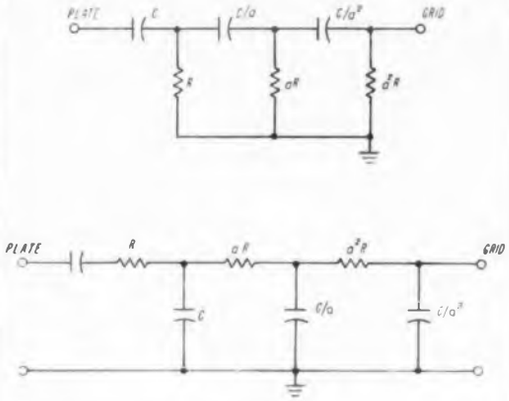


Fig. 3. Two phase shift networks. The plate leads to a blocking capacitor and the grid leak resistor is shown on the grid side.

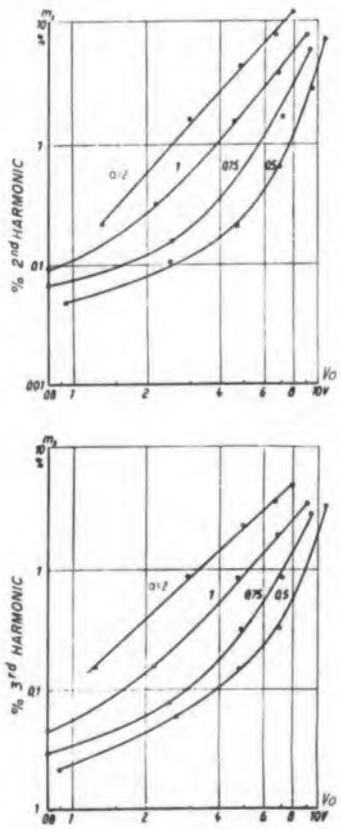


Fig. 4. Per cent second and third harmonic content as a function of output voltage in a phase shift oscillator with *a* as a parameter.

cessive gain (more than 70) required when *a* is reduced below one half, limits the allowable design freedom.

Abstracted from an article by T. Zagajewski, Hochfrequenztechnik und Elektroakustik, *Vol. 68, No. 4, Nov. 1959, pp 127-136.*

GERMAN ABSTRACTS

E. Brenner

Millimicron Measurements

DURING oscillation, mechanical deflections of 10^{-8} to 10^{-10} meters determine the constants that describe the piezoelectric properties of crystals. When these constants are calculated from the measured input impedance near resonance, the technique is so elaborate as to be unsuitable for quality control purposes. However, the capacitance variation between a leaf-shaped probe and the metallized surface of the oscillating element can be used to devise a direct reading mechanical deflection meter.

For reasons of sensitivity and precision, a frequency modulation method is preferred to an unbalanced bridge method (amplitude modulation). The apparatus, Fig. 1, is suitable for crystals in the 50-kc to 2-mc range. It consists of a test stand, a modulated oscillator and an indicator cir-

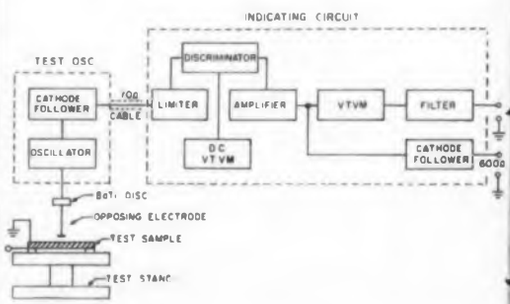


Fig. 1. Block diagram of measuring circuit.

Deflection

H. Herold, A. Lenk

cuit. The modulated 62.5-mc oscillator, Fig. 2, furnishes the fm signal to a uhf section. This section is similar to the if stage of an fm receiver.

The oscillator frequency is initially adjusted to null the discriminator output. Vernier displacement of the test stand can be used for static calibration. Alternatively, a barium titanate disc with known oscillation amplitude can be used both for calibration and for exciting the test object.

The technique can also be used to examine the amplitude distribution on the radiating surfaces of ultrasonic oscillators. Results obtained with round barium titanate plates are similar to those obtained from more complicated optical interference procedures.

Abstracted from an article by H. Herold and A. Lenk, Hochfrequenztechnik und Electroakustik, *Vol. 68, No. 5, December 1959, p 152-158.*

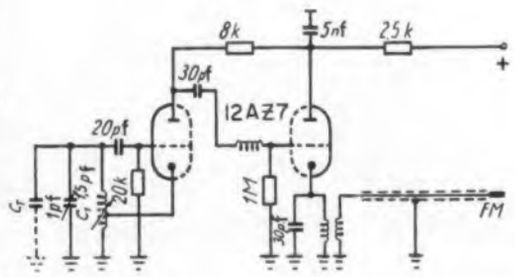


Fig. 2. Test oscillator. C_T represents the variable capacities under test.

Corner-Reflector Antenna-Design

A DESIGN analysis of corner-reflector antennas has been carried out by the National Bureau of Standards Boulder (Colo.) Laboratories under the sponsorship of the U. S. Air Force. The results of this evaluation[1] by H. V. Cottony and A. C. Wilson of the Bureau's Central Radio Propagation Laboratory provide comprehensive and detailed information on designing high-performance, economical corner reflectors.

A corner-reflector antenna consists simply of two plane reflecting surfaces joined edge-to-edge to form a corner, which is usually parallel to the ground. The driven element is placed in the aperture between the two planes. This type of antenna has the advantages of high-gain, broad-frequency response, narrow beam-width, low back-radiation, low cost, ease of construction.

Early experimental work in ionospheric scatter propagation stimulated interest in corner reflectors because they are particularly suitable for this mode of communication. Even though these antennas had been used prior to the new experimental scatter circuits, their performance was known only qualitatively. Therefore as part of its propagation research programs, the Bureau undertook an investigation of corner reflectors to determine how gain varies with changes in width and length of reflecting surfaces, angle of aperture and position of driven element.

Experimental Equipment

The experimental corner-reflector antenna used for this investigation consisted of two lattice-type wooden frames, each 12.3 ft (five wavelengths at 400 mc) wide by 12.3 ft long, supporting the reflecting surfaces. The reflectors were of overlapping strips of sheet aluminum fastened to the frames so that removal of one strip would subtract 0.2 wavelength from the surface. Width could be varied by trimming the lengths of the strips. The two frames were pivoted along the same axis and the angle of aperture could be varied from 20 to 180 deg.

The driven element was a folded half-wave dipole. Its position could be varied from 0.07 to 2.5 wavelengths from the apex of the reflecting surfaces. The dipole's support also served as a balun to transform the impedance of the system to about 50 ohms. Fine adjustment, for an exact match to a 50-ohm line, was provided by a two-stub tuning unit. Gain was measured at 400 mc by comparing the system with a known antenna.[2]

Although in practice collinear arrays of four and more dipoles are used in scatter antennas to obtain gains of over 20 db, the general performance can be predicted from an experimental system using only a single dipole. Therefore, only the single dipole was used for the measurements.

