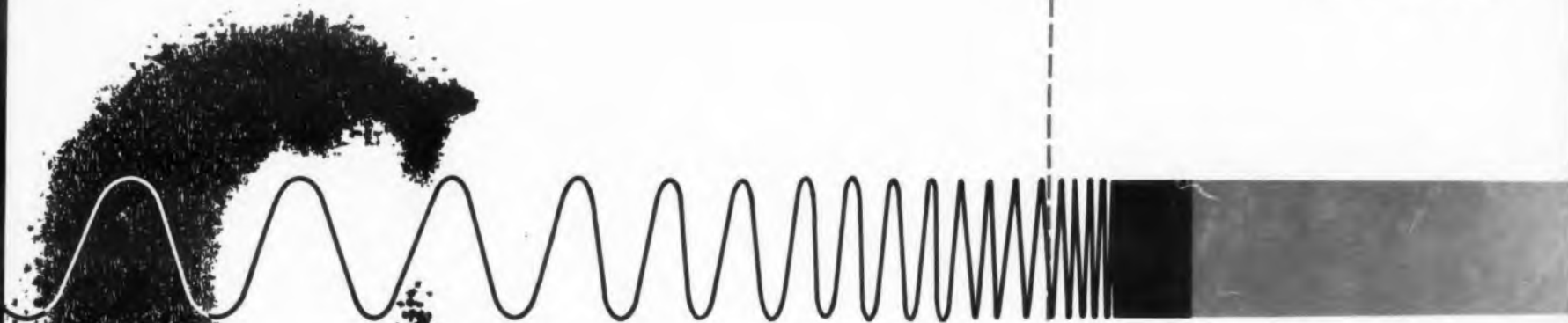


ELECTRONIC DESIGN

MAY 11, 1960

CS + AD



PRECISION SLOTTED WAVEGUIDE FOR 2 mm ... P 76
PRECISION SLOTTED WAVEGUIDE FOR 2 mm ... P 76



PRECISION SLOTTED WAVEGUIDE FOR 2 mm ... P 76
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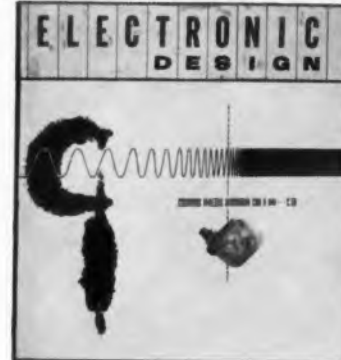
During this 20 month period, Clifton Precision was under the heaviest pressure for deliveries in its history, but was still able to deliver 14,580 acceptable units 9 calendar days ahead of promised delivery schedules on an average.



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CIRCLE 1 ON READER-SERVICE CARD



COVER: Precision measurement of vswr in the 2-mm range of microwaves is the subject of this issue's cover. *ELECTRONIC DESIGN*'s art director has used a micrometer to symbolize the order of precision involved. The frequency spectrum represents the range of the electromagnetic energy from the vhf to the infrared band. The dotted corner indicates the portion of the spectrum at which this device, with its companion pieces, operates. Its introduction pushes the frontier of coherent microwaves to the very door of infrared.

Selected Topics in This Issue

Communications

- 20-kc NBS Frequency p 3
- High Power Sin² Pulses p 6
- Corner-Reflector Antenna p 25

Computers

- Computer Index Literature p 1
- Commercial Alpha-numeric Reader p 2
- Digital Tape Transport p 7
- Punched-Tape Reader p 19

Materials

- Magnetic Properties of Core Materials p 5
- IR Transmitting Materials p 7

Microwaves, Radar

- Storage Technique Lengthens Side-Looking Radar p 12
- 2-mm Slotted Section Shifts Standing Wave p 7

Semiconductors, Circuits

- Transistor Reactor For Navy Find Transistor Gain p 32
- And Input Impedance p 52
- Micro-Energy Transistor p 74
- Transistor Circuits p 236

Systems

- Microcircuitry Packaging p 8
- Power Sources p 10

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.

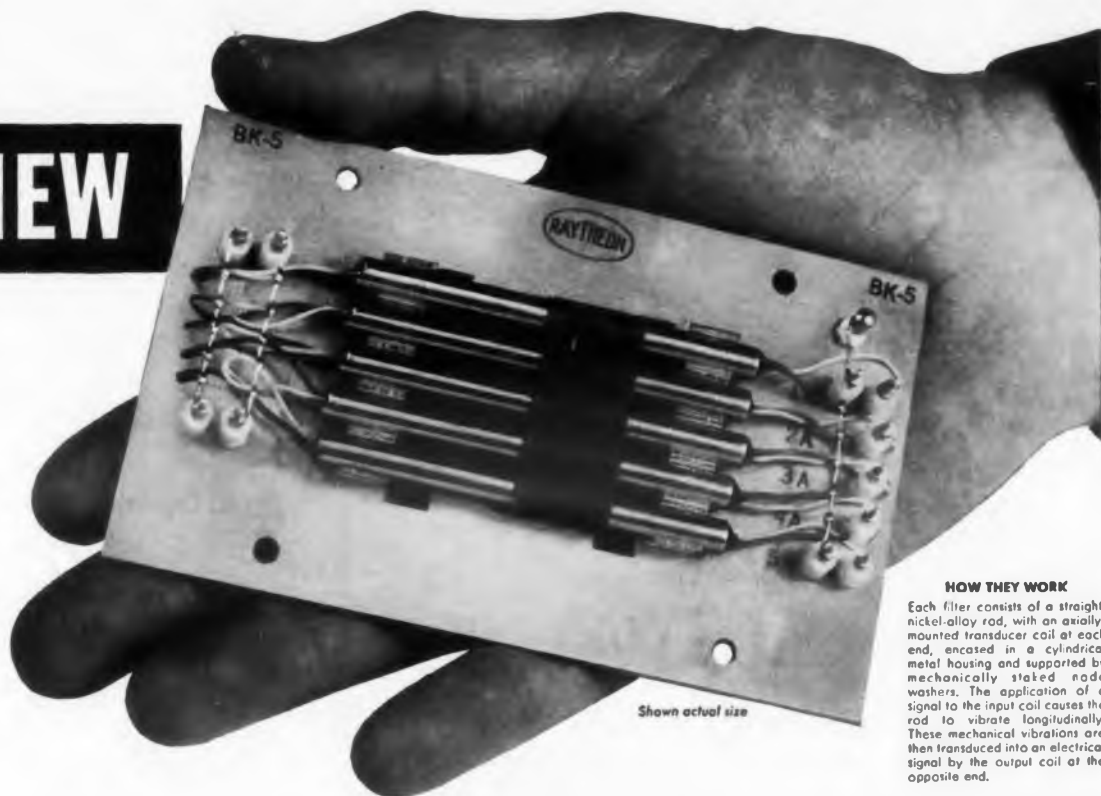
According to those in the know, the situation is critical but not hopeless. *ED*'s comprehensive coverage of this all-important phase of national defense tells how industry and the military can best serve the national interest.

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.

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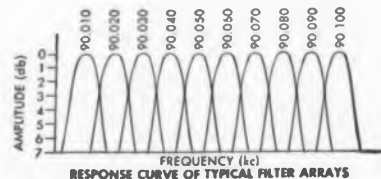
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CIRCLE 3 ON READER-SERVICE CARD

- | | |
|--|----|
| We Need Some Rules for The "Numbers" Game | 43 |
| An Editorial | |
| A Stable Transistor AGC Amplifier | 44 |
| Full design steps for an agc amplifier using a servo-type closed-loop feedback network for high stability. A typical design problem is worked out as an example of the design procedure—J. Shirman | |
| An Engineer's Guide to Straight-Pull and Rotary Solenoids | 48 |
| A roundup of the important solenoid types and how they're best applied—C. R. Strain | |
| Find Transistor Gain and Input Impedance Quickly Using Hybrid-Pi Equivalent | 52 |
| A simple transistor equivalent with a simple procedure for finding necessary parameters—P. Margolin | |
| What Happens to Magnetic Properties of Core Materials at Elevated Temperatures | 56 |
| Effect of high temperature on some commonly used core materials—D. E. Meehan | |
| Generation of High Power Sin² Video Pulses | 60 |
| Design information, plus design example, of a medium-power modulator to produce a non-rectangular pulse shape for radar operation. By reducing the radiated spectrum, RFI effects on adjacent equipment is greatly minimized.—A. P. Standing | |
| Hall Generator Fluxmeter | 64 |
| A practical application of a Hall effect generator | |
| Make Your Own Basic Line Nomograms, Part 1 | 66 |
| A simplified approach to making line nomograms to solve many general equations—B. R. Hatcher | |
| Infrared Transmitting Materials | 70 |
| Latest information on materials that pass infrared radiation—T. Lusk | |
| Micro-Energy Transistor Switches Even Low Power—Fast | 74 |
| A new transistor to switch levels as low as 1 ma at 1 v | |
| 2-Mm Slotted Section Shifts Standing Wave Past Fixed Probe | 76 |
| Makes commercial exploitation of 2-mm band possible | |
| Digital Tape Transport Has 5-Msec Start-Stop Time | 78 |
| Tape speeds adjustable from ½ to 45 in. per sec. | |
| Sequence Programmer Measures Less Than 1-3/4 In. Long | 79 |
| Its weight is 0.9 oz. | |

ELECTRONIC DESIGN News 4

Systems Researchers Link Talents for Progress p 4	Alphanumeric Reader Due in Commercial Versions p 26
Airborne TV to Serve Schools in Midwest p 4	NBS 20-Kc Standard Frequency Accurate to 10^{10} p 30
Microcircuitry Packaging Concept p 8	Transistor Reactor Controls for Navy's Atom Destroyer p 32
Storage Technique Lengthens Army Side-Looking Antenna .. p 12	EIA Condemns Bills Allowing FCC Pick Receiving Channels p 38
Computer Uses "Key Word" to Index Scientific Literature .. p 14	News Briefs p 41

Design Decisions 190

Getting Down to Cases p 190	Punched-Tape Reader p 193
-----------------------------------	---------------------------------

Engineering Data 195

High-Frequency Cable Length Nomogram p 195
--

Ideas for Design 228

Adjustable Multi Bias Allows Variable Frequency Operation p 228	Transistorized Neon Drivers Eliminate Leakage Glow ... p 230
Crystal Oscillator Provides Good Load Isolation p 229	Log-Log Slide Rule Converts Directly to Db p 231

Books 236

New Manual Collects Reliable, Well-Designed Transistor Circuits p 236

Russian Translations 240

Millimicrosecond Pulse Generator p 240
--

German Abstracts 244

Frequency Stable Oscillators p 244	Distortion in RC Oscillators ... p 245
Millimicron Deflection Measurements p 248	

ELECTRONIC DESIGN Digest 250

Corner-Reflector Antenna-Design p 250

Washington Report 22 Report Briefs 252

New Products 80 Standards & Specs 258

Service for Designers 194 Careers 260

New Literature 196 Your Career 260

Patents 232 Career Brochures 262

Advertisers' Index 269



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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)

disciplines."

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

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

While systems researchers are drawn from any scientific disciplines, Dr. Ackoff said, the common denominator in their background is advanced mathematics, statistics and physics.

One of the most important and least defined areas of systems research, observers at the meeting said, is an effective appraisal of ultimate objectives. This area was discussed by representatives of two leading operations research groups in the country.

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

- "Objectives are multiple and conflicting, and alternative means of satisfying any one are likely to produce substantial and differential 'spillover' effects on others. We are all, or almost all in favor of God, motherhood, peace—and therefore deterrence or winning a war if deterrence fails. But lists of this kind are almost useless for the analyst."

- "We have spoken of deterrence as an objective—perhaps the primary objective—of our military force. But you learn after only a little study that there are many different forms of deterrence, many different sorts of action by an enemy that it would be nice to deter. There is the usual question: how far down the deterrence road is it desirable to go? We know we want the military capacity to deter him from striking us directly and that, on the other extreme, it is probably silly to try to deter him by military means from frowning at us. But where in between do we draw the line?"

- "Nothing but rigorous, quantitative analysis can tell us whether some objective makes sense or not—whether it is feasible, how much it will cost".

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

"These goals are based on the value scale of the

(continued on page 6)



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NEWS

Systems Symposium (continued from page 6)

culture," he went on, "and while it is true that it is difficult to get government officials to define goals, we can go back to the Constitution itself. From this and similar documents which set forth our basic national aims, the researcher can locally derive alternate sets of objectives and present these to the executives with his reasons. And from these reasons and goals, the executives can make their decision."

Dr. Johnson saw three levels of activity in systems engineering: basic research, a planning group to translate the results of research and present the data for executive decision, and a design group to carry out the chosen system design.

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

Airborne TV (continued from page 6)

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

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

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

Narrow Band Transmissions Also Planned

The Midwest Program on Airborne Television Instruction, which is the planning body for the operation, has also scheduled experiments in narrow-band uhf television in anticipation of increased demands on educational TV channels. Narrow-band transmissions will be interspersed among the regular educational telecasts for reception by five selected schools in the test area. Special airborne equipment and receivers for this aspect of tests is being developed by CBS Laboratories, Stamford, Conn.

Narrow-band transmissions will be over a

John Fluke



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CIRCLE 6 ON READER-SERVICE CARD

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

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

These mathematical tools are concerned with decisions.

A system operating to make a decision was envisaged by Dr. Harry Goode, Professor of electrical and industrial engineering at the University of Michigan.

In his system, all available information on a given problem would be fed into a computer, which would sift and evaluate the information, both relevant and irrelevant, and supply a decision based on rewards. The system takes into account capabilities and limitations, costs and achievements. ■ ■

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

Electronic Image Enhancement To Be Used

In addition, narrow band receivers will employ "Crispening" circuits to compensate for the poorer image quality inherent in narrow-band transmission. Nonlinear circuitry in the video amplifiers introduces signals to steepen the wave fronts of the video signals. The result is an apparent enhancement of the image. Medium-long decay phosphors are specified for the kinescopes to eliminate flicker caused by the 48-field per second transmission rate. CBS is supplying special driver units for the airborne transmitters. Narrow band videotape units will also be employed.

The 13,000 schools in the area to be served may ultimately require up to 100,000 TV receivers if the system is widely adopted. For small schools using only a few receivers, each set will be equipped with its own uhf antenna. For economy, larger installations will employ a master antenna, an uhf-vhf converter, and a standard vhf closed-circuit distribution system.



Enlarged photograph of raw crystal



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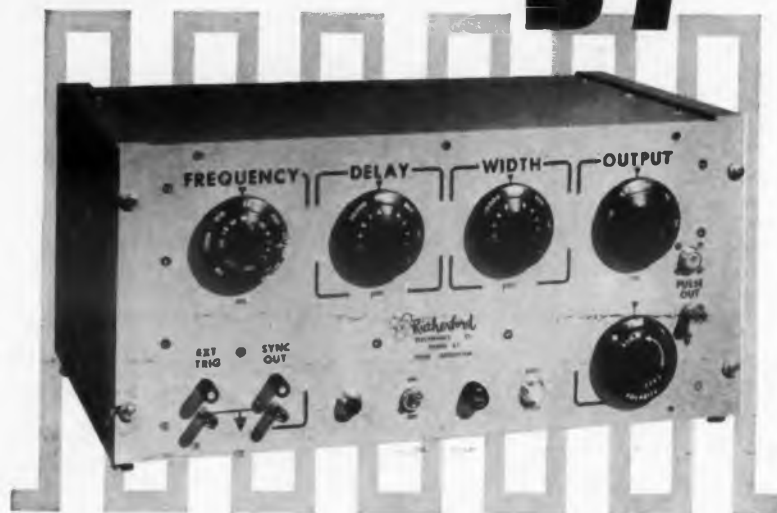
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NEWS

Microcircuitry Packaging Concept Detailed By Hughes Researcher

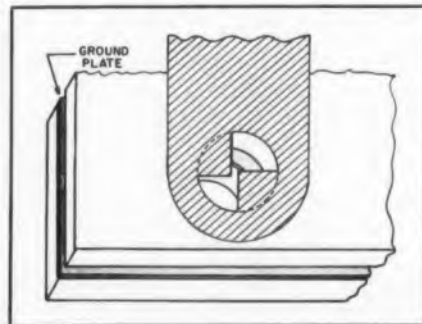
*Components May Be Inserted Into Holes
In Printed-Circuit Boards*

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.

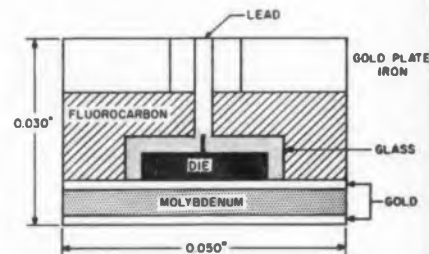


Diagram shows basic construction of silicon diode package, although various portions are not to scale.

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

For K_u and K-Band Radars



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.

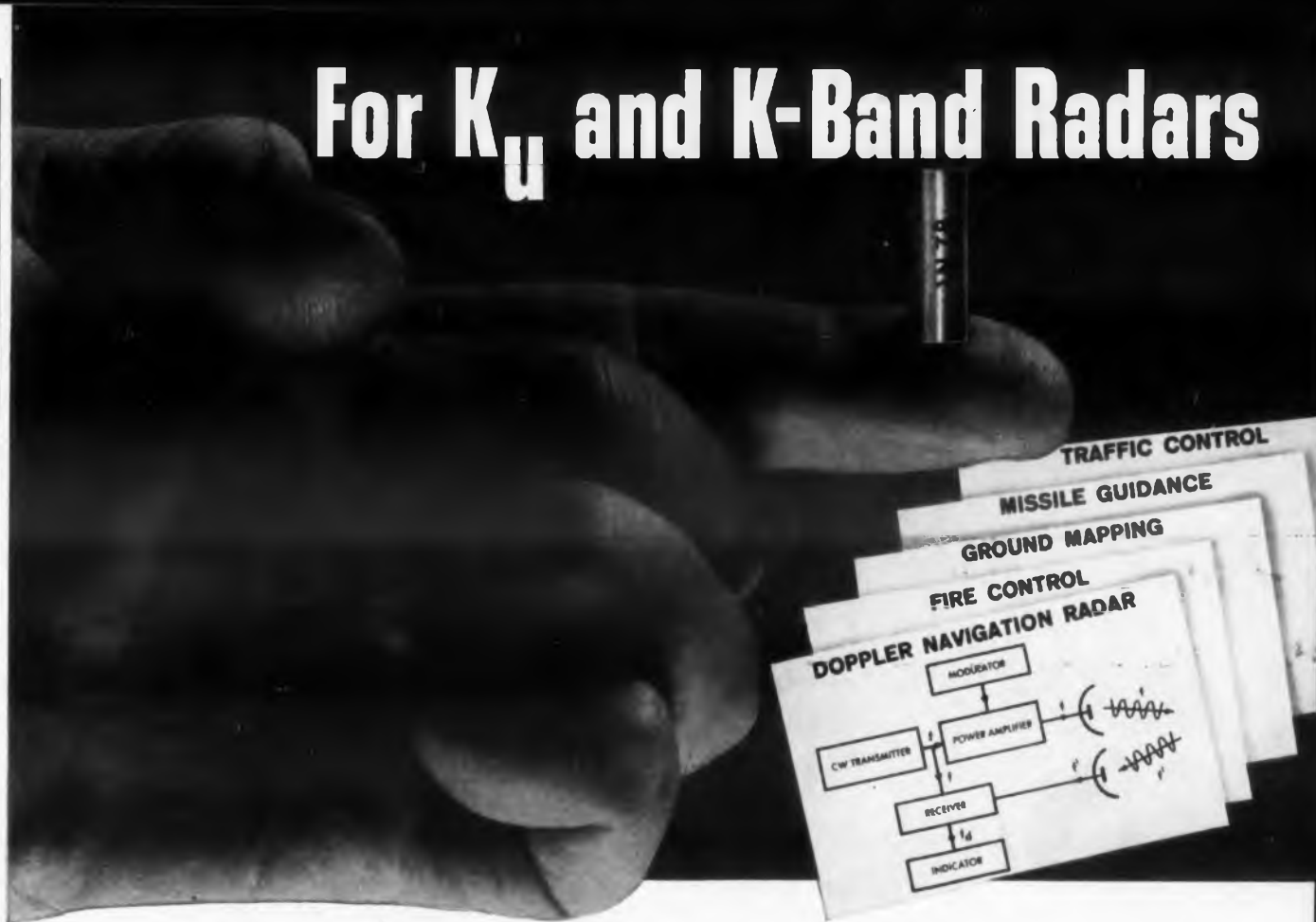
Component densities for this type of circuitry range from about 1.7 to 4 million parts per cu ft, Mr. Warren said. He pointed out, however, that circuit densities fall far below this when interconnections required in operational circuitry are included.

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, pre-packaged 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. ■ ■

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	1N26	1N26A	1N26B	
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Noise Ratio	2.5	2.0	1.5	(times)
RF Impedance	—	1.6	1.5	(VSWR)
Over-all Receiver Noise	13.1	11.3	10.0	(db)

	1N78	1N78A	1N78B	1N78C	1N78D	
Conversion Loss	7.5	7.0	6.5	6.0	5.7	(db)
Noise Ratio	2.5	1.5	1.3	1.3	1.3	(times)
RF Impedance	—	1.6	1.6	1.5	1.5	(VSWR)
Over-all Receiver Noise	11.8	9.8	8.8	8.3	7.5	(db)
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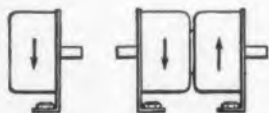
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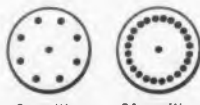


New Ledex Digimotor[®]

IS MAJOR ADVANCE IN STEPPING MOTOR FIELD

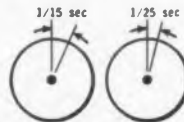


Operates as uni-directional or bi-directional stepping motor or indexing device.



8 position 24 position

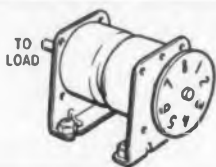
Available with 8, 10, 12, 18, 20 and 24 steps per revolution.



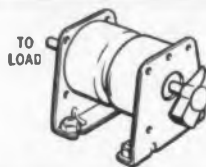
Stepping rate is 15 to 25 steps per second, depending on number of positions, load, or other factors.



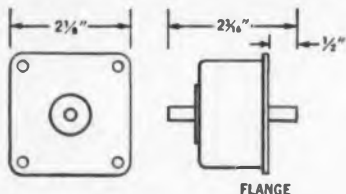
Unit has exceptionally high torque-to-size ratio, with proven reliability and long life.



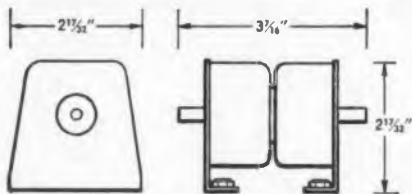
Shaft permits direct coupling of load at one end and mounting of position indicator at other.



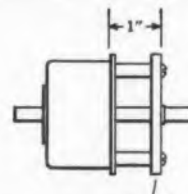
Mechanical load can be positioned manually, clockwise or counterclockwise.



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FOOT



DETENT

Uni-directional has flange or foot mounting.

Bi-directional has foot mounting.

All models available with or without detent.

Size 5 models shown are available in any duty cycle within operating voltage range from 6 to 350 VDC. Shaft extensions available one or both ends. Completely enclosed in protective housing.

The new Ledex Digimotor is a stepping motor or indexing device with exceptionally high reliability and torque-to-size ratio. Its new design concept gives it features never before available. Size 5 stock models come in a variety of shaft positions and in any duty cycle within a wide operating voltage range. It is jam proof, permanently lubricated, has magnetic anti-overcoast, and operates at "whisper" noise level.

New Ledex Digimotor Switches are rotary selector switches with all advantages of the Digimotor drive plus other special features.



Ledex, Inc. was formerly G. H. Leland, Inc.

CIRCLE 10 ON READER-SERVICE CARD

Other Ledex products include Rotary Solenoid, Rotary Solenoid Selector Switch, Hermetically Sealed Selector Switch, and Syncremental Stepping Motor. Mechanical applications include actuation of valves, vanes, printers, shafts. Switching applications include circuit selecting, stepping, counting, programming and sequencing. Write for literature, mentioning application, to Ledex, Inc. (formerly G. H. Leland, Inc.), Dayton 2, Ohio; Marsland Engineering, Ltd., Kitchener, Ont.; NSF Ltd., 31 Alfred Place, London, Eng.; NSF GmbH, Nurnberg, Germany.

NEWS

1970 Power Sources for Space

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. Homer, 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 other 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 electro-mechanical 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. ■ ■

Surpassing
MIL-C-25A,
CP-70,
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for -55 to +125 C operation without derating

Sprague's new series of small, drawn-rectangular case capacitors are far and away the best of their type that can be produced in the present state of the art. Surpassing MIL-C-25A Type CP-70 requirements for performance, reliability, minimum size, and temperature range without derating, DIFILM Vitamin Q[®] Capacitors are made to withstand the most severe operating conditions encountered in military and industrial electronic equipment.

Type 271P Capacitors are designed to operate over the temperature range of -55 C to +85 C, while Type 272P Capacitors will withstand operation at temperatures up to 125 C without voltage derating. Because of the superior electrical characteristics of both Type 271P and 272P Capacitors, their physical

size is smaller than mineral oil capacitors customarily used where wide ambient temperature ranges are encountered.

The new dual dielectric used in these capacitors consists of both synthetic polyester film and the highest grade capacitor tissue... a combination which offers the *best* properties of *both* materials!

The impregnant is Vitamin Q, a synthetic polymer which has been used by Sprague with outstanding success in paper capacitors for many years.

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For complete engineering data on Drawn-Rectangular Case DIFILM Vitamin Q Capacitors, write for Engineering Bulletin 2340 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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THE 64IN CALORIMETRIC WATTMETER establishes RF power reference of an accuracy of 1% of value read, and is used to calibrate other wattmeters. Five power scales, 0-3, 3-10, 10-30, 30-100, and 100-300 watts, are incorporated in the wattmeters for use in the 0-3000 mcs range.

711N and 712N FEED-THROUGH WATTMETERS, after comparison with the 64IN, can be used continuously as secondary standards and over the same frequency range as covered by the primary standard. The MODEL 711N is a multirange instrument covering power levels from 0 to 300 watts in three ranges, 0-30, 30-75, and 75-300 watts. MODEL 712N covers power levels of 0 to 10 watts in three switch positions, 0-2.5, 2.5-5, and 5-10 watts full scale.

636N and 603N RF LOAD RESISTORS absorb incident power during measurements. MODEL 636N is rated at 600 watts, and MODEL 603N is rated at 20 watts. Both models perform satisfactorily over the entire frequency range to 3000 mcs. These loads, in conjunction with the MODELS 711N and 712N Feed-through Wattmeters, form excellent absorption type Wattmeters.

152N COAXIAL TUNER is used to decrease to 1.000 the residual VSWR in a load. The tuner is rated at 100 watts, and its frequency range is 500-4000 mcs.

For more information on Tuners, Directional Couplers, R. F. Loads, etc., write



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CIRCLE 12 ON READER-SERVICE CARD

NEWS

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.





The following Fairchild Diffused Silicon Mesa Transistors are available from stock for same day shipment in quantities up to

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pieces per type.

Standard NPN 2N696,
2N697; Low Beta NPN
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NPN 2N706; VHF
Oscillator NPN 2N707; General
Purpose NPN 2N717, 2N718;
Low Storage NPN 2N1252,
2N1253; High Beta NPN
2N1420; Standard NPN
2N1131; 2N1132.



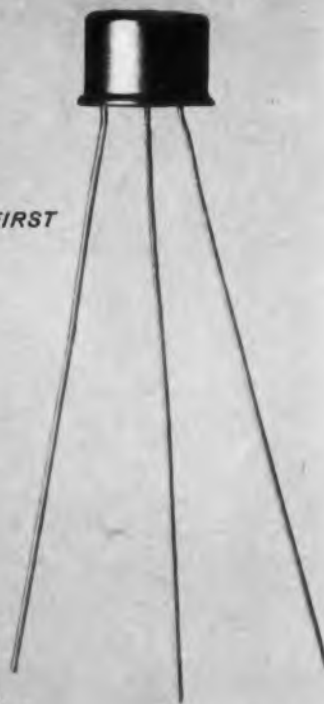
80 HERRICKS ROAD, MINGOLA, L. I., N. Y.
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FAIRCHILD'S 2N1613 DIFFUSED SILICON PLANAR TRANSISTOR

GUARANTEED USEFUL BETAS FROM 100 μ A to 0.5A:

15 @ .1mA 20 @ 1mA 30 @ 150mA 15 @ 500mA
Guaranteed minimum Beta over a 5,000 to 1 range of collector current makes the 2N1613 the most versatile transistor presently on the market.

WIDE RANGE OF APPLICATIONS: in Fast Switching (logic and high current); Amplifiers (low level, low noise, wideband, VHF power).

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Transistor is the most thoroughly proven transistor ever introduced commercially, with over 5,000,000 transistor hours plus 300°C. stabilization on all units.

SOME IMPORTANT PARAMETERS: 7 db—Noise Figure; 100 megacycles—Gain-bandwidth product; 0.0005 μ A ICBO typical at 60V, 25°C.

IMMEDIATE AVAILABILITY: Quantities from 1-999 from franchised Fairchild distributors at factory prices.

TENTATIVE SPECIFICATIONS— FAIRCHILD 2N1613

f_t typical	100 mc
P_C @ 25°C. Case Temperature	3W
h_{FE} (see Beta paragraph above)	Min 30
V_{CE}	40V
V_{CBO}	75V
$V_{BE SAT.}$ (Max.)	1.3V
$V_{CE SAT.}$ (Max.)	1.5V
ICBO @ 25°C. (Max.) measured at 60V	25 μ A



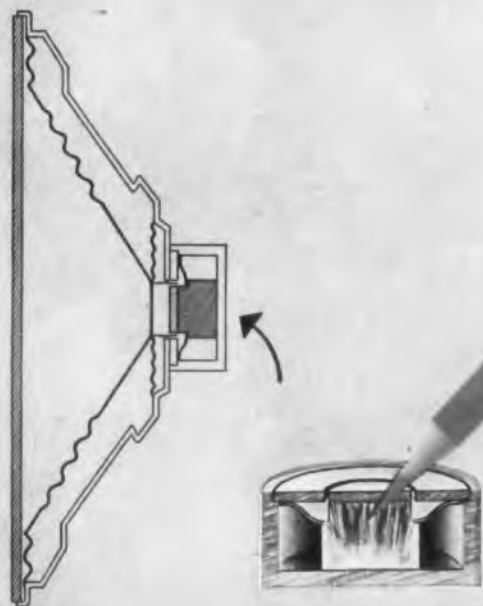
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For full specifications, write Dept. B

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CIRCLE 14 ON READER-SERVICE CARD

Magnetic Materials from General Electric

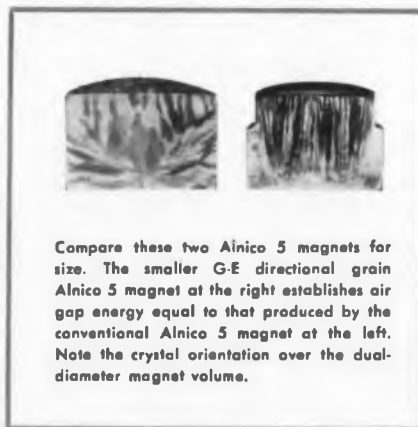


Compact G-E dual-diameter d.g. magnets give you a free hand in speaker design

General Electric dual-diameter, directional grain magnets clearly demonstrate that magnet size and weight are no longer any criterion of speaker performance. And, the reason is simple.

G-E engineers have purposely designed weight and size out of dual-diameter, directional grain Alnico 5 magnets by concentrating magnetic field energy within the area of voice coil travel. By combining the outstanding properties resulting from the G-E patented d.g. process with a design integrated to use these properties, a new level of efficiency at the higher levels of gap energy has been achieved.

In addition, smaller, lower cost pole pieces and return paths of powdered iron are now feasible in larger speaker sizes. Send for full technical information on G-E directional grain Alnico 5. And, for a freer hand on any magnetic design, turn first to: *Magnetic Materials Section, General Electric Company, 7820 N. Neff Blvd., Edmore, Michigan.*



Compare these two Alnico 5 magnets for size. The smaller G-E directional grain Alnico 5 magnet at the right establishes air gap energy equal to that produced by the conventional Alnico 5 magnet at the left. Note the crystal orientation over the dual-diameter magnet volume.

MAGNETIC MATERIALS SECTION

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NEWS

Computer Uses Program To Prepare Periodic Index

Other Literary Uses Predicted; Emphasizes 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-

KEYWORD-IN-CONTEXT INDEX		
IC ACIDS OF THE LEAVES	ROOTS AND WOODS OF THE HORSE BE	COICY -80-CDA
CELL-GROWTH OF PLANT	ROOTS; THIOANIC SALTS AND NATIVE ST	ROEWE-80-018
ON THE DETERMINATION OF	CASIN ACIDS IN TAL OIL	SHEEN-80-081
ES; CALCULATION OF THE	ROTARY DISPERSION OF THE ALPHA	TIROCI-80-080
ON OF CHROMIC ACID ON A	ROTATING DISC ELECTRODE	RUEVE-80-088
MOLECULES WITH SYMMETRI	ROTATIONAL BARRIERS	THOMM-80-089
ELECTRIC MOMENTS OF	ROTATIONAL COMBINATIONS OF THE PENT	THOMM-80-089
TO RESTRICTED ROTATION		HALLM-80-088
RESTRICTED INTERNAL	ROTATION IN HYDROXY AMIDES	SPINNE-80-018
SYSTEM OF THE MAGNETIC	ROTATION OF BOND; SIGMA BONDS IN TH	SALLAF-80-018
OF BICYCLIC TERTIARY	SALTS; SYNTHESIS AND BASE DEGRADAT	HEINW-80-087
DIARYL IODONIUM SALTS	SALTS IN WHICH THE CATIONS N	HEIFM-80-018
MONO HYDRAZINE TO FORM	SALTS; SILVER SALTS; (GER)	HODOR-80-018
Y OF LIQUID METALS WITH	SALTS; SODIUM-SODIUM HALIDE SYSTEMS	BEDEW-80-018
TIC SYSTEMS	TROPILUM TANNINS AND BENZENE	VOLWE-80-086
PLANT ROOTS; INORGANIC	SALTS AND NATIVE CARBON DIOXIDE	ROEWE-80-088
HEXACRYSTALLINE AMMONIUM	SALTS AND THEIR HYDRATES	ROEWE-80-088
R QUININE AND QUINIDINE	SALTS AND THEIR HYDRATES	KIRICH-80-088
N OF OXIDES IN FLUORIDE	SALTS BY HIGH-TEMPERATURE FLUORINAT	GOLDM-80-087
UTANCES OF MULTIVALENT	SALTS IN AQUEOUS SOLUTION; ZINC SUL	DYEL -80-018
DIARYL IODONIUM SALTS	SALTS IN WHICH THE CATIONS BEAR CARB	HEIFM-80-018
S IN WATER SOLUTIONS BY	SELF-DIFFUSION MEASUREMENTS	BERNE-80-018
ONS IN SULPHURIC ACID	SELF-DISSOCIATION EQUILIBRIA OF SULF	RASS-80-088
HIGH-TEMPERATURE	SELF-HEALING OF IMPERFECTIONS AT THE	ODDLE-80-081
ION OF THE CHEMISTRY OF	SELF-QUENCHING OF GLOW COUNTERS CONTA	COLLA-80-088
ATION OF ACTION OF THIO	SEMICARBAZIDE AND METRAZOL ON CPENT	DUNL-80-081
OMIC CONTACTS TO	SEMICONDUCTING CERAMICS	THOMM-80-088
ECT OF FREQUENCY ON	THE SEMICONDUCTIVITY OF RANGANESE DIOXIDE	HEINW-80-088
UTION OF CARRIERS IN A	SEMICONDUCTOR; (ENG)	RODOL -80-081
FOR THE PREPARATION OF	SEMICONDUCTOR GRADE SILICON BY	ELLER-80-081
RNAL IMPURITY LEVELS IN	SEMICONDUCTORS; EXPERIMENTAL IN P-T	HEINW-80-088
BIBLIOGRAPHY		
DULOS-80-081	DULOS J	KEPP HW
DISCUSSION OF	LIQUID ACID METHYL ESTERS	
DEVI FARBEN-EX 14 10-16 (1961)		
HEINW-80-088	HEINW J	HEINW HW
STRUCTURES OF SURFACE SITE; STRUCTURE OF		
CYCLODIBENZENE; (GERMANY)		
HEINW-80-088	HEINW J	HEINW HW
ACTA METAL 13 10-15 (1964)		
DUNL-80-081	DUNL C	HEINW HW
MECHANISM OF ACTION OF THIO SEMICARBAZIDE AND METRAZOL ON		
CERAMIC AND CERAMIC ACTIVITY IN THE		
HEINW-80-088	HEINW J	HEINW HW
DISCUSSION OF EXPERIMENTAL EVIDENCE OF BOUNDARY		
MIGRATION		
ACTA METAL 13 10-15 (1964)		

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.

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CIRCLE 17 ON READER-SERVICE CARD

S.A.-2128

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 μ sec 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

ELECTRONIC DESIGN • May 11, 1960

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 programming 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 Programming 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.

INSTANT INDICATION of Voltage Tolerance with NLS Series 50 Comparators



NEED TO DETERMINE IF INPUT VOLTAGES ARE WITHIN PRESET LIMITS? Within 90 milliseconds, NLS transistorized voltage comparators indicate voltage tolerance through colored bulbs . . . and transmit go/no-go commands to electrical control and warning systems. Here are complete voltage comparison systems in single, compact packages — ready to use in a wide range of applications in automatic go/no-go testing, decision making, and automatic control. Model 50 is for manual limit setting — Model 51 for applications where limits are already in analog voltage form. Also available are Programmed Comparators for remote control of limits in automatic systems. Write NLS.