Gain Measurements

Results of the measurements indicate that minimum reflector width is 0.5 wavelength for the smallest usable value of gain. With an increase in width up to 2 wavelengths, gain increases. However, beyond this, there is little or no increase in gain, and under some circumstances it may actually decrease.

For maximum gain, the dipole must be in one of several discrete positions—referred to as first, second, third, etc., in order of distance from the apex. The exact location of each position is a function of the aperture angle.

When the dipole is in the first position, gain increases monotonically as reflecting surface length increases. When the dipole is in the second

Fig. 1. Experimental corner-reflector antenna analyzed by the National Bureau of Standards. Length and width of reflecting surfaces, position of dipole, and aperture can all be varied to determine effect on gain.

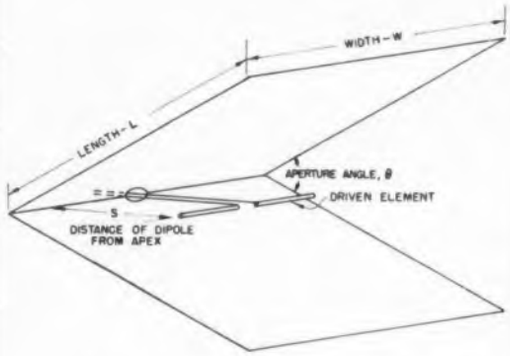


Fig. 2. Diagram of corner-reflector antenna.

or third positions, the same relation holds true generally, except for surface lengths less than 1.5 wavelengths. For these shorter lengths, the relation is not only too irregular for simple analysis but also does not provide the antenna designer with any useful data.

Maximum gain along the forward axis seems to be achieved with the dipole in the second position. In this case, the reflecting surface should be more than two wavelengths long and approximately two wavelengths wide.

Radiation Pattern

Ionospheric scatter antennas designed for the lowest portion of the vhf band should have especially low secondary lobes and minimal radiation to the rear, as radiation in these undesired directions is likely to result in self-interference from multi-path propagation. An important advantage of the corner reflector over other types of antennas is that it can be designed to have extremely low back radiation. The small amount that does occur results from diffraction around the edges and from penetration through small openings in the reflector surfaces.

Radiation patterns have been compiled for a variety of sizes of corner reflectors.[1] This material has been further summarized graphically so that beam widths and back radiation levels for any combination of surface lengths and widths are easily determined.

Reprinted from "Design of Corner Reflector Antennas." *Summary Technical Report from U. S. Department of Commerce, April 1960.*

References

1. Radiation Pattern of Finite-Size Corner-Reflector Antennas, by A. C. Wilson and H. W. Cottony, IRE Trans. Ant. & Prop. AP-8, No. 2, March 1960; for further technical information, see Gains of Finite-Size Corner-Reflector Antennas, by H. V. Cottony and A. C. Wilson, *IRE Trans. Ant & Prop.*, Vol. AP-6, No. 4, October, 1958
2. Techniques for Accurate Measurement of Antenna gain, by H. V. Cottony, NBS Circ. No. 598. Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, 15c.

REPORT BRIEFS

Surface Wave Antennas

The purposes of the project were to study methods of increasing the efficiency of the dielectric image line antenna and the development of a method of launching the image transmission line mode with a flush launcher. Investigations were made to determine the efficiency of the antenna and ways of improving the efficiency. Also, methods of launching the transmission line mode with a flush launcher, which would eliminate the horn launcher, were investigated. A number of patterns for the flush launcher are included. *Surface Wave Antenna Study, W. P. Hooper and E. A. Wolff, Litton Industries, College Park, Md., May 28, 1959, 29 pp, Microfilm $2.70, Photocopy $4.80. Order PB 143355 from Library of Congress, Washington 25, D.C.*

Radiation Damage To Transistors

Studies of the radiation damage to 23 silicon and germanium transistor types were made. The damage constant (K) for each transistor type was determined. Larger K indicates smaller susceptibility to permanent radiation damage. *Radiation Damage To Transistors, D. A. Hicks, D. V. Keller and others, Boeing Airplane Co., Seattle, Wash., Dec. 1, 1958, 124 pp, Microfilm $6.30. Order PB 143692 from Library of Congress, Washington 25, D.C.*

Network Synthesis

The standard lattice synthesis technique is extended to active networks in which the available network elements are positive and negative resistors and capacitors. The designation of the immittances of the arms of the active lattice as "single NIC realizable" is shown to be useful and to lead to a variety of lattice realizations including the constant-resistance lattice. The general method described for synthesizing the active lattice requires the introduction of a surplus factor with real, simple and negative zeros. Several procedures are given for reducing the active lattice to an unbalanced equivalent two-port made up of resistors, capacitors and negative impedance converters. Both reciprocal and non-reciprocal reductions are obtained. NIC biasing provisions and termination conditions are met by inserting appropriate immittances into the lattice at an appropriate stage of the reduction process. *Active Network Synthesis By Lattice Reduction, R. E. Thomas, Electrical Engineering Research Laboratory, University of Illinois, Urbana, May 15, 1959, 100 pp, Microfilm $5.40, Photocopy $15.30. Order PB 143515 from Library of Congress, Washington 25, D.C.*

Strip Line Directional Couplers and Resonators

The outstanding characteristics, possible applications, and important design procedures for coupled strip-line directional couplers and resonators are treated in this report. The design information is available in the various Stanford Research Institute progress reports, however, as presented in this memorandum, the designer will find it unnecessary to digest the SRI research work before he can design either of these components. This memorandum also serves as a summary for those who do not have the time to follow the detailed analysis carried out by SRI, but who are interested in forming an idea of what can be achieved with these components. *Design Techniques for Strip Line Directional Couplers And Resonators, Isaac Abeyta, Army Signal Research and Development Laboratory, Fort Monmouth, N. J., June 10, 1957, 36pp, Microfilm $3.00, Photocopy $6.30. Order PB 142809 from Library of Congress, Washington 25, D. C.*

Transistorized Matched Filter

A matched filter for pulsed sinusoidal symbols has been designed and constructed in which transistors are used as the active elements. The filter has a gain variation of less than one db as a result of variation of component parameters, temperature, age, and supply voltages. The filter has a useful dynamic range of at least 80 db. *Transistorized Matched Filter For Pulsed Sinusoids, P. L. Fleck, Jr., Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Mass., Apr. 12, 1957, 27 pp, Microfilm $2.70, Photocopy $4.80. Order PB 138607 from Library of Congress, Washington 25, D.C.*

Parametric Amplifiers

This paper presents the circuit considerations for the wide-band operation of a traveling-wave parametric amplifier. The model analyzed is a transmission line periodically loaded with parametric diodes. The diodes constitute the variable elements. Across each diode is fed a large pumping voltage which produces a time-varying capacitance. A Brillouin diagram for the structure (a plot of ω vs β) can be computed from the analysis. The conditions for high gain, wide band, and other desirable characteristics are conveniently determined from this diagram. *Circuit Considerations in Traveling-Wave Parametric Amplifiers, C. V. Bell and G. Wade, Stanford Electronics Laboratories, Stanford University, California, Aug. 28, 1959, 31pp, Microfilm $3.00. Photocopy $6.30. Order PB 143483 from Library of Congress, Washington 25, D. C.*

REPORT BRIEFS

Transistorized Power Supplies

High voltages may be obtained from a low-voltage dc supply when some form of converter is employed. A literature survey shows that transistorized converters, because of their high efficiency and lack of moving parts, are tending to displace rotary converters and vibrator-power units. Various transistor circuits of interest in ammunition electronics for converting dc-to-ac or dc-to-dc are reviewed here. The ringing choke converter offers a simple method of obtaining high voltage at power levels up to about two watts. For powers up to 200 watts the transformer-coupled, push-pull circuit is recommended. Of particular interest is the driven type converter for high-power, single- and three-phase applications. *Transistorized Power Supplies: A Literature Survey, Floyd Allen, Diamond Ordnance Fuze Laboratories, Washington, D. C., Aug. 25, 1959, 24pp, $0.75. Order PB 161266 from OTS, Washington 25, D. C.*

Transistorized Delay Circuits

The study of a transistor emitter-coupled monostable multivibrator, the duration of whose output pulse can be controlled linearly by the setting of the input potentiometer is the subject of this report. This circuit can be used as a linear delay circuit or as a gate in its own right. It can also serve as an important building-block for linear time base circuits. *A Study Of Transistor Linear Time Delay Circuits, R. P. Nanavati, Syracuse University Research Institute, Syracuse, N.Y., Dec. 1957, 68 pp, Microfilm $3.90, Photocopy $10.80. Order PB 143526 from Library of Congress, Washington 25, D.C.*

Frequency Standard

A preliminary analysis has been made of the behavior of quartz crystal over a wide range of frequencies at very low ambient temperatures. Some experimental results are given for the temperature coefficient and Q as a function of temperature. An analysis is made of the effects on frequency resulting from variations in circuit reactances and tube-gain characteristics for two kinds of oscillators, with a comparison of the theoretical stability limitations of both types. *An Ultra-Precise Standard of Frequency, R. A. Sykes, Bell Telephone Laboratories, Inc., Whippany, N. J., Nov. 21, 1956, 39pp, Microfilm $3.00, Photocopy $6.30. Order PB 143348 from Library of Congress, Washington 25, D. C.*

Microwave Filters

Tunable bandpass microwave filters with independently adjustable upper and lower cutoff frequencies have been developed. These filters use the hybrid junction cutoff waveguide structure, modified by the introduction of variable height ridges in the cutoff waveguide sections. The center frequency of the pass band can be varied over a maximum band of 20 per cent and the bandwidth can be varied from 1.5 per cent to 20 per cent with low pass band losses. The maximum insertion loss at mid-band is 1.0 db for the narrowest bandwidth. It has been shown that this loss can be significantly reduced by minimizing the reflections from the tapered line inputs to the cutoff waveguide sections. *Tunable Microwave Filters, Danlyo Jacenko and Eugene N. Torgow, Microwave Research Institute, Polytechnic Institute of Brooklyn, N. Y., May 6, 1959, 67pp, Microfilm $3.90, Photocopy $10.80. Order PB 143768 from Library of Congress, Washington 25, D. C.*

Solid State Receivers

With new variable reactance semiconductor diodes, ferrites, and maser materials and techniques, broad-band and narrow-band receivers have been built up to X-band frequencies. Their effective noise temperatures have been less than 200°K. The relative importance of these various types of solid state receivers and their future possibilities are presented. *Recent Advances in Solid State Receivers, Wesley G. Matthel, Army Signal Research and Development Laboratory, Forth Monmouth, N. J., Oct. 15, 1958, 29pp, Microfilm $2.70, Photocopy $4.80. Order PB 143352 from Library of Congress, Washington 25, D. C.*

Crystal Oscillators

This manual provides the information necessary to select a crystal oscillator design for operation at frequencies throughout the 0.8 to 150 mc range. It indicates methods of predicting the performance characteristics of these circuits under wide variations in operating conditions. In general, output voltage predictions are within 20 per cent of the values indicated for specific oscillator circuit designs. Crystal drive prediction accuracy is within 30 per cent. This latter figure is based on measurements of crystal voltage and assumed resistive operation of the crystal. *Design Data For Crystal Oscillator Circuits, Harold E. Gruen and Alan O. Platt, Armour Research Foundation, Chicago, Ill., Aug. 1957, 160 pp, Microfilm $7.50, Photocopy $24.30. Order PB 143562 from Library of Congress, Washington 25, D.C.*

REPORT BRIEFS

Magnetic Amplifier Circuits Part 1—The Series Circuit with a Nonlinear Inductor

Free oscillations of a circuit are examined for circuits with nonlinear restoring force, under influence of a driving force. Forced oscillations are then investigated and two different stable first integrals are obtained—one associated with the forced oscillations and going to zero with the driving force; the other associated with the free oscillations of the circuit, remaining finite as the driving force goes to zero. The mechanism of subharmonic generation is discussed, explaining under what conditions subharmonics of the driving force may be generated in the circuit response. This doctoral thesis contains four appendices with calculations and discussions. *Magnetic Amplifier Circuits: Part 1–The Series Circuit with a Nonlinear Inductor, A. Rasiel, Yale University for Wright Air Development Center, U.S. Air Force, May 1959, 101 pp, $2.50. Order PB 161142 from OTS, Washington 25, D. C.*

Magnetic Amplifier Circuits Part 2—The Full-Wave-Bridge Amplifier with Two-Terminal Loads

This report describes the physics of a "universal" full-wave-bridge magnetic amplifier. It analyzes several circuits and connection configurations for two-terminal loads. Many aspects of the amplifier are explained and mathematical relationships of various components derived. *Magnetic Amplifier Circuits: Part 2–The Full-Wave-Bridge Amplifier with Two-Terminal Loads, R. C. Barker, Yale University for Wright Air Development Center, U.S. Air Force, May 1959, 100 pp, $2.24. Order PB 161086 from OTS, Washington 25, D. C.*