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A man sits at a drawing board. The CASTELL pencil in his hand is almost an extension of the man himself—as his gray matter is translated into the gleaming black shape of a new bridge—for Africa. In other lands other creative craftsmen with CASTELL pencils conceive hydroelectric plants for India, low-cost dwellings for England, hotels for the Middle East, jet planes for the United States. CASTELL is the partner of progress the world over. Its unquestioned superiority is one of the immutable facts in a creative man's life.



#9000 CASTELL Pencil with world's finest natural graphite that tests out at more than 99% pure carbon. Exclusive microlette mills process this superb graphite into a drawing lead that lays down graphite-saturated non-feathering lines of intense opacity for cleaner, more durable originals and clearer, sharper prints. Extra strong lead takes needlepoint sharpness without breaking or splintering. Smooth, 100% grit-free consistently uniform pencil after pencil, in full range, 8B to 10H.

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CIRCLE 19 ON READER-SERVICE CARD

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 photomultiplier 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 problems 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.

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CIRCLE 21 ON READER-SERVICE CARD

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. C. 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.

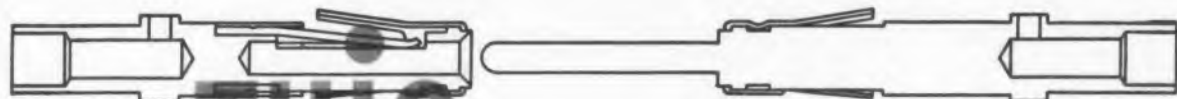
According to the American Electronic Laboratories, Inc., of Philadelphia, the tower can withstand winds up to 87 mi an hour. It can be used to support external antenna wires, or the antenna wires can be attached or coated to the inside surface. Deflated, the tower stores in a transit case.

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.

IN RACK AND PANEL CONNECTORS



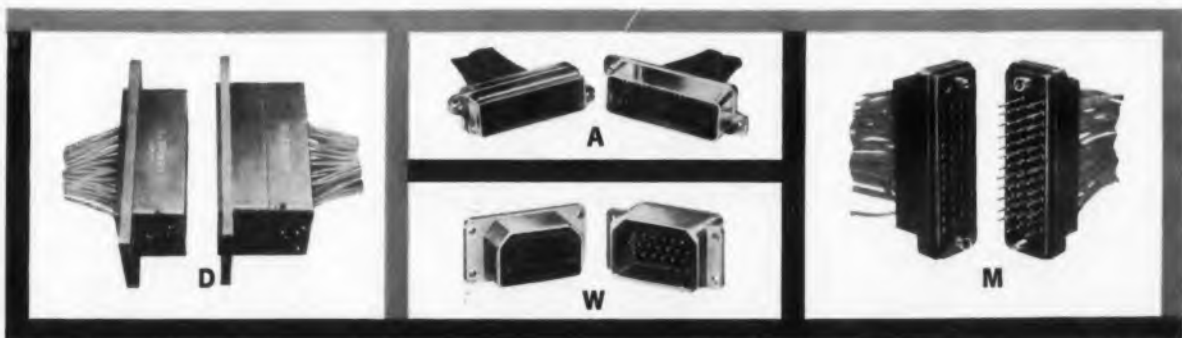
THIS MAKES THE DIFFERENCE!

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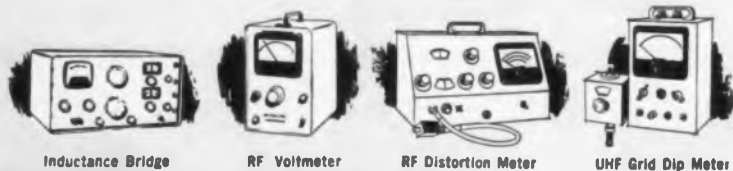


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CIRCLE 23 ON READER-SERVICE CARD

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

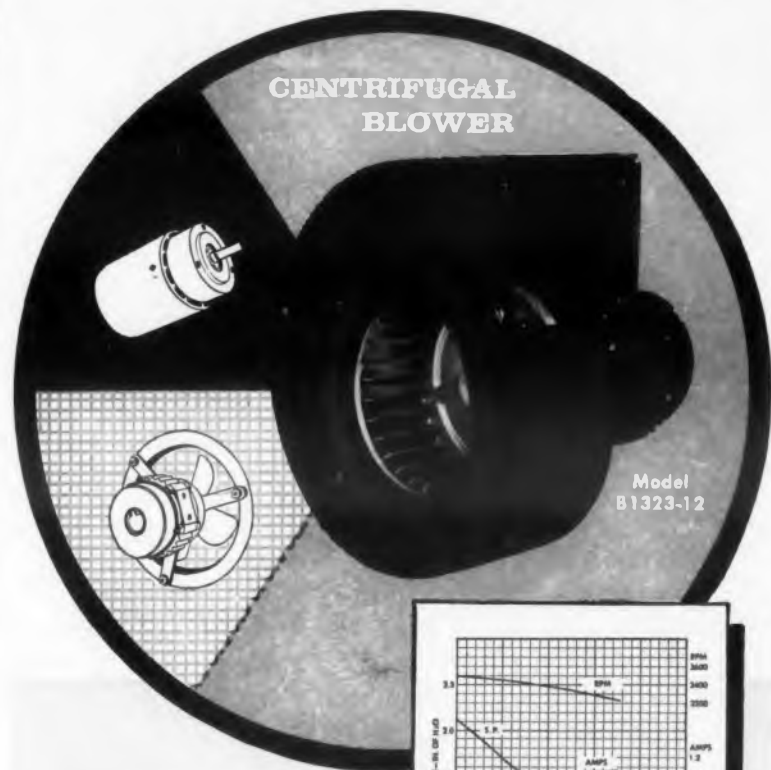
unsatisfied? (3) Does it complement (or duplicate) work in progress? (4) Can it be applied to other problems? Note that the Navy will consider "the economics" of any system offered, as well as other factors.

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.

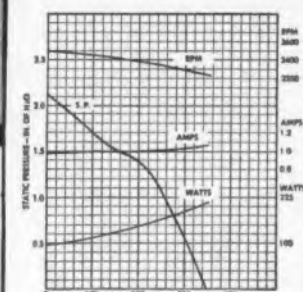
INTER-SERVICE SUPPORT in logistics and administration should be encouraged to the maximum extent, states a Defense Department directive. This document is believed to have been inspired by repeated Congressional criticism of military inefficiency and duplication of facilities. According to the directive, 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."



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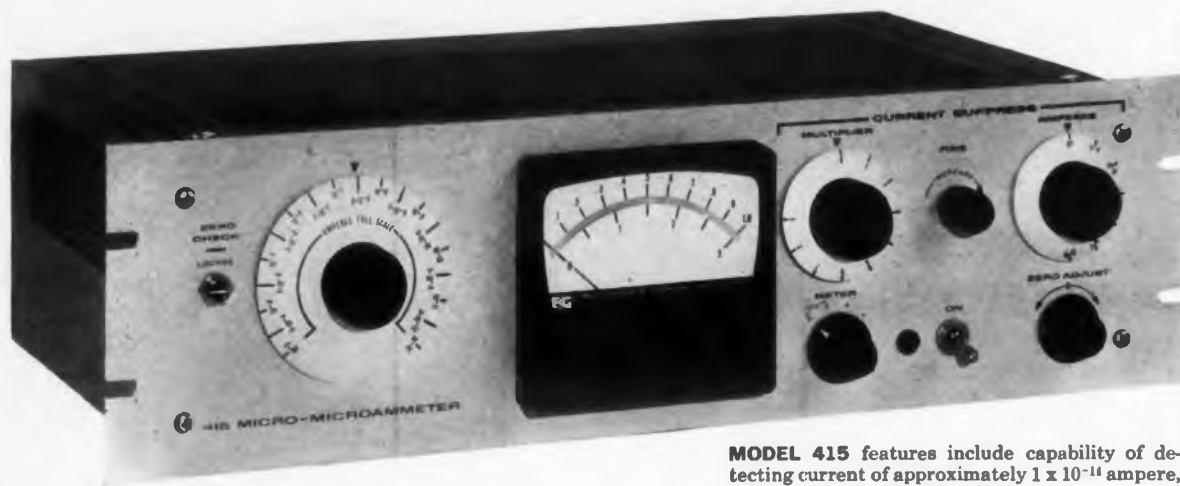
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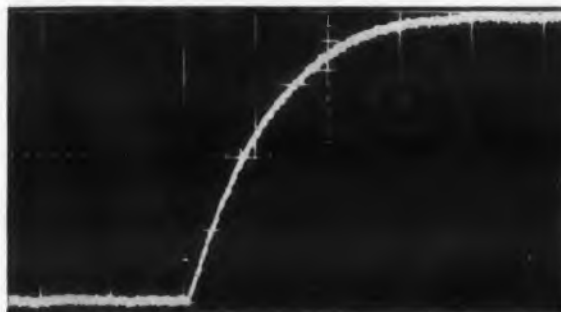
The new Model 415 incorporates advanced high-speed circuitry developed by Keithley Instruments for rocket and satellite experimentation — where measurements of Lyman-Alpha night glow and upper air density require fast response.

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 ($\mu\mu\text{f}$). 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 $\pm 2\%$ of full scale on 10^{-3} through 10^{-9} ampere ranges, and $\pm 3\%$ 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 re-setting 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 ($\mu\mu\text{f}$). 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: $\pm 2\%$ f.s. 10^{-3} thru 10^{-9} ampere ranges; $\pm 3\%$ 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.	$C_{in} = 50 \mu\mu\text{f}$ seconds	$C_{in} = 150 \mu\mu\text{f}$ seconds	$C_{in} = 1500 \mu\mu\text{f}$ 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 6, 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 >

ELECTRONIC DESIGN • May 11, 1960

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 dbm.
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.

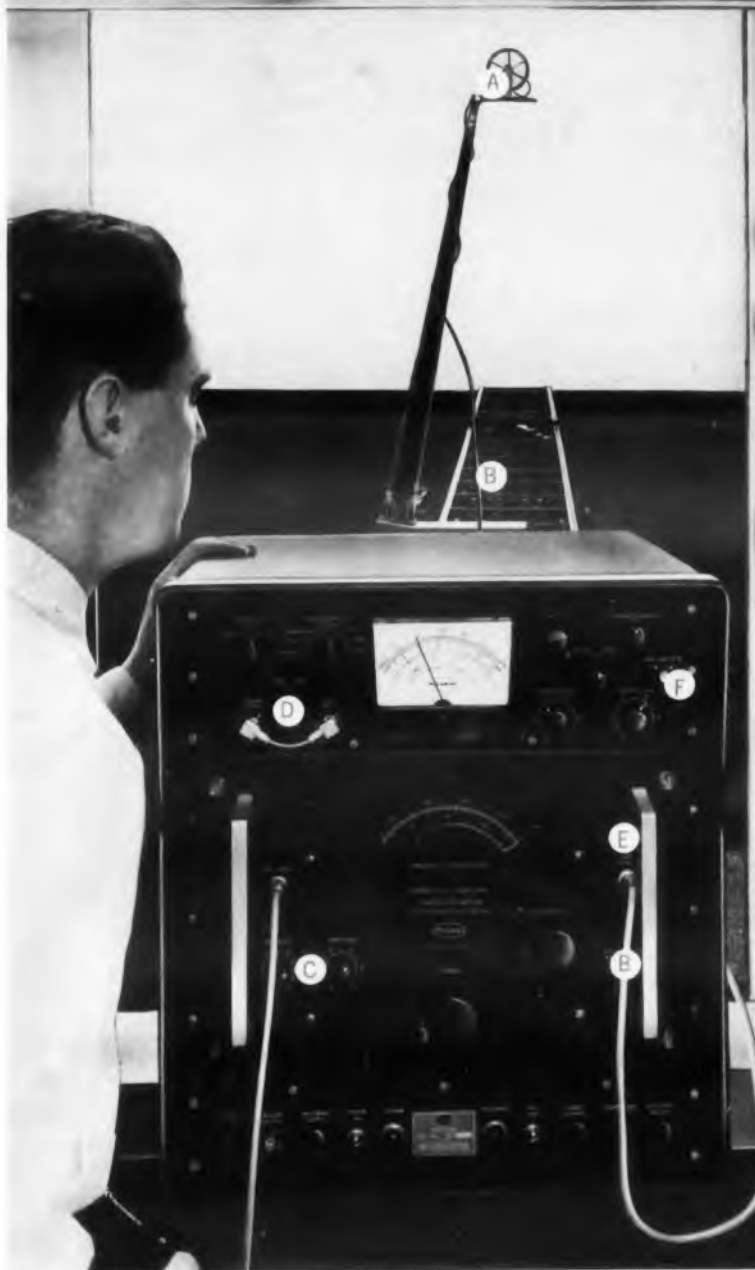


**POLARAD
ELECTRONICS
CORPORATION**

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

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



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 $0.15 \mu\text{Sec}$. The unit has an adjustable attenuator and low incidental AM and FM at relatively high power.

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

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If Mailed in the
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Yellow Pages) for
a copy of "Notes
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Measurements."

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ON ALL POLARAD
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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.

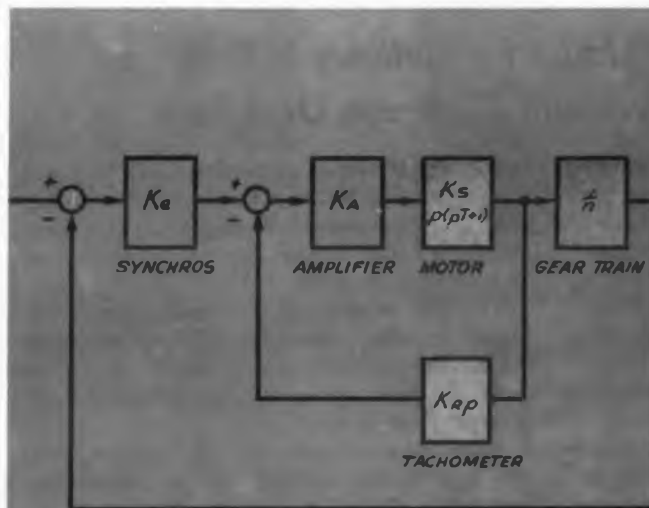
◀ CIRCLE 26 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

THOMAS A.

EDISON

**Servo Motor-Generators
are designed specifically
for your systems
applications**



Edison Servo Motor-Generators are available with any type or size gear head or gear train.

Unlike ordinary "off-the-shelf" components, Edison Servo Motor-Generators are designed specifically to operate as part of an electro-mechanical system.

For example, their motor sections are built to have minimum time constants and reversing times. To insure precise coupling with mating gear trains, output pinions are fabricated to *better than AGMA standards*. Damping constants, from unit to unit, are held to very close tolerances.

In addition to these special system features, Edison Servo Motor-Generators are made to the highest

quality standards. They outperform MIL-S-17087 (for motors) and MIL-S-17806 (for generators).

Edison engineers provide you with the exact servo motor-generator your system calls for—not a cataloged component that will only approximate your needs. For this reason, they will work closely with you in developing components that will assure you of the best system performance.

For additional information on Edison Servo Motors, Motor-Generators and other rotary components, write for Catalog 3044.

Thomas A. Edison Industries
INSTRUMENT DIVISION

55 LAKESIDE AVENUE, WEST ORANGE, N. J.

◀ CIRCLE 27 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

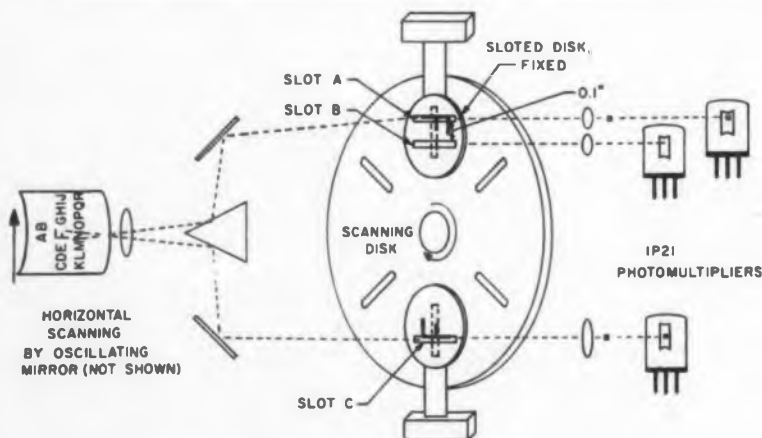
reduction, literature abstraction and language translation. The National Bureau of Standards is considering the possible reprogramming of a sister machine to read Russian-language documents for translation by computers.

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.

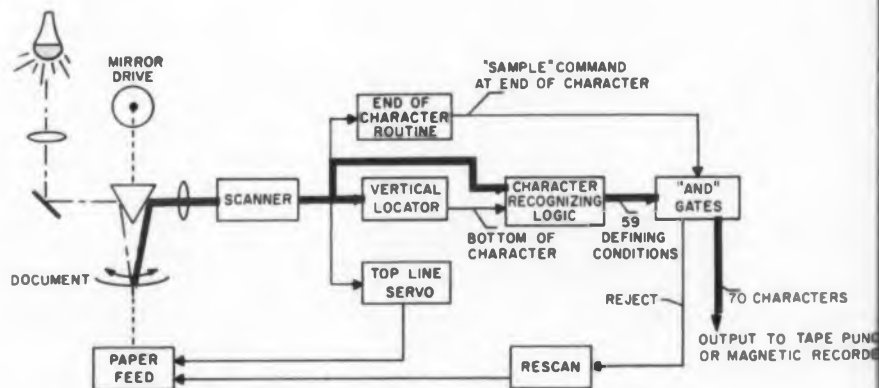
The commercial units will have approximately this capacity, but will be housed in a single cabinet rather than in the three cabinets now required. This will be accomplished through replacement of about 1,000 vacuum tubes by transistors and the elimination of certain redundant logic functions. Commercial 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 of magnitude less can be expected.

Scanning Scheme Described

The character-recognition scheme for the commercial page readers now being designed is essentially the same as for the Air Force machine.

In the Air Force unit each character is scanned both horizontally and vertically. Horizontal scanning is accomplished by a mirror oscillating across the width of the paper. A spot of light synchronized to the mirror illuminates the area to be scanned. Vertical scanning is performed by a slotted wheel and slotted disks (see accompanying diagram). The combination of vertical and horizontal scanning gives up to 25 successive vertical slices through each character. Scanning resolution is 0.005 in.

The three vertical scanning stations operate simultaneously. The first scan (through slot A) locates the bottom of the character. This information helps to identify the descenders of "p," "q," "y," etc. and provides a reference for vertical location of other character features by the succeeding scan. The next scan (through slot B) is one character width behind the first scan. Together with the vertical reference established by the first scan, it determines the character structure for interpretation by the logic system. The scans through slots B and C are separated horizontally by 0.01 in. to detect stroke characteristics, like the slanted portions in "M," "N," and "W."

Characters Recognized by Key Elements

As in human logic, the page reader recognizes each character by its several key elements. The 10 characters identifiable in the Air Force reader require the definition of 59 key elements, some quite subtle but capable of recognition by machine logic.

As the character is scanned, appropriate circuits recognize the presence or absence of each element. After the character is scanned, these circuits are sampled by "and" gates. Each character has its corresponding gate, which conducts only if all the criteria for that character are present. The logic of all gates is mutually exclusive; that is, a partial definition of one character is never a complete definition of another character. Thus an imperfectly typed "E" cannot yield outputs of letters "E" and "F" simultaneously.

If no definitions are satisfied, the character is rejected. After a predetermined number of unsuccessful scans, the character is rejected.

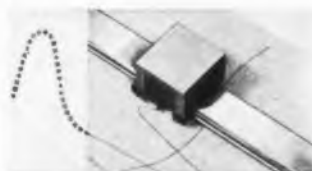
A truth table for recognition of numbers is illustrated. These numbers are of the Selfchek type design used in Farrington's numerical readers for credit-card and billing applications. Selfchek numbers are shaped so that there are at least two differences between any one number



PUSH BUTTON PANEL controls operations rapidly, even at remote locations.



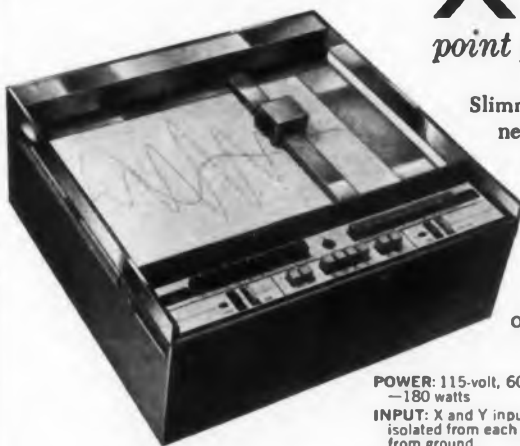
FLAT VACUUM PLATEN assures positive hold down of roll or sheet paper up to 12 1/4" width. Plot area, standard 10x15".



PRINTING FEATURES: Multiple symbol printing head—12 symbols...self contained ink supply. Pen System—capillary action; splatter-proof. Point joiner available.



INTERCHANGEABLE MODULES add versatility...interchange with basic control section.



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Slimmer, flatter, push-button fast...Librascope's newest, most advanced plotter is the result of personally-conducted field research by Librascope engineers. Compact design permits rack mounting in groups, saves desk space. Many new conveniences have been added to answer *your* needs.



OPERATING INFORMATION

POWER: 115-volt, 60 cycle
—180 watts
INPUT: X and Y inputs
isolated from each other and
from ground.
INPUT RESISTANCE:
2 megohms nominal on
most scales. 1 megohm per
volt on .5 millivolts per inch
to .1 volts per inch scales.

INPUT SENSITIVITY: .5 millivolts per inch
to 50 volts per inch with calibrated push
button scales at .5, .1, .5, 10 and 50 milli-
volts per inch and .1, .5, 1, 5 and 10 volts per
inch. Vernier controls permit continuous sen-
sitivity adjustment between fixed scales, per-
mitting full scale plotting for any sensitivity.
ACCURACY: Static .1%, dynamic .2% at 10"
per second.
PLOTTER CALIBRATION ACCURACY:
.05% on all scales.
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For full details — dimensions, applications, list of accessory equipment, call our Sales Engineering Department or send for illustrated brochure on Model 210, XY Plotter.

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

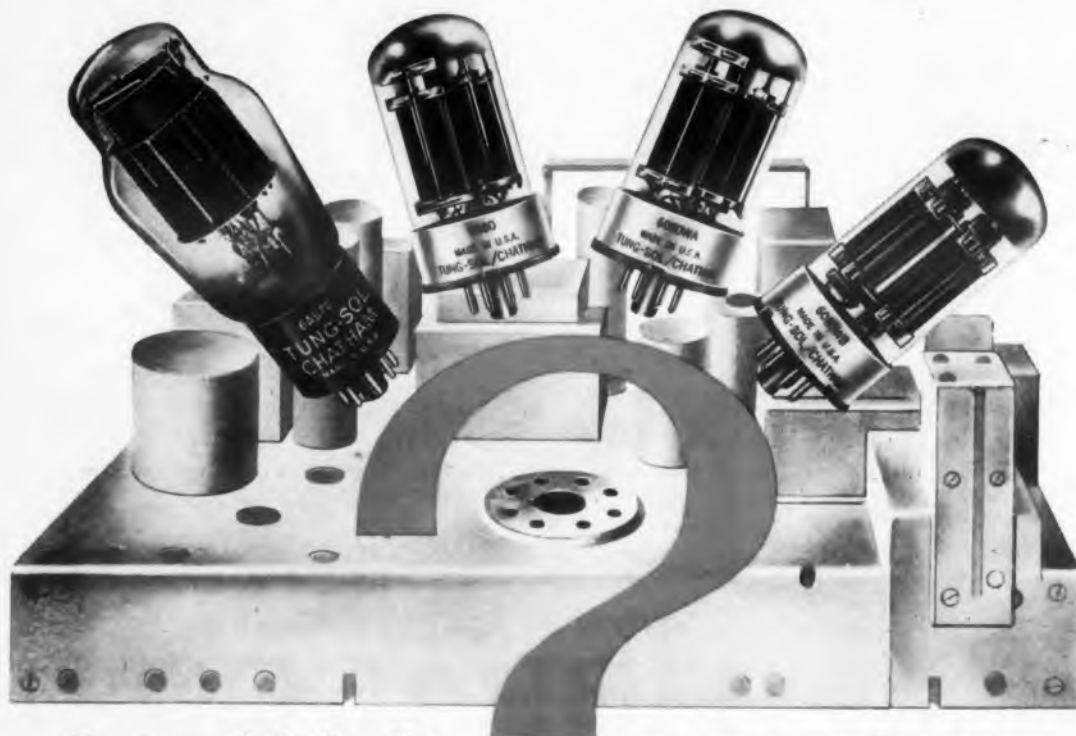


LI 9-20

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CIRCLE 28 ON READER-SERVICE CARD

TUNG-SOL/CHATHAM 6080 FAMILY

All fit the same socket . . .



But which fits your application

Like most circuit designers, you're probably often confronted with a wide choice of tubes which meet the *electrical requirements* specified by your design. But depending on other factors, such as the kind of environment in which the tubes are expected to operate, your choice may be limited.

Consider the Tung-Sol/Chatham 6080 tube family, for example. The 6080, the 6080WA, the 6080WB and the prototype 6AS7G all fit the same socket. The electrical ratings of these series regulator tubes are the same. Would you know which to specify for your power supply? The differences are vital. Knowing them can make all the difference in the ultimate reliability of your design.

If economy in original component cost is paramount and size not a factor, then the 6AS7G may be your choice. If size is a factor, the smaller 6080 would be used. The 6080WA is the right tube if more closely controlled characteristics are important, if environmental conditions are severe, and if greater assurance of long life is needed. Where the tube is expected to operate under high ambient temperatures and

severe vibration, and if many tubes are to be operated in parallel, then the 6080WB is best.

Of this you can be sure: Tung-Sol will recommend the "best" tube for your particular requirements. Once you have specified a Tung-Sol tube for your application, you'll be gratified by the superior performance and the highest operational reliability all Tung-Sol components provide. Every Tung-Sol tube is the product of the highest manufacturing standards and unexcelled quality control.

Full technical details on the Tung-Sol/Chatham 6080 family are also available to you on request.

And if you would like prompt and able assistance in selecting the correct tube for your application, get in touch with Tung-Sol tube experts. They'll be glad to study your design and recommend the tubes best for you. Tung-Sol Electric Inc., Newark 4, N. J. TWX: NK193

Technical assistance is available through the following sales offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Texas; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Toronto, Ontario.



TUNG-SOL®

CIRCLE 29 ON READER-SERVICE CARD

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. ■ ■

CDE Consistently Dependable Capacitors



miniaturized
pi filters
suppress
electronic
interference
from 150 kc
to 10,000 mc

C-D miniaturized tubular pi filters and 3-terminal feed-thru capacitors suppress electronic interference effectively at any frequency from 150 kc to 10,000 mc. Regardless of your design requirements, the C-D Filter Laboratories can supply you with the exact suppression component you need with tubular shapes, neck-mounting designs and smallest possible case sizes to save space and weight, enable easy installation. C-D miniaturized pi filters and feed-thru capacitors also provide better insertion loss per unit volume, weight and cost as compared to other types of suppression devices at identical ratings.

To obtain complete engineering data and specifications, write for Engineering Bulletins 171, 172 and 166 to

Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey. *Manufacturers of consistently dependable capacitors, filters and networks for electronics, thermo-nucleonics, broadcasting and utility use for 50 years.*

SPECIFICATIONS

Tubular Pi Filter TYPE NFR113

Voltage: 120 VAC (60 cycles), 300 VDC
Current: 0.5 Amperes
Dimensions: 1" x 2 1/16" Weight: 4.0 oz.



Feed-Through Capacitor TYPE NFT5W4P22W

Voltage: 125 VAC (60 cycles), 400 VDC
Current: 25.0 Amperes
Capacitance: 0.22 mfd.
Dimensions: 1/16" x 1 1/16" Weight: 0.83 oz.



CORNELL-DUBILIER ELECTRIC CORPORATION

AFFILIATED WITH FEDERAL PACIFIC ELECTRIC COMPANY

CIRCLE 30 ON READER-SERVICE CARD

**Storage at
Less than
1½¢ per bit!**



with the

BRYANT Model 7508 Magnetic Storage Drum

Bryant's new Model 7508 Magnetic Storage Drum offers you a convenient size memory at extremely low cost-per-bit. (Less than 1.5 cents per bit.)

This compact and efficient 7.5" diameter by 8"-long drum is enclosed in its own dust-tight cabinet. Complete with connectors and isolator mounts. Overall dimensions are 14" diameter by 16" high.

Standard Operating Parameters include:

Bit Repetition Rate (Return to Bias):
Over 300 KC • Bit Repetition Rate (Non-
Return to Bias): Over 600 KC • RPM: 900
to 6,000 • Number of Tracks: 250 • Bit Ca-
pacity: 460, 800 • Bits-Per-Track: 3072 •
Design Life (at 6,000 RPM): Over 3 years
• Guaranteed Runout: Less than .0001"
TIR • Military Specifications: Compatible
with MIL-E-4158A and MIL-E-16400B.

For more information about the Model
7508 and other Bryant Standard Mag-
netic Storage Devices, from 7500 to
75,000,000 Bits, write to Bryant Com-
puter Products Division, P.O. Box
620, Springfield, Vermont.

NEWS

New NBS Standard Frequency of 20 Kc Reported Furnishing Accuracies to 10¹⁰

A NEW 20-kc standard frequency broadcast is providing users with a measurable accuracy approaching one part in 10¹⁰, 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 10⁷ due to progressive movements of the ionosphere. Measurements over a 30-day period can extend this to a few parts in 10¹⁰, 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.

CIRCLE 31 ON READER-SERVICE CARD



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. ■ ■

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GOODYEAR



In all types of GAC trainers, realism is simulated to highest degree.



Electronic countermeasures — simulated station for bomber ECM operator.

SYSTEMS SIMULATION: a GAC specialty

Complete Weapon System Training Capability — from part-task trainers to system trainers — can be obtained at Goodyear Aircraft Corporation (GAC). Here, where the development of effective training devices is achieved, you'll find the engineering skills to design and build tactics trainers, flight trainers, maintenance trainers, and integrated weapon system trainers. Emphasis throughout is on practical realism and the latest concepts in biomechanical engineering. This includes many special effects such as visual simulation, which GAC has brought to a high degree of refinement. Whatever your training device needs — whether for aircraft, missiles, space vehicles — GAC has the experience, and the facilities, to fill any military requirement. Goodyear Aircraft Corporation, Dept. 916TQ, Akron 15, Ohio.

GOODYEAR AIRCRAFT

providing all 3 weapon system skills.

DESIGN

MANAGEMENT

Plants in Litchfield Park, Arizona, and Akron, Ohio



Classroom trainer, radar target generator — also available at GAC.

Mobile flight simulator — built by GAC for Navy.



EIMAC CERAMIC TUBES DESIGNED FOR SPACE WITH RUGGED NEW 26.5 VOLT HEATERS

Three extremely sturdy Eimac ceramic tetrodes have been specially designed for missile telemetry and airborne military communication systems—with rugged new 26.5 volt heaters.

In actual missile systems and current key projects, these tubes have passed severe tests with flying colors. And have dramatically proved that they *can take it!*

For your space age needs, investigate the many advantages of these pioneering Eimac tubes: the X578G, X578H and X578J. Write for complete information.

GENERAL CHARACTERISTICS EIMAC 26.5 VOLT CERAMIC TUBES

Tube	Eimac Tube With Similar Characteristics	Length	Diameter	Frequency for Max. Ratings	Max. Plate-Diss. Rating	Heater Voltage
X578G	4CX300A	2.5"	1.65"	500 mc	300 watts	26.5
X578H	4CX125C	2.5"	1.25"	500 mc	125 watts	26.5
X578J	4CN15A	2.5"	0.9"	500 mc	15* watts	26.5

*A nominal rating. May be increased by employing a suitable heat sink or liquid immersion.

CIRCLE 33 ON READER-SERVICE CARD

EITEL-McCULLOUGH, INC.
San Carlos, California



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

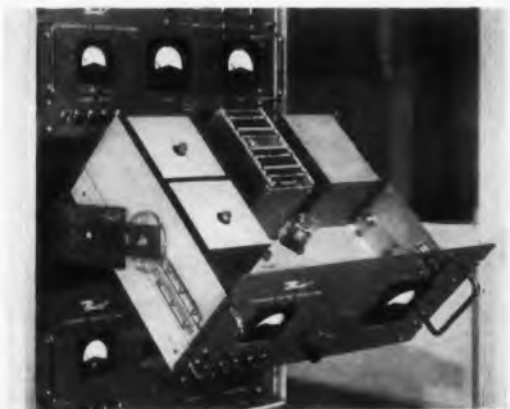
The magnet switch in the Bendix system is a transistor in either a fully conducting or a cut-off condition. Transistors are wired in a load-sharing manner, so that if one should open, another will maintain current to the magnet served by that transistor. Meanwhile a panel light will go on indicating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

HIGHEST
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BANDWIDTHS
EVER

465

362

133

GAIN-BANDWIDTH PRODUCT



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NEW FRAME GRID
E280F/7722

NEW FRAME GRID
7721

TWO NEW CBS FRAME-GRID WIDEBAND PENTODES

Exclusive new CBS E280F/7722 and 7721 sharp-cutoff, 9-pin miniature pentodes offer you the highest ratings ever for gain-bandwidth product. The premium quality tubes make possible new high levels of performance in i-f and video stages of industrial and instrumentation equipment. You benefit from fewer stages, fewer tubes, fewer passive components, and fewer interconnections . . . due to the many advantages of true frame-grid construction.

Order from your local sales office or Manufacturers Warehousing Distributor. Get technical bulletins T-1006 and T-1007. Ask about other CBS frame-grid types. Watch for many new announcements on the rapidly expanding CBS industrial tube line.

ELECTRICAL CHARACTERISTICS

	E280F/ 7722	7721
Plate supply voltage	190	190 volts
Grid supply voltage	+8	+10 volts
Cathode bias resistor	370	400 ohms
Plate current	20	22 ma
Screen-grid current	6	6 ma
Transconductance	26,000	35,000 μ mhos
C _{g-p}	.035	.035 μ fd
C _{in}	9.3	10 μ fd
Cost	2.1	2 μ fd
Gain-bandwidth product	362	465
Input resistance, 100 mc	1400	1000 ohms

OTHER NEW CBS INDUSTRIAL TUBES . . . NOW AVAILABLE!

ECC88/8D18	High-gain, low-noise, frame-grid twin triode
EB8CC/8922	Reliable version of ECC88/8D18
PCC88/7D18	7-volt version of ECC88/8D18
EF86/8267	Low-noise audio preamplifier pentode
E182CC/7119	Reliable high-perveance computer twin triode
EB3F/8689	Reliable, 10,000-hour wide-band pentode
EB1L/8688	Reliable, 10,000-hour wide-band output pentode
E235L	Reliable, 10,000-hour switching power pentode
EB4L	Reliable version of EL84 (6BQ5) audio power pentode
EB0L/8227	Reliable, 10,000-hour industrial power pentode

Write for Chart E-378 on CBS Industrial Tubes.



CBS ELECTRONICS

Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

Sales Offices: Danvers, Mass., 100 Endicott St., Springfield 4-2360 • Newark, N. J., 231 Johnson Ave., TAlbot 4-2450 • Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • Los Angeles, Calif., 2120 S. Garfield Ave., RAYmond 3-9081 • Atlanta, Ga., Cary Chapman & Co., 672 Whitehall St., JACKson 4-7388 • Minneapolis, Minn., The Heimann Co., 1711 Hawthorne Ave., FEderal 2-5457.

NEW!

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Power Supply in a 3 1/2" Panel (Pat. Pending)

This fully transistorized power supply delivers maximum power and performance in minimum panel size at surprisingly low cost. It is NJE's ultimate answer to power supply requirements. Complete with meters, it is fully capable of remote sensing and remote programming. It is the only unit that can be used easily for series or parallel operation. No fans or blowers utilized.

Output Volts Amps	Model No.	Input Power Volts Freq.**	Max. Ripple mv RMS	Static Regulation Load* Line*	Dimensions H x W x D	Approx. Weight Pounds	Price
0-10 0-10	QR-10-10	105-125 55-65	1	±0.01% or ±1 mv ±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	\$485
0-18 0-6	QR-18-6	105-125 55-65	1	±0.01% or ±1 mv ±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	485
0-36 0-4	QR-36-4	105-125 55-65	1	±0.01% or ±1 mv ±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	485
0-60 0-2.5	QR-60-2.5	105-125 55-65	1	±0.01% or ±1 mv ±0.03% or ±3 mv	3 1/2" x 19" x 16 3/8"	41	510

* Whichever is greater.

** Available for 400 cycle operation.

60 and 400 cycle from stock subject to prior sale.



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NEWS

Satellite Study of Ionosphere Planned as Joint Venture

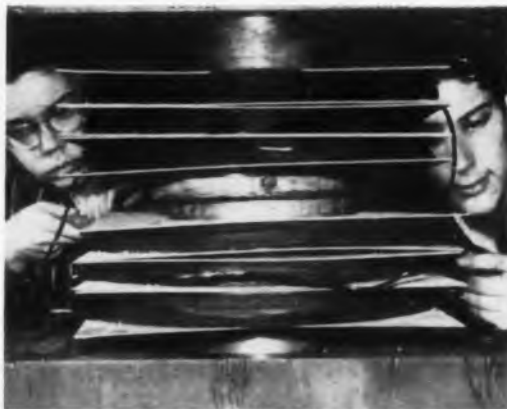
A scientific partnership has been formed to develop satellite equipment for study of the electron density of the upper ionosphere. The Central Radio Propagation Laboratory of the National Bureau of Standards and Airborne Instruments Laboratory of Long Island, N.Y., are planning the venture.

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 International 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.

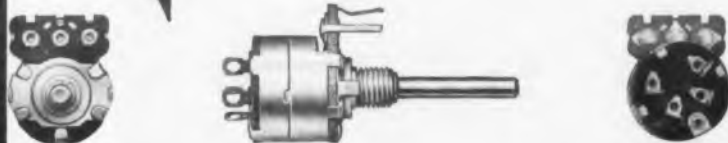
The pledge, which members may stamp on recorders or tape packages, reads:

"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."



5/8" DIA.

CONTROLS



... Everything's small but the ratings

When the "package" calls for something smaller . . . when the circuit calls for dependability . . . Stackpole F-Series Controls lead the way. Used on everything from transistor auto sets and pocket portables to electronic organs, these fully-proved miniature variable resistors provide quiet, reliable operation.

Stackpole F Controls are conservatively rated at 0.3-watts. They're available with threaded bushings or fold-tab mounts as well as with standard lugs or printed wiring terminals.

DP-ST and SP-ST "B"-Series Switches perfectly complement the small size of F Controls and give the tease-proof, positive feel and audible "click" only a true snap-action switch can provide. They're U.L. Inspected for 1 ampere at 125 volts ac-dc; 4 amperes at 25 volts dc.

For those who have no miniaturization problems, however, Stackpole also produces a complete line of standard-size single and dual controls. Send today for full details. *Electronic Components Division, STACKPOLE CARBON COMPANY, St. Marys, Pa.*

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CERAMAG® FERROMAGNETIC CORES • SLIDE AND SNAP SWITCHES • FIXED COMPOSITION CAPACITORS • COLDITE 70+®
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CIRCLE 36 ON READER-SERVICE CARD

FREQUENCY STANDARDS

PRECISION FORK UNIT TYPE 50



Size 1" dia. x 3 3/4" H. Wgt., 4 oz.
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 ($\pm 0.02\%$ at -65° to 85°C)
Type R50 ($\pm 0.002\%$ at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

*3 1/4" high
400 - 1000 cy.

FREQUENCY STANDARD TYPE 50L



Size 3 3/4" x 4 1/2" x 5 1/2" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L ($\pm 0.02\%$ at -65° to 85°C)
Type R50L ($\pm 0.002\%$ at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

PRECISION FORK UNIT TYPE 2003



Size 1 1/2" dia. x 4 1/2" H. Wgt. 8 oz.
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 ($\pm 0.02\%$ at -65° to 85°C)
Type R2003 ($\pm 0.002\%$ at 15° to 35°C)
Type W2003 ($\pm 0.005\%$ at -65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

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

FREQUENCY STANDARD TYPE 2005



Size, 8" x 8" x 7 1/4" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: $\pm 0.001\%$ from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

FREQUENCY STANDARD TYPE 2007-6



NEW
TRANSISTORIZED, Silicon Type
Size 1 1/2" dia. x 3 1/2" H. Wgt. 7 ozs.
Frequencies: 400—500 or 1000 cycles
Accuracies:
2007-6 ($\pm .02\%$ at -50° to $+85^{\circ}\text{C}$)
R2007-6 ($\pm 0.002\%$ at $+15^{\circ}$ to $+35^{\circ}\text{C}$)
W2007-6 ($\pm 0.005\%$ at -65° to $+125^{\circ}\text{C}$)
Input: 10 to 30 Volts, D. C., at 6 ma.
Output: Multitap, 75 to 100,000 ohms

FREQUENCY STANDARD TYPE 2121A



Size
8 3/4" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
 $\pm 0.001\%$ from 20° to 30°C
Input, 115V (50 to 400 cycles)

FREQUENCY STANDARD TYPE 2001-2



Size 3 3/4" x 4 1/2" x 6" H., Wgt. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: $\pm 0.001\%$ at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3-12-28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD TYPE 2111C



Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8 3/4" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: ($\pm 0.002\%$ at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS for TYPE 2001-2



L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

*This organization makes frequency standards
within a range of 30 to 30,000 cycles. They are
used extensively by aviation, industry, govern-
ment departments, armed forces—where maxi-
mum accuracy and durability are required.*

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American Time Products, Inc.

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Watch Master
Timing Systems

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

CIRCLE 37 ON READER-SERVICE CARD

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.



The way to know — An ominous shadow over ocean or wasteland... an unidentified "blip" on a radar scope! A challenge from an airborne AN/APX-7 interrogating unit spurts into the ether. In microseconds a reply identifies the potential marauder as friendly. The absence of such a reply alerts the protective and retaliatory might of the nation.

ENGINEERING BEYOND THE EXPECTED Packard Bell's reputation as a leading designer and foremost producer of IFF (identification, friend or foe) equipment is indicated by the fact that both the AN/APX-7 and the AN/APX-6, which returns the reply, are products of our Technical Products Division. Advanced development, company-sponsored, has recently produced miniaturized IFF modules which operate up to 200°C.



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C '59 PB

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Whether you make missiles and rockets or provide lockets for misses, there's an *exclusive* SEL-REX PRECIOUS METALS PLATING PROCESS to meet your particular needs.

*SEL-REX BRIGHT GOLD—the standard of the industry—twice as hard as ordinary 24K Gold Plate—mirror-bright in any thickness, directly from the bath.

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*DOPED GOLD PROCESSES—doped with antimony or indium, depending on desired characteristics—best for Silicon and Germanium semiconductor applications.

*TEMPEREX—Produces pure 24K Gold electroplate which will withstand higher temperatures than any pure Gold plate known.

*THERMOKARAT®—Produces exceedingly hard (470 Vickers) 18K Gold electroplate for decorative or industrial applications.

*RHODEX®—a patented Rhodium plating process which yields compressively stressed, crack-free deposits, permitting thicker Rhodium electroplate than ever before possible.

*PLATANEX® L/S—low stress Platinum plating process produces essentially nonporous electroplate for high temperature and other exacting industrial applications—no intermediate scratch brushing or burnishing required.

*KARATCLAD® GOLD PROCESSES—acid Gold processes for decorative applications—Jeweler's Finish in any thickness, in a wide range of non-varying colors.

BRIGHT RHODIUM PROCESS—yields brilliant, fine grained, non-tarnishing deposits. Manufactured in our air conditioned laboratories, its purity assures consistent quality results for all decorative applications.

*SILVREX® BRIGHT SILVER—mirror-bright deposits in any thickness, operates at room temperature in current densities from 10 to 40 asf—hard and ductile deposits.

SILVER SOL-U-SALT®—a water soluble double cyanide salt—permits new ease and facility in the preparation of Potassium Silver Cyanide plating solutions.

POTASSIUM GOLD CYANIDE—the purest available—used in the preparation of our own exclusive Gold Plating Processes—manufactured in moisture controlled facilities.

INDUSTRIAL SILVER PLATING PROCESSES—a complete line of silver plating formulations for high speed industrial applications.

*Patented and patents pending



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Nutley 10, New Jersey

Exclusive Precious Metal Electroplating Processes

CIRCLE 39 ON READER-SERVICE CARD

NEWS

EIA Condemns Congressional 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. Secret, 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 man-
ufacture of products through the control of inter-
state commerce, which the courts have held to be
unconstitutional. It would substitute arbitrary gov-
ernment regulation for public control in the con-
sumer field."

The National Association of Broadcasters is still
formulating its position on the FCC bills, but it is
expected to be against the legislation. A top NAB
officer told ELECTRONIC DESIGN, "In matters of this
sort we generally want to present a united front
with the manufacturers."

All-Channel Receiver Cost Debated

Opinion is divided as to the increased cost of
all-channel TV receivers. FCC engineers believe
that a continuous TV spectrum, which might per-
mit the use of continuous-strip tuners, might add
no more than \$10" to the retail cost of each mass-
produced receiver. An NAB engineer felt, how-
ever, that allocation of a continuous spectrum was
by no means assured. A divided spectrum would
result in the use of turret tuners that would cost
at least \$25 per set."

The FCC feels that the existence of a large
market for all-channel TV sets would stimulate
design efforts to create a really low-priced tuner
and that present cost figures do not mean much in
the light of possible new developments. The FCC
has further proposed that the 10 per cent excise
tax be waived in the case of the proposed all-
channel receivers.

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

The EIA fears, however, that the FCC might
short-circuit this plan and merely call for the man-
ufacture of all-channel receivers for the present
mixed uhf-vhf spectrum, thus freezing TV broad-
casting at the present spectrum. This, the EIA has
indicated, does not offer a satisfactory long-term
solution to the allocation problem. ■ ■

a new type
primary standard
for measuring
AC/DC power

INTRODUCING



Model 1483

THE WESTON ELECTRONIC WATTMETER

- Transfer accuracy between DC and AC is within 0.01%
- Unprecedented versatility and reliability

CHECK THESE FEATURES

- **NEGLIGIBLE STATIC FRICTION** between pivot and jewel bearing to affect accuracy. A small-amplitude vibration is fed constantly to the sensing element—makes possible resolutions down to .01% — 1/5 the resolution of the best indicating meter.
- **NO SPRING FATIGUE** — Springs have been eliminated.
- **TEMPERATURE COMPENSATED** — reduced self-heating errors.
- **LOW EDDY CURRENTS** — due to ferrite shields. Frequency compensated.
- **NO MUTUAL INDUCTANCE ERRORS** — The coils are oriented at 90°.
- **POWER-FACTOR** — full operation down to 5%.
- **ONLY ONE POTENTIOMETER** needed for DC Standardization — other wattmeters need two standards, multiplying costs . . . and errors.
- **READ-OUT VERSATILITY** — can actuate remote indicators, digital meters; drive strip-chart recorders, integrators; used in parallel or alone.

With the development of its Model 1483 Electronic Wattmeter, Weston now brings to AC and DC power measurement a degree of accuracy which extends even beyond the traditional accuracy of Weston's indicating type dynamometer wattmeters. With quick, precise operation, the Model 1483 provides a low impedance DC output that can be measured by present day highly accurate techniques. Truly, here's a new concept in quality and capability.

Weston Instruments Division, Daystrom, Incorporated, Newark 12, N. J. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom's International Sales Division, 100 Empire St., Newark 12, N. J.

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NEWS

Company Grants \$25,000 For Science Collegiates

Six eastern universities and colleges will share a \$25,000 fund for scholarships established by American Machine and Foundry Co., New York.

The schools are Princeton University, Harvard University, Dartmouth College, the Massachusetts Institute of Technology, Cornell University, and Rensselaer Polytechnic Institute.

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

Automatic Weather Observer Detects Different Precipitations

An automatic weather observer for remote, unattended weather stations is said to distinguish between different forms of precipitation with human-like recognition.

The system, developed by Thompson Ramo Wooldridge, Inc., makes use of digital electronic techniques. It is comprised of sensor units, which are integrated into a logic interpreter system (complex digital electronic memory) to differentiate and record data. The data can be relayed through a series of automatic teletype systems to data-gathering centers.

The system is one of four electronic sensors being developed by Thompson Ramo Wooldridge for the Weather Bureau's Automatic Meteorological Observing Stations project.



Engineers examine data recorded by automatic weather sensors developed by Thompson Ramo Wooldridge. The sensors distinguish between different forms of precipitation. Data can be relayed by digital electronic techniques from remote weather stations to data-gathering centers.

NEWS BRIEFS

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

ROUGHES 205 SYSTEM, an electronic computer, "speaks" the international language of mathematics. It is on its way to the National Laboratory, Tokyo, to translate wind-tunnel data on flight behavior of aircraft.

TWO TRANSISTORIZED SOLID-STATE digital computer systems developed by Daystrom, Inc., of Murray Hill, N.J., will be installed in the South by power utilities.

VER-THE-AIR PHONEVISION system, developed by Zenith Radio Corp. of Chicago, will be used by RKO General, Inc., New York, in a three-year trial of subscription TV in Hartford, Conn.

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

NEW PERSONNEL PLACEMENT company, Davies & Shea, Inc., is opening at 332 S. Michigan, Chicago. Eugene B. Shea and C. A. Davies, formerly with Cadillac Associates, will deal exclusively with placement and procurement in the electronics field.

TWO-WAY RADIO SYSTEM, so compact that it can be carried in a hat, is under development at Bendix Aviation, Baltimore. The system will equip flight-deck crewmen on aircraft carriers with helmet-enclosed receiver and transmitter units for continuous voice contact with flight-control stations aboard ship.

100-KW TURBINE GENERATOR SET developed by Garrett Corp.'s Air Research Manufacturing Div. of Phoenix, Ariz., is reported to have 5,000-hr overhaul period; insensitivity to dust, cold or heat, and completely automatic single-switch operation. Utilizing silicon-controlled rectifiers, the unit generates 3,200-cycle electricity. The output is statically converted to either 60 or 400 cycles.

Model 120B f.o.b. Oakland, Calif. \$1275

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SPECIFICATIONS

RISE TIME (10% to 90%)
Less than 2.5 millimicroseconds

PULSE WIDTH
2.5 to 25 millimicroseconds

REPETITION RATE (External or Internal)
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OUTPUTS
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Impedance, 93 ohms

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CONNECTORS
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Amplitude required, 3 volts rms

ELECTRONIC GATE
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Amplitude required, positive 20 volts



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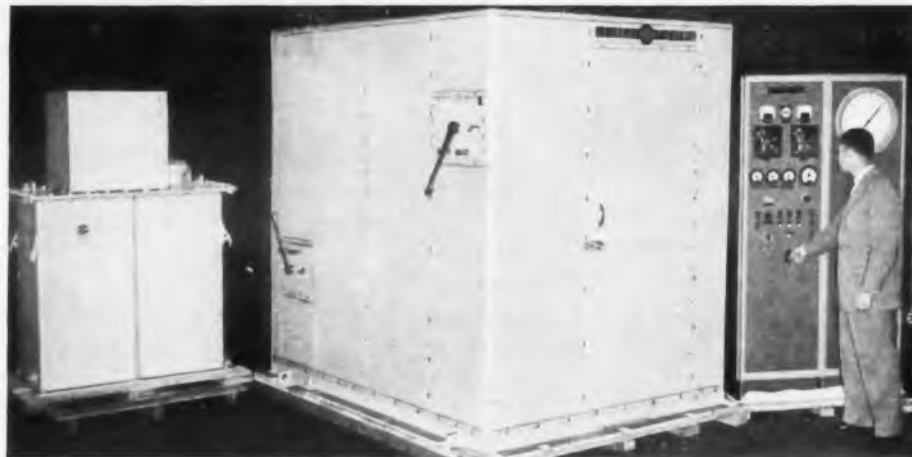
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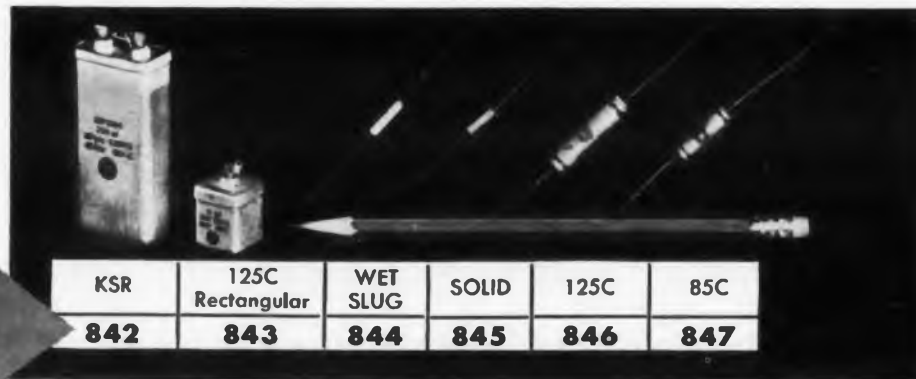
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NEW PRODUCTS

NEW Tantalitic Capacitors in ratings to 300 volts

The General Electric Company has announced the availability of new high-voltage foil capacitor rated to 300 volts at 85C and 250 volts at 125C, in both polar and non-polar designs. The new units are smaller than any previously available capacitor with similar voltage ratings and also provide size and weight advantages over series arrangements of lower voltage units.

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NEW Radar Transformer

Typical of G.E.'s line of custom designed high-voltage transformers, this new 1800-lb pulse unit has a specially developed molded epoxy bushing for operation above 250 kv. It incorporates a special series reactor for protection from load transients. The new unit is still another example of the wide range of specially engineered high-voltage transformer products available from General Electric.

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



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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.

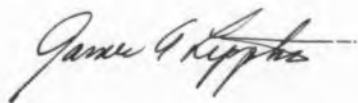
Of course, others play the game, too. The space age requires many to use astronomical numbers. The length of time it will take a signal to travel to another galaxy is measured in light years. But these magnitudes unnerve the reliability boys who are still trying to get MTBF's in hours. A neat way to avoid the obvious is to play the smaller numbers. Components, therefore, have reliability indexes stated with large negative subscripts—for example, 3×10^{-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.



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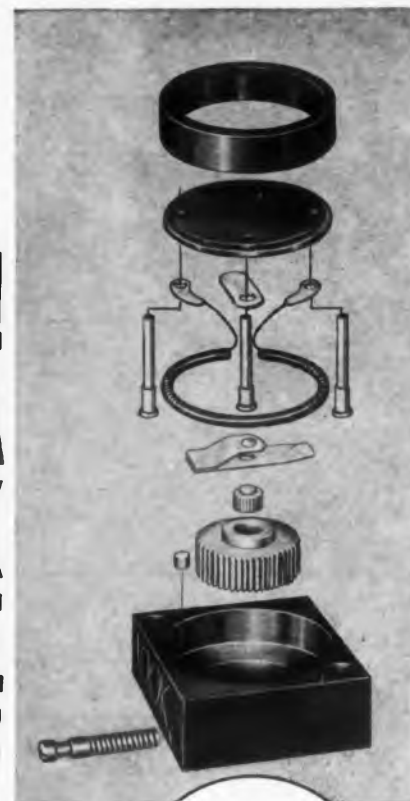
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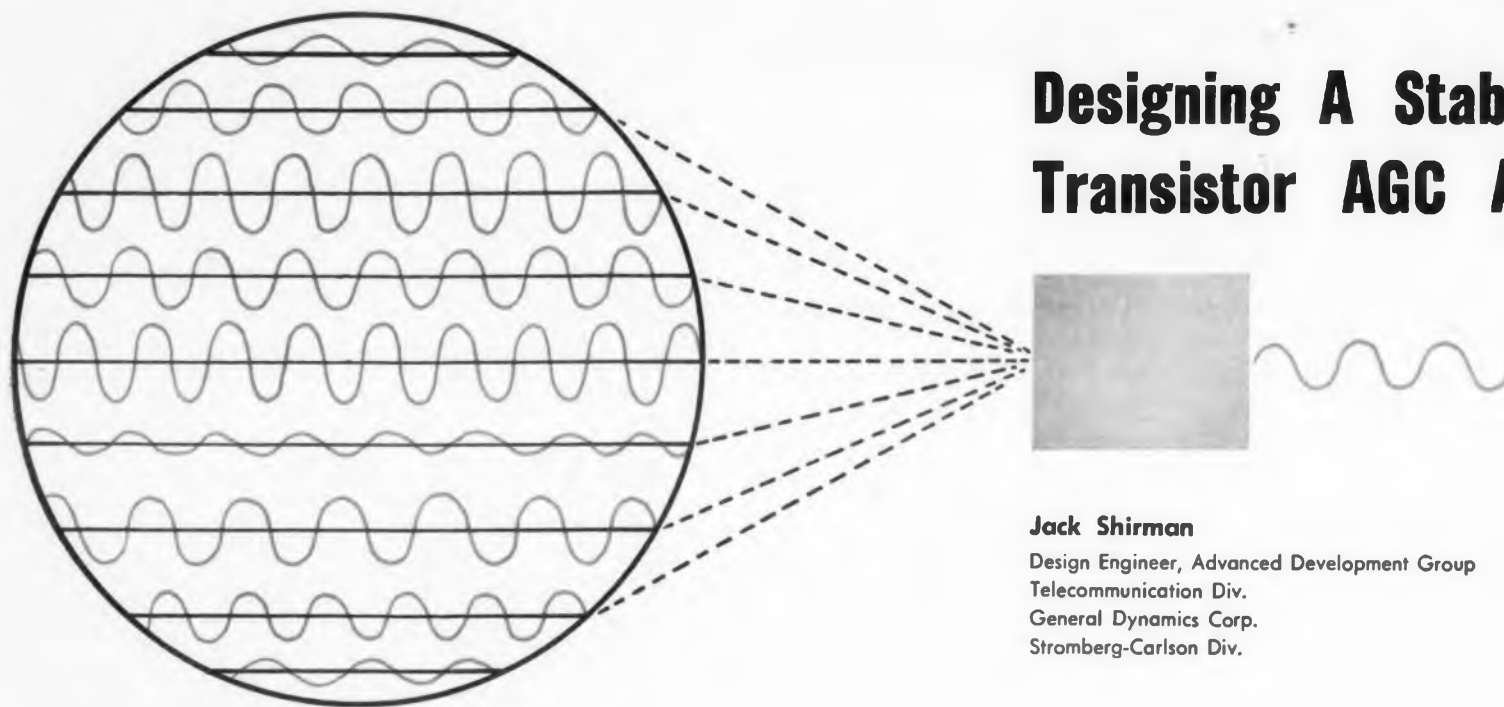
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ACTUAL SIZE

Designing A Stable Transistor AGC Amplifier

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.

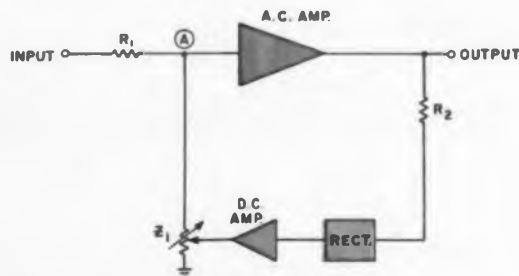


Fig. 1. Simplified block diagram representation of an agc amplifier.

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

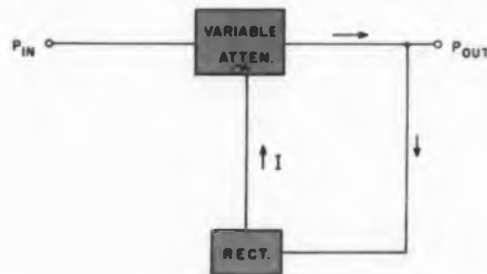


Fig. 2. Basic agc circuit showing relationship of main parameters.

of this pad is such that the voltage at point A is kept constant over the control range of the diode.

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

If a high-level input, at the maximum control level of the agc system is applied, the fixed gain amplifier delivers a much higher output. This signal is again fed back around the loop and results in a large current in Z_1 , lowering its dynamic impedance. This results in considerable attenuation of the input signal which, with proper adjustment

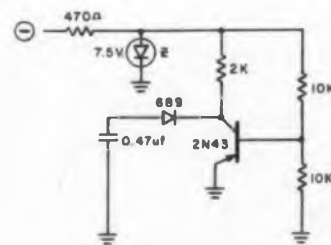


Fig. 3. Recommended peak-rectifier circuit.

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 millisecc.

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:

$$\frac{dP_o}{dP_i} \quad (1)$$

where P_i and P_o are input and output power respectively 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:

$$P_o = P_i - x \quad (2)$$

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

$$I = f_1(P_o) \quad (3)$$

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

$$x = f_2(I) \quad (4)$$

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

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

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:

$$A = e^{CB} \quad (6)$$

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

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

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

$$e^{qV/kt} \gg 1 \quad (8)$$

which means that Eq. 7 reduces to

$$I = I_s e^{CV} \quad (9)$$

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

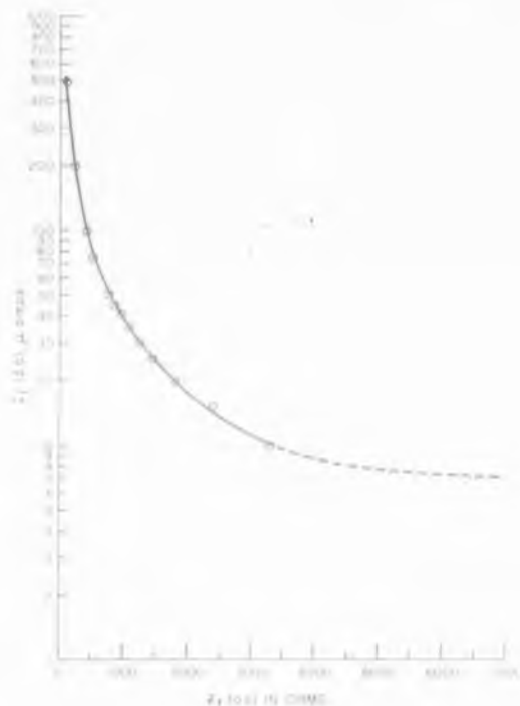


Fig. 4. I_b vs Z_f (ac) for 689 si diode at 25 C.

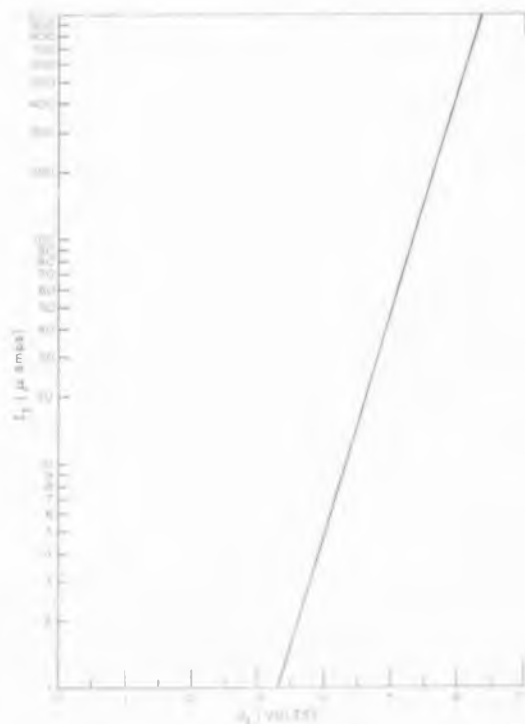


Fig. 5. I_b vs V_f for 689 si diode at 25 C.

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 stabili-

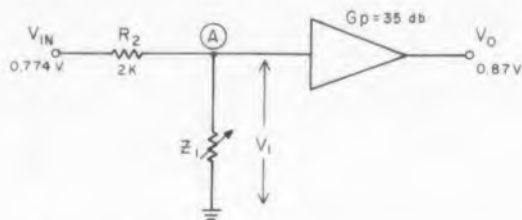


Fig. 6. Equivalent circuit used to calculate L-pad values.

zation of the operating point can be achieved. This method is employed in the example given later.

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 system 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:

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

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

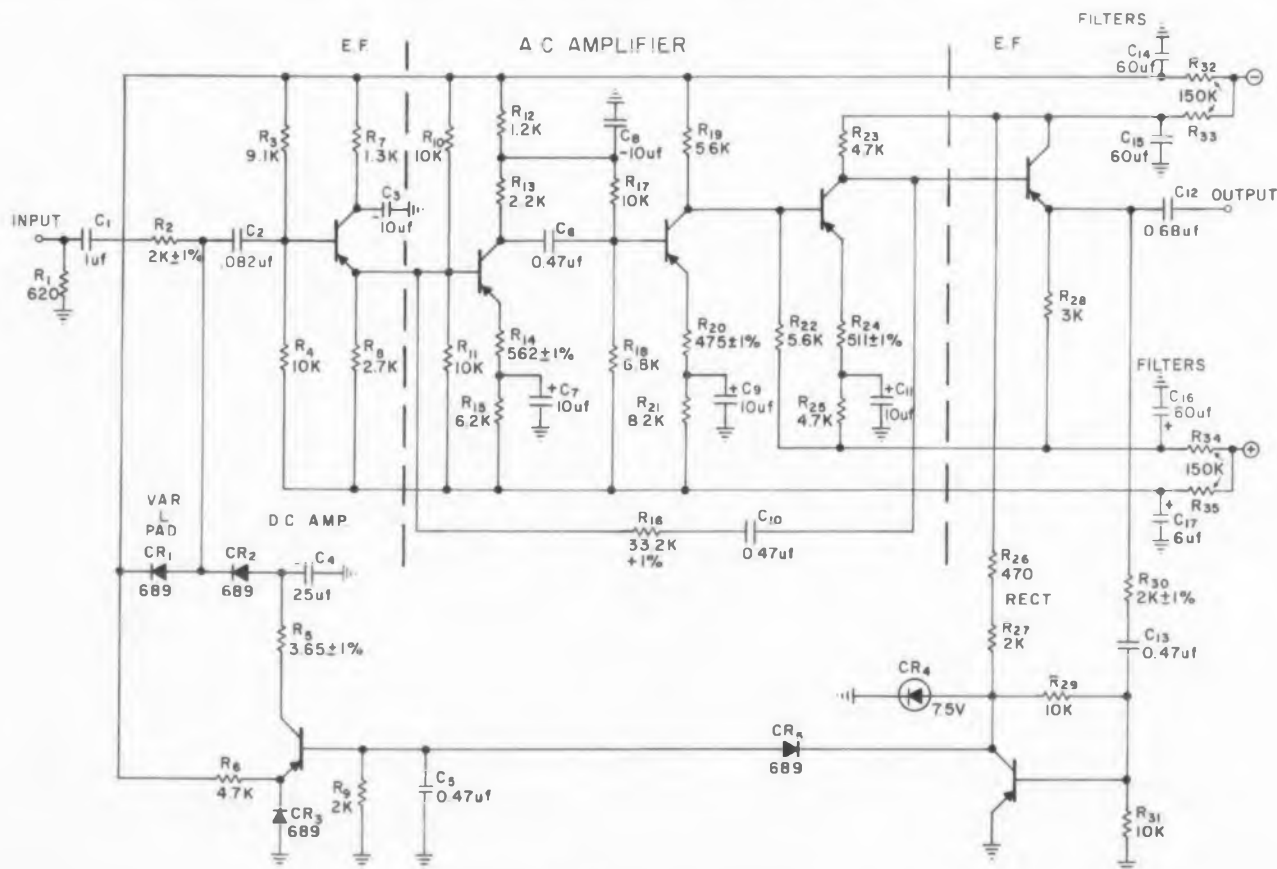


Fig. 7. Schematic of agc system discussed in text.

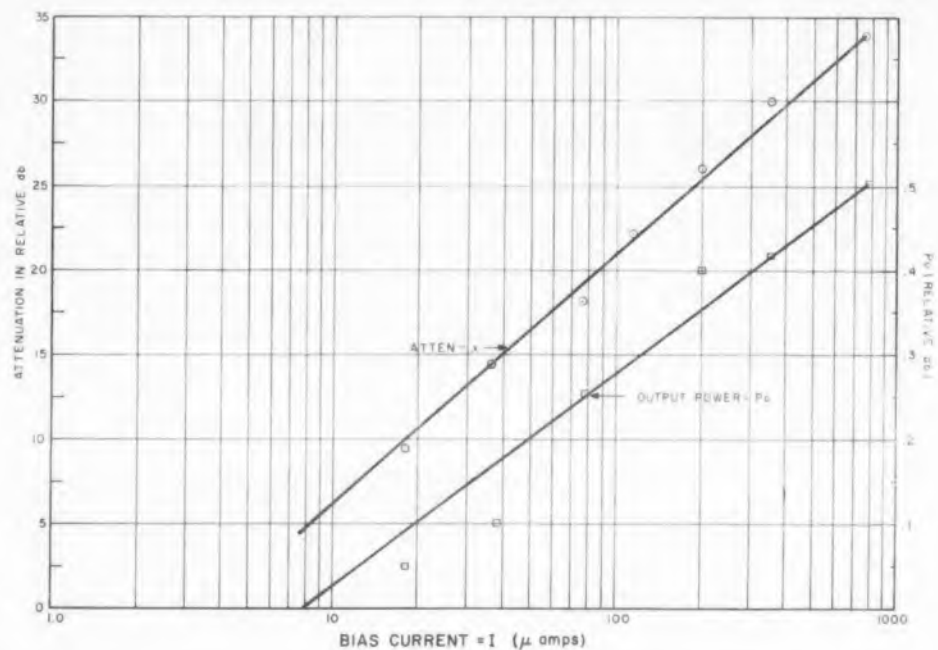


Fig. 8. Typical agc characteristics obtained during development of example circuit.

± 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 $I_f V_f$ curve of the diode, the required bias current is 750 μ amp.

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 μ amp. 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 μ amp 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.

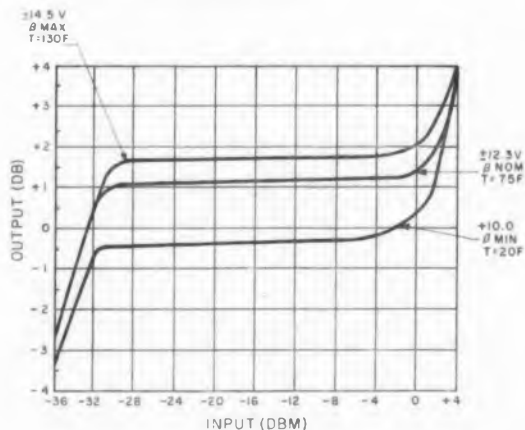


Fig. 9. Input vs output at $f = 2500$ cps. (β min = 20 , β nom = 60 , and β max = 150).

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 agc 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 agc 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 agc 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
G. H. Leland, Inc.
Dayton, Ohio



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.

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.

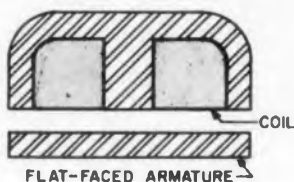
Rotary for Linear Loads. By the same token, a rotary solenoid can also be used, with a proper linkage and crank arm, to produce a straight-pull motion when there is not enough length for a straight-pull solenoid.

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.

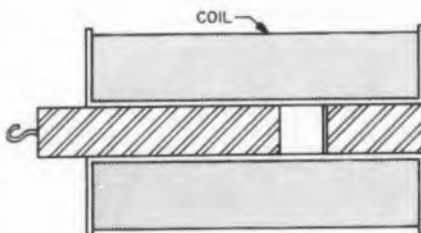
In this conversion, the incline of the ball races is steep at the beginning of the rotary stroke and gradually decreases as the balls approach the deep end of the ball races. This transfers torque to the start of the rotary stroke where it is usually needed.

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.

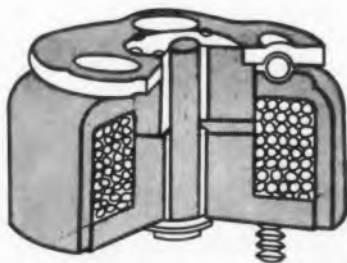
Distorted-Field Type. Another type, available in an ac model, uses the distorted-field or stalled-motor principle. However, because it is designed for ac use and, like the compensated plunger-



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



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.

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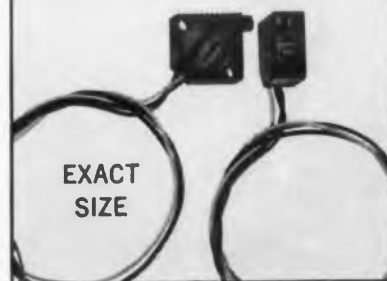
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type solenoid, it uses shaped pole pieces which are not flat and parallel, it loses some efficiency.

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 solenoids 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. ■ ■

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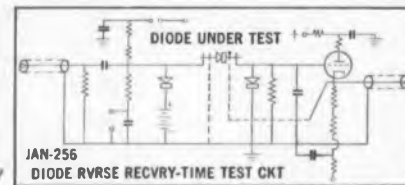
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Peak Forward Current	120 mA	120 mA	120 mA
Forward Current (minimum)	2.0 mA @ 1.0 V	10.0 mA @ 1.0 V	10.0 mA @ 1.0 V
Reverse Current (max @ 25° C)	0.20 μA @ -10 V	0.10 μA @ -5 V	0.025 μA @ -12 V
Reverse Current (max @ 100° C)	10.0 μA @ -10 V		
Reverse Current (max @ 125° C)		10.0 μA @ -5 V	
Reverse Current (max @ 150° C)			5.0 μA @ -12 V
Peak Inverse Voltage (minimum)	40 V @ 125 mW	40 V @ 100 μA	40 V @ 100 μA

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Find Transistor Gain and Impedance Quickly Using Hybrid-Pi Equivalent

Paul Margolin

Allen B. Du Mont Laboratories, Inc.
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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

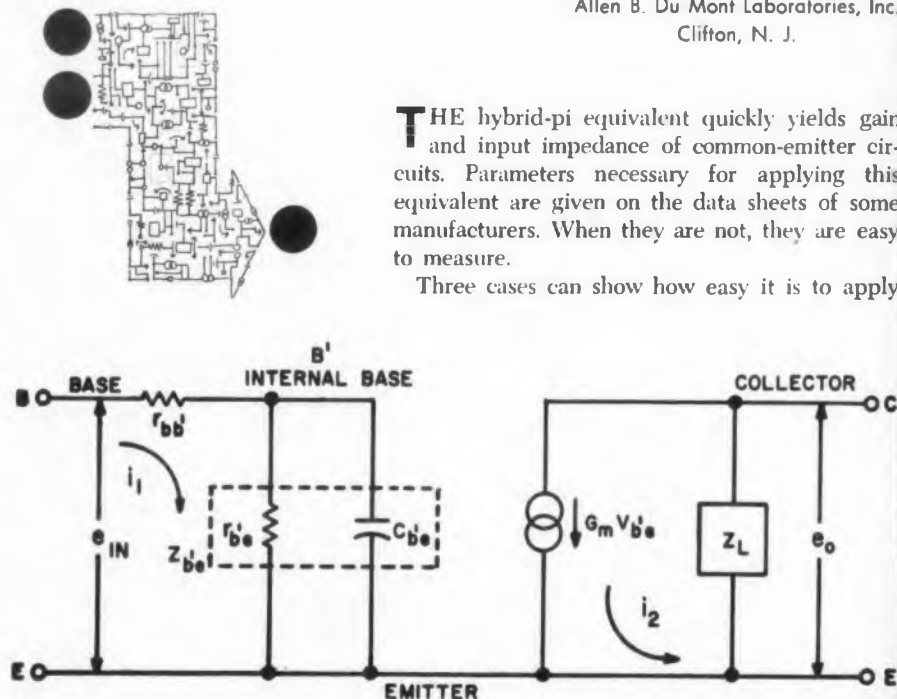


Fig. 1. Hybrid equivalent of a common-emitter circuit with the emitter grounded.