Bandwidth Conservation

New advances in communications theory are discussed in terms of television bandwidth conservation. Purely theoretical possibilities and those demonstrated practical by experiment are distinguished between. Suggested courses of action are tempered by what has been most readily acceptable by the industry, and what can be counted on for adequate engineering compliance with theoretical design requirements. *Communication Theory Aspects of Television Bandwidth Conservation, W. C. Coombs, NBS Technical Note 25, Aug. 1959, 27 pp, $0.50. Order PB 151384 from OTS, Washington 25, D. C.*

K-Band Mixer Diode

Gallium-arsenide diodes were developed with very low noise figures (10, 16, and 24 kmc) and an upper operating limit of 300 C. In addition, their frequency response is flat within 2 db over the range 20 to 300 C, a considerable improvement over germanium or silicon. During the successful research, equipment was adapted to purify gallium arsenide and the two elements prior to reaction. Conditions for growth of single crystals were established. An internal geometry was adapted to the compound and a fabrication process developed. Fabrication problems such as crystal-to-stud bonding, optimum whisker shape, and whisker contact radius were solved. Fifty diodes were manufactured. *Improved K-Band Semiconductor Mixer Diode, W. L. Barnes, B. V. Lawson, and C. Wood, Philco Corp. for Wright Air Development Center, U.S. Air Force, June 1959, 97 pp, $2.25. Order PB 151970 from OTS, Washington 25, D. C.*

Magnetron Amplifier

An experimental two-circuit backward-wave magnetron amplifier was developed. Low-level operation showed a dependence of gain on beam velocity and current like that of the equivalent O-type device. An over-all stable gain of 10 db was easily obtained. In studies of the effect of beam spread, an attempt was made to correlate experimental results with theoretical models for magnetron operation. One model showed some promise for describing the interaction. The tube proved very valuable in giving information on the dc beam model and the character of growing waves on this beam. However, it did not appear practical as either a small-signal or large-signal backward-wave amplifier. The report recommends some design modifications for a more practical tube. *Experimental Study of Cascade Backward-Wave Magnetron Amplifier At Low Levels, J. W. Kluver and G. A. Becker, University of California for Wright Air Development Center, U.S. Air Force, Jan. 1959, 38 pp, $1.00. Order PB 151829 from OTS, Washington 25, D. C.*

Radio Propagation Attenuation

Reports a survey of transmission losses expected for a wide range of conditions, including distances from 10 to 10,000 statute miles, radio frequencies from 10 kc to 100,000 mc, vertical or horizontal polarization, ground waves, ionospheric waves, and tropospheric waves, rough or smooth sea water or land, and various geographical and climatological regions. *Transmission Loss in Radio Propagation—2, K. A. Norton, NBS Technical Note 12, June 1959, 156 pp, $3.00. Order PB 151371 from OTS, Washington 25, D. C.*

STANDARDS AND SPECS

AF Redesigns Publications Spec For Ground Communication Items

The Rome, N.Y. Air Materiel Area has released a new publications spec that covers all phases of servicing ground electronic communications equipment. The new manual includes all information necessary for installation, operation, maintenance, calibration and repair of the equipment.

All instructions to maintain the equipment are in the manual, except preventive maintenance procedures at the apprentice level and complete circuit diagrams of the equipment and its components. Under the new concept, there will be only one manual, of which volumes cannot be more than 1-in. thick.

Separate preventive maintenance handbooks are no longer required for ground electronics equipment. The new spec calls for work cards only.

Information for alignment and adjustment of the equipment will be in pocket-sized manuals, but these will not list specialized factory procedures.

A section of the spec, providing parts breakdowns, states that electrical accounting machine copy is preferred. The application of techniques specified in MCP Exhibit 71-673 is limited to the group assembly parts list.

Electrical accounting machine copy is also suggested for the illustrated parts breakdown. The new spec has changed the arrangement of the breakdown. Section 2 of the spec is now the numerical index, and section 3 is the reference designation index. The group assembly parts list is now section 4.

Apparently it will be standard practice to have a separate circuit diagram manual, which will contain block and schematic diagrams, voltage and resistance charts, waveforms, cabling diagrams and system signal diagrams.

The general instructions for preparation of manuals contain several new requirements. There are now two kinds of Air Force manuals: Grade I, covering equipment procured for general service in the field; and Grade II, covering equipment procured through developmental-model or service-test-model contracts.

Grade II manuals may be produced on bond paper, to be reproduced by the Xerox method, or may be typed directly on paper multilith masters.

An outstanding new requirement for Grade I

manuals is that unjustified office composition—that is, typewritten pages whose right-hand margins are uneven—may be supplied for reproduction copy. When using office composition, it is not necessary to strip-in or vary type for primary side heads.

To support this new effort, RAMA will review technical publications submitted by contractors. In addition it is planned that each future C-E contractor receive the authority to print AF technical orders resulting from his equipment contract without the extensive delays required by separate negotiations, funding, etc.

Item Descriptions

Every production contract must supply descriptive identification data. The Air Force has revised its spec covering the procedures, terms, and conditions for supplying these data.

The new requirements for submitting prescreening data call for item descriptions to be sent directly to the Inventory Manager using new forms. Provision has been made for the emergency assignment of Federal Stock Numbers.

This new technique should obtain stock numbers within seven days. MIL-D-26715B(USAF), Descriptive Identification Data To Be Furnished By Government Suppliers, 1 January 1960.

Soldering Techniques Described In New Navy Spec

The Navy has released a new spec to establish the requirements for soldering to standard-type solder terminals. These requirements are applicable to electrical and electronic equipment. Soft solder having flow temperatures below 800 F is specified. The spec covers the preparation of connection materials, the placement of leads and wires, and the procedures for soldering. Also included are quality assurance provisions and precautions. MIL-STD-440(SHIPS), Soldering Techniques for Standard Type Solder Terminals.

Precision Resistors

Fixed precision wirewound resistors of 1 per cent accuracy and better are covered by this recently issued EIA standard.

Normally the resistors can operate from dc to 10 kc. The noise level of resistors conforming to this standard is inherently low, approaching the thermal agitation level. When used within the design limits specified, the change in resistance with life will not exceed 50 per cent of the initial resistance tolerance.

Copies are available from Electronic Industries Association, 11 W. 42nd St., New York 36, N.Y., $1.10 each. Specify EIA RS-229, Fixed, Wirewound, Precision Resistors, issued December 1960.

YOUR CAREER

NEWS AND NOTES

Industrial engineering recruiters working the nation's campuses are doing a good job, a recent survey suggests. The survey, conducted by the American Management Assoc., sampled the opinions of 139 college placement officers.

Ninety per cent felt that recruiters were effective company representatives. And 80 per cent thought that recruiters were able to evaluate students effectively.