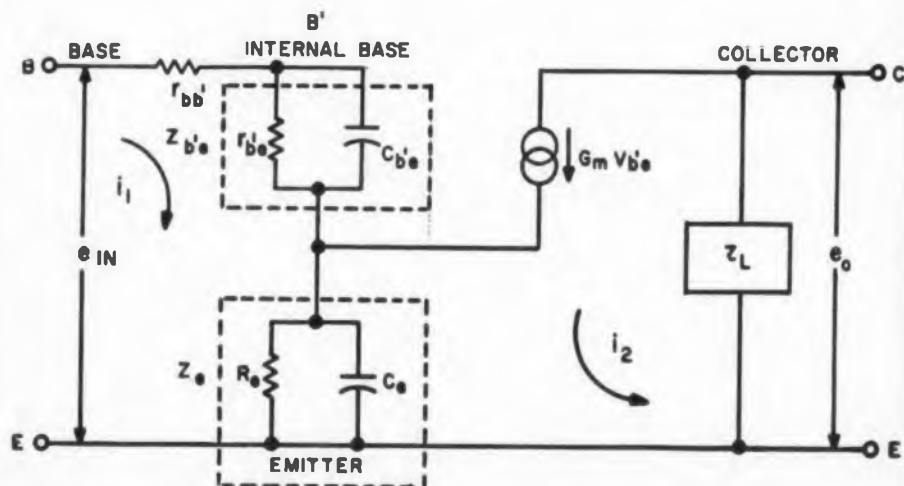


Fig. 2. Hybrid-pi equivalent with emitter impedance considered.

the hybrid pi to determine voltage gain and input impedance.

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

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

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

Case 2. Emitter impedance considered. $Z_{b'e} = \infty$. (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 $Z_{b'e}$ considered. (See Fig. 3.)

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

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

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 $G_m = 37,000$ μ mhos.

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

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

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

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

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

(continued on p 55)



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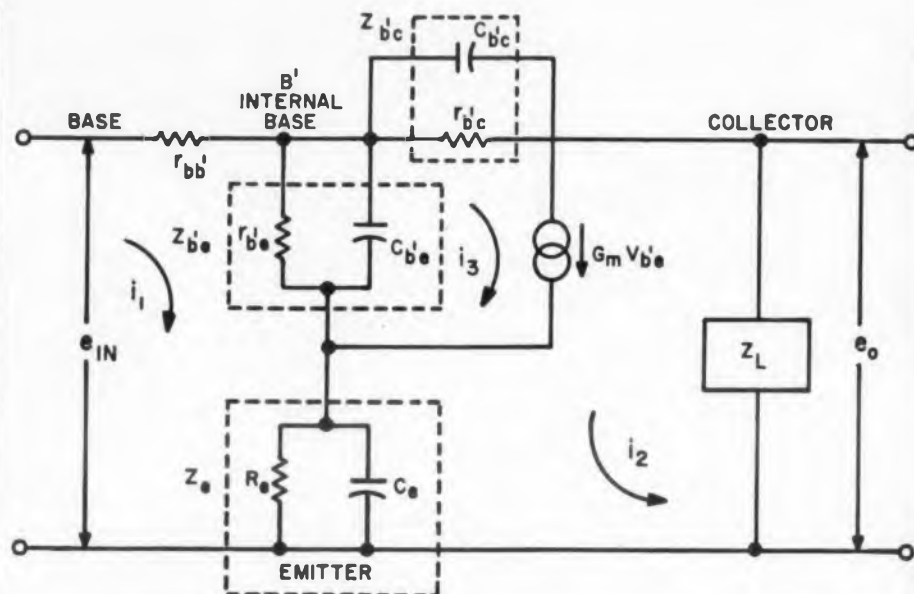


Fig. 3. Hybrid-pi equivalent with emitter impedance and degenerative effect of collector-to-base impedance considered.

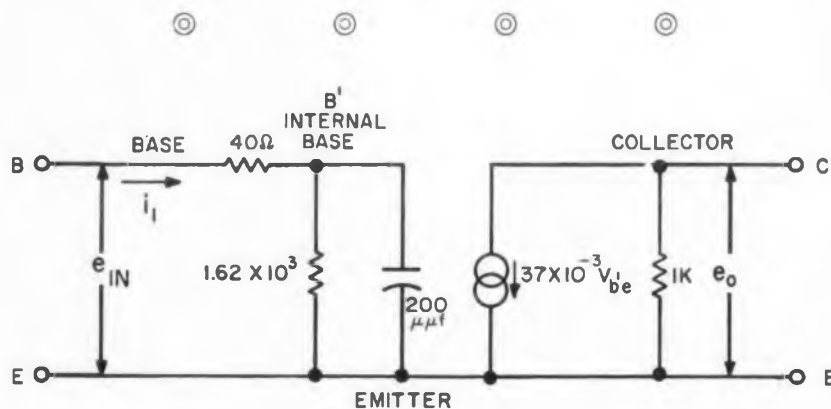


Fig. 4. Equivalent circuit for the sample problem in the text.

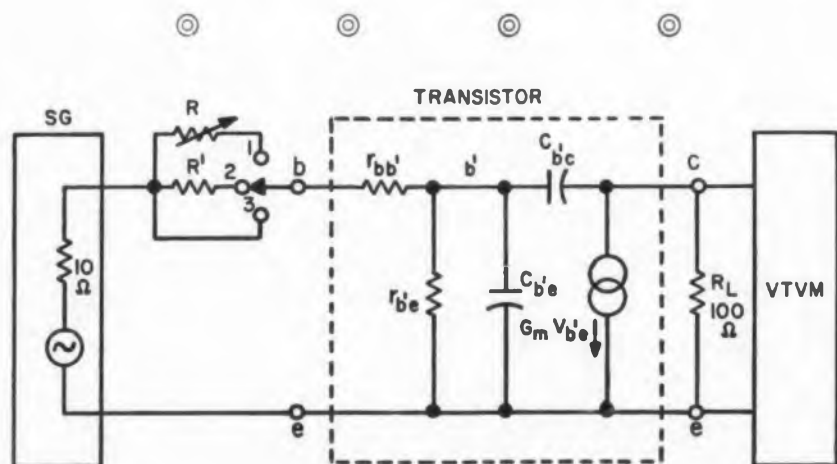


Fig. 5. Test setup for measuring $C_{b'e}$, $r_{b'e}$, and $r_{bb'}$.

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

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

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:

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

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 $C_{b'e}$.

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

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

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

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.

"A Simple Method for Measuring Some Important Transistor Parameters," Hazeltine Technical Report No. 7189.



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Acceleration at stall, rad/sec ²	88,000	22,200	100,000	22,200
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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.

D. E. Meehan, Research Engineer
Armco Steel Corporation (Research Laboratories)
Middletown, Ohio

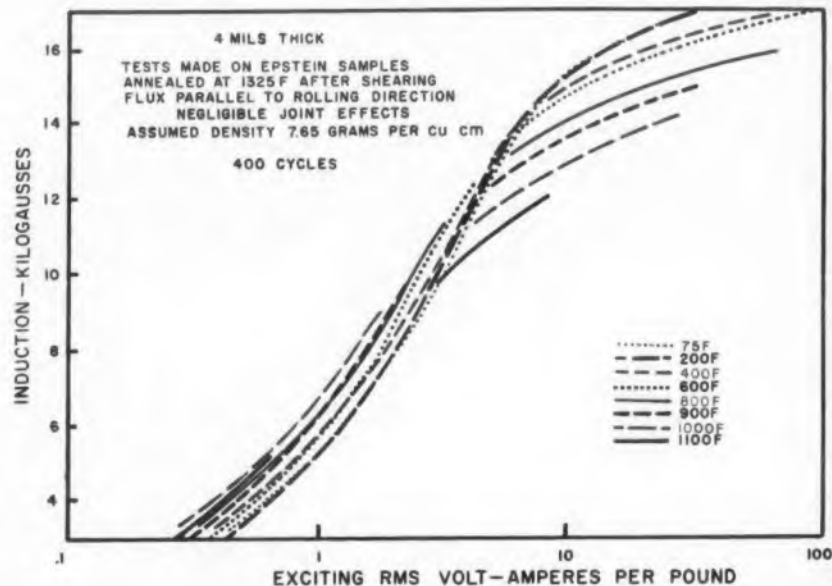


Fig. 1. Exciting rms volt-amperes per pound at high inductions and elevated temperatures for Armco oriented T.

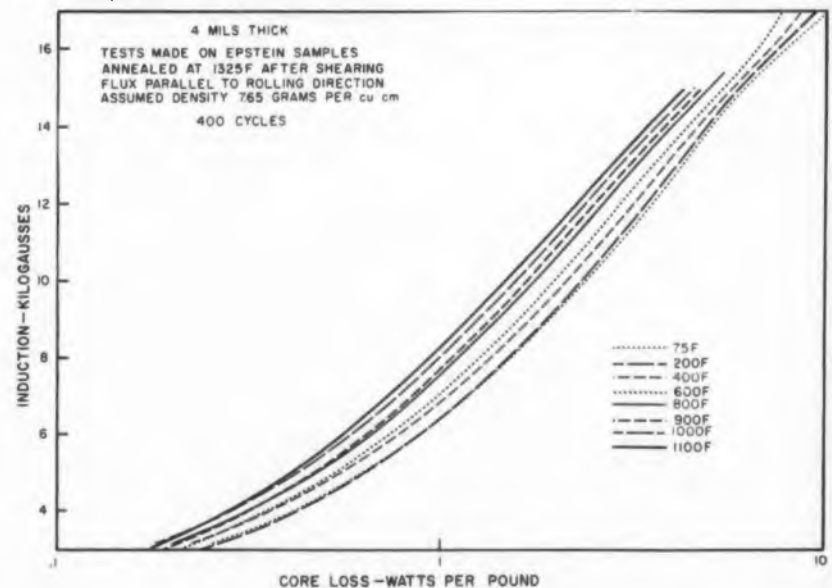


Fig. 2. Core loss at high inductions and elevated temperatures for Armco oriented T.

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

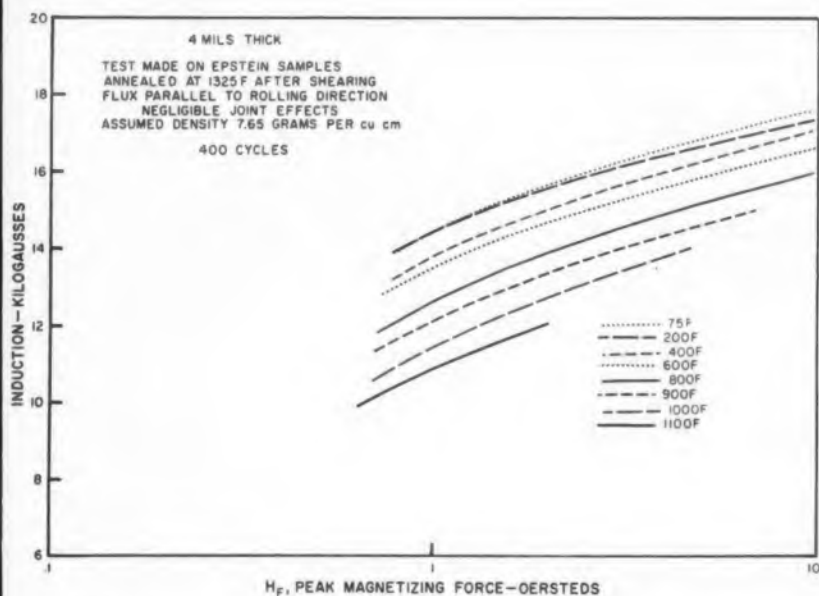


Fig. 3. Ac magnetization curves at high inductions and elevated temperatures for Armco oriented T.

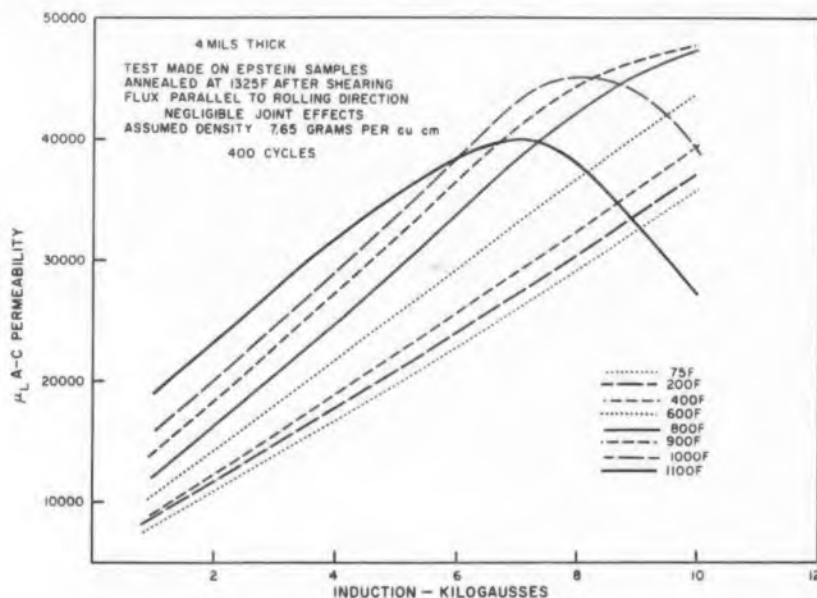


Fig. 4. Ac permeability at elevated temperatures for Armco oriented T.

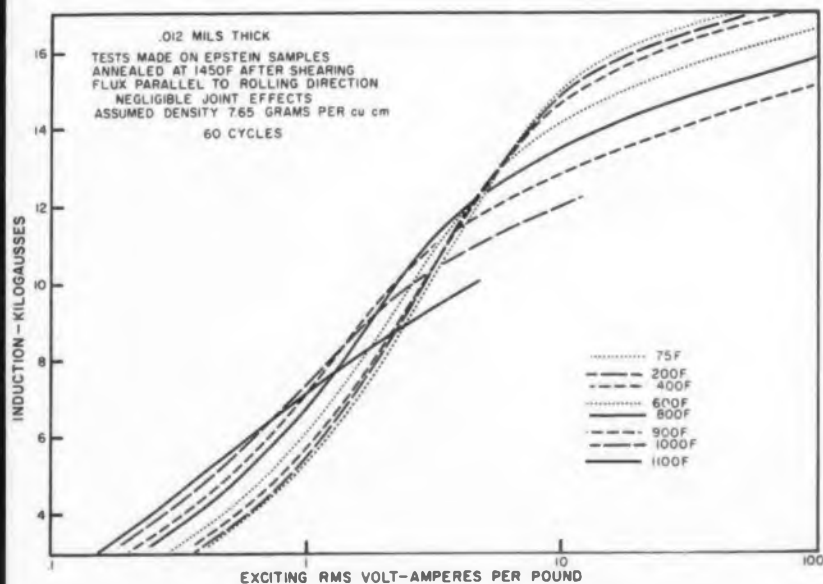


Fig. 5. Exciting rms volt-amperes per pound at high inductions and elevated temperatures for Armco oriented M-6W.

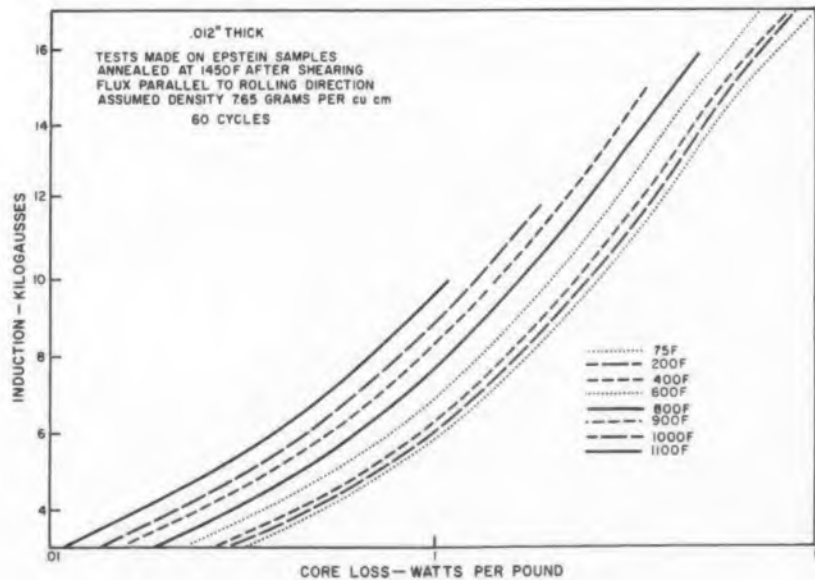


Fig. 6. Core loss curves at high inductions and elevated temperatures for Armco oriented M-6W.

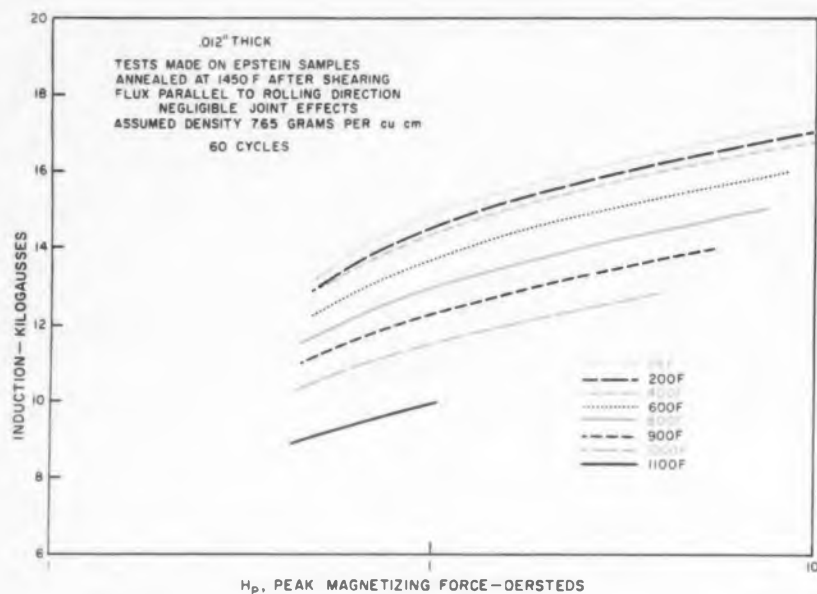


Fig. 7. Ac magnetization curves at high inductions and elevated temperatures for Armco oriented M-6W.

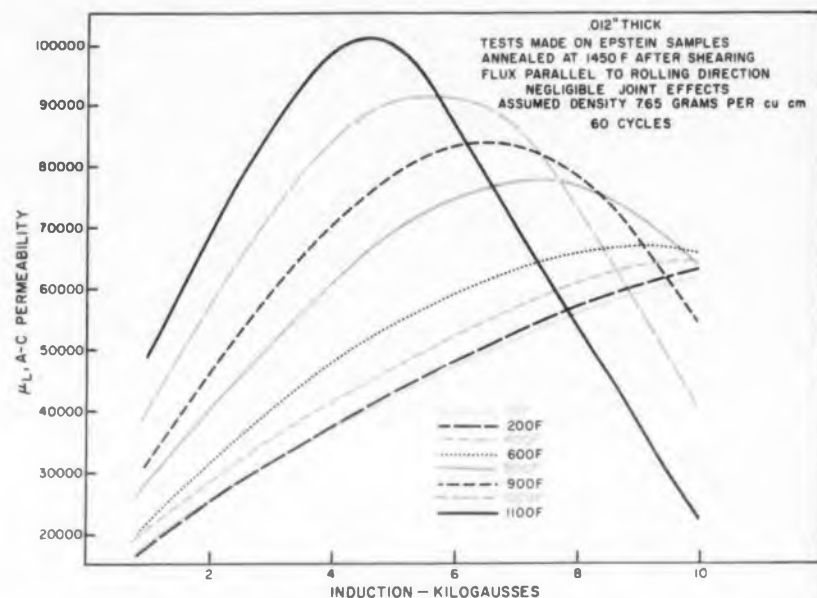


Fig. 8. Ac permeability at elevated temperatures for Armco oriented M-6W.

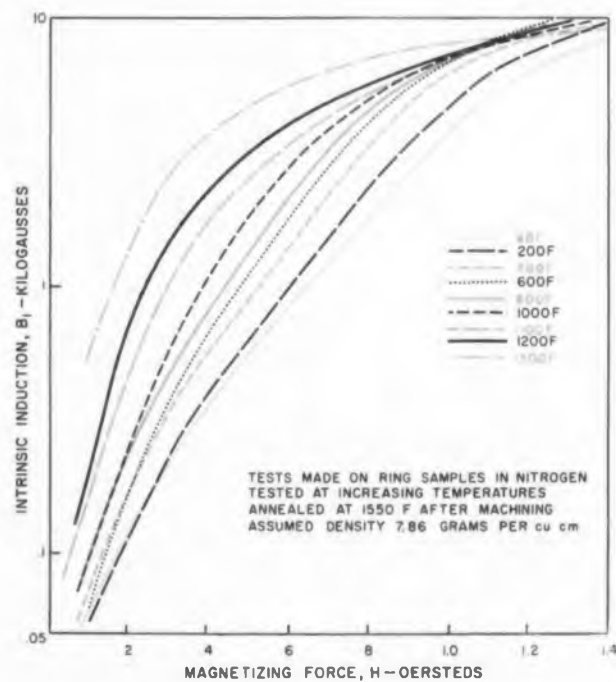


Fig. 9. Dc magnetization curves at low inductions and elevated temperatures for Armco ingot iron.

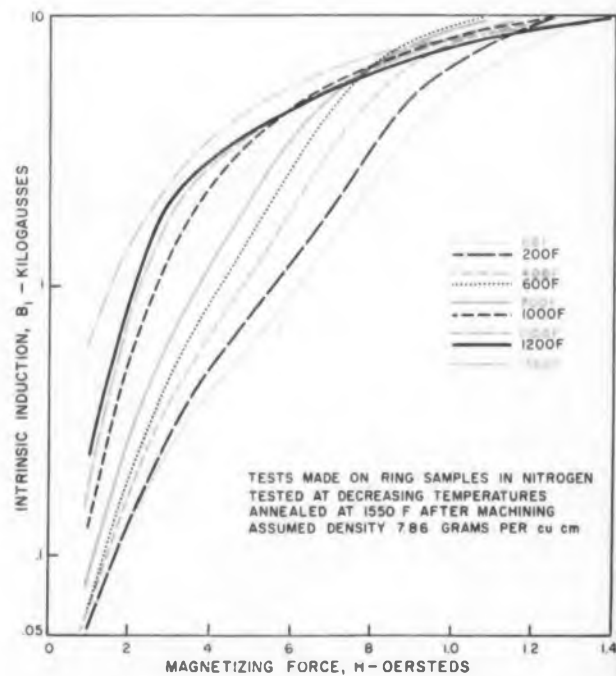


Fig. 10. Dc magnetization curves at low inductions and elevated temperatures for Armco ingot iron.

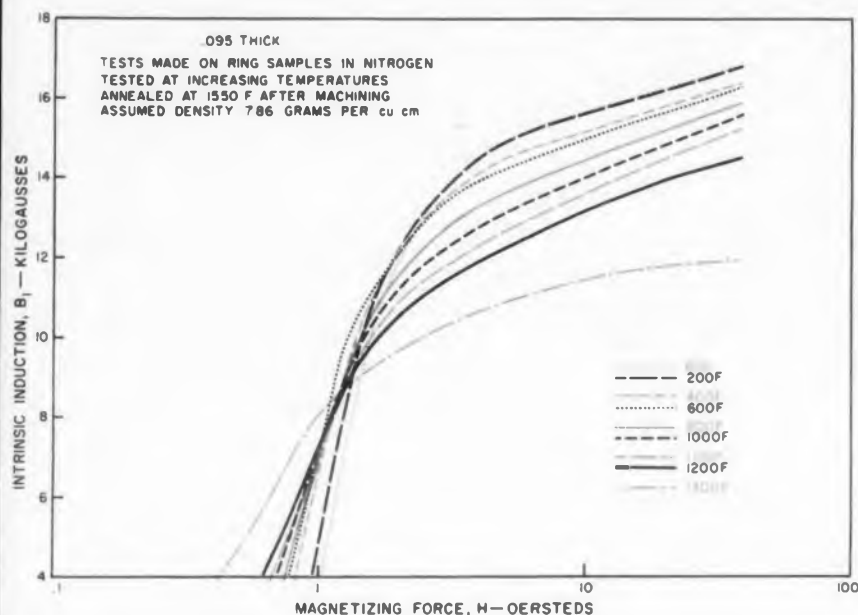


Fig. 11. Dc magnetization curves at high inductions and elevated temperatures for Armco ingot iron.

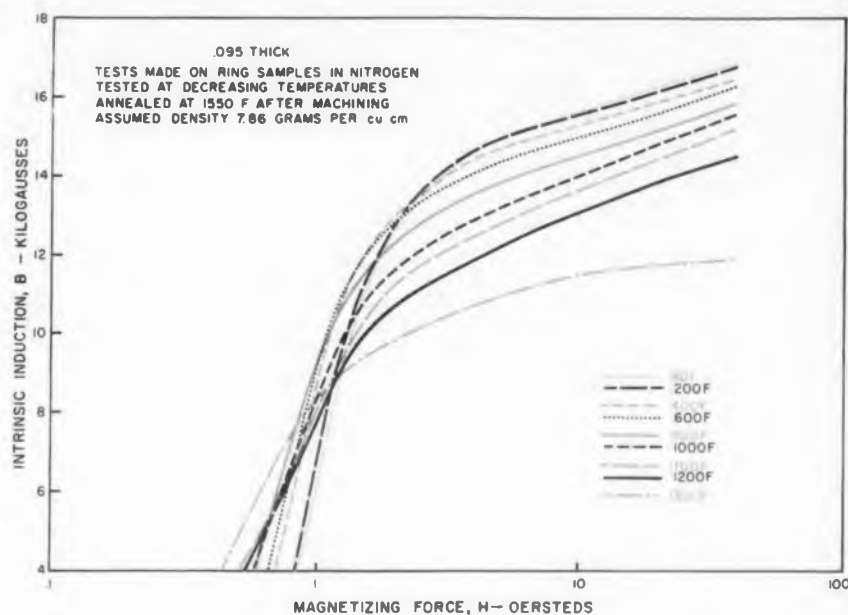


Fig. 12. Dc magnetization curves at high inductions and elevated temperatures for Armco ingot iron.

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.

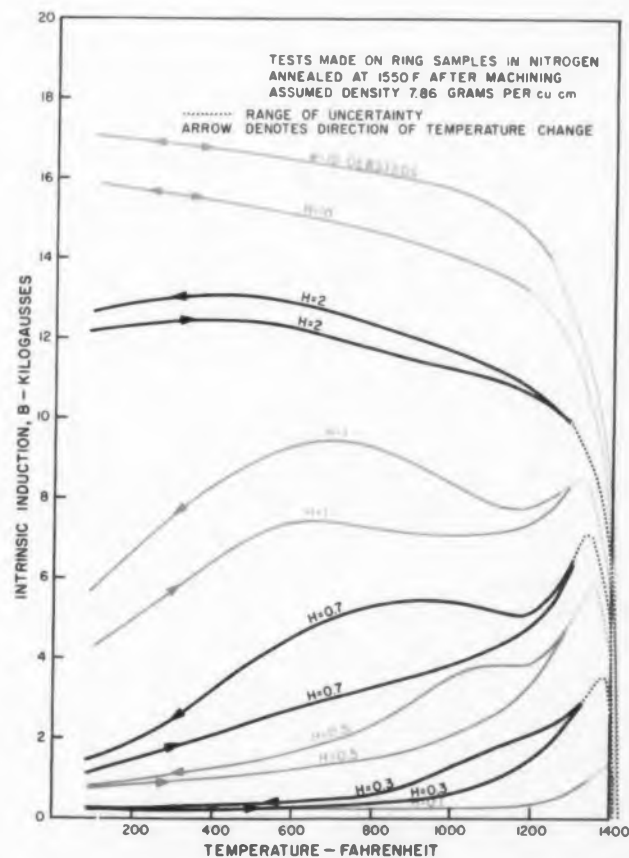


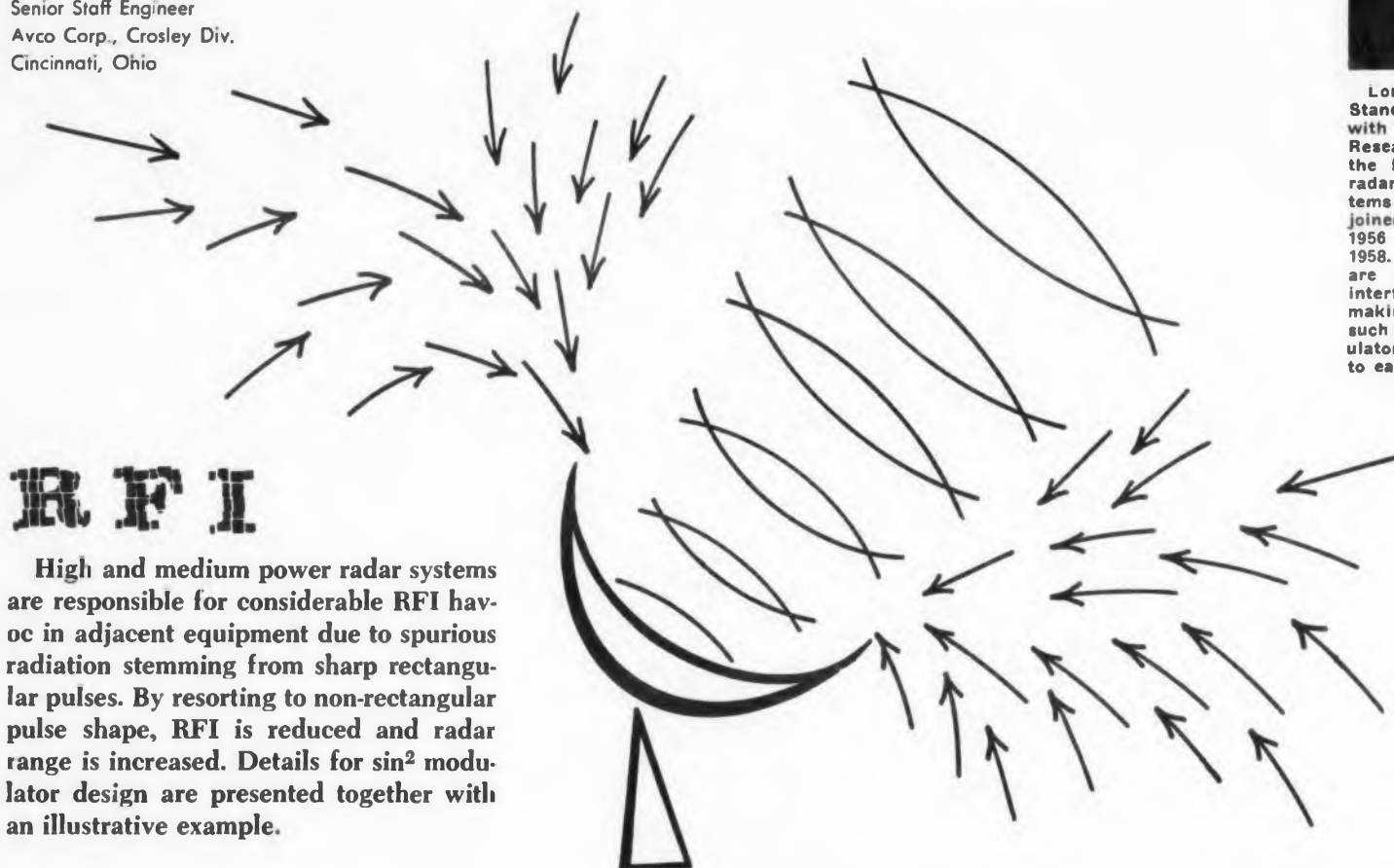
Fig. 13. Temperature dependence of flux density at constant magnetizing forces for Armco ingot iron.

Generation of High Power \sin^2 Video Pulses

Arthur P. Standing
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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 \sin^2 modulator design are presented together with an illustrative example.

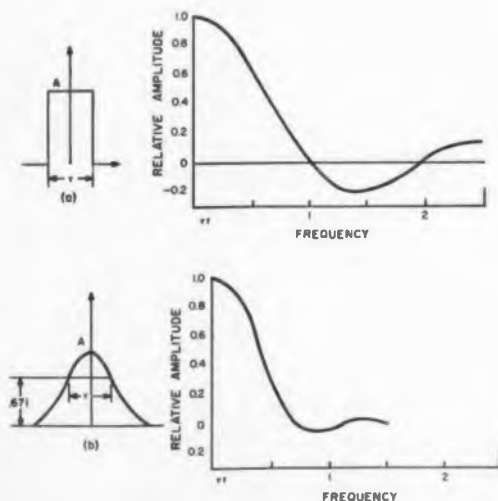


Fig. 1. Comparison between spectrum requirements for rectangular (A) and \sin^2 (B) pulses.

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 problem¹ 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

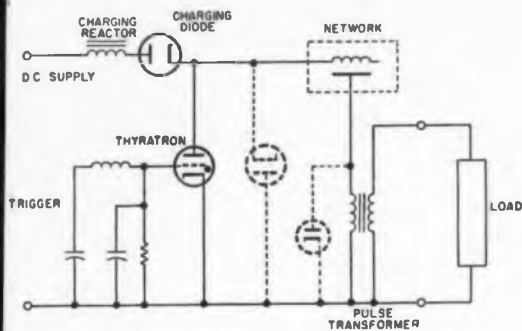


Fig. 2. Conventional line type modulator cannot generate pulses with sloping edges.

The particular pulse shape discussed in this article is the \sin^2 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 \sin^2 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 \sin^2 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 edges² 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

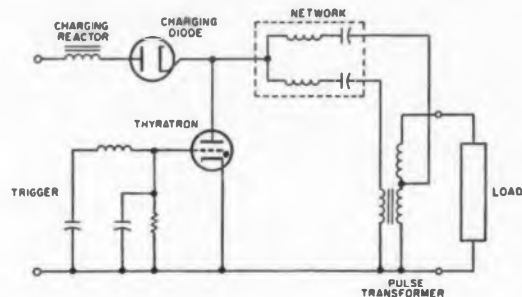


Fig. 3. \sin^2 thyatron modulator uses network currents obtained from the primary and secondary windings of a pulse transformer to achieve the equivalent of negative circuit components.

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 \sin^2 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

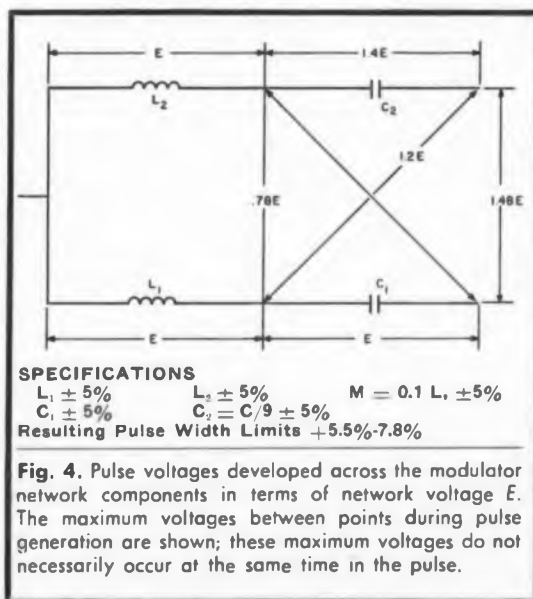


Fig. 4. Pulse voltages developed across the modulator network components in terms of network voltage E . The maximum voltages between points during pulse generation are shown; these maximum voltages do not necessarily occur at the same time in the pulse.

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 = capacitance 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 = thyatron current during the pulse

I_n = 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 \sin^2 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:

$$L_1 = L_2 = Z_n \tau \quad (1)$$

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

Giving:

$$C_1 = \tau / Z_n \quad (2)$$

$$C_2 = C_1 / 9 \quad (3)$$

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 modulator 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.

$$V = 0.74 E \quad (4)$$

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

$$I_1 (\text{peak}) = \frac{0.69 E}{Z_n} \quad (5)$$

$$I_2 (\text{peak}) = \frac{0.34 E}{Z_n} \quad (6)$$

$$I (\text{peak}) = \frac{0.94 E}{Z_n} \quad (7)$$

$$I (\text{mean}) = \frac{0.375 E}{Z_n} \quad (8)$$

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

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)

$$\text{Peak Voltage } C_1 = E$$

$$\text{Peak Voltage } C_2 = 1.4 E$$

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 \times 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 pos-

sible 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 μ sec 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 thyatron 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 thyatrons.

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

$$Z_n = \frac{V^2}{\text{Power}} = \frac{(15 \times 10^3)^2}{1.96 \times 10^6} = 115 \Omega$$

Network Voltage E from Eq. 4

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

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

Thyatron gas drop = 250 v

Thus $E = 20.25 + 0.25 = 20.5 \text{ kv}$

I peak thyatron current

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

I mean thyatron pulse current Eq. 8

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

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

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

Thyatron rating check

$rms = 167.2 \times 0.1666 = 5.27 \text{ amps}$

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/ μ sec 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:

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

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

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

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

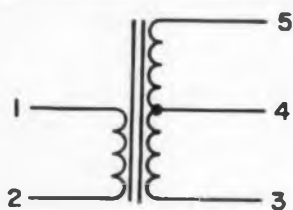
Assuming the charging system to be a standard type resonant charge, the reactor and diode combination can be calculated in the normal manner.

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

$L_c < 16.8 \text{ h}$

Mean current (as before) = 166.6 ma

Peak charging current = $\pi/2 \times 166.6 \text{ ma} = 262 \text{ ma}$



SPECIFICATIONS

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

Leakage Measurement

	Measure	Short	Leakage
a1	1-2	3-5	$0.1 L$, + 0% - 50%
b1	4-3	3-5	$0.1 L$, + 0% - 50%

Primary Inductance Measurement

	Measure	Open Circuit Inductance
a1	1-2	3-4-5 $\geq 10L$,
b1	4-3	1-2 8 3-5 $\geq 10L$,

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.

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

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

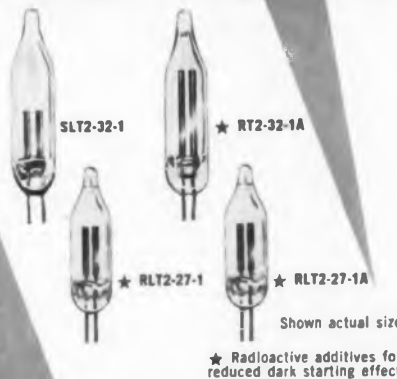
The basic design of hydrogen thyratron modulators is well known,⁴ and thus no attempt has been made to cover any of this ground in the present article. The use of over-swing and clipping diodes follows normal practice, with the network diodes setting the charging voltage in the usual manner.

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. ELECTRONIC DESIGN "Line-Type Modulator", I. Limansky Part 1—Feb. 17, 1960 Part 2—Mar. 2, 1960 Part 3—Mar. 16, 1960

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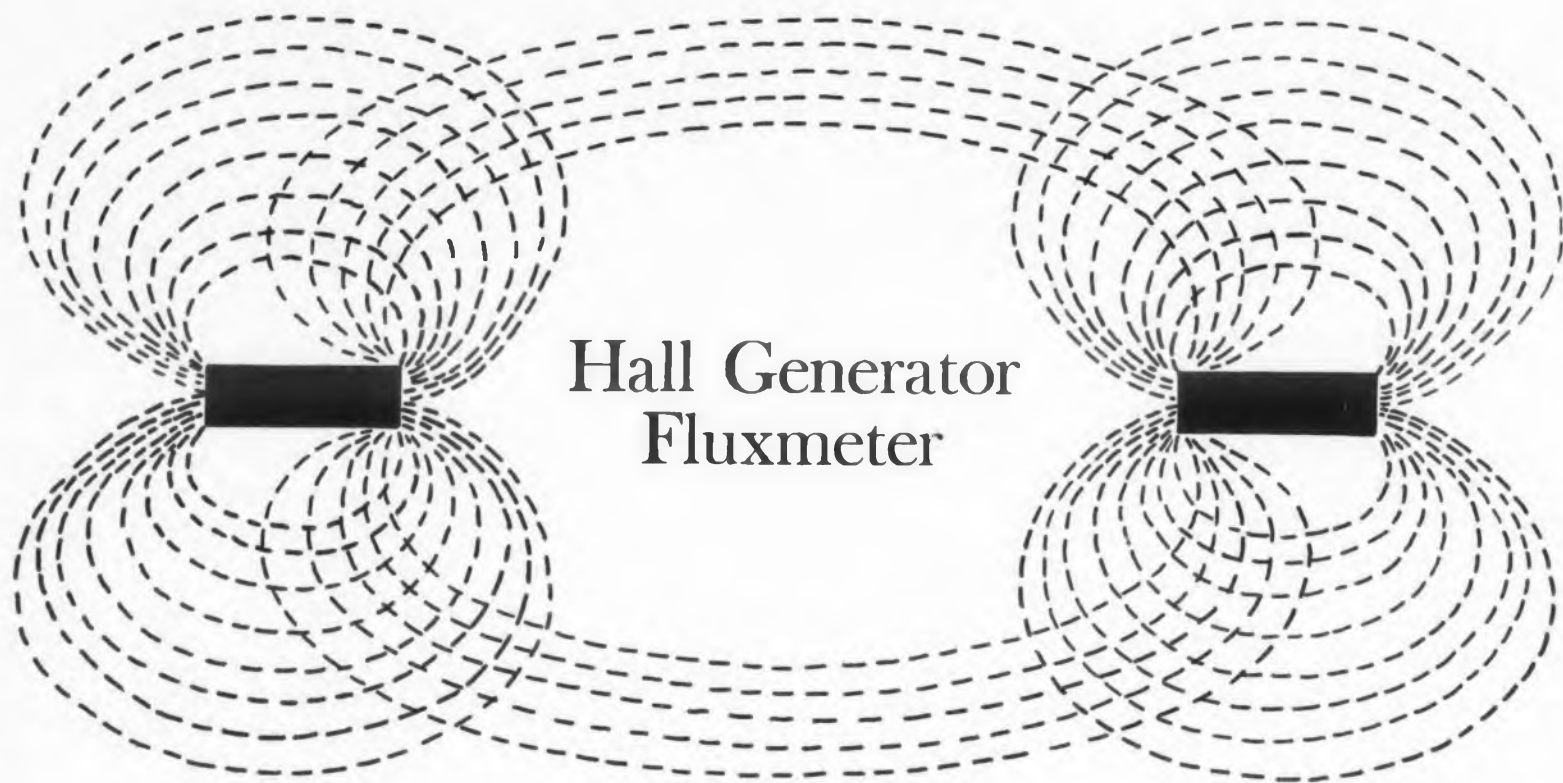
For indicating functions these high-light intensity lamps are characterized by brilliance, ruggedness and long life.



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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.

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

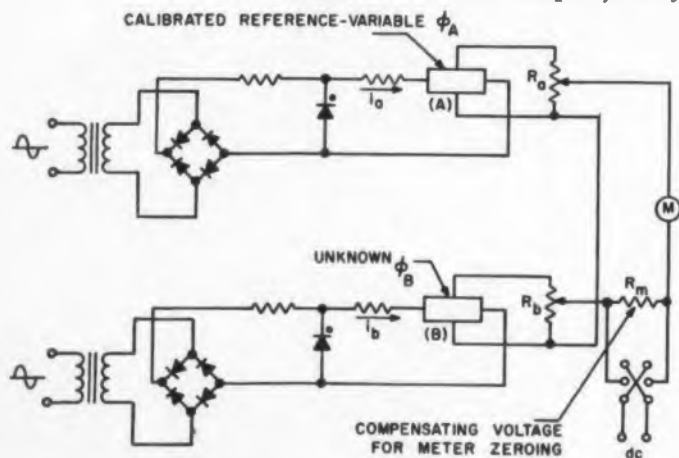


Fig. 1. Gaussmeter circuit using two Hall generators.

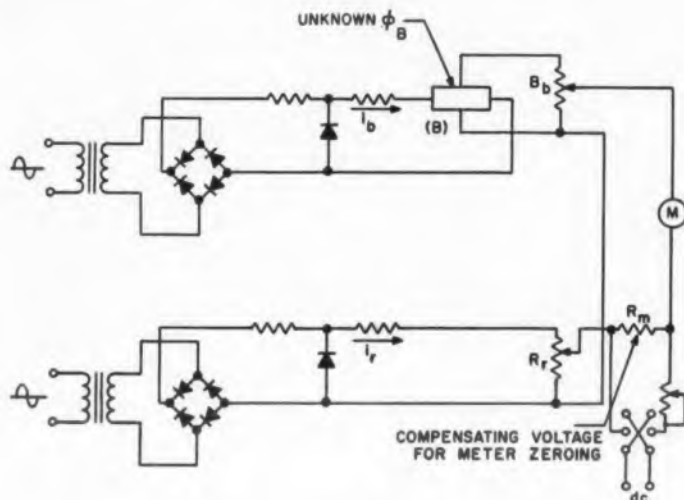


Fig. 2. Gaussmeter circuit using one Hall generator.

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 accu-

racy 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. ■ ■

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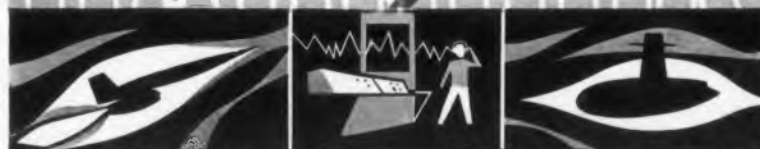
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SPECIFICATIONS

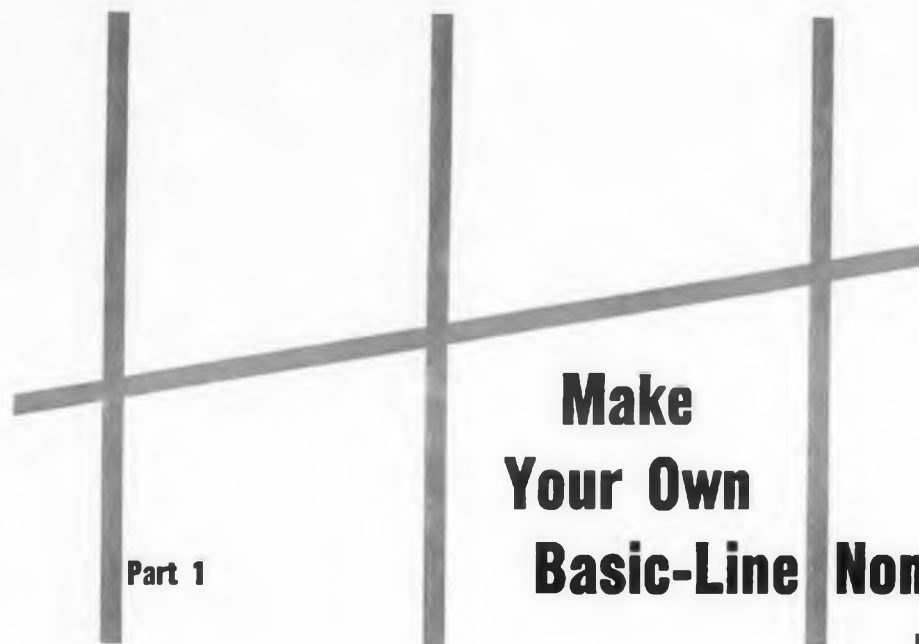
Vibration: 30 g, 10-2000 cycles. Shock: 50 g, 11 millisecc. Dielect. Str.: 1250 V. Insul. Res.: 10,000 M Ω . Life: 100,000 operations min. @125 C to Mil R 5757C. Temp. Range: -65°C to +125°C to Mil R 5757C. Duty: Continuous. Contact Rating: BR-9X: 10 amp resistive, 28 V DC or 110 V AC. BR-9Y: Dry circuit to 5 amps. Derate 50% for inductive loads. Overload Rating: 25 amps min. for BR-9X. Contact Arrangement: DPDT. Max. Coil Dissipation: 3 watts. Min. Pull-In Power: BR-9X — 100 mw, 2 coil pulse operation (15 millisecc. pulse). Operating Characteristics: Refer to BR-7Z coil resistance and operating characteristics, Bulletin BR-592. Operate Time: 10 millisecc. max.

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Part 1

Make Your Own Basic-Line Nomograms

Burrell R. Hatcher
Convair

Division of General Dynamics Corp.
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 $S_F = 0.1x$ would be laid off along the x -axis.

Case 2. $F(x) = x^3 + 0.1x + 1$

$$m_F = \frac{14}{[150^3 + 0.1(150) + 1] - [10^3 + 0.1(10) + 1]} = 0.606 \text{ in.}$$

One unit change in $F(x)$ is represented by 0.606 in. on the scale. The scale itself is given by $S_F = 0.606(x^{3/2} + 0.1x + 1)$. 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 $S'_{F(x)}$ be the distance of the graduation x_i 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

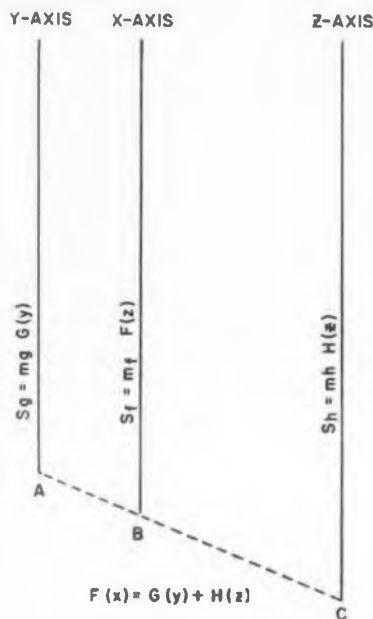


Fig. 1. Basic form of the addition nomogram.

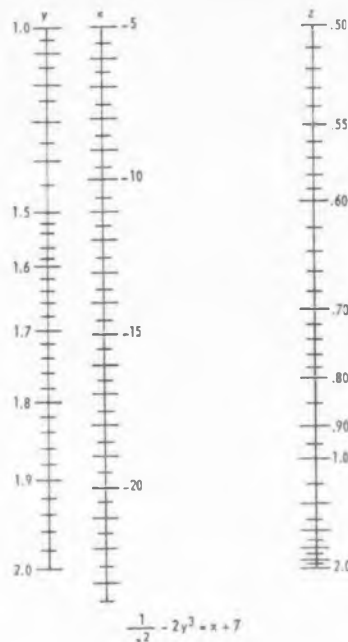


Fig. 2. Addition by nomogram. Details are in Chart 1.

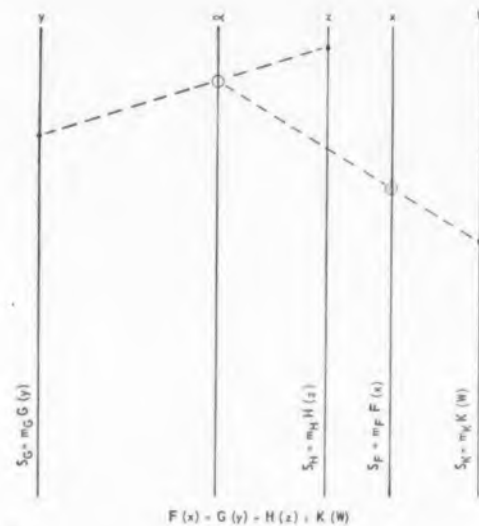


Fig. 3. Nomogram form for the addition of three terms.

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 AC , and choosing convenient scale factors. 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 $AB/BC = m_G/m_H$. 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

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

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

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

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

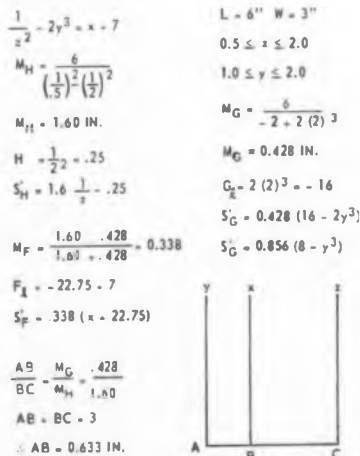


Chart 1. Detailed Computations and Assumptions for Nomogram of Fig. 2.

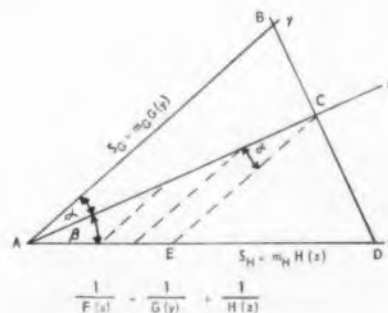


Fig. 4. A convenient nomogram for adding reciprocals.



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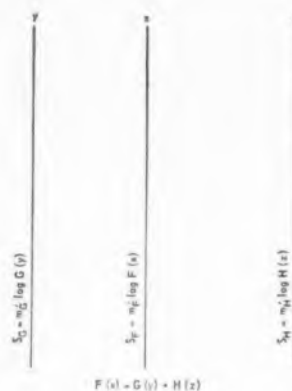


Fig. 5. Basic form of the logarithmic multiplication nomogram.

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 C 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.

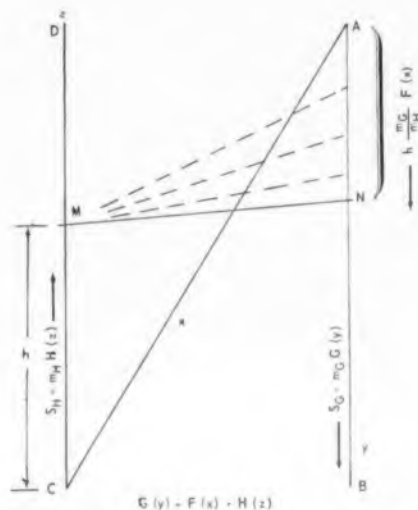


Fig. 6. Basic nomogram form for non-logarithmic multiplication.

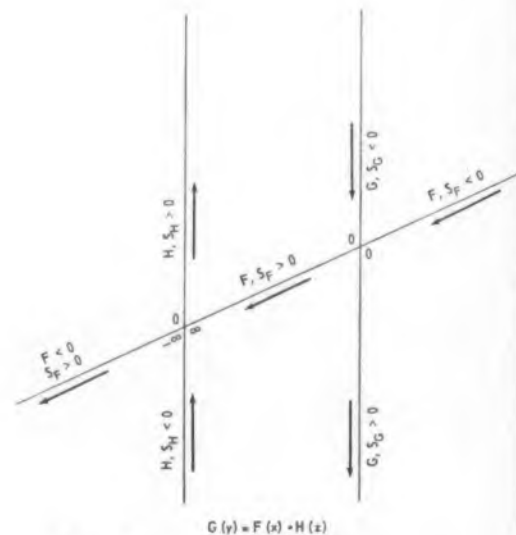


Fig. 7. Scales can be extended for negative values of functions.

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.

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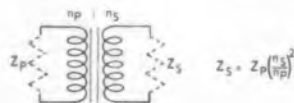
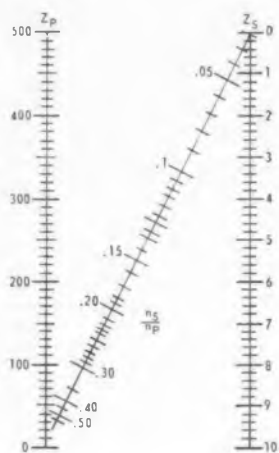


Fig. 8. Nomogram for non-logarithmic multiplication. Details are in Chart 2.

$$z_s = z_p \frac{n_s^2}{n_p^2}$$

$$0 \leq z_s \leq 10$$

$$0 \leq z_p \leq 500$$

$$L = 10$$

$$W = 5$$

$$m_p = \frac{10}{500} = .02$$

$$S_p = .02 z_p$$

$$m_s = \frac{10}{100} = .1$$

$$S_s = .1 z_s$$

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

$$S_n = \frac{11.18 \frac{n_s^2}{n_p^2}}{.02 + \frac{n_s^2}{n_p^2}} = \frac{11.18 N^2}{.02 + N^2}$$

$$\text{OR } \frac{AN}{AN} = 5 \frac{1}{.02} N^2 \quad (h = 5)$$

$$\frac{AN}{AN} = 25 N^2$$

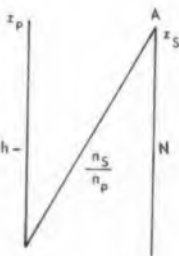


Chart 2. Detailed Computations and Assumptions for Nomogram of Fig. 8.

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_p 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



Thomas Lusk
General Electric Co.
Ithaca, N. Y.

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 hygroscopic, 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-

important design consideration. Optical grade magnesium oxide, for example, is obtainable in crystals only two inches in diameter. This is obviously too small for an application which calls for a six inch diameter dome. Small pieces can often be joined together to form larger pieces, but the interfaces usually block and scatter the incident radiation to such an extent that a segmented dome cannot be used, unless the individual pieces are large enough so that only a few are required. Also, from an optical point of view, it is better that the dome be constant radius of curvature and not composed of flat segments.

The cost of such materials is usually of great importance. For instance, silicon has many desirable properties, but one 6-in. hemispherical dome may cost about \$2000, and sometimes more. An equivalent quartz dome is less expensive, but quartz does not have the long wavelength transmission of silicon. Less costly domes may be made of amorphous glass such as Corning #0160 or Pyrex, but at the expense of transmission and physical properties.

Reflection Losses

Many of the infrared transmitting materials which are suitable for military applications transmit less than 80 per cent of the incident radiation. In most cases the loss is primarily due to Fresnel reflection at the surface of the material. For wavelengths in the micron region, for normal angles of incidence and a single surface, the reflection from the surface of a transparent material is approximately given by:

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

where n_1 and n_2 are the index of refraction of two adjacent media. When the first medium is air, the equation becomes:

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

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

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

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

Fortunately, such reflection losses can be greatly reduced by applying the appropriate coating to the material. For maximum reflection reduction, the refractive index of such an anti-reflection coating should be equal to the square root of the substrate index. Since the index of substances varies with wavelength, an anti-reflection coating can be optimized for one wavelength only. 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 ger-

manium 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 hygroscopic.

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	TEMPERATURE	HARDNESS	WATER ABSORPTION	INDEX OF REFRACTION	DENSITY	COEFFICIENT OF LINEAR THERMAL EXPANSION		YOUNG'S MODULUS $\times 10^{11}$	MAXIMUM DIAMETERS AVAILABLE AS OF 1/59								
							UNCOATED - ROOM TEMPERATURE WAVELENGTH MICRONS	THICKNESS MM			MELTING	SOFTENING OR DEFORMATION	MOH	ROOM TEMPERATURE	WAVELENGTH MICRONS	TEMPERATURE RANGE °C	$\times 10^{-6}/^{\circ}\text{C}$	DYNES/CM ²
As_2S_3	ARSENIC TRISULFIDE	300	195	2	LOW	2.423	2.398	2.380	3.20	24	26	16	DOMES - 12"					
Al_2O_3	SAPPHIRE	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)	1420	1300	7	0	3.452	3.420	3.418	2.33	10-50	42	109	DOMES - 6" DISKS - 6"					
SiO_2	QUARTZ (2)	1750	1585	7	0	1.438			2.20	20-320	0.56	0.68	DOMES - 14" DISKS - 18 1/2"					
	CORNING 0160		610	2-3	0	1.56			3.05				PLATES - 6 1/2" x 6 1/2" x 11/32"					
$\text{SiO}_2 \cdot \text{B}_2\text{O}_3 \cdot \text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3$	PYREX CORNING 7780		820	6	0	1.46			2.23	0-300	3.2	6.76	LARGE SIZES					
MgO	PERICLASE	2800	2000	5	LOW	1.709	1.597		3.58	0-1000	13.9	25.1	DISKS - 2"					
CaF_2	FLUORITE	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)	414.5		2	HIGH	2.396	2.379	2.376	7.37	20-200	58	18-2.5	CRYSTALS - 5" x 3 1/2"					
$\text{CF}_2 - \text{CFCI}$	KEL-F	260		-1 (4)	0	1.43			2.12	20-150	54.5		A PLASTIC AVAILABLE IN LARGE SIZES					
KCl	SYLVITE	776		0.5	HIGH	1.475	1.468	1.457	1.98	150-200	37	3.5	CRYSTALS - 7 1/2" x 5" HIGH					
TiO_2	TITANIA	1825		7	0	2.4			4.25	40	7.1-9.2		CRYSTALS - 5/8" x 1 1/2" HIGH					
AgCl	SILVER CHLORIDE (5)	475		1.3	HIGH	2.006	1.994	1.980	5.58	150-100	31	1.6-2.0	CRYSTALS - 3 3/4" x 5" HIGH					
Ge	GERMANIUM	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	1600	790	6	HIGH	1.635			3.67	20-400	8.4	10.5	DOMES - 10"					
MgF_2	MAGNESIUM FLUORIDE (EASTMAN KODAK)	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 - III-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, feldspar = 6, apatite = 5, fluorite = 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 heat-

ing 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 meniscus dome 6 in. in diameter, making the cost of such a dome almost prohibitive. It also introduces many interfaces which effectively reduce the total transmission of the shape.

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

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 (CaAl₂O₄). 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, CaAl₂O₄ finds limited application in military uses and will prob-

ably be replaced in the near future by certain infrared transmitting glasses.

Quartz (SiO₂). 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 (SiO₂) 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 10⁹ roentgens of cobalt 60 without effect, although a slight bluish tint, together with a loss of transmission in the ultraviolet occurs at 1.4 x 10¹⁰ 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 (MgF₂). 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 visible 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 com-

pounds 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 (Sb₂S₃) 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. Gilsomite 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 hygroscopic 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. ■ ■

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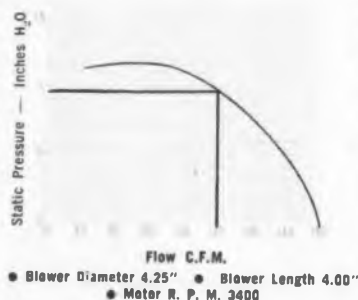
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Frequency	Decibel Rating
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600 - 1200	56
1200 - 1400	66
2400 - 4800	67
	64



The problem of obtaining high pressure with low speed blowers has been solved with the new D & B contra-axial design. With these light weight compact units, you can forget about bulky multi-staged units on your next high performance requirement. In addition to these performance advantages, low sound levels are achieved to provide you with the ultimate in design features. Our standard wrought aluminum construction assures you of a quality blower at an economical price.

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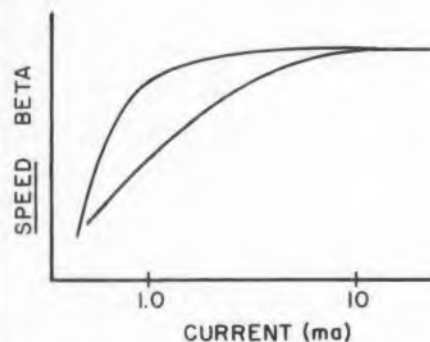


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CIRCLE 54 ON READER-SERVICE CARD

Micro-Energy Transistor Switches Even Low Power—Fast

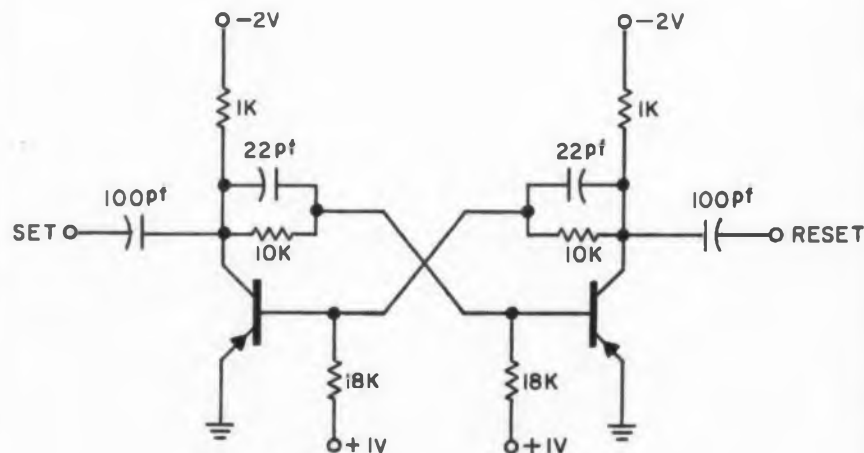


Beta and rise time both fall off rapidly below about 10 ma with conventional switching transistors (solid line). With micro-energy switch, they stay up to about 1.0 ma.

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 as 1 ma.

Where most high-speed switching transistors require collector voltages of from 6 to 10 v, and currents of 10 ma or more, 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.

Widest Option in Low-Power Rotary Switches



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 μ w.

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.

Note: Dimensions Nominal. See Catalog for Exact Details.

SECTIONS

<p>15/16" 1"</p> <p>THROW: 30°, 36°, 45° INSULATION: stator glass silicone; rotor, KEL-F</p>	<p>1-9/32" 1-5/16"</p> <p>THROW: 30°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	<p>1-13/32" 1-17/32"</p> <p>THROW: 25.7°, 30°, 36°, 45°, 60° INSULATION: phenolic, ceramic</p>	<p>1-5/8" 1-7/8"</p> <p>THROW: 18°, 20°, 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>	<p>1-7/8" 1-7/8"</p> <p>THROW: 30°, 36°, 45°, 60°, 90° INSULATION: phenolic, Mycalex, ceramic</p>
<p>1-31/32" 2-5/16"</p> <p>THROW: 20°, 40° INSULATION: phenolic</p>	<p>1-3/4" 2-5/16"</p> <p>THROW: 15°, 30° INSULATION: phenolic</p>	<p>2-5/16" 2-5/16"</p> <p>THROW: 20°, 40° INSULATION: phenolic, Mycalex</p>	<p>1-23/32" 2-17/32" or 2-5/16"</p> <p>THROW: 12.85°, 25.7° INSULATION: phenolic</p>	<p>2-1/32" 2-17/32"</p> <p>THROW: 12.85°, 18°, 25.7°, 36° INSULATION: phenolic</p>

METAL PARTS AND FINISHES

STANDARD COMMERCIAL—Punched steel parts are lead-coated, cold-rolled steel. Parts such as nuts, lockwashers, etc., are cadmium-plated steel. Shafts may be cadmium-plated steel, brass, or aluminum. Brass parts are unplated.

TROPICAL OR 50-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All steel and brass parts are cadmium-plated and chromate-dipped. Stainless steel parts are passivated.

200-HOUR SALT SPRAY MILITARY SPECIFICATIONS—All brass parts are nickel plated. All stainless steel parts are passivated. Shafts, "C" washers and index springs, balls and plates are stainless steel.

CONTACTS



Famous Oak double wiping, high-pressure design. Riveted or eye-letted in place and keyed from turning. Rotors shorting or nonshorting.

TYPE 1—Contacts are spring brass, silver-plated. Rotors are brass, silver-plated. Temperature limit: 100°C constant ambient.

TYPE 2—Contacts, spring tempered-silver alloy. Rotors, coin-silver alloy. Temperature limit: 100°C constant ambient.

TYPE 3—Contacts and rotor blades made of Oak alloy

CMS-202. This is a special alloy for high temperature operation to 150°C.

GOLD-PLATED CONTACTS—Type 1 or 2 contacts may be gold-plated. 0.002" thick. Not to be confused with gold flash.
FOR PRINTED CIRCUITS—Standard Oak contacts with a lug extending from the terminal end. Lug inserts in board for die soldering.

ACCESSORIES



AC SNAP SWITCHES—36 models for use on most switch types. All are UL approved.

POTENTIOMETERS—Customers' choice. Mounts on rear of Oak switches. Operates by switch shaft or separate concentric shaft.

ELECTROSTATIC SHIELDS—Used between sections. Sizes and shapes for all switches.

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Bulletin unfolds to 17" x 22" wall chart (right) which matches 34 rotary switch sections (shown actual size) to corresponding frames. Also contains specifications and dimensions for rotary, pushbutton and lever switches.



CIRCLE 55 ON READER-SERVICE CARD

TWELVE IMPORTANT CONTROLS

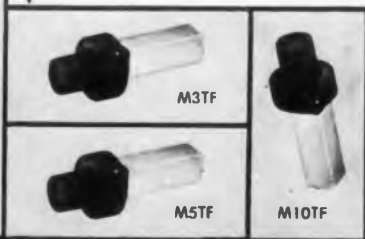
Uses include such equipment as aircraft instrument panels, shipboard control centers, ground control equipment in either fixed or mobile installations, industrial process control centers, electronic test instruments and computers. Twelve important controls to meet your design problems provide a new standard in reliability of operation.

TP SERIES — Types TP05, TP09, TP11, TP13, TP17 and TP20, in 6 sizes from 1/2" to 2" diameter. Each is a single-turn, high torque, rotary, wire-wound pot, engineered for peak performance under severe environmental conditions. Threaded bushings, precision register, mounting nut, lock washer and locating pin permit exact positioning for precise control. Available with non-linear functions, including complete series of sine-cosine functions. Accurate, dependable, long-life performance.



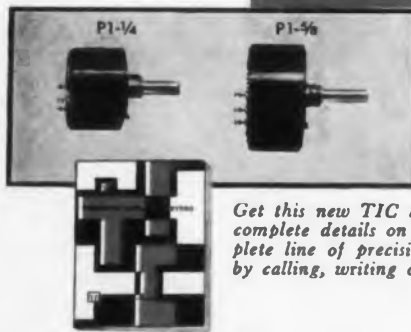
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POTENTIOMETERS

MTF SERIES — Types M3TF, M5TF and M10TF. Housed in corrosion resistant box-like enclosures, all have a lead screw shaft arrangement for driving the wiper transversely from end to end of the resistance element. Encapsulated metallic film resistance element provides infinite resolution, 3, 5 or 10 turns (1080°, 1800°, 3600°) of rotation for accurate setting. Threaded bushing, with concentric locking device supplied to provide simple panel mounting knob for precise manual control.



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P SERIES — Types P1 1/4, P1 1/2 and P3 with numerals designating diameters. Especially designed for low cost commercial applications. These rotary type pots feature low inductance and capacitance. Available in linear or non-linear functions, single or ganged assemblies.



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CIRCLE 56 ON READER-SERVICE CARD

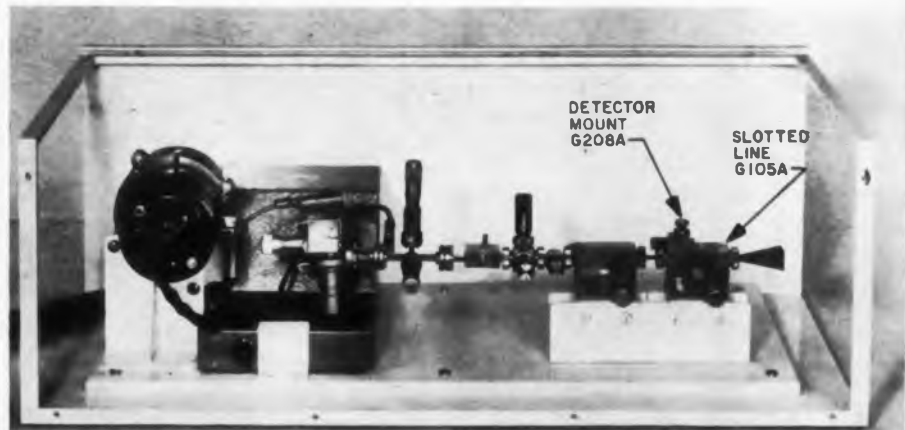
2-Mm Slotted Section Shifts Standing Waves Past Fixed Probe

EMPLYING 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 ma-

chining 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.

verted, infinite vswr should theoretically be measured. Comparison of the actual swr obtained with this theoretical value shows 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 plasma 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.

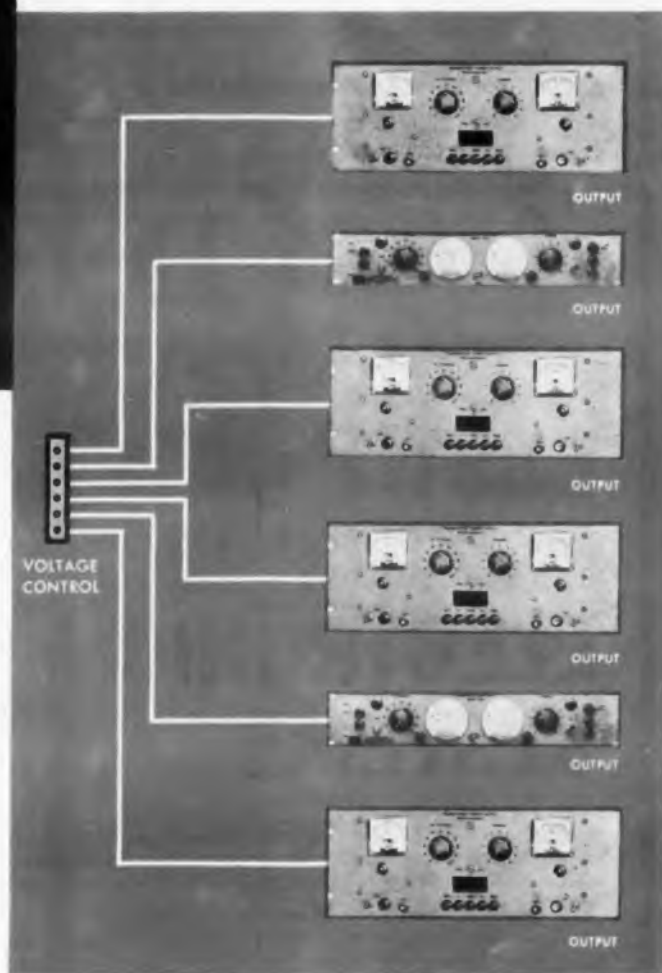
how to pack
the performance of
6 Power Supplies
in **6 Square Inches**
of panel space

they're doing it with
REGATRON
PROGRAMMABLE
POWER SUPPLIES

Panel space at a premium? You'll find a practical solution in the remote-control feature of a Regatron Programmable Power Supply. The power supply need not be installed in the main rack. It can be placed at any convenient location. Run a line between the programming terminals of the power supply and a variable resistor on the panel. Then, for every 1000 ohms, the power supply delivers one volt. (For example, 47,500 ohms of programming resistance sets the output to 47.5 volts.) The programming resistor carries no load current, and draws negligible current from the power supply.

For more information about the features of Regatron Programmable Power Supplies, ask for a copy of Bulletin 765D . . . A New Approach to Practical Control.

Models without the programmable feature also available.



TRANSISTOR MODELS

MODEL NUMBER	OUTPUT		REGULATION				MAXIMUM RIPPLE IN MV
	Voltage	Current	LINE 105-125 V AC 50-60 CPS		NO LOAD TO FULL LOAD		
			%	V	%	V	
212A ¹	0-100 V DC	0-100 MA	0.15	0.05	0.1	0.05	1/2
2-212A ¹	EQUIVALENT TO TWO MODEL 212A's. OUTPUTS MAY BE USED IN SERIES, PARALLEL, OR INDEPENDENTLY.						
224A ¹	0-100 V DC	0-200 MA	0.15	0.05	0.1	0.05	1
220A	0-50 V DC	0-500 MA	0.1	0.05	0.1	0.05	1
221A	0-100 V DC	0-500 MA	0.1	0.05	0.1	0.05	1
213A	0-50 V DC	0-1 AMP	0.1	0.05	0.1	0.05	1
214A	0-100 V DC	0-1 AMP	0.1	0.05	0.1	0.05	1
215A	0-50 V DC	0-3 AMP	0.1	0.05	0.1	0.05	1
218A	0-100 V DC	0-3 AMP	0.1	0.05	0.1	0.05	1

1. Modulation input provided for measurement of transistor parameters by small signal method.



ELECTRONIC
MEASUREMENTS
COMPANY, INCORPORATED
EATONTOWN, NEW JERSEY

Registered U. S. Patent Office. Patents Issued and Pending.