The college placement officers offered the following rule-of-thumb advice to recruiters:

- Discuss the candidate's interests and qualifications, and spend less time on information that can be given to him in writing.
- Make sure the company literature includes job descriptions, not just glamorous generalizations.
- If you do not want students with less than a B average, state this plainly.
- Explain beginning jobs accurately. Let the applicant know the good as well as the bad about his prospective job.
- Evaluate candidates objectively. See each man as an individual, not as a potential cog in a machine.

• • •

Most recent electrical engineering graduates are receiving starting salaries just a shade less than their instructors get, two reports indicate. One is from the Case Institute of Technology, Cleveland, and the other from the Research Div. of the National Education Association.

The association reported that the median salary paid to male instructors in colleges and junior colleges was between $560 and $575 a month. According to Case Institute, its electrical engineering graduates have received an average starting salary of $532 a month.

The association noted that there were 1,300 teachers in American colleges who earned $15,000 a year or more. At the same time, it continued, 13,000 teachers earn less than $5,000 for an academic year.

• • •

Most American families are changing their residences because daddy is an electronics executive.

This is the conclusion of a recent survey by Sales Management Magazine, New York.

It reports that companies engaged in electronics research, development and manufacturing are sending more and more of their top personnel to new plants in the South, West and Southwest. These companies are responsible for most of the nation's interstate migration, the magazine said.

Advancement Your Goal? Use CONFIDENTIAL Action Form

ELECTRONIC DESIGN's Confidential Career Inquiry Service helps engineers "sell" themselves to employers—*as confidentially and discreetly as they would do in person.* The service is fast. It is the first of its kind in the electronics field and is receiving high praise from personnel managers.

To present your job qualifications immediately to companies, simply fill in the attached resume.

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

ELECTRONIC DESIGN will act as your secretary, type neat duplicates of your application and send them to all companies you select—*the same day the resume is received.*

The standardized form permits personnel managers to inspect your qualifications rapidly. If they are interested, they will get in touch with you.

Painstaking procedures have been set up to ensure that your application receives complete, confidential protection. We take the following precautions:

- All forms are delivered unopened to one reliable specialist at *ELECTRONIC DESIGN.*
- Your form is kept confidential and is processed only by this specialist.
- The "circle number" portion of the form is detached before the application is sent to an employer, so that no company will know how many numbers you have circled.
- All original applications are placed in confidential files at *ELECTRONIC DESIGN,* and after a reasonable lapse of time, they are destroyed.

If you are seeking a new job, act now!

ELECTRONIC DESIGN CAREER INQUIRY SERVICE

USE BEFORE JUNE 22, 1960

CAREERS

After completing, mail career form to *ELECTRONIC DESIGN,* 830 Third Avenue, New York, N. Y. Our Reader Service Department will forward copies to the companies you select below. (10)

(Please print with a soft pencil or type.)

Name _____ *Telephone* _____

Home Address _____ *City* _____ *Zone* _____ *State* _____

Date of Birth _____ *Place of Birth* _____ *Citizenship* _____

Position Desired _____

Educational History

College	*Dates*	*Degree*	*Major*	*Honors*

Recent Special Training _____

Employment History

Company	*City and State*	*Dates*	*Title*	*Engineering Specialty*

Outstanding Engineering and Administrative Experience _____

Professional Societies _____

Published Articles _____

Minimum Salary Requirements (Optional) _____

Use section below instead of Reader Service Card. Do not write personal data below this line. This section will be detached before processing.

Circle Career Inquiry numbers of companies that interest you

900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924

925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949

YOUR CAREER!

Does it still hold its stimulating challenge? Are all of your abilities being utilized? Have you gone far enough, fast enough?

Today, Motorola's rapid expansion in the Chicago area has created an immediate need for experienced engineering talent. Never before have secure career opportunities been more abundant, challenging and rewarding—in a wide selection of electronic fields.

A picture-packed 36 page booklet is waiting for you. It details the work, the people, the living at Motorola. If you are sincerely seeking broader career opportunities and responsibilities, investigate Motorola immediately.

- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstrom, traveling wave tube and backward wave oscillator
- Display and storage devices

2-WAY RADIO COMMUNICATIONS

- VHF & UHF receiver
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering
- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

Also Splendid Opportunities In:

Phoenix, Arizona and Riverside, California

Send Complete Resumé to:

MR. L. B. WRENN
Engineering Personnel Mgr.
Dept. B
4501 Augusta Blvd.
Chicago 51, Illinois

EQUAL JOB OPPORTUNITY For All Qualified Applicants

MOTOROLA Inc.

CIRCLE 905 ON CAREER INQUIRY FORM

CAREER OPPORTUNITIES BROCHURES

CONSOLIDATED ELECTRODYNAMICS

Consolidated Electrodynamics

A four-page folder describing briefly the overall picture of the work done by Consolidated Electrodynamics and its subsidiaries is available.

One feature of the bulletin is a detailed map of greater Los Angeles carrying the locations of the CEC operations in California.

Consolidated Electrodynamics. 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 870 ON READER-SERVICE CARD

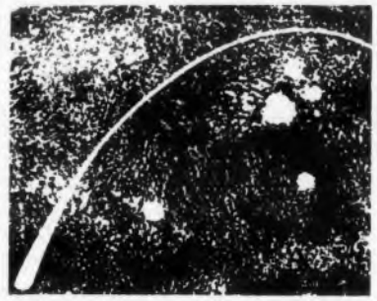
McKiernan-Terry

"Career Opportunities" is a six-page brochure on the McKiernan-Terry Corp., an organization of manufacturing engineers. They specialize in the design, engineering and manufacture of precision equipment for industrial and defense markets. Commercial products include construction equipment, materials handling equipment, textile finishing machinery and heavy mechanized structures. McKiernan-Terry has pioneered in the field of dynamic-flight- and motion-simulation devices. Radar equipment, electro-hydraulic and pneumatic devices and sonar equipment are other fields in which McKiernan-Terry excel.

McKiernan-Terry offers career opportunities to antenna-design, project- and machine-design engineers. The corporation maintains two plants; one at Dover, N.J., and the other at Harrison, N.J.

Engineering Personnel, McKiernan-Terry Corp., Dept. ED, 100 Richards Ave., Dover, N.J.

CIRCLE 871 ON READER-SERVICE CARD



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offers the opportunity and the challenge of key assignments in...

GUIDED MISSILE ELECTRONICS

ELECTRONIC ENGINEERS

MECHANICAL ENGINEERS

Here is your chance to prove your ability doing *important* work on missile fuzing, beacons, guidance, packaging and related test equipment. We have key openings that offer you the opportunity to move ahead rapidly in your profession. At Bendix York, you benefit from the advantages of a small company atmosphere in a growing division of one of the nation's largest engineering and manufacturing corporations. Also, you'll enjoy the "good life" in our beautiful suburban community. Good salaries, all employee benefits.