CIRCLE 57 ON READER-SERVICE CARD

BY DEFINITION...

A PRECISE-POWER SET is a rotary electro-mechanical system, statically regulated, which performs **one or more** of the following functions:

Isolates the DC power system from static and/or transient power line changes.

Raises the power-line frequency, reducing the cost, size, and complexity of the system power supplies.

Performs the conversion to (regulated or unregulated) DC directly.
Multiple outputs are common.



BEST FOR LARGE ELECTRONIC SYSTEMS

Don't freeze your designs for large electronic power-supply systems until you have given mature consideration to the striking advantages obtained by interposing a PRECISE-POWER SET between the power line and your electronic-circuit loads.

Designers who worry about reliability, cost, size, and weight—particularly those working in the fields of computing, automation, telemetry, missile checkout and guidance, process control—will find our complete and authoritative 32-page technical bulletin S-59 of great interest.

Why pay for, make room for, **suffer** for the 25%-55% of excess power dissipation forced on regulated DC power supplies by power-line fluctuations, when a compact, maintenance-free PRECISE-POWER SET will pay for itself several times over, and virtually eliminate them?

Write today. The bulletin is free... and immediately available.



Partners
in Power

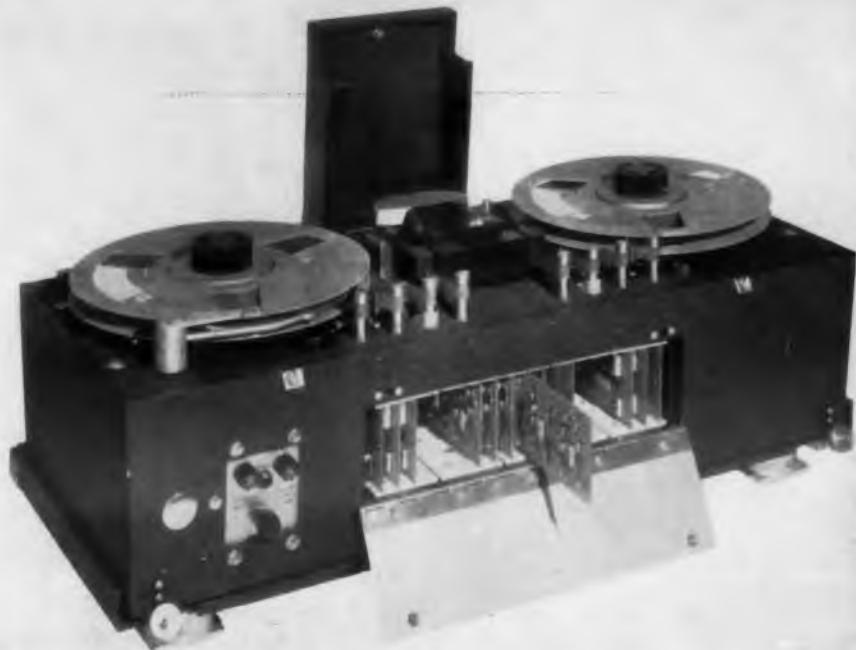
**ELECTRIC
SPECIALTY CO.**

201 SOUTH STREET, STAMFORD, CONNECTICUT
Flieside 8-6203



REGULATORS, INC.

CIRCLE 58 ON READER-SERVICE CARD



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, ship-board 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-direc-

tional 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 programmer operates in a temperature range of -40 to +165 F.

Sequence Programmer Measures Less Than 1 3/4 In. Long

A LENGTH of 1-3/4 in. and a weight of 0.9 oz makes a new sequence programmer 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 programmer, 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 programmer, turn to the Reader-Service card and circle number 253.

INDUSTRIAL POWER TRANSISTORS

3 AMP

Type Number	MAXIMUM RATINGS				Electrical Characteristics	
	V _{CE} volts	V _{CE(sat)} volts	T _J °C	I _C amps	min	h _{FE} @ I _C amps max
2N1335	50	40	100	3.0	35	90
2N1360	50	40	100	3.0	60	140
2N2375	80	60	100	3.0	35	90
2N2916	80	60	100	3.0	60	140
2N1362	100	75	100	3.0	35	90
2N1363	100	75	100	3.0	60	140
2N1364	120	100	100	3.0	35	90
2N1366	120	100	100	3.0	60	140
2N2974 (SIL. C)	80	50	100	3.0	40	100
2N1811	80	60	100	3.0	30	75
2N1811 (SIL. C)	80	60	100	3.0	30	75

New 5 AMP

Type Number	MAXIMUM RATINGS				Electrical Characteristics	
	V _{CE} volts	V _{CE(sat)} volts	T _J °C	I _C amps	min	h _{FE} @ I _C amps max
2N1326	40	30	100	5	20	40
2N1330	60	45	100	5	20	40
2N1331	80	60	100	5	20	40
2N1332	100	75	100	5	20	40
2N1333	120	90	100	5	20	40
2N1334	40	30	100	5	35	70
2N1336	60	45	100	5	35	70
2N1337	80	60	100	5	35	70
2N1337	100	75	100	5	35	70
2N1338	120	90	100	5	35	70
2N1339	40	30	100	5	50	100
2N1340	60	45	100	5	50	100
2N1341	80	60	100	5	50	100
2N1342	100	75	100	5	50	100
2N1343	120	90	100	5	50	100
2N1344	40	30	100	5	75	150
2N1345	60	45	100	5	75	150
2N1346	80	60	100	5	75	150
2N1347	100	75	100	5	75	150
2N1348	120	90	100	5	75	150

10 AMP

Type Number	MAXIMUM RATINGS				Electrical Characteristics	
	V _{CE} volts	V _{CE(sat)} volts	T _J °C	I _C amps	min	h _{FE} @ I _C amps max
2N257	40	30	100	10.0	10	30
2N228	60	45	100	10.0	10	30
2N229	80	60	100	10.0	10	30
2N230	100	75	100	10.0	10	30
2N1126	80	70	100	10.0	10	30
2N1126 (SIL. C)	80	70	100	10.0	10	30

New 15 AMP

Type Number	MAXIMUM RATINGS				Electrical Characteristics	
	V _{CE} volts	V _{CE(sat)} volts	T _J °C	I _C amps	min	h _{FE} @ I _C amps max
2N1550	40	30	100	15	10	30
2N1550	60	45	100	15	10	30
2N1551	80	60	100	15	10	30
2N1552	100	75	100	15	10	30
2N1553	40	30	100	15	30	60
2N1554	60	45	100	15	30	60
2N1555	80	60	100	15	30	60
2N1556	100	75	100	15	30	60
2N1557	40	30	100	15	50	100
2N1558	60	45	100	15	50	100
2N1559	80	60	100	15	50	100
2N1560	100	75	100	15	50	100

25 AMP

Type Number	MAXIMUM RATINGS				Electrical Characteristics	
	V _{CE} volts	V _{CE(sat)} volts	T _J °C	I _C amps	min	h _{FE} @ I _C amps max
2N1163	50	35	100	25	15	65
2N1163	50	35	100	25	15	65
2N1164	80	60	100	25	15	65
2N1165	80	60	100	25	15	65
2N1166	100	75	100	25	15	65
2N1167	100	75	100	25	15	65

SELECT YOUR SPECIAL INDUSTRIAL POWER TRANSISTORS FROM MOTOROLA'S STANDARD TYPES

With NEW 5 AMP and NEW 15 AMP Series MOTOROLA Now Offers 72 Power Transistors

No need to waste valuable time searching for costly "specials" to meet your specific design requirements. With 72 different power transistors, Motorola now has a standard device to fit nearly every special need. You can now design equipment with the assurance that the power transistor you specify is immediately available from the industry's most dependable line of transistors. You save time and money... and receive outstanding performance when you specify Motorola.

Only Motorola power transistors offer both:

- 90 watts power dissipation
- .8 °C/W maximum thermal resistance

plus V_{CE} of 30 to 100 volts, operation to 100°C junction temperature, four-point control of collector breakdown, 100% stabilization bake for 100 hours at 125°C and thorough production lot reliability tests.

Motorola's complete line of power transistors is available for immediate delivery at your Motorola Semiconductor distributor.

FOR COMPLETE TECHNICAL INFORMATION and applications assistance contact your Motorola Semiconductor district office:

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 MINNEAPOLIS 37, 7721 6th Avenue North Liberty 5-2198
 NEW YORK 1031 Bloomfield Ave., Clifton, N.J. Gregory 2-5300
 from New York Wisconsin 7-7960
 SAN FRANCISCO 1299 Bayshore Highway, Burlingame, Calif. Diamond 2-2228
 ST. LOUIS 101 South Selma Qbanite 4-3321



MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

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 $\pm 0.015\%$ 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 $\pm 2.5\%$, 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 μ f 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.

300% INCREASE IN RANGE NO INCREASE IN SIZE!



JFD



MINIATURE TRIMMER SEALCAP®

Now you can cut precious inches and ounces from your assemblies with space-saving, weight-saving MAX-C Sealcaps.

The surprising increase in range of the Max C trimmer capacitor is obtained by embedding the electrode band in the glass cylinder. This design provides the thin dielectric required for a large capacitance range while retaining the ruggedness and mechanical strength of a heavy wall glass tube.

Included in the Max C design is the Sealcap construction which provides the additional stability safeguard of a completely sealed interior.

The Max C retains all the advantages of glass tubular trimmers: Working voltage of 1000 VDC, Insulation Resistance of 10⁶ megohms, Q of 500 at 1MC, operating temperature range of -55°C to +125°C, and high stability. It meets or exceeds the applicable performance and environmental requirements of Mil-C-14409A.

Escape from the design limitations of conventional trimmers by specifying JFD MAX-C Sealcaps for your current and projected circuitry. Write today for the complete catalog describing MAX-C Sealcaps and other JFD precision electronic components. Other JFD components are...

FOR PANEL MOUNTS AND PRINTED CIRCUIT MOUNTING

MINIATURE PANEL MOUNT MAX-C SEALCAP SERIES

Model	Min.	Max. (PF)	Distance Beyond Panel	Maximum Diameter
MC601	1.0	14.0	29/64"	5/16"
MC603	1.0	28.0	11/16"	5/16"
MC604	1.0	42.0	29/32"	5/16"
MC606	1.0	60.0	1 5/32"	5/16"
MC609	1.0	90.0	1 3/4"	5/16"

SEAL CAP
TRIMMER CAPACITORS
GLASS OR QUARTZ DIELECTRIC
DISTRIBUTED CONSTANT DELAY LINES
FILTERS
LC TUNERS

MINIATURE
TRIMMER CAPACITORS
LUMPED CONSTANT DELAY LINES
PULSE FORMING NETWORKS
METALIZED INDUCTORS

Detailed data sheets on any of these components selected from the extensive J.F.D. line are yours for the asking. Our engineering staff is at your service for consultation on your particular application.

Pioneers in electronics since 1929

JFD

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CIRCLE 60 ON READER-SERVICE CARD

Thousands of Slip Ring Assemblies for Rotating Radar Antenna Systems

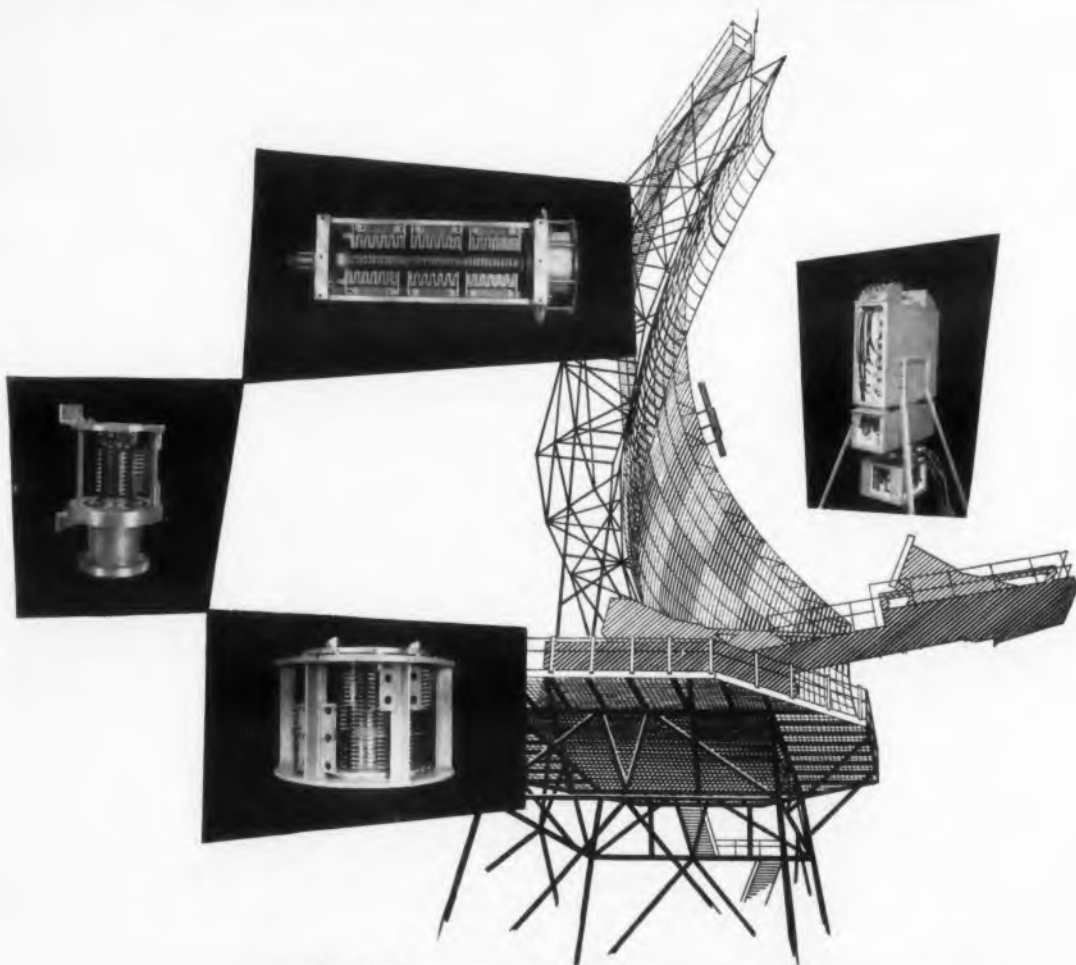
That's the Breeze Corporations' experience record in designing and producing slip ring assemblies for radar applications ranging from small shipboard and airborne antenna mounts to five-story-high giants used in ground early warning systems. With this experience record behind it, the Breeze organization is well-staffed and equipped to design and produce a slip ring assembly for any radar application.

Because many of these applications require assemblies having similar size and operating characteristics, Breeze offers a line of standard assemblies with ring envelope diameters from 1" through 10½". These are flat, stacked assemblies of fabricated construction and are built from

off-the-shelf components for rapid delivery at reduced costs.

Breeze also produces flat, concentric and cylindrical custom slip ring assemblies for radar application requirements which include general purpose control and power, radio frequency and video, high voltage and switching. Depending upon the application, Breeze custom assemblies are made by any of the basic methods of production: fabricated, electroplated and plastic molded.

You'll want a copy of the new 28-page Catalog 66SR which describes and provides operating data on a wide range of Breeze custom units and drawings and specifications of all standard slip ring assemblies.



BREEZE CORPORATIONS, INC.

700 Liberty Avenue, Union, New Jersey • Telephone: MUrdock 6-4000

Manufacturers of electrical, electro-mechanical and hydro-mechanical components and systems and fabricated metal products.

CIRCLE 61 ON READER-SERVICE CARD

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



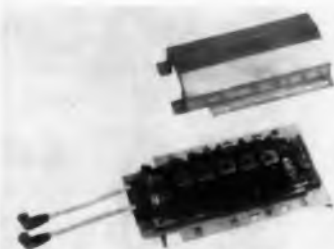
Model 0169B bandswitched discriminator uses the phase-lock technique to obtain good selectivity on each of 23 standard channels. Sensitivity is 10 mv rms to 14.5 kc and 70 mv rms at 70 kc. Stability is $\pm 0.5\%$ of bandwidth; linearity is 0.1% of bandwidth. Input is usually supplied by a tape reproducer. 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

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.

746

Vibration Test System

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.

664

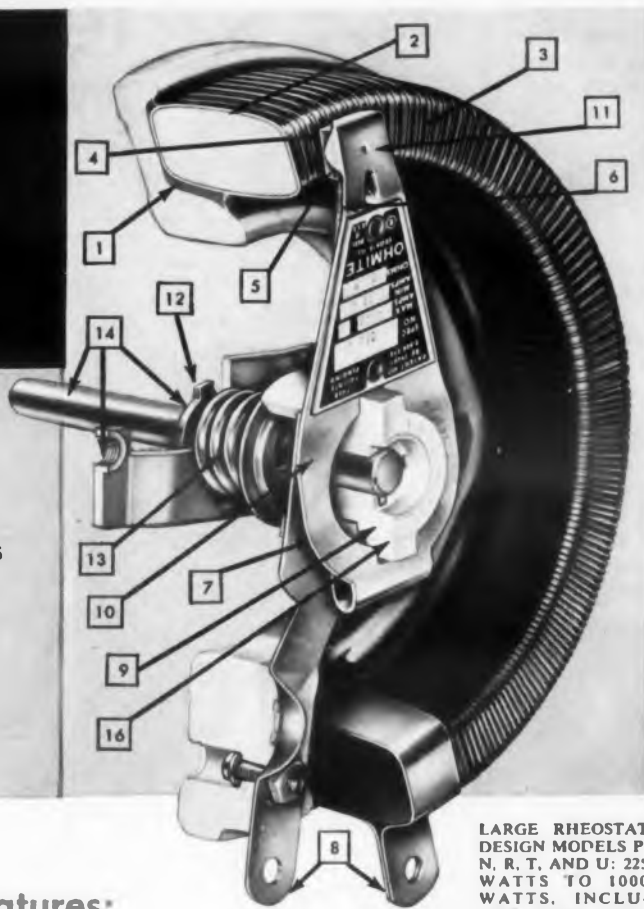
OHMITE



RHEOSTATS

NOW 11 Sizes! 12½ to 1000 Watts

Ohmite offers you industry's most complete line of rheostats. All sizes are available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in each of the 26 type designations.



LARGE RHEOSTAT DESIGN MODELS P, N, R, T, AND U: 225 WATTS TO 1000 WATTS, INCLUSIVE. OTHER MODELS ARE SIMILAR.

16 Quality Engineering Features:

1. Vitreous enamel bonds the core and base together into one integral unit.
2. The wire is wound over a solid porcelain core, and each turn is locked against shifting by vitreous enamel. Uniform or tapered winding.
3. Close graduation of control. Each turn of wire is a separate resistance step.
4. Large, flat surface upon which the contact brush rides.
5. Metal-graphite contact brush (varied to fit current and resistance) insures good contact, with negligible wear on the resistance wire.
6. Shunt pigtail of ample size carries the current directly to the slip-ring.
7. Large slip-ring of high-current carrying ability minimizes mechanical wear and provides connection from the moving contact to the terminal.
8. Potentiometer use. The rheostats are provided with three terminals so they can be used as potentiometers or voltage dividers.
9. High strength ceramic hub insulates the shaft and bushings from all live parts. All sizes will stand a 3000 volt a-c breakdown test to ground.
10. The contact arm is a long tempered steel spring which assures uniform contact pressure at all times. Cadmium-plated for corrosion resistance.
11. Rounded pivot holds contact brush in flush-floating contact with wire.
12. Stops which are keyed to the shaft and base limit the rotation—thus no torsional strain is imposed on the contact arm on stopping.
13. Compression spring maintains uniform pressure and electrical contact between slip-ring and center lead at all times.
14. Models E, H, J, G, K, and L: End-thrust is taken by a retaining ring. Models P, N, R, T, and U: End-thrust is taken by a stop washer. Steel shaft in brass bushing provides a wear-resistant, wobble-free bearing.
15. Ohmite rheostats meet requirements of NEMA and EIA (formerly RETMA).
16. There are only ceramic and metal in the construction of Ohmite rheostats—there is nothing to char, burn, shrink, or deteriorate.

Write on company letterhead for Catalog 58

OHMITE

MANUFACTURING COMPANY
3643 HOWARD STREET
SKOKIE, ILLINOIS

RHEOSTATS • RESISTORS • TAP SWITCHES
RELAYS • R.F. CHOKES • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS • GERMANIUM DIODES

CIRCLE 62 ON READER-SERVICE CARD

Micro Min $1\frac{5}{16}$ " long

with 38 contacts on .050" centers

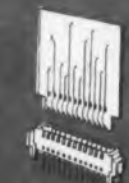
38 CONTACTS
DOUBLE SIDE

actual size

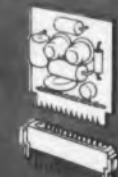
19 CONTACTS,
SINGLE SIDE

SUGGESTED APPLICATIONS

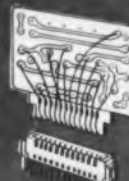
19 Contacts, Single Side



Component Mounting Board and Receptacle (front view)



Component Mounting Board and Receptacle (back view)



Printed Wiring Board Adapter, and Receptacle



Flexible Printed Wire Cable Plug, and Receptacle

38 Contacts, Double Side



Printed Wiring Board Adapter, and Receptacle



2 Flexible Printed Wire Cables with Adapter, and Receptacle



Plug and Receptacle for Module/Chassis Applications

AMPHENOL

CONNECTOR DIVISION

1830 SOUTH 54TH AVENUE, CHICAGO 50, ILL.

Amphenol-Borg Electronics Corporation

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.

◀ CIRCLE 63 ON READER-SERVICE CARD



**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.



60 HERRICKS ROAD, MINEOLA, L. I., N. Y.

PIONEER 6-8520. TWX G-CY-NY-580U
CIRCLE 64 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

Bourns Trimpot® Puts the Proof in Humidity-Proof

NUMBER 5—RELIABILITY SERIES

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.

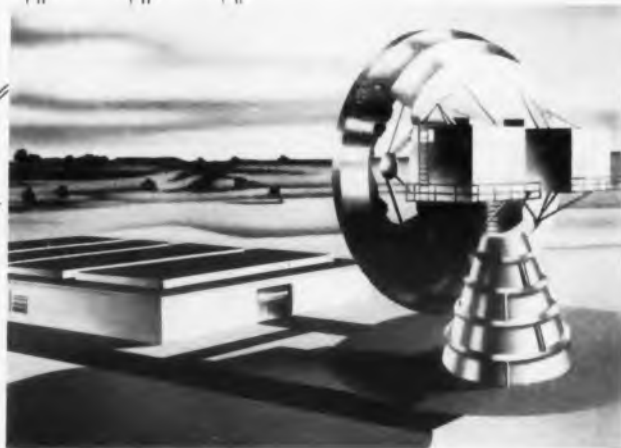
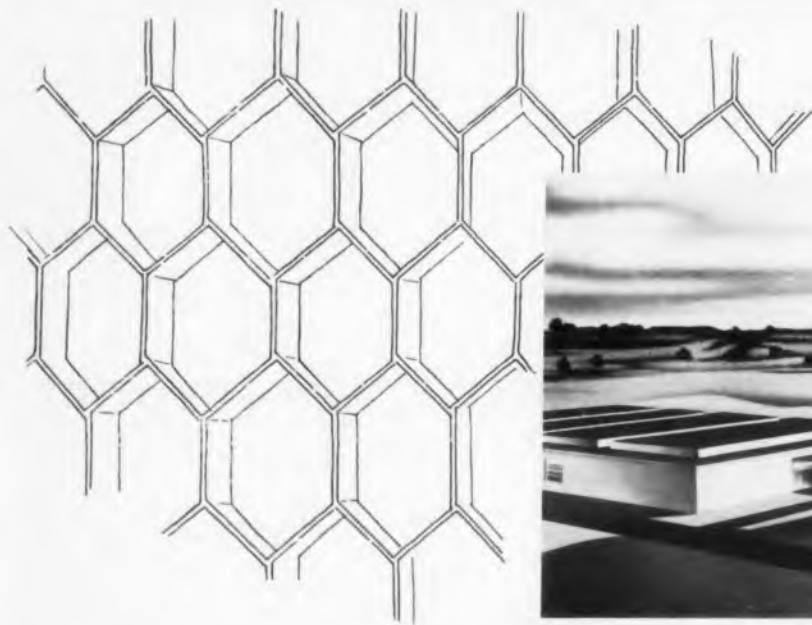
Further protection against humidity results from manufacturing procedures, such as internal potting of the resistance element and sub-components. Finally, Bourns samples all production for compliance to MIL-STD-202A, Method 106 as a routine part of a Reliability Assurance Program. As a result, Trimpot 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





FAIRCHILD

*for high-strength, low-weight
honeycomb sandwich construction*

Fairchild Aircraft & Missiles Division offers industry a unique capability in honeycomb sandwich design and construction. Typical of its stature in this field is the recent contract awarded the Division to design and manufacture a giant parabolic reflector for use in a five-story-high radar system "Pin-cushion" which will track and identify intercontinental ballistic missiles thousands of miles away. Fairchild will also fabricate the five 30' x 40' x 40' rooms for the antenna's electronic equipment. These



units will utilize aircraft design and fabrication principles due to their critical dynamics and stringent light-weight requirements.

The reflector, to weigh 13,000 pounds, will be built of aluminum and its reflective surface will be made of honeycomb panel material which will require the extensive use of still another Fairchild capability—bonding. The use of honeycomb paneling in this project imparts

rigidity, reduces weight and cost, and also simplifies tooling and replacement.

Write for complete information on the many ways Fairchild honeycomb sandwich construction can be of assistance to you.



Fairchild also produces major B-52 assemblies, consisting of honeycomb sandwich wing panels, tapered honeycomb wing trailing edges and honeycomb wheel and strut doors.



FAIRCHILD AIRCRAFT & MISSILES DIVISION
Fairchild Engine & Airplane Corp. • Hagerstown, Maryland
CIRCLE 66 ON READER-SERVICE CARD

NEW PRODUCTS

Ferrite Circulator

748

Isolation is 20 db from 380 to 420 mc



Model X-127 ferrite circulator, 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 ➤



recti/riter® recorders prove what every engineer knows . . . SIMPLICITY MEANS RELIABILITY

What simpler and more reliable actuating device can you employ in an amperage-voltage-frequency recording instrument than a d'Arsonval galvanometer . . . a trouble-free horseshoe magnet and a coil of wire? The same is true of the exclusive "recti/rite"® system . . . a simple, shock resistant trigonometric linkage that straightens the arc described by the galvanometer metering arm, changing curvilinear motion to rectilinear motion.

All the other "recti/riter" recorder features which contribute to this instrument's multi-industry acceptance and hardworking reliability are equally simple: The optional a-c or d-c drives couple directly with chart speed change gears to allow ten chart speeds; all routine operations and adjustments are performed "up front"; the non-corrosive, honed metal alloy pens, closed ink system, and large capacity ink well give you long, consistent writing performance.

With all their simplicity and reliability, "recti/riter" recorders are offered in extremely wide and useful Basic Recorder Ranges (Dual channel recorders offer combination of any two ranges):

Two Cycle Pen Response
D-c Milliampere Ranges ¼ ma to 100 ma
A-c Ampere Ranges 0.25 A to 25 A
D-c Ampere Range .. 100 mv for use with standard shunts
Expanded Scale A-c Voltage Ranges 80-130 V,
160-260 V, 320-520 V
A-c and D-c Voltage Ranges 10 V to 1000 V
Frequency Ranges 50, 60, 400 cps

Five Cycle Pen Response
D-c Milliampere Range 5 ma

Ask the TI engineer about *customized* recorders for your OEM applications. Don't settle for any recorder until you know all the facts on the complete "recti/riter" recorder line.



TEXAS INSTRUMENTS INCORPORATED

GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

The proved "recti/riter" recorder is a companion to the new "servo/riter" recorder.

"servo/riter" is a trademark of Texas Instruments



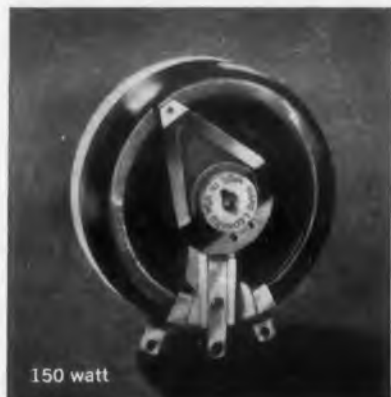
25 watt



50 watt



100 watt



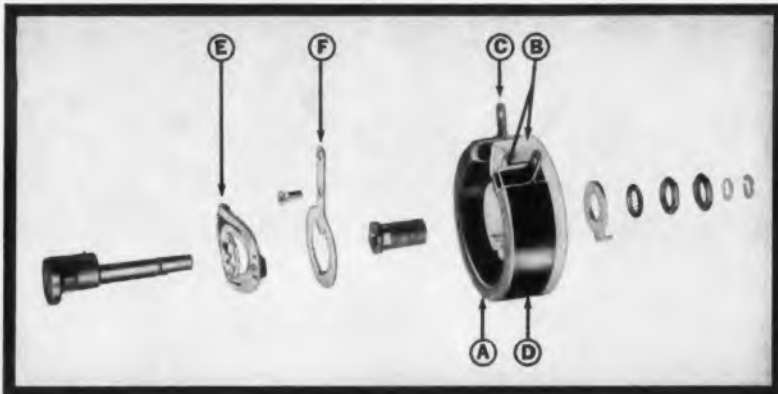
150 watt



300 watt



**THIS IS A
RHEOSTAT
YOU CAN
STAKE YOUR
REPUTATION ON**



From 25 to 300 watts these VITROHM ring rheostats are engineered for longest life, maximum reliability

To be sure about smooth, trouble-free control in the 25- to 300-watt range—just specify a VITROHM rheostat.

You get smooth control: Close-laid twin turns (A) of special high-stability, low-temperature-coefficient wire or ribbon to insure smooth gradual resistance change from zero to maximum.

You get reliability: VITROHM ring rheostats are engineered for permanence from highest-grade ceramic base and core (B), durably bonded, tinned-alloy terminals (C), to final craze-proof, shock resistant, long-lasting VITROHM bonding (D).

You get positive action: Self-lubricating twin-shoe contacts—exclusive with W/L—on balanced beryllium copper contact arm (E) eliminate backlash, contribute to smooth operation, minimize wear on resistance wire (A), assure positive contact to collector ring (F).

You get many more features than we can detail here. Check them all in W/L Bulletin 60RR (and, above 300 watts, check "plate rheostats" in Bulletin 60A). Either bulletin, yours for the asking. Ward Leonard Electric Co., 77 South St., Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)
Write for list of stocking distributors
CIRCLE 68 ON READER-SERVICE CARD

**WARD
LEONARD
ELECTRIC COMPANY**
MOUNT VERNON, NEW YORK

LIVE BETTER...Electrically

Result-Engineered Controls Since 1892



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 unit 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 $\mu\text{in. per in.}$ 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 $\mu\text{in. strain}$ 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 168, 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.

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 μ sec 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.

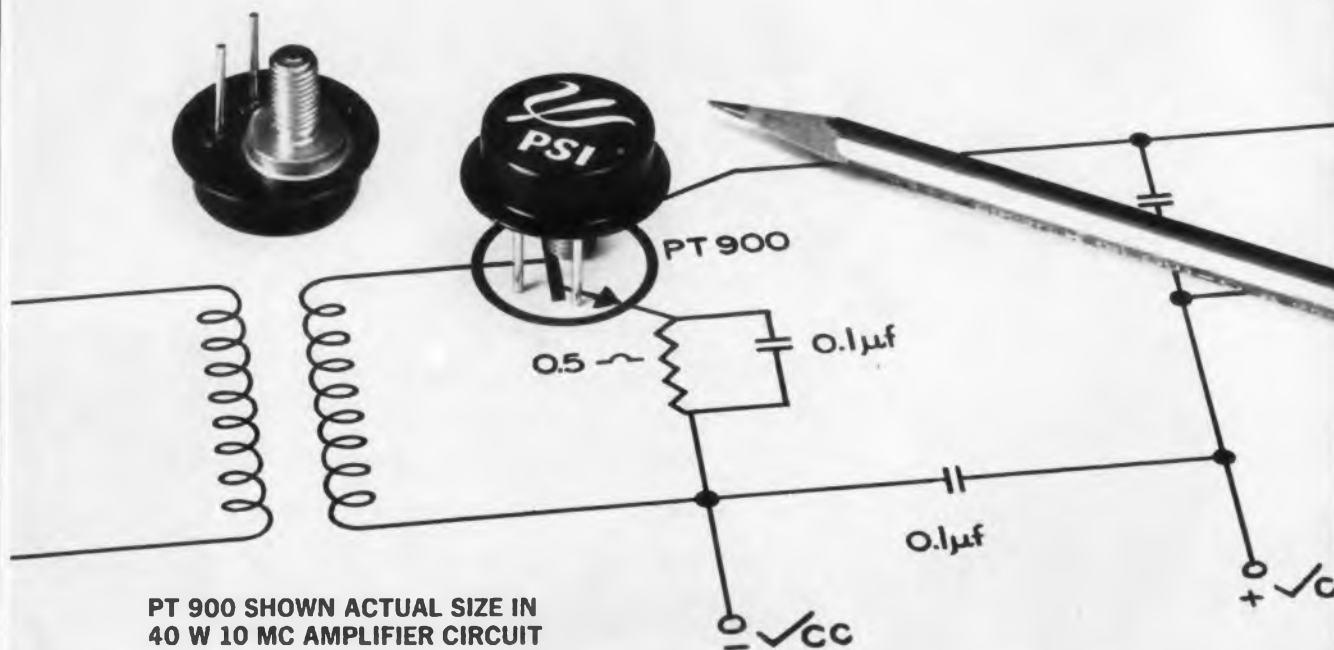
Power Amplifiers 591

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 μ sec 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,

Available for evaluation...

the only silicon power transistors offering 100 w at 5 mc...less than 100 nanosecond* high current switching!



PT 900 SHOWN ACTUAL SIZE IN
40 W 10 MC AMPLIFIER CIRCUIT

*Millimicrosecond

10 Ampere High Frequency, High Speed, High Power Oscillators ... Amplifiers ... Switches ... Converters

TYPES PT 900, PT 901

- 50 mc alpha cut off frequency
- 10 amp continuous at 25°C.
- 125 w at 25°C. case temp.
- 0.2 ohm saturation resistance

Pacific Semiconductors, Inc.

12955 Chadron Avenue
Hawthorne, California

(A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.)

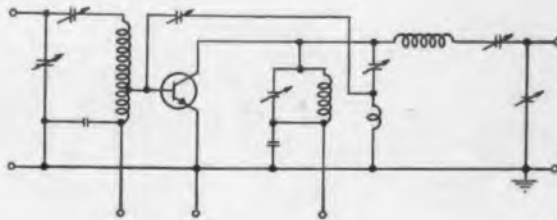
THESE SILICON MESA TRANSISTORS
OFFER UNIQUE CAPABILITIES...

and all are available immediately in production quantities

NPN VHF Power Amplifiers and Oscillators

Types 2N1505, 2N1506

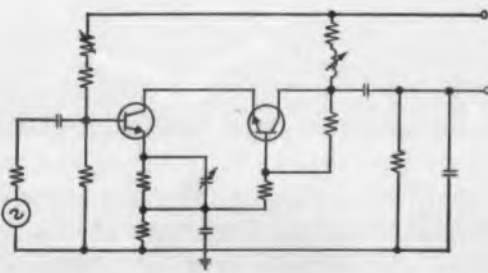
Specially designed for high frequency, high power operation at low supply voltages, these transistors give typical power outputs of 1 w at 70 mc and 500 mw at 200 mc. Highly efficient high frequency operation is assured by combining either type with a Hi Q Varicap frequency multiplier. At right: Typical amplifier circuit for 200 mc power gain measurement.



NPN VHF, High Voltage, High Power Amplifiers... Switches... Oscillators

Types 2N1335 thru 2N1341

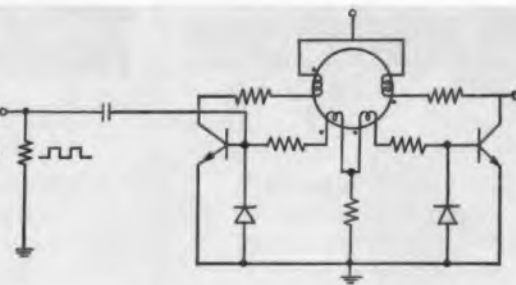
A unique combination of high voltage, high frequency and high power makes it possible for the first time to design video amplifiers with output voltages of 140 v and bandwidth of 10 mc. Other applications are power amplifiers, power oscillators and high voltage switches. At right: Typical high voltage video amplifier.



NPN High Speed, High Current Core Drivers and General Purpose Switches

Types 2N1409, 2N1410

Fastest switching time at high current ratings combined with extremely low saturation resistance make these units ideally suited for transistor-ferrite circuitry and many other computer applications. At right: Transistor-core flip flop.



TYPES 2N696 and 2N697 are also immediately available from PSI.

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 electro-mechanical 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



PSI

Write today for complete information and specifications on PSI silicon transistors.

PSI regional or district sales offices are located in all major electronic centers. Consult your yellow pages.

Authorized
CANNON PLUG DISTRIBUTORS
 COAST TO COAST



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.

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With RICHEY it's the *service* that counts! Our experienced *Staff* and huge *Shelf Stock* assures you prompt delivery.

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CIRCLE 850 ON READER-SERVICE CARD

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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.

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CIRCLE 851 ON READER-SERVICE CARD

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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.