Drop us a card, briefly stating your education & experience. We'll act immediately to get together with you and talk it over.

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PLACEMENT
DEPT. D

Bendix
AVIATION CORPORATION
York Division
York, Penna. York 47-1951

CIRCLE 906 ON CAREER INQUIRY FORM

ENGINEERS:

A NEW CONCEPT IN PROFESSIONAL JOB SELECTION

New technical tests enable you to calculate your probability for success at LMED – in 1 hour at your own home!

BY GENERAL ELECTRIC'S LIGHT MILITARY ELECTRONICS DEPARTMENT

If you've been thinking of changing your job some day—or in the near future—but have hesitated because of the many uncertainties involved, Light Military's new concept in professional job selection will be of paramount interest to you.

What is it?

The new concept is based on a series of technical tests developed and pretested by Light Military engineers. They are designed to be taken, scored and evaluated by the individual engineer, all in the privacy of his own home. And, because the sole purpose is to provide you with a novel, objective means for self-appraisal, your score need not be divulged to us at any time.

Here's how it works:

First, fill out the coupon below and check off the tests which apply to your training and professional experience. Forward the completed coupon to us and in a few days you will receive the tests, a sealed answer sheet and explanatory material.

During a convenient hour at home, take the test and score it with the answer sheet provided. Then, compare your performance with the criterion group composed of Light Military engineers at all levels who took the same test. In most cases you will be able to relate your score to years of experience, from 2 to more than 10.

What it measures:

If your adjusted score is equal to, or more than the years of experience you possess, the probability is excellent that a significant community of technical interest exists between you and The Light Military Department. In addition, a valid assumption can be made that a high probability for success awaits you here. And remember, your score need not be divulged to us at any time; it is for your own guidance exclusively!

CURRENT AREAS OF ACTIVITY AT THE LIGHT MILITARY DEPT.

SPACE COMMUNICATIONS & TELEMETRY • MISSILE & SATELLITE COMPUTERS • SPACE VEHICLE GUIDANCE • UNDERSEA WARFARE SYSTEMS • THERMOPLASTIC DATA STORAGE • SPACE DETECTION & SURVEILLANCE • COMMAND GUIDANCE & INSTRUMENTATION • INFRARED MISSILE APPLICATIONS

Facts about the tests

1. Each technical test is composed of 40 multiple choice questions.
2. To find answers for some questions, mathematics is involved—but only to the degree normally associated with the work.
3. The "mix" of questions includes some easy ones, some bordering on the state of the art.
4. None of our engineers achieved a perfect score.
5. The test for Engineering Administration is psychological, designed to reveal aptitudes and abilities most often found in good engineering managers or administrators.

Reply direct, using coupon in ad.

MAIL THIS COUPON FOR YOUR TESTS

76-ME

Mr. R. Bach
Light Military Electronics Dept.
General Electric Company, French Road, Utica, New York

Please send me tests (limited to 2 subjects per individual) answer and self-evaluation sheets covering the areas checked:

☐ RADAR ☐ MICROWAVE ☐ ELECTRONIC PACKAGING (ME)
☐ COMMUNICATIONS ☐ ADMINISTRATIVE ENGINEERING

NAME _____

HOME ADDRESS _____ HOME PHONE _____

CITY _____ ZONE ____ STATE _____

DEGREE(S) _____ YEAR(S) RECEIVED _____

LMED
LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

CAREER BROCHURES

Texas Instruments

"The Business of Texas Instruments, Inc." presents the story of the company and its divisions in a 36-page illustrated brochure. Texas Instruments has steadily advanced the science of geophysics for finding oil.

Texas Instruments' Geosciences and Instrumentation Div. is widely experienced in designing and manufacturing geophysical and industrial instruments and systems.

Texas Instruments' policies include insurance protection, educational assistance, service recognition, retirement pensions, and a profit-sharing program.

W. T. Hudson, Manpower Director, Texas Instruments, Inc., Dept. ED, P. O. Box 1079, Dallas, Texas.

CIRCLE 872 ON READER-SERVICE CARD

Rand Corp.

"The Rand Corporation," a 42-page illustrated brochure, describes the organization's activities and employe benefits.

Located in the Civic Center of Santa Monica, Calif., The Rand Corp. is a non-profit research organization, presently involved in problems of importance to national security. The Corporation operates Project Rand under a contract with the United States Air Force, conducts research for the Atomic Energy Commission, and maintains a program of Rand-sponsored research.

Research under Project Rand is carried on through five technical divisions: Economics, Engineering, Mathematics, Physics, and Social Science.

Inquiries concerning employment should be addressed to: Mr. David Lederer, Personnel Manager, The Rand Corporation, 1700 Main St., Santa Monica, Calif.

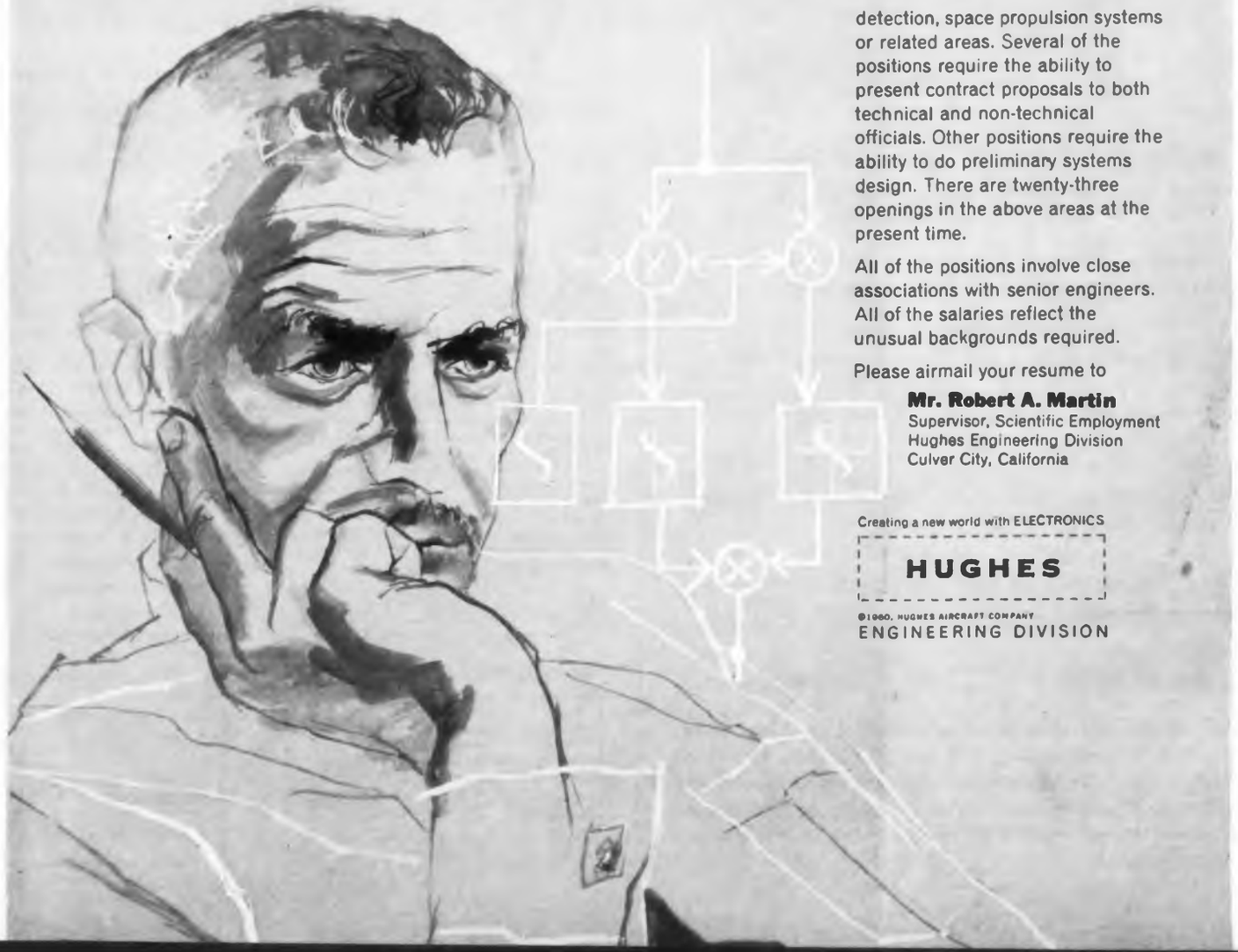
We promise you a reply within one week

The complexity of modern technology...the rapid increase in the number of specializations...and the frequent shifts in technological emphasis all have combined to require a staff of alert, aggressive, creative teams of engineering specialists. Their responsibility is to assist management in the formulation of plans for future efforts.

For our purposes the teams should be staffed by graduate Electronic Engineers and Physicists who have acquired several years of experience with radar, guided missiles, computers, infrared detection, nuclear radiation equipment, micro-electronics, underwater

Opportunities in:

Exploratory Studies · Advanced Planning · Systems Analysis



detection, space propulsion systems or related areas. Several of the positions require the ability to present contract proposals to both technical and non-technical officials. Other positions require the ability to do preliminary systems design. There are twenty-three openings in the above areas at the present time.

All of the positions involve close associations with senior engineers. All of the salaries reflect the unusual backgrounds required.

Please airmail your resume to

Mr. Robert A. Martin
Supervisor, Scientific Employment
Hughes Engineering Division
Culver City, California

Creating a new world with ELECTRONICS

HUGHES

ENGINEERING DIVISION

another electronic engineer becomes an editor....

Alfred Rosenblatt tells "Why I Became an Editor of

ELECTRONIC DESIGN"

Alfred Rosenblatt, BEE, was employed as an electronic engineer before joining Hayden Publishing Company, Inc. Now an engineer-editor, he tells of the advantages from such a change.

"***as an editor*** you combine your technical knowledge with the challenge of relaying this knowledge to thousands of interested engineers.

"***as an editor*** you are in on the news as it happens . . . before it happens.

"***as an editor*** you have the opportunity to contact a variety of people while working on a variety of technical projects.

"***as an editor*** your opinions are valued; you maintain your individuality.

ELECTRONIC DESIGN OFFERS YOU A CAREER IN EDITORIAL WORK

For further details and description of editorial positions open, write to Edward E. Grazda, Editor, ELECTRONIC DESIGN, 830 Third Ave., New York 22, N.Y. Or begin at once by sending us the Resume Form in the Career Opportunities Section of this issue and circling the Reader Service Number listed below. Each application will receive careful attention.

CIRCLE 911 ON CAREER INQUIRY FORM

Opportunities in:

GROW with Kollsman

Kollsman's leadership and continuing growth in the field of automatic navigation and flight instrumentation assures excellent opportunities for qualified men. Send resumes to Mr. T. A. DeLuca.

FLIGHT DATA INSTRUMENTS & SYSTEMS
Senior Project Engineers, EE & ME

For aircraft and missile instrumentation. 5 to 10 years project experience in precision electromechanical devices.

AUTOMATIC ASTRO TRACKING SYSTEMS
Project Engineers, EE

For automatic astro tracking systems. Up to 5 years related experience.

STAFF ENGINEERS & SPECIALISTS

a. Experience in the research and development of transistors in servo, digital and instrumentation application. Minimum 3 years experience desired in transistor circuit design for military applications.

b. Experienced with IR to UV radiation properties and applications, noise theory and detectors.

c. Optics – IR through visual optical design, lens design, materials.

d. Digital computers – logic or packaging experience.

e. Theoretical mechanics – inertial and trajectory studies.

kollsman INSTRUMENT CORPORATION

80-08 45th AVENUE, ELMHURST, NEW YORK • SUBSIDIARY OF *Standard* COIL PRODUCTS CO., INC.

CIRCLE 912 ON CAREER INQUIRY FORM

Engineers, Physicists

Your talent and time are worth more to you— and to your family—in Minneapolis

Talent and time are man's most precious tools—but, unfortunately, they are also his impediments.

If you suspect that you could put your talent and time to more productive and rewarding work, investigate opportunities at General Mills, in Minneapolis. We respect creative freedom, encourage innovation, recognize and appreciate professional competence. In short, we provide the environment that brings out the finest talents in engineers and scientists. And then we give these creative people rein to ply their talents against intriguing problems in fields that interest them most.

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Time in the laboratory. Time with your family. Ninety percent of our people live within 25 minutes from work. A short drive takes them to some of the best hunting, fishing and camping sites anywhere. Some of them live right next to a park, lake or golf course.

At General Mills, in Minneapolis, you have time to know your family, yourself and your contribution to the future.

Make the most of your talent and time in one of these fields—at General Mills

- **Digital System Configuration**
- **Electronic Circuit Design**
- **Micro-wave Development**
- **Digital Computer Logic**
- **Electronic Packaging**
- **Advanced Pulse and Video Circuit Development**
- **Advanced Inertial Navigational System Development**
- **Optical and Infra-Red Equipment Engineering**

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Manager Professional Employment
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Minneapolis 13, Minnesota

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Address .....
City ..... Zone .... State .....
College ..... Degree ..... Year .....