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 Milwaukee 12, Wisconsin
 Phone: WO 4-4321

CIRCLE 852 ON READER-SERVICE CARD

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Time Electronic Sales

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

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 New York 13, New York
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CIRCLE 853 ON READER-SERVICE CARD

NEW FROM CANNON



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

CIRCLE 854 ON READER-SERVICE CARD



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

CIRCLE 855 ON READER-SERVICE CARD



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

CIRCLE 856 ON READER-SERVICE CARD



MEET morpho*



* trademark
pat. pend.

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



CIRCLE 857 ON READER-SERVICE CARD

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*.

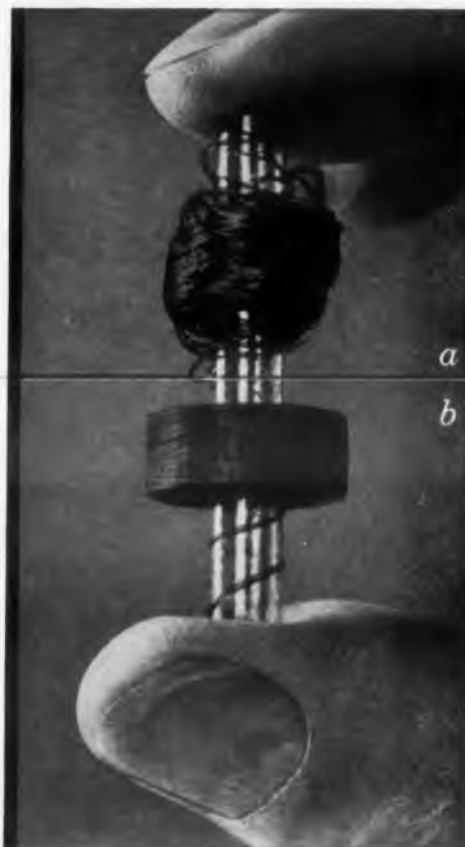
CANNON PLUGS



If you have this problem, investigate

GRIP-EZE[™]

—an example of Phelps Dodge's
realistic approach
to Magnet Wire research



THE PROBLEM: To develop a solderable film-coated wire without fabric for winding universal lattice-wound coils without adhesive application.

THE SOLUTION: Phelps Dodge Grip-eze—a solderable film wire with controlled surface friction for lattice-wound coils that provides mechanical gripping between turns and keeps wire in place.

EXAMPLE: Coils wound with (a) conventional film wire; (b) Grip-eze. Note clean pattern of Grip-eze as compared to fall-down of conventional film wire.

*Any time magnet wire is your problem, consult Phelps Dodge
for the quickest, easiest answer!*

FIRST FOR
LASTING QUALITY
— FROM MINE
TO MARKET !



**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

**INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA**

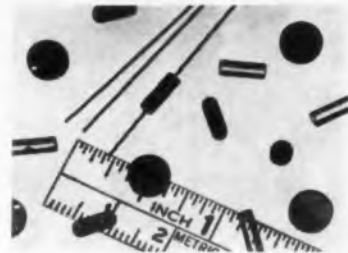
CIRCLE 71 ON READER-SERVICE CARD

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 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 tolerances 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.

ELECTRONIC DESIGN • May 11, 1960



DC Wideband 742 Amplifiers

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 μ v in 500 hr, input impedance is 100 meg ohms, 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.



ACTUAL SIZE



ACTUAL SIZE



ACTUAL SIZE



ACTUAL SIZE



ACTUAL SIZE



ACTUAL SIZE

NEW $\frac{1}{2}$ " CARBON CONTROL

another Mallory "first" in miniaturization

Only $\frac{1}{2}$ -inch in diameter, the new Mallory carbon control is the world's smallest conventional-type control for commercial applications. It takes less cabinet space, less panel space, weighs but a fraction as much as the conventional $\frac{15}{16}$ " controls. It's especially adaptable to miniature, table and clock radios; portable dictating equipment; portable television receivers; test instruments; and hi-fi amplifiers and pre-amps for small cabinets.

The tiny half-inch control retains the quality features that have gained the larger Mallory controls their reputation for outstanding performance: the same high-density, mirror-surface element for long, quiet service; the same ring-type, snap-action switch—simple in design and operation, with high, constant contact pressure, positive contact alignment and continually changing "floating" contact surface.

Available with or without rotary switch, nylon or steel shaft. Rotation: 290° without switch, 320° with switch. Linear taper: 100 ohms to 10 megohms; audio taper: 500 ohms to 5 megohms. Can be applied with element having low end resistance, for use in transistor circuits.

For further information, write to J. R. Woods, Dept. H, Mallory Controls Company, Frankfort, Indiana.

Mallory Controls Company, Frankfort, Indiana

a division of

P. R. MALLORY & CO. Inc.
MALLORY

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Trying to remember who makes a certain product? Now you can find it easily! EDC lists over 6000 new product items carried in Electronic Design during the preceding 18 months. Follows up with complete manufacturer's product data in catalog form. A tremendous aid in the quick selection of electronic components, materials and test equipment to solve design problems. Also contains a list of manufacturers' and representatives' sales offices. Lists what's available and where to buy it. Your copy will be a valuable reference source throughout the year. Free to Electronic Design subscribers.

ELECTRONIC
DESIGN

ELECTRONIC DESIGNERS' CATALOG
a HAYDEN publication
830 THIRD AVE., NEW YORK, N.Y.



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 μ a, 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.

CIRCLE 73 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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: MILE 1/700, 1/993A, and 1/961.

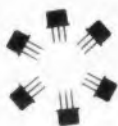
The semiconductors listed on this page are all designed to meet MIL specs.



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



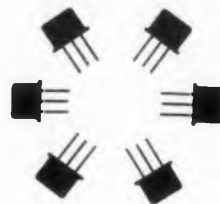
HAWK

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_{CB0} (Volts)	Punch thru V_{PT} (Volts)	Collector Cutoff Current I_{CO} (μA)	D.C. Current Gain h_{FE}	Alpha Cutoff Frequency f_{α} (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				
	NPN			NPN			NPN				
DISSIPATION RATINGS:											
TOTAL TRANSISTOR DISSIPATION AT 25°C	GE Alloy Junction			GE Alloy Junction			GE Alloy Junction				
	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})	$I_C=25 \mu\text{a}$		90 v			75 v			50 v		
EMITTER-BASE VOLTAGE (V_{EBO})	$I_E=25 \mu\text{a}$		20 v	50 v		20 v	50 v		20 v	40 v	
COLLECTOR-EMITTER VOLTAGE (V_{CE}) (PUNCH-THRU)	$I_E=25 \mu\text{a}$		90 v			75 v			50 v		
COLLECTOR CUT-OFF CURRENT (I_{CO})	$V_{CBO}=5 \text{ v}$			3 μa	7 μa		3 μa	7 μa			7 μa
EMITTER CUT-OFF CURRENT (I_{EO})	$V_{EBO}=5 \text{ v}$			3 μa	7 μa		3 μa	7 μa			7 μa
D.C. AND SWITCHING RATINGS:											
D.C. CURRENT GAIN (h_{FE})	$I_C=5 \text{ ma}$	$V_{CE}=0.25 \text{ v}$	20			15			20	30	
	$I_C=20 \text{ ma}$	$V_{CE}=0.25 \text{ v}$					25				
D.C. BASE VOLTAGE (V_{BE})	$I_C=5 \text{ ma}$	$V_{CE}=0.25 \text{ v}$			0.5 v			0.5 v			
	$I_C=20 \text{ ma}$	$V_{CE}=0.25 \text{ v}$								0.3 v	
D.C. COLLECTOR VOLTAGE (V_{CE})	$I_B=10 \text{ ma}$	$I_C=100 \text{ ma}$		0.2 v			0.2 v			0.2 v	
SMALL SIGNAL RATINGS:											
CURRENT GAIN COMMON EMITTER (h_{re})	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$			35			30			40
ALPHA CUT-OFF FREQUENCY (f_{α})	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$			1 mc			1.5 mc			2 mc
COLLECTOR CAPACITY (C_{ob})	$I_E=1 \text{ ma}$	$V_{CE}=5 \text{ v}$			11 μmf			11 μmf			11 μmf
INPUT IMPEDANCE (h_{ie})	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$			35 Ω			35 Ω			35 Ω
REVERSE TRANSFER RATIO (h_{re}) ($\times 10^{-4}$)	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$				15			15		15
OUTPUT ADMITTANCE (h_{oe})	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$				2 μS			2 μS		2 μS
NOISE FIGURE (NF)	$V_{CE}=5 \text{ v}$	$I_E=1 \text{ ma}$			10 db				10 db		10 db
											BW=100-

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 specifica-

tion 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.

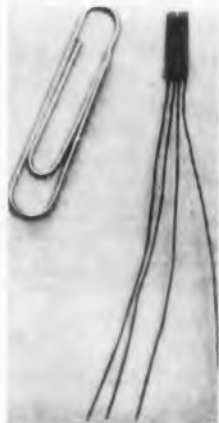
91-27 138th Place / Jamaica 35, New York

In Thermistors, the key name is KEYSTONE...

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

20 YEARS OF
Keystone THERMISTOR*
RESEARCH and PRODUCTION

Within the brief span of two decades, Keystone Carbon Company pioneered the development and commercial introduction of *negative temperature coefficient resistance thermistors, and has become the principal supplier of these remarkable units to American industry, in the widest variety of forms.

It is an historic fact that the first thermistor shipment from Keystone, totalling 5000 units, occurred early in 1941 after three years of laboratory and pilot work. These units were for bomber intervalometers—a temperature compensation application. Later that year, 125,000 thermistors were supplied as sensing units for tank engine water temperatures—and the production flood began.

Since then, Keystone Thermistors have been supplied to the great names in American manufacturing for many measurement, control, and temperature compensation applications, including such uses as automobile temperature gauges, in meat probes for modern ovens, clinical thermometers, aircraft liquid fuel level indicators, and surge reducers in radio and TV circuits.

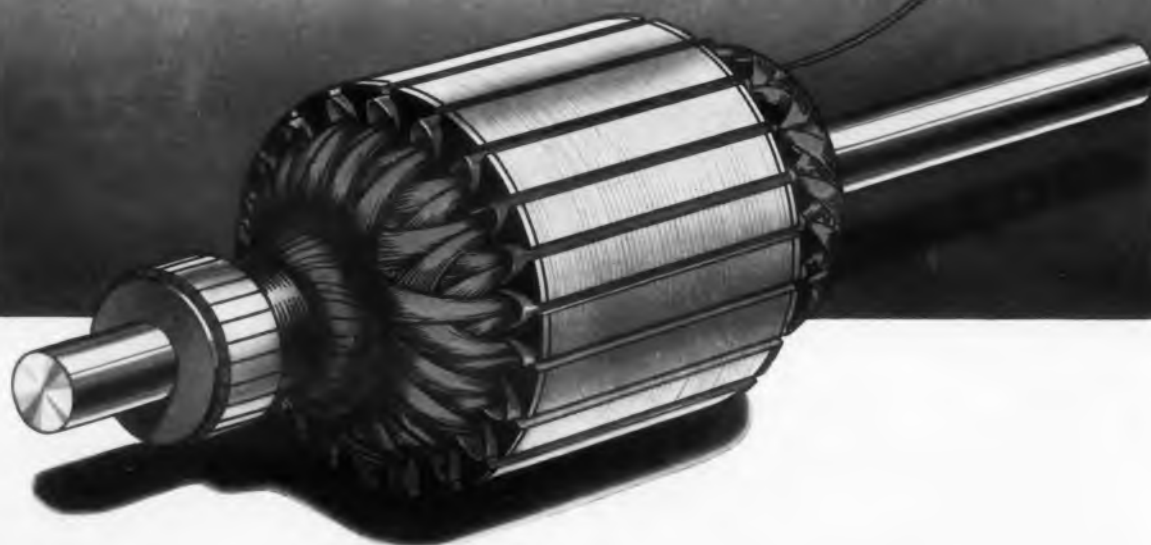
Today, some of the most interesting and promising new applications for Keystone Thermistors are in the very low temperature ranges, where stability and workable resistance values as low as -250°C are necessary.

Let us suggest that you bring your temperature sensing and compensation problems to **KEYSTONE**—thermistor headquarters for 20 years. Our full cooperation is always available.

Keystone

CARBON COMPANY
ST. MARYS, PA.

**Over 40,000
motor armatures
wound with Belden
Nylclad* Magnet Wire...
and not a
single reject!**



a story that's hard to believe... but true!

A well-known manufacturer of appliances had excessive trouble with the magnet wire he was using to wind his motor armatures. In an effort to cut down on rejections, he switched to Belden Nylclad Magnet Wire. Result: Not a single rejection out of a 30-day run of over 40,000 armatures. Such a record would not have been possible

without a shop using the most modern winding techniques and without operators who take a real pride in their work! Belden Nylclad Magnet Wire is ideal for motor stators and rotors, encapsulated control coils, relays, toroids, and random and deep windings. Nylclad gives the best windability... has the toughest film coating.

Other Belden Magnet Wire: Bakelaminol, Vitresinious • Bakisol[®], polyurethane-Nylon • Beldure[®], polyurethane • Calenamel[®], Cellulose acetate • Formvar, vinyl acetal • Nylclad[®], vinyl acetate-Nylon

*Belden Trademark
Reg. U.S. Pat. Off.

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

*one wire source for everything
electrical and electronic*

lead wire • power supply cords • cord sets • portable cordage •
electronic wire • control cables • automotive replacement
wire and cable • aircraft wire

1-2-0

98

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 $\pm 0.005\%$. 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.

ELECTRONIC DESIGN • May 11, 1960



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 $+125^{\circ}\text{C}$. Temperature coefficient zero to plus 20ppm/ $^{\circ}\text{C}$. Tolerance $\pm 10\%$.



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.

CORNING

ELECTRONIC COMPONENTS

Distributed exclusively by

ERIE DISTRIBUTOR DIVISION

CIRCLE 76 ON READER-SERVICE CARD

CORNING STANDARD INDUCTOR KIT

Immediate delivery from these distributors

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Radio Specialties & Appliance Corp.
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ARIZONA Tucson
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807 South Park Avenue

CALIFORNIA Glendale
R. V. Weatherford Company
9521 San Fernando Road

CALIFORNIA Inglewood
Newark Electronics Corp.
1747 West Century Blvd.

CALIFORNIA Los Angeles 15
Universal Radio Supply Company
1729 South Los Angeles Street

CALIFORNIA Oakland 7
Diner Electronics, Inc.
140 13th Street

CALIFORNIA Palo Alto
Eck Electronics
634 High Street

CALIFORNIA San Diego 1
Western Radio & TV Supply Co.
1011 India Street

CALIFORNIA San Francisco 1
Pacific Electronics Company
1780 Mission Street

CALIFORNIA San Francisco 7
Zach Electronics
1412 Market Street

COLORADO Denver
Irene Alan Radio & Supply Company
1000 Stout Street

WASHINGTON D.C.
Lafayette Radio Electronics, Inc.
1730 1st Street N.W.

WASHINGTON D.C.
Electronic Industrial Sales, Inc.
2280 Connecticut Avenue, N.W.

FLORIDA Clearwater
Electronic Supply
P. O. Box 1855
501 Birmingham Drive

FLORIDA Miami 22
Electronic Supply
87 N. E. North Street

ILLINOIS Chicago 1
Rosaire Electronics Company
222 West Madison Street

INDIANA Ellettsville 1
Ph. Wilson Electronics Supply, Inc.
308 Monroe Avenue

INDIANA Indianapolis 10
Graham Electronics Supply, Inc.
122 South Senate Avenue

IOWA Cedar Rapids
Deeco, Inc.
615 First Street N. W.

LOUISIANA New Orleans 19
Electronic Parts Corp.
402 Toulouse Street

MARYLAND Baltimore 1
Kane Electronics, Inc.
Howard A. Redwood Street

MARYLAND Baltimore 1
Wholesale Radio Parts Co., Inc.
308 310 West Redwood Street

MASSACHUSETTS Boston 16
Cramer Electronics, Inc.
811 Boylston Street

MASSACHUSETTS Boston 17
Radio Shack Corporation
710 Commonwealth Avenue

MICHIGAN Detroit 10
Feigson Electronic Supply
2306 Puritan Ave.

MINNESOTA St. Paul 3
Stark Electronics
134 West University Ave. (at Rice)

NEW JERSEY Camden 2
General Radio Supply Co., Inc.
600 Penn Avenue

NEW JERSEY Mountonide
Fenestrated Parts, Inc.
1011 G. & Route 22

NEW MEXICO Albuquerque
Radio Specialties Co., Inc.
509 Penn Avenue

NEW MEXICO Albuquerque
Radio Specialties Co., Inc.
6179 Acqua Road, S. E.

NEW YORK Binghamton
Federal Electronics, Inc.
P. O. Box 208

NEW YORK Buffalo 3
Radio Equipment Corporation
317 Elm Street

NEW YORK Hempstead
Davis Electronics Corporation
731 Main Street

NEW YORK New York 23
Hudson Radio & TV Corp.
38 West 86th Street

NEW YORK New York 7
Interstate Electronics, Inc.
201 Junction Street

NEW YORK New York 6
Mitzig Electronics, Inc.
136 Liberty Street
Room 510

NEW YORK New York 13
GMA Electronic Corporation
316 Canal Street

NEW YORK New York 11
Technical Electronics, Inc.
220 West 47th Street

NEW YORK Philadelphia
Wagner A. Zimm Electronics, Inc.
Ely, Duthers, Turpin &

NEW YORK Rochester 5
Rochester Radio Supply Co., Inc.
600 East Main Street

NEW YORK Syracuse 4
Alvord Distributing Co., Inc.
1051 West Fayette Street

NEW YORK Utica 1
A. J. F. Electronics, Inc.
1115 Simons Street, West

NORTH CAROLINA Winston-Salem
Dillon Hays Radio Supply Co., Inc.
616 Burke Street

OHIO Akron 4
The Sun Radio Company
111 East Market Street

OHIO Cincinnati 10
Haines Radio, Inc.
2129 Spangman Street

OHIO Columbus 15
Higgins Radio, Inc.
111 111 East Long Street

OHIO Cincinnati 15
Pat & A. Electronic Parts Corp.
3709 Pleasant Avenue

OHIO Dayton 4
Siegro, Inc.
218 Lee Street

OKLAHOMA Tulsa 16
Di Capital Electronics Corp.
Administration Box 66
708 South Sheridan

OREGON Portland 9
United Radio Supply, Inc.
22 N. W. Ninth Avenue

PENNSYLVANIA Philadelphia 7
Almo Radio Company
913 Arch Street

PENNSYLVANIA Philadelphia 7
Hobbs & Radman, Inc.
804 Arch Street

PENNSYLVANIA Pittsburgh 22
Cambridge Company
1121 Penn Avenue

PENNSYLVANIA Scranton 9
Fred P. Purcell
1221 27 North Washington Ave.

TENNESSEE Nashville 4
Electra Distributing Company
1916 West End Avenue

TEXAS Dallas 35
Engineering Supply
6000 Denton Drive

TEXAS Houston 15
Buckley Electronic Equipment Co.
1216 West Clay Street

UTAH Salt Lake City 1
Kimball Distributing Company
250 Perpetua Avenue

VIRGINIA Norfolk 9
Prest Electronics, Inc.
6411 Tidewater Drive

WASHINGTON Seattle 1
Seattle Radio Supply, Inc.
2117 Second Avenue



Two each of these four different types of cores: 1) red dot, 5.0 permeability; 2) blue dot, 9.2 permeability; 3) $\frac{1}{4}$ " brass; 4) $\frac{3}{16}$ " brass.

NEW PRODUCTS

Time Delays

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 $\pm 1\%$ 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

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.

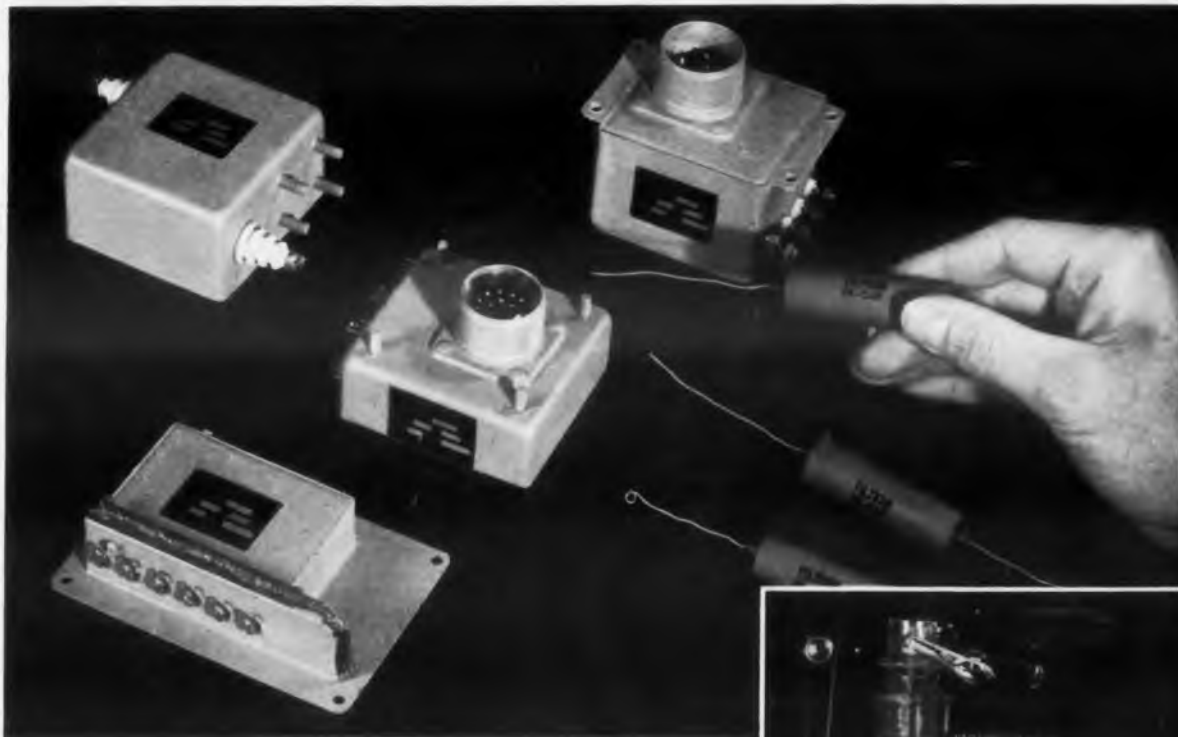
Waltham Precision Instrument Co., Dept. ED, 221 Crescent St., Waltham 54, Mass.

Price & Availability: Price is under \$40. Delivery time is one week.

537

SILICONE NEWS from Dow Corning

Plan For Uniform Performance



Low Power Factor and Constant Capacity Assured by Dow Corning Silicone Fluids

Here's an example of value engineering with silicone fluids:

The Filtron Co., Inc., of Flushing, N. Y., manufactures RF interference filters and capacitors for both military and commercial use. To assure an almost constant capacitance vs temperature relationship for their specialty capacitors . . . and the lowest possible power factor for their RF interference filters . . . Filtron engineers impregnate them with Dow Corning silicone fluids.

Silicone fluids are, in themselves, excellent dielectrics. In capacitors and RF filters such as these, silicone fluids boost the performance of the paper dielectric . . . substantially increase permissible operating temperatures, decrease electrical losses. Highly stable to changing environments, silicones show little drift in electrical or physical properties over a broad range of temperature and frequency conditions. They add greatly to reliability . . . often eliminate costly compensating circuits.

Dielectric-Coolants . . . Silicone fluids also make highly effective heat transfer media. Because of their relatively constant viscosity, their pumping rate does not vary appreciably at differing temperatures. They're nonoxidizing, nongumming . . . can be sealed in for the life of the equipment. Electric grade fluids may be cycled directly over operating assemblies.



Typical Dielectric Properties of 200 Fluid, 100 CSTK.

Property	Temperature		
	-55 C	23 C	200 C
Dielectric Constant,			
1.0 kcs.	3.1	2.7	2.3
0.1 mcs.	3.1	2.7	2.3
Dissipation Factor,			
1.0 kcs.	0.0005	0.00004	0.001
0.1 mcs.	0.0002	0.00001	0.0003
Resistivity, ohm-cm . .	10×10^{14}	2.0×10^{14}	1.0×10^{15}
Electric Strength, dc, 20 mil gap			
v/mil	700	650	550

CIRCLE 800 ON READER-SERVICE CARD

Your nearest Dow Corning office is the number one source for information and technical service on silicones.



Dow Corning

... engineer for value with silicones



Solventless Resin Fills A Void

This servo motor, made by G-M Laboratories, Inc., Chicago, must withstand high humidity and high temperatures in operation. On analyzing the requirements of size, weight and reliability, engineers at G-M Laboratories concluded that a silicone insulation system would permit the best design, so they impregnated the stator under vacuum with Dow Corning solventless silicone resin. This moisture-proof, heat-resistant material fills the coil interstices and sets up to a solid, bubble-free mass. It protects against vibration, oxidation, corona and moisture . . . provides good heat transfer.

Investigate Dow Corning solventless silicone resins for use as rigid potting, filling, impregnating or encapsulating materials. They're radiation resistant . . . can be used with inorganic fillers.

CIRCLE 801 ON READER-SERVICE CARD

Soften Shock With Silastic RTV

This transistorized oscillator, produced by Delta-f, Inc., Geneva, Illinois, is designed for use in airborne and transportable communications equipment. To protect against shock, Delta-f engineers use a flowed-on blanket of Silastic® RTV. It supplies needed cushioning, and is unaffected by the built-in heating element. Silastic RTV can withstand temperatures up to 260 C, down to -70 on the cold side. In addition, it resists moisture, oxidation, and other adverse conditions.

Silastic RTV is the Dow Corning fluid silicone rubber that vulcanizes at room temperature. Easy to use, it can be applied by dipping, pouring or with a caulking gun. When used as a potting material, it flows into place, filling all voids . . . sets up to form silicone rubber with excellent dielectric properties.

CIRCLE 802 ON READER-SERVICE CARD



For Maximum Security: Silicone-Glass

Ground approach radar must provide the ultimate in reliability. That's why Gilfillan Brothers, Inc., of Los Angeles, use silicone-glass laminates in their Quadradar sets which are designed to provide vital flight information that facilitates ground controlled approach and landing of high speed aircraft.

Silicone laminates are specified because they have uniform dielectric properties under climatic and atmospheric conditions. Little affected by moisture, silicone-glass terminal boards prevent recurrent arcing even at high voltage and high humidity . . . provide low loss factor and low attenuation at RF frequencies. In addition, silicone laminates are strong and resist creep under pressure of fasteners; and, when needed, their heat resistance is exceptional . . . up to 250 C continuous for years on end.

CIRCLE 803 ON READER-SERVICE CARD



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 μ sec. 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



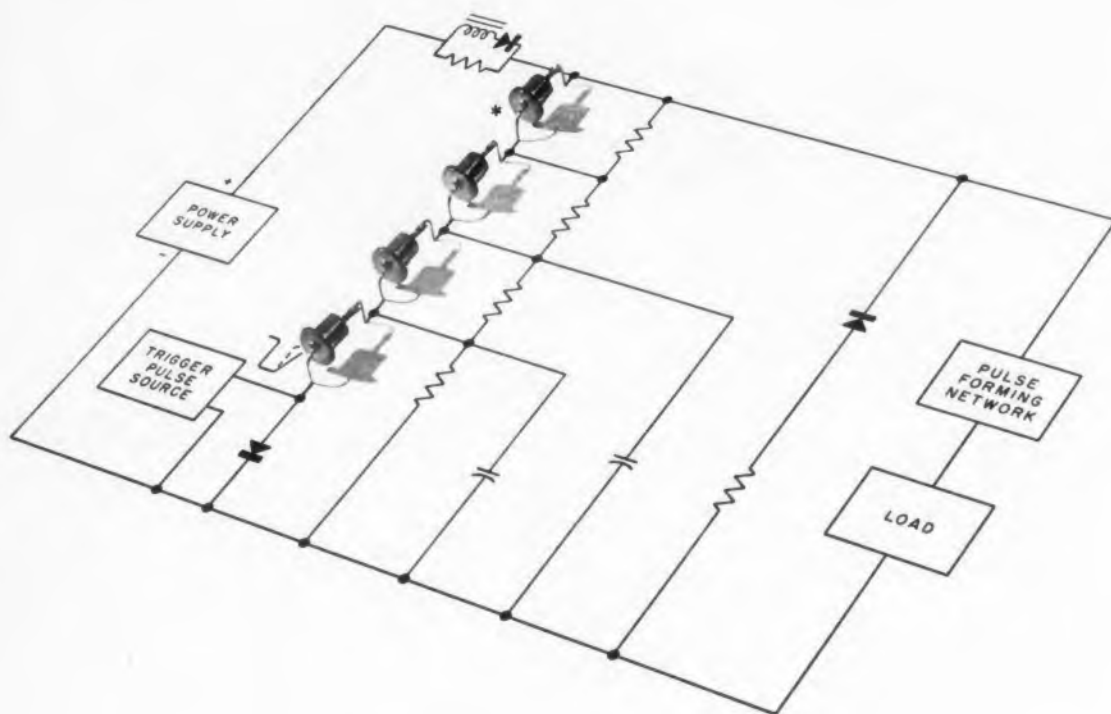
Consisting of an input mechanical modulator, a high-gain ac amplifier, and an electrical demodulator output, type A3700-01 dc-dc amplifier has a gain of 25,000. Input impedance is 100,000 ohms, output voltage is ± 10 v dc, and signal frequency is 400 ± 2.5 cps.

Kearfott, Div. of General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

CORPORATION MIDLAND, MICHIGAN

branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

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



*SHOCKLEY 4-LAYER DIODES used in series to reach voltages of 1000 or 1500 volts in medium power modulator circuit. Jitter: less than 6 milli-micro seconds. Turn on time: 0.1 μ s.

A NEW PULSE MODULATOR

Solid state reliability...drastically reduced power consumption...small size...light weight...and speed—all these are yours when your pulse modulator circuit includes Shockley 4-layer diodes.

These are *important* considerations no matter what your pulse modulator applications may be...whether you're working with modulators for driving sonar oscillators, modulators for driving magnetrons and klystrons, modulators for driving triodes or pentodes.

And, they are *critical* considerations where space

and weight are limited, where the size of the power supply must be reduced, where maximum reliability is a must...as in missile work.

Pulse Modulator applications, using 4-layer diodes, are described in a new data sheet, just released. Or, are you interested in how 4-layer diodes can solve circuit problems in counters, flip-flops, alarm circuits, magnetic memory driving, d-c to a-c inverters, oscillators, detonators, pulse amplifiers, or just plain switching? If so, call or write your local Shockley field representative or write Dept. 8-2.

Shockley TRANSISTOR CORPORATION

Stanford Industrial Park, Palo Alto, Calif.

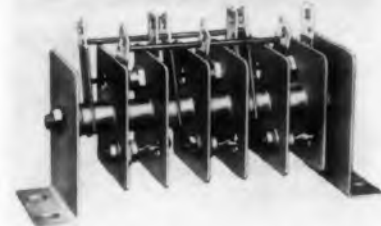
CIRCLE 79 ON READER-SERVICE CARD

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.

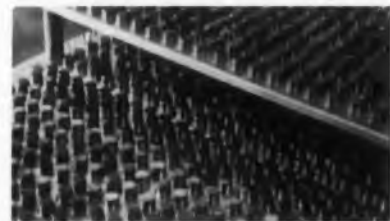
The Electric Hotpack Co., Inc., Dept. ED, 5065 Cottman St., Philadelphia 35, Pa.

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.

ELECTRONIC DESIGN • May 11, 1960

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 Å and for the 505, 6900 Å. 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-Hexam Corp., Dept. ED, 638 University Ave., Los Gatos, Calif.

Price: \$625.

TAILOR-MADE TELEMETRY WITH BENDIX-PACIFIC SERIES 300

These revolutionary Series 300 Telemetry components offer you a quick, easy "building block" method of assembling a system to meet your instrumentation requirements. • Besides this extreme flexibility each Series 300 unit is sub-miniature in both size and weight (approximately 1.6 cu. in. and 2 oz.) Performance is guaranteed to exceed that of old-style components. Phone or wire for complete specification and prices.



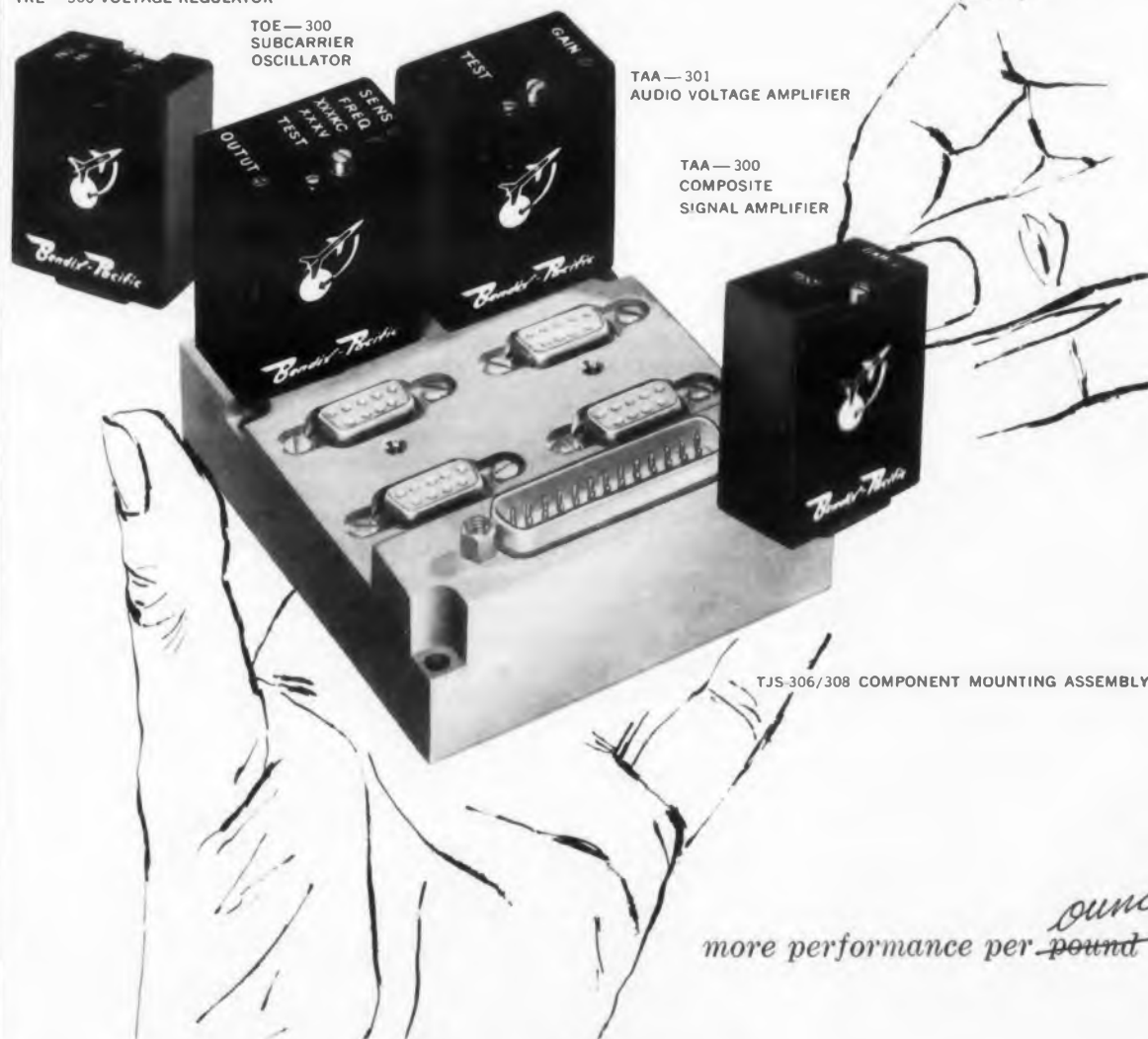
Instrumentation Facility
7250 Laurel Canyon Blvd.
North Hollywood, California

TRE — 300 VOLTAGE REGULATOR

TOE — 300
SUBCARRIER
OSCILLATOR

TAA — 301
AUDIO VOLTAGE AMPLIFIER

TAA — 300
COMPOSITE
SIGNAL AMPLIFIER



TJS-306/308 COMPONENT MOUNTING ASSEMBLY

ounce
more performance per ~~pound~~

CIRCLE 78 ON READER-SERVICE CARD



NEW MONITOR OSCILLOSCOPES



**View up to
7 circuits simultaneously!**

New Sierra Model 218 Monitor Oscilloscopes provide, in the smallest possible package, a convenient and practical means for viewing and evaluating complex voltages. Up to seven oscilloscopes can be mounted side by side in a standard relay rack—units measure only 10½" high x 2½" wide (front panel). Thus seven circuits can be monitored simultaneously.

Designed primarily for tape recording and data handling systems, the Monitor Oscilloscopes are particularly suited for measuring and analyzing mechanical quantities through a transducer. Such quantities include stress, strain and vibration, pressure, displacement and acceleration.

Unusual design features include printed circuitry, broad bandwidth, smooth high frequency rolloff without overshoot and minimum heating (only 20 watts dissipation per scope unit, including filaments!) Request bulletin and demonstration.

sierra

SIERRA ELECTRONIC CORPORATION

A Division of Philips Corporation

5444K Bohannon Drive • Davenport 6-2060 • Menlo Park, California, U.S.A.

Sales representatives in all major cities

Canada: Atlas Instrument Corporation, Ltd., Toronto, Montreal, Vancouver.

Export: Frazer & Hansen, Ltd., San Francisco,

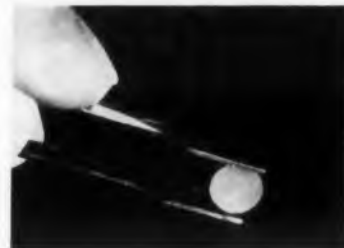
CIRCLE 75 ON READER-SERVICE CARD

NEW PRODUCTS

Moisture Getters

546

For semiconductors



These semiconductor moisture getters are made 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.