MECHANICAL DIVISION General Mills

CIRCLE 913 ON CAREER INQUIRY FORM

Look into the Special Challenges and Rewards of Industrial Electronics specifically:

MOBILE RADIO

at General Electric's growing Communication Products Department

RECEIVER DESIGN

This senior level opening carries system design responsibility for the receiver portion . . . with full support of design engineers and technical specialists. Experience should include tubed FM receiver design; background in entertainment receiver design acceptable. Equipment under development utilizes both tube and transistor circuitry.

TRANSMITTER DESIGN

Involves developing miniature and subminiature circuitry for pocket communications, design of transistorized oscillators, modulators and multiplexers . . . and designing power amplifiers involving both conventional and non-conventional techniques.

POWER SUPPLIES

Includes design of vehicular power supplies utilizing novel circuitry, transistors and other new semiconductor devices. May also include design of power supplies based on solar and other novel energy sources.

also openings for Electronics Technicians

A LOOK AT OUR GROWTH PICTURE

A review of the past 5 years' mobile radio equipment sales and conservative predictions of market and Department growth indicate that those who join us now are likely to enjoy greatest opportunities for advancement.

OUR LYNCHBURG LOCATION

Here you and your family will enjoy traditional charm and hospitality combined with all the conveniences of a progressive cultural and recreational center and the advantage of a pleasant Virginia climate.

Please write in confidence to Mr. W. J. Kelly, Dept. 76-ME.

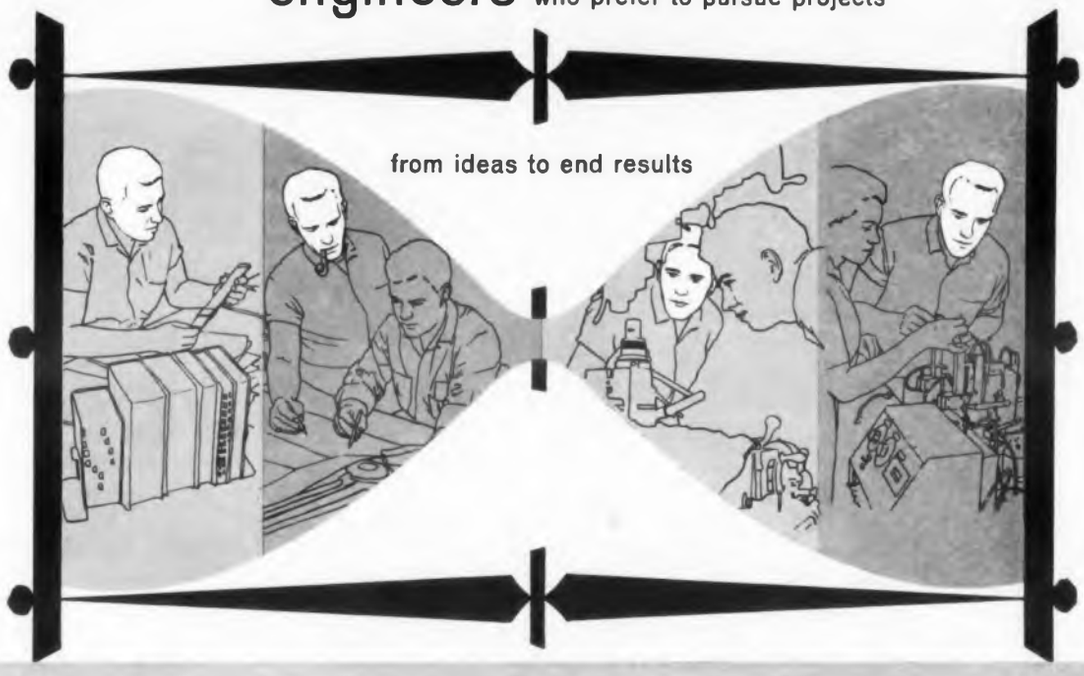
COMMUNICATION PRODUCTS DEPT.

GENERAL ELECTRIC

Mountain View Road,
Lynchburg, Virginia

CIRCLE 914 ON CAREER INQUIRY FORM

T/I S-C wants senior electro-mechanical engineers who prefer to pursue projects



You won't find frustrating bottlenecks in TI's immense semiconductor mechanization program. Unhampered progress toward ideal end results is assured because TI permits mechanization engineers to stay with their projects from beginning to end. Hence the remarkably short time interval between conception and production of new TI semiconductor manufacturing machines and the devices they produce.

In a broader sense your work will be a cooperative venture. For at TI S-C you are free to work even in the shop with tool makers, as with all other professional and technical specialists whose talents will help you convert your conceptions into realities. In this ideal working climate your challenging assignments will include design, development and evaluation of mechanical, electronic and electrical mechanization equipment of widely varying types and sizes.

succeed in '60 with T/I

Requirements include a BS or MS in Mechanical or Electrical Engineering with emphasis on mechanical or servo-mechanism design and at least three years in two of the following fields: design of semiconductor test equipment, mechanized semiconductor machinery, computers, servos.

whether applying or not, mail coupon for your copy of TIps *today and learn more about T/I Semiconductor-Components division.*

INTERVIEWS are scheduled for your area. If qualified for this position please send confidential resume immediately to C. A. BESIO, Dept. 112.

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SEMICONDUCTOR – COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

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TEXAS INSTRUMENTS INCORPORATED
Semiconductor-Components Division
P. O. Box 312, Dept. 112. Dallas, Texas

Please send me TIps, containing specific facts about now available T/I S-C assignments *in my field,* and related information.

NAME _____

ADDRESS _____

CITY _____ STATE _____

My professional field is _____

My specialty is _____

CIRCLE 915 ON CAREER INQUIRY FORM

ADVERTISERS' INDEX

May 11, 1960

IDEAS FOR DESIGN—*ENTRY BLANK*

To the *Ideas-For-Design* Editor of ELECTRONIC DESIGN —
830 3rd Ave., New York 22, N.Y. • PLaza 1-5530

Here is my design idea for possible publications in your *Ideas For Design* department. I can expect $10 for this idea if accepted for publication.

(Ideas suitable include: *1.* new circuits or circuit modifications, *2.* new design techniques, *3.* designs for new production methods, *4.* clever use of new materials or new components in design, *5.* design or drafting aids, *6.* new methods of packaging, *7.* design short cuts, or *8.* cost saving tips)

STATEMENT OF THE PROBLEM—

MY SOLUTION. AND WHY—(Please be explicit. Include sketches or photos that will help the idea across)

Name_____

Title_____

Company_____

Address_____

(Place illustrations on separate sheet if necessary)

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Recognizing the power of the printed word to influence, it is ELECTRONIC DESIGN's policy:

To make all reasonable effort to insure accuracy of editorial matter.

To publish promptly corrections brought to our attention.

To not knowingly publish misleading advertisements.

To reserve the right to refuse any advertisement.

Readers noting errors or misstatements of facts are encouraged to write the editor.

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ELECTRONIC DESIGN

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