Coming Glass Works, Dept. ED, Corning, N.Y.
Availability: Large quantities can be supplied in three weeks.

Polycrystalline Silicone Rods 571

For floating zone crystal growing

For floating zone crystal growing, these polycrystalline silicon rods are uniform in diameter and have a boron content of 1 ppb, and have a very high density. Standard diameters of the rods are 3/4 to 7/8 in. with tolerances of ±0.005 in. Nominal 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 for 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

ELECTRONIC DESIGN • May 11, 1960

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 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 megohms 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.

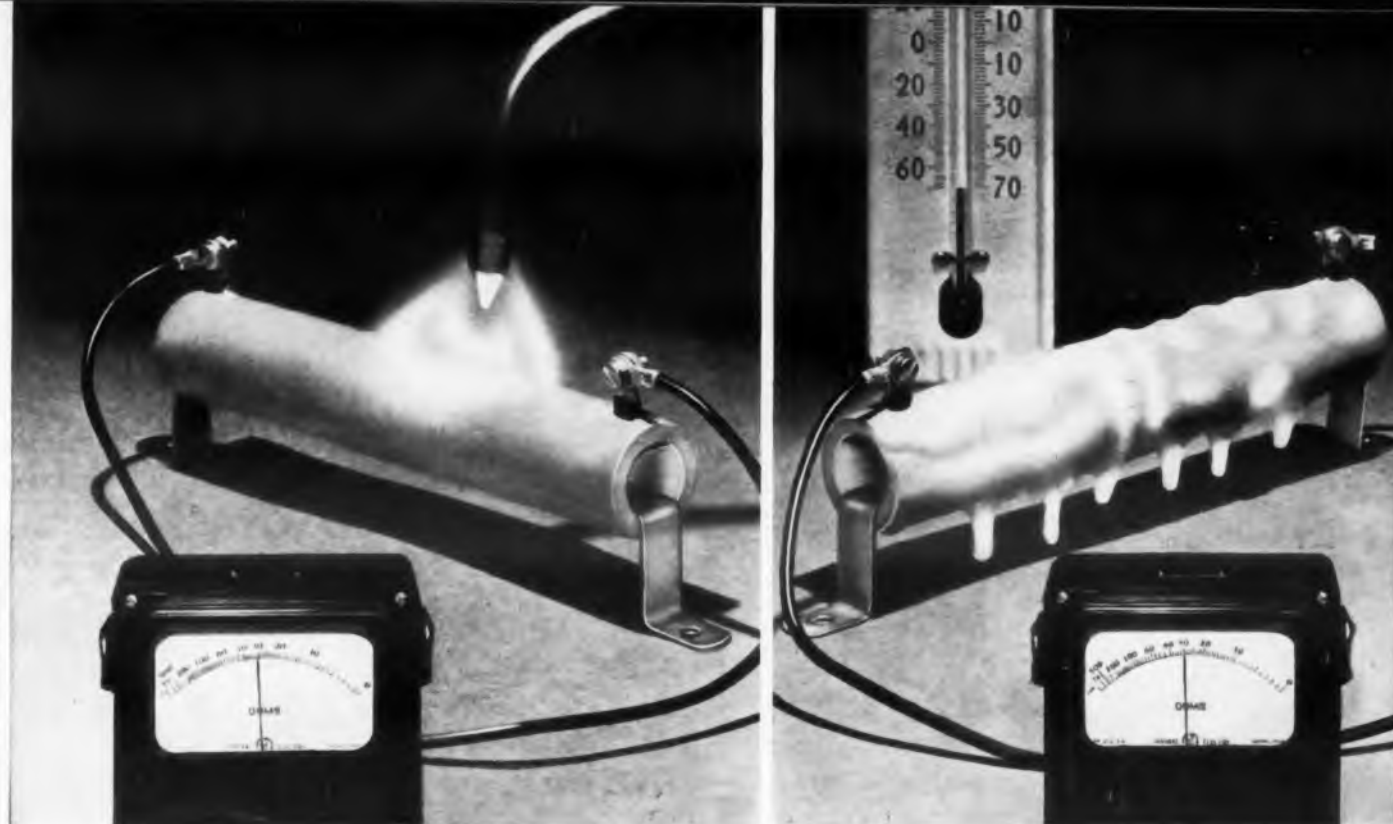
Ceramic Capacitors 397

Range is 47 to 56,000 μ f

Available in parallel lead, axial or feedthrough combinations, type EC ceramic capacitors range from 47 to 56,000 μ f. Their temperature range is -55 to $+150$ C; capacity variations are limited to $\pm 10\%$ 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 ►



TESTS ON NEW GENERAL ELECTRIC RESISTORS PROVE . . .

Stable operation from $+700^{\circ}$ to -70° F

Under searing heat or sub-zero cold, General Electric resistors maintain their rated ohmic values. Actual laboratory tests have proved that these vitreous-enameled resistors hold their rated resistance under ambient temperatures from $+700$ F to -70 F.

These General Electric resistors are available in over 1400 combinations of ratings (5 to 200 watts), types, and mountings. Stable operation is but one

of their outstanding qualities: They have sufficient terminal strength to hold up to 21 pounds of right-angle pull, and special terminals are available to hold up to 34 pounds. Their vitreous-enamel coating provides resistance to adverse atmospheric conditions.

Like to know more? Ask your General Electric Apparatus Sales Engineer for a free set of sample resistors and test them yourself! And mail this cou-

pon today for the 36-page catalog containing complete information on ratings, dimensions and ordering directions.

NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays, and plate rheostats for all your control needs. For more information, contact your General Electric Sales Engineer or mail this coupon today! Industry Control Department, Salem, Virginia.

GENERAL ELECTRIC

D-c contactors and relays—feature new “building-block” construction to give maximum flexibility with minimum inventory.



Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.



To: Section 784-D23
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- GEA-6592—Vitreous-enameled resistors
- GEA-6474—Plate-type field rheostats
- GEA-6621—D-c contactors and relays

Name _____
Company _____
Address _____
City _____ State _____

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 pre-cleaning 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.

FULL LINE OF HIGHEST BETA GERMANIUM

New TI high-efficiency emitter gives you high beta germanium power transistors!



Now minimum and maximum betas are guaranteed from 20 to 60 at the maximum current rating

of $I_C = 25$ amps in new TI 2N514 series transistors. New high efficiency emitter makes possible greatly improved specifications for TI 2N456, 2N511, 2N512, 2N513, 2N514, and 2N1021 series alloy-junction germanium power transistors.



TI gives you design leadership in quality germanium power transistors

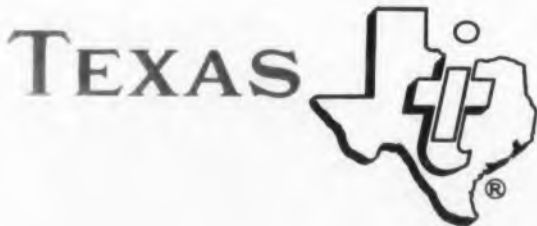
INCREASED BETA THROUGH HIGH-EFFICIENCY EMITTER

Emitter efficiency can be improved by increasing the ratio of resistivities between the emitter and base region. For example, when a 10 ohm-centimeter resistivity germanium wafer is used as the base material, it is advantageous to have less than a .01 ohm-centimeter resistivity emitter regrowth region. Since initial doping of the germanium crystal establishes base resistivity, the ratio can be changed only by varying the emitter material. TI utilizes an emitter material that results in a lower emitter resistivity and an increased emitter efficiency, plus providing the higher beta at high currents.



Optimum reliability for all TI germanium power transistors is assured by . . . 100% testing . . . 100% temperature cycling . . . 100% hermetic seal testing . . . continuous and intensive quality assurance program. Write on your company letterhead for germanium power transistor specifications.

GERMANIUM POWER SWITCHING / DEFLECTION CIRCUIT TRANSISTORS



**INSTRUMENTS
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SEMICONDUCTOR-COMPONENTS DIVISION
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GERMANIUM POWER TRANSISTORS

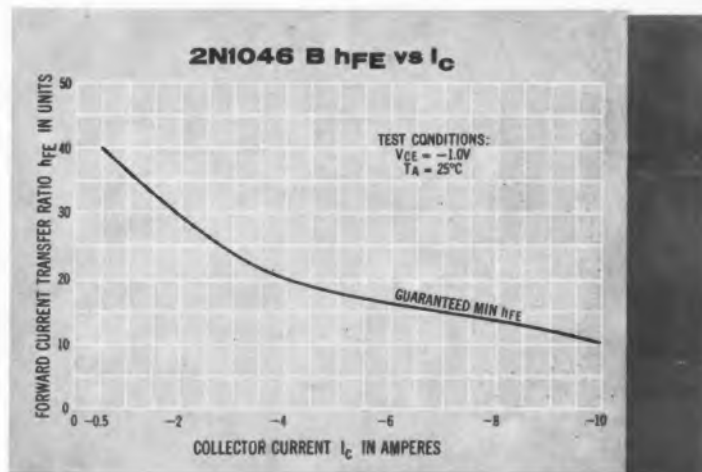
New high current 2N1046-A-B give you high frequency/dissipation/voltage with high beta!



New TI 2N1046B germanium power transistors give you 10 amp I_C with typical 18 mc f_T^* . . . 130 volt BVC_{BO} . . . 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 BVC_{EO}	Emitter to Base Voltage-v min BVE_{BO}	Collector Current Amps max	h_{FE} @ I_C		Collector Reverse Current I_{CO}		Typ R_{CS} @ I_C ohms	Internal Cutoff Frequency avg f_T
						min	max	ma	v		
2N456A	50	-80	-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	-125 μ a	-20	0.150 @ 1a	8.0 kc f_{oe} min
2N1039	20	-60	-40	-20	-3	20 @ 1a	60	-125 μ a	-30	0.150 @ 1a	8.0 kc f_{oe} min
2N1040	20	-80	-50	-20	-3	20 @ 1a	60	-125 μ a	-40	0.150 @ 1a	8.0 kc f_{oe} min
2N1041	20	-100	-60	-20	-3	20 @ 1a	60	-125 μ a	-50	0.150 @ 1a	8.0 kc f_{oe} min
2N1042	20	-40	-30	-20	-3	20 @ 3a	60	-125 μ a	-20	0.167 @ 3a	8.0 kc f_{oe} min
2N1043	20	-60	-40	-20	-3	20 @ 3a	60	-125 μ a	-30	0.167 @ 3a	8.0 kc f_{oe} min
2N1044	20	-80	-50	-20	-3	20 @ 3a	60	-125 μ a	-40	0.167 @ 3a	8.0 kc f_{oe} min
2N1045	20	-100	-60	-20	-3	20 @ 3a	60	-125 μ a	-50	0.167 @ 3a	8.0 kc f_{oe} min
2N1046	30	-100	-50	-1.5	-10	40 @ 0.5a	60	-1	-40	0.500 @ 1a	15 mc min
2N1046A	30	-140	-50	-1.5	-10	20 @ 4a	60	-1	-40	0.125 @ 4a	15 mc min
2N1046B	30	-140	-50	-1.5	-10	10 @ 10a	60	-1	-40	0.050 @ 10a	15 mc min

CIRCLE 84 ON READER-SERVICE CARD

CIRCLE 85 ON READER-SERVICE CARD

ONE ORDER TO

ALLIED

FILLS THE WHOLE BILL

... for All your
ELECTRONIC
SUPPLY
NEEDS

SAME-DAY SHIPMENT

... next-day delivery
(by air where required)

ON
TEXAS
INSTRUMENTS
SEMICONDUCTORS

O. E. M.

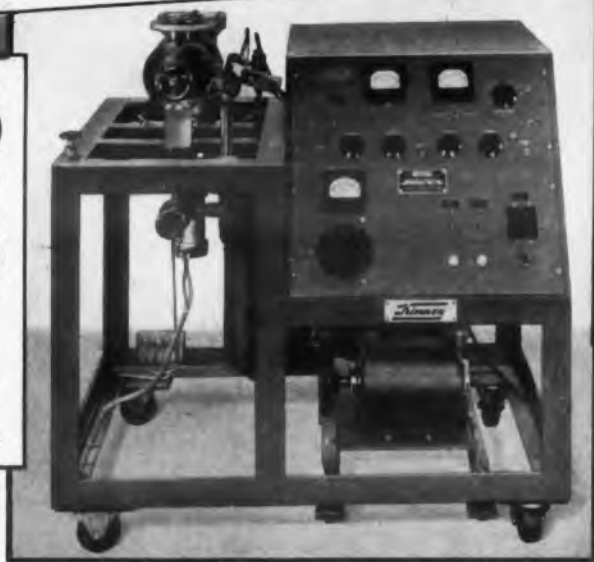
PRICES ON

Silicon Transistors: 1-999
Germanium Transistors: 1-999
Silicon Diodes and Rectifiers: 1-999
Carbon Film Resistors: 1-999
sensitive Silicon Resistors: 1-499
tan-TI-cap Tantalum Capacitors: 1-99

ALLIED RADIO CORP.

100 N. WESTERN AVE.
CHICAGO 80, ILLINOIS
HAYmarket 1-6800
TWX: CG - 2898

a Vacuum Workhorse for Laboratories with Many and Varied Problems...



Kinney

PW-200 Packaged Pumping System

**IT'S MOBILE...
CAN BE MOVED
ANYWHERE!**

**EASY TO CONVERT
TO A VACUUM
EVAPORATOR**

**PRESSURES TO
5 x 10⁻⁷ MM HG**

**STURDY,
VERSATILE,
DEPENDABLE**

The popularity of KINNEY Packaged Pumping Systems stems from the fact that they are so downright useful. They'll evacuate chambers, tanks, bell jars, furnaces, tubes or equipment—anywhere—and quickly. With main valve closed, the KINNEY PW-200 will attain ultimate pressures to 5×10^{-6} mm Hg with no coolant in the trap, (5×10^{-7} mm Hg with coolant).

The Rotatable "T" Manifold is a feature of KINNEY Packaged Pumping Systems. The stem of the "T" can be rotated a full 90°—from horizontal to vertical—so that the system is readily converted to form a complete Evaporator by the addition of a suitable baseplate. Get the facts on the PW-200 and other KINNEY Packaged Pumping Systems.

KINNEY VACUUM DIVISION THE NEW YORK AIR BRAKE COMPANY

3561E WASHINGTON STREET, BOSTON 30 • MASS.

Please send me Bulletin No. 4000.1 describing KINNEY Packaged Pumping Systems.

Name _____

Company _____

Address _____

City _____ Zone _____ State _____

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WRITE—
for your copy of Bulletin 4000.1. It's FREE.

NEW PRODUCTS

Digital Meter

Measures ac, dc, and ohms

565



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 $\pm 0.1\%$ on dc ranges and $\pm 0.5\%$ on ac ranges. Resistance range is 1 meg at an accuracy of $\pm 0.2\%$. 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

Handles 5, 6, 7, and 8-level codes

560



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.

for SPECIFICATION Electroplating

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24 KT ACID GOLD

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Chicago Office
7001 North Clark Street

CIRCLE 87 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 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 milliammeter, 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.



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136 Liberty Street, New York 6, New York

RE 2-4400

TWX: NY 1-4013

* silicon transistors germanium transistors, silicon diodes and rectifiers, carbon film resistors, generator, silicon resistors, tan Ti cap, tantalum capacitors.

CIRCLE 88 ON READER-SERVICE CARD

L-BAND KLYSTRON EXTENDS BROADBAND PERFORMANCE

This addition to Litton Industries' Klystron family not only extends the bandwidth of our broadband L-band amplifier tubes, but does so in a reduced package size. Through improvements of the recently developed Skirtron* bunching technique, the L-3270 achieves gain and power output characteristics, which are essentially flat over the minimum bandwidth of 100 Mc. Its minimum peak power output at the band edges is 2 MW. A linear phase shift versus frequency characteristic makes it ideally suited for application in sophisticated radar systems, where electronic tuning and pulse shaping are required.

This tube, like all other tubes produced by Litton Industries, is conservatively designed and rated; and rigorously processed to provide thousands of hours of reliable operation. Typical of the performance obtained from applying this design philosophy is that of the L-3035, a 2.2 MW L-Band Klystron, whose *average* operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide top performance after operating for more than 10,000 hours.

The Skirtron technique is being applied to other tubes now being developed to obtain even broader-band performance at higher power levels and in other frequency ranges. Should you require high power broadband performance for your current (L-3270 is available now) or future system planning, write to Litton Industries, Electron Tube Division, Office E37, 960 Industrial Road, San Carlos, California.

*A technique developed by Litton Industries which provides improved broadband performance.

LITTON INDUSTRIES Electron Tube Division
BARRATRON® TRANSMITTING TUBES • MAGNETRONS • KLYSTRONS • TRAVELING WAVE
TUBES • BACKWARD WAVE OSCILLATORS • GAS DISCHARGE TUBES • NOISE SOURCES
CROSSED-FIELD AMPLIFIERS • HIGH DEFINITION CRT • DIRECT-WRITING CRT
COLOR CRT • STORAGE TUBES • MICROWAVE FILTERS • DUPLEXERS • TR TUBES



**CAPABILITY
THAT CAN CHANGE
YOUR PLANNING**

NEW PRODUCTS

Airborne Pressure Transducer

Accuracy is 0.25%

Model 181 miniature pressure transducer is designed for airborne applications whose measurements of 0.25% accuracy are required over a wide temperature range. Pressure ranges are: 0 to 250, 0 to 300, 0 to 350, 0 to 500, 0 to 750, and 0 to 1000 psi. The unit is able to stand three times rated full-scale pressure. It has a low sensitivity to vibration, a virtually infinite resolution, and a pressure-cavity clean-out feature. The unit can be used with either a constant voltage or constant current system.

Taber Instruments Corp., Dept. ED, N. Tonawanda, N.Y.

Price: \$350 for standard unit.

Laboratory Standard Console

For ac and dc instruments

Designed to check ac ammeters, ac voltmeters, dc ammeters, dc voltmeters, and wattmeters, this laboratory standard console has an accuracy of 0.05%. Ranges are 0 to 15 v and 0 to 50 amp for ac, 0 to 750 mv and 1.5 to 30 ma, and 0 to 1 amp for dc. The unit operates over the temperature range of 40 to 100 F. It requires 110 to 120 v at 60 cps, measures 5 x 7 x 2 in., and needs only one non-skilled operator.

Weston Instruments, Daystrom Inc., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Microwave Wattmeter 39

Has self-balancing bolometer bridge

This microwave wattmeter, designed for highly accurate bolometric power measurements up to 100 ma dc, is made up of two basic units: model 1493 self-balancing bolometer bridge and model 1494 reference-current generator. The bridge automatically adjusts the

← **CIRCLE 95 ON READER-SERVICE CARD**

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 to order.

Motor-Alternator Sets 416

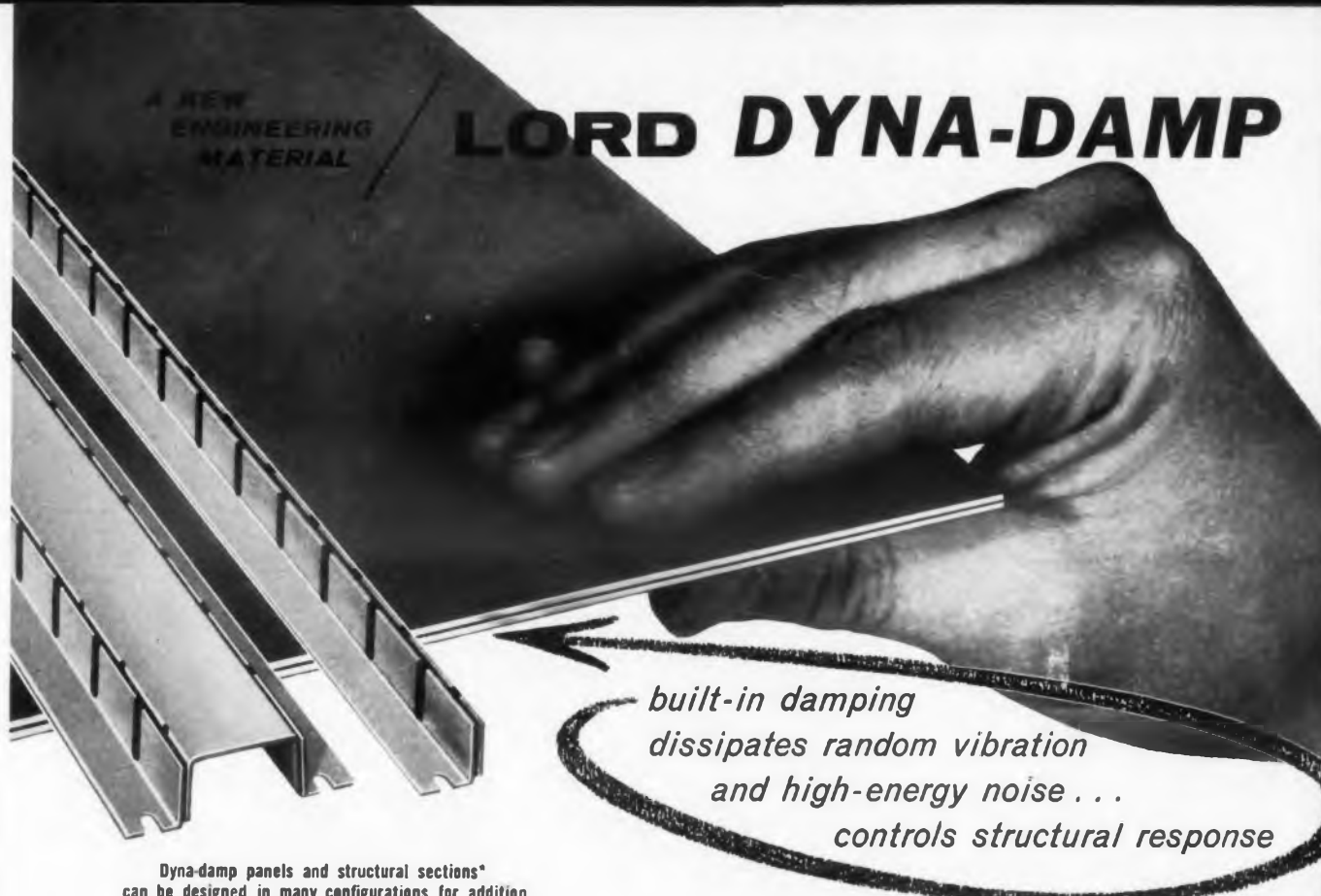
Provide ac line power at 60 or 400 cps

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, 108 South St., Stamford, Conn.

Availability: Made on order only.

CIRCLE 90 ON READER-SERVICE CARD ▶



Dyna-damp panels and structural sections* can be designed in many configurations for addition to existing structures or fabrication as complete damped assemblies.

Lord announces Dyna-damp—a new engineering material that counteracts broad-band “white” noise and vibration. It offers a new, better way to solve acoustic fatigue and structural response problems.

Dyna-damp’s laminated design converts vibratory energy into shear strains which are dissipated in a highly damped viscoelastic layer. The damping medium is a special form of BTR® elastomer, bonded between metal elements to give structural integrity and load-carrying strength.

In jets, missiles, ships, vehicles, electronic units—wherever control of resonant response is required—Dyna-damp can introduce dramatically improved performance, higher reliability. It is available to industry in sheet and structural sections or in engineered, finished products for use as primary or secondary structures, electronic chassis, complete mounting systems.

Design engineers can obtain further information and able application assistance on Dyna-damp from the nearest Lord Field Engineering Office or the Home Office, Erie, Pennsylvania.

*patent applied for

FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7-9247
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In Canada—Railway & Power Engineering Corporation Limited

LORD MANUFACTURING COMPANY • ERIE, PA.

Radically improved damping is illustrated by typical decay rate traces.



Undamped: 2024 T-3 aluminum panel



Damped: 3-ply Dyna-damp panel

DYNA-DAMP FEATURES

High strength: bonded construction provides structural integrity across complete part. Ultimate strength: 60% of solid aluminum. Shear strength of BTR layer: over 500 psi. Climbing drum peel strength: over 60 lbs.

Light weight: lighter than aluminum sheet of equal thickness.

Excellent fatigue life: proved greatly superior to aluminum in acoustic tests to 170 db.

Broad temperature operation: -65° to +250°F.

Ease of fabrication: can be punched, sheared or stretch formed by standard methods . . . fastened by riveting or adhesive bonding . . . sections can also be spot welded.

Environmental resistance: good strength and damping ability maintained after 7-day immersion in aircraft fluids.



See us at the Design Engineering Show—Booth 1620.

NEW PRODUCTS

Differential Trans- former 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.

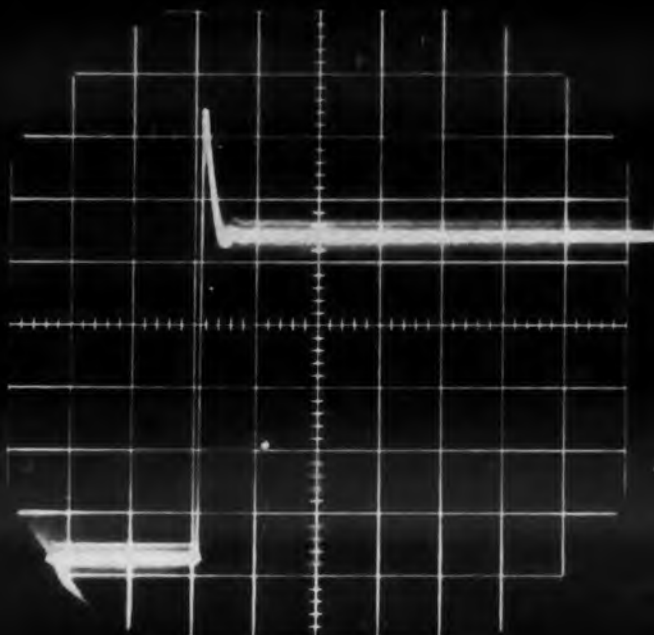
Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

Oscilloscope Recording Camera 417

Modular design

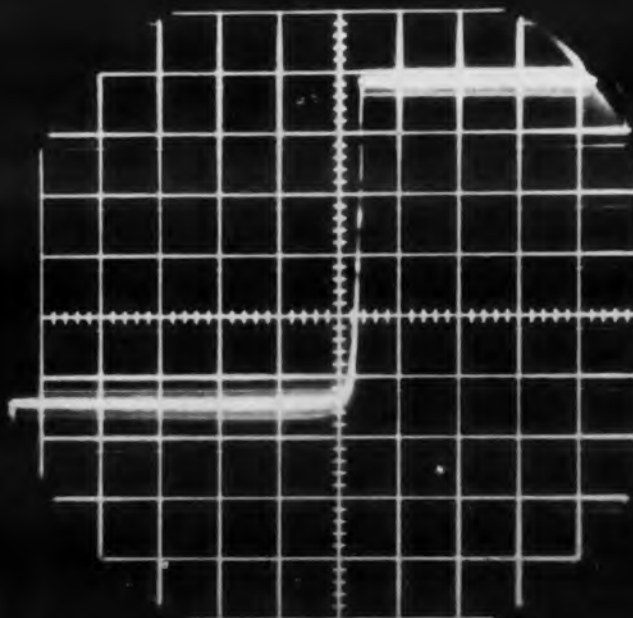
This oscilloscope recording camera, called Minute Man Oscillotron, has a polaroid, Land back providing either 60-sec prints or transparencies. Of modular design, it can be converted to record a wide range of object-to-image ratios. It can be attached to any 5-in. oscilloscope.

Beattie-Coleman, Inc., Dept. ED, 1042 N. Olive St., Anaheim, Calif.



Actual photographs
of power supply
turn-on at 28v setting.
Scope settings: 5v per cm
vertical, 0.2 sec. per cm
horizontal.

TRANSISTOR KILLER: THE VOLTAGE SPIKE...



TAMED BY NEW PERKIN MTR DC POWER SUPPLIES

The voltage spike in the top photo could destroy the transistors in your circuit in microseconds. This one happens to be a "turn-on" transient—one of several treacherous, instantaneous overshoots encountered in the everyday use of dc supplies. For complete protection against line and load transients, use new Perkin MTR power

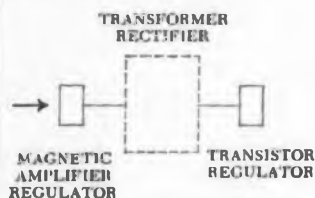
supplies. Combining the best two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous regulation and low ripple. Made without tubes or moving parts, they give you long, trouble-free service. They're ideal for continuous-duty and unattended operation. Perkin MTR units sustain shorts and overloads indefinitely without suffering internal damage or shooting spikes into the load. After shorts, they resume normal operation automatically. And their protection is constant... even if an internal transistor fails, your Perkin MTR power supply continues to regulate smoothly and safely!

PERKIN

PERKIN



MODEL NO. MTR-636-15



NEW SOLID STATE REGULATION PRINCIPLE:

magnetic amplifiers for efficiency and reliability, transistors for fast response

Rugged magnetic amplifiers provide steady-state regulation of line and load. Fast-acting transistors suppress ripple and transients. Because the transistors function only during instantaneous line and load changes, their actual use is held to a minimum. MTR units thus have far better dynamic regulation than magnetic amplifier-regulated power supplies and much higher reliability than fully transistorized supplies.

PERKIN / MTR REGULATED LOW-VOLTAGE DC POWER SUPPLIES

prompt delivery

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 CPS		Ripple
	Volts	Amps	Line	Load	Line†	Load††	Volts	Phase	RMS
MTR060-1 A	0-60	1	±10MV	±25MV	±10MV	±.2V	95-135	1	2MV
MTR060-5 A	0-60	5	±10MV	±25MV	±10MV	±.3V	95-135	1	2MV
MTR036-5	0-36	5	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125	1	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125	1	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125	1	5MV
MTR615-5	6-15	5	±10MV	±50MV	±0.1%	±.2V	105-125	1	3MV
MTR28-2	24-32	2	±0.1%	±0.1%	±0.1%	±.2V	105-125	1	5MV
MTR28-3	24-32	3	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125	1	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125	1	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125	1	5MV
MTR28-100	24-32	100	±0.1%	±0.1%	±0.5%	±2.0V	208/230/ 460 ±10%	3	20MV

†For 10V step change on 115V nominal input units; 10% step change on Model MTR 28-100

††For changes no load to full load or full load to no load. On fractional load changes, specifications are improved.

All models have Automatic Current Limiting protective circuitry which eliminates fusing. Voltage and current are automatically reduced to a safe level on overloads of 125% rated output and above, including dead short circuits. Over-

loads and shorts can be sustained indefinitely without damage to the power supply. All units available standard 19" rack or cabinet mount. Dynamic impedance down to 25 milliohms.

WRITE FOR COMPLETE PERKIN CATALOG on tubeless power supplies and new technical article on dc power sources for transistorized circuits.



PERKIN
ENGINEERING CORPORATION

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New England Area Office: 46 Amesbury St. • Lawrence, Mass. • MURdock 3-3252

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Syracuse, N.Y.—GIBson 6-0220
Washington, D.C.—JUniper 5-7550
Agincourt, Canada.—AXminster 3-7011

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 µmf 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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113



We Can Make Alumina Ceramic Parts in Sizes from Micromodules to Nose Cones

You are looking at the largest high alumina Isostatically formed ceramic part in the world. It is 12 $\frac{5}{8}$ " outside diameter at the base and stands 40" high. This nose cone is the result of Coors research and development work.

In my right hand you can just see one of the tiny micromodule wafers (.310" square x .010" thick) from our current production. Coors is producing wafers of this type to different designs in constantly increasing quantities. We also supply these wafers with metalized and

plated patterns as required.

Coors employs many different ceramic forming techniques—including the unique Isostatic Process, dry pressing, extrusion, casting, jiggering and ram pressing. Thus, depending upon the type of part that must be formed, we select the manufacturing process best suited to make it most economically.

If you need high strength alumina ceramic parts—large, miniature or in between, get in touch with us here in Golden or call the Coors regional sales manager nearest you.

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Coors
COORS PORCELAIN
COMPANY

600 Ninth Street, Golden, Colorado

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, $\pm 10\%$, 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 18, 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,

◀ CIRCLE 92 ON READER-SERVICE CARD

powered by ultrasonics, rinsed, then drained and passed through an isolated solvent drying chamber before being discharged. The solvent process removes oils, drawing lubricants and smut, chips, and abrasives and dust.

Metalclean Equipment Co., Dept. ED, Box 177, Bala Cynwyd, Pa.

Price & Availability: Available from stock by April 1, 1960. Delivered 8 weeks after order is received. Price is under \$3000 per unit. Water drying facilities between \$250 and \$400 depending on whether gas or electricity is used.

Resistor Alloy 410

Made of 74% nickel and 20% chromium

Called Chromel-R, this resistor alloy consists of 74% nickel and 20% chromium plus small percentages of other alloying materials. Specific properties include an electrical resistivity of 800 ohm-cmf at 20 C, and a temperature coefficient of resistance within 0 ± 10 ppm per deg C over the operating range from -65 to +150 C. The material comes in drawn wire sizes from 0.0031 in. down to 0.0004 in. in diameter, bare or enameled.

Hoskins Manufacturing Co., Dept. ED, 4445 Lawton Ave., Detroit 8, Mich.

Availability: Available from stock.

Induction Heater 590

For processing semiconductors

This 3-mc induction heater, designed for the processing of semiconductors and other miniature components, permits instantaneous, pinpoint heat with no contamination and no preheating. The unit operates on 220 or 440 v. Other features are instant change coils, and a built-in current transformer. The unit is shockproof and is housed in a welded, formed steel cabinet. Automatic production units can be built to meet individual requirements.

Sherman Industrial Electronics, Dept. ED, State College, Pa.

The New Donner 3500



THE FIRST SMALL COMPUTER WITH BIG COMPUTER PERFORMANCE

Program it for

- ANALOG COMPUTING
- SIGNAL GENERATION
- DATA REDUCTION

The Donner 3500 brings all the versatility of big general-purpose analog computers right to your desk or bench. And it's practical for more than computing.

Here's Why: *it's small and portable (23 lbs); precise (0.1%); contains 10 amplifier channels; is reasonably priced (\$1200-\$1800) and convenient. By repatching, you can use it in the lab as a versatile signal generator, for data reduction or signal conditioning at test sites, and as a general purpose computer in the classroom, field, or at your desk.*

As A Computer—Up to three 3500's can be slaved together, giving big, 30 amplifier computer performance in a small package. Chopper stabilized amplifiers and 0.1% computing components assure high precision over full 100 volt range. A complete line of accessories lets you solve non-linear equations or equations with non-constant coefficients. For teaching, a single 3500 can be used simultaneously by two groups of students without mutual

interference. Two detachable problem boards, each controlling half the computer, replace the standard problem board for this purpose.

As A Signal Generator—Re-programming the problem board converts the 3500 to a signal generator, simultaneously forming sine, cosine, square and triangular waveforms of high precision. You can also use the 3500 as a constant current or constant voltage power supply and a low frequency wave analyzer.

For Data Reduction—The 3500's amplifiers are easily programmed at the problem board for signal conditioning or data reduction. By simply removing a few screws, the problem board tilts up for mounting the 3500 in the instrumentation rack. Remote control feature allows data to be controlled at the test site.

Want More Information? *Your nearby Donner engineering representative will be happy to give you complete information on the 3500 and arrange a demonstration. Or you may write Department 36.*

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA MULberry 2-6161

210

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 μ sec, 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.

When it comes to SEMICONDUCTOR

For the most complete line of solid state devices...

- Westinghouse has perfected the widest selection of rectifiers, transistors, and special semiconductor devices available in the industry. In Silicon power rectifiers, Westinghouse is acknowledged leader in the field.

For the most dependable semiconductor devices...

- Every Westinghouse semiconductor device has been carefully designed, manufactured, and thoroughly tested to assure long life, high reliability, and excellent stability.

For true voltage ratings in silicon power transistors...

- Only Westinghouse 2N1015 and 2N1016 silicon power transistors offer true voltage ratings, guaranteed by 100% power testing—means they may be operated continuously at the V_{CE} listed provided the power dissipation of the transistor does not exceed. Other conventional power transistors derate the V_{CE} voltage under comparable conditions.

For new and unusual ideas in semiconductors...

- Westinghouse is constantly pioneering in exciting new semiconductor devices. Among the latest: a new 50 ampere "TRINISTOR" controlled rectifier; new thermoelectric cooling devices; an extremely rapid and sensitive infrared detector.

For quality, reliability, performance, and availability...

- Come to Westinghouse! For more information call your Westinghouse representative or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pa.

YOU CAN BE SURE...IF IT'S **Westinghouse**
Westinghouse Semiconductor Department, Youngwood, Pa.

●Westinghouse Trademark

Come in 4 and 5-digit models



Available in 4 and 5-digit models, types HTCcZ4E and HTCcZ5E 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

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.
		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.
		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.
		1N1660 SERIES	50-500 V.	160 A @ 125°C. CASE	2000 AMPS.
		1N1670 SERIES	50-500 V.	240 A @ 125°C. CASE	3000 AMPS.
		439 SERIES	50-600 V.	240 A @ 125°C. CASE	3000 AMPS.

GERMANIUM TRANSISTORS



	Class	Typical Operation			Maximum Ratings			
		I _{CEO} 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

2N1015 SERIES—2 AMP.



2N1016 SERIES—5 AMP.

Type	h _{FE} or h _{FE}	f _{mc}	V _{CE} Volts	I _C Amps	T _J °C
NPN	10 (V _{CE} =4 V I _C =2 A)	ALPHA CUTOFF .300	30-200	7.5a	150
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.	Reverse Blocking Voltage @ 125°C T.	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.
812	TYPICAL LIMIT 5x10 ⁻¹¹ 10 ⁻¹⁰ MAX.	1-12	TYPICAL LIMIT 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.

CIRCLE 94 ON READER-SERVICE CARD



TIROS relies on LAMBDA reliability

Standard Lambda Regulated

Power Supplies have again been selected for a job where reliability and quality are of vital importance. They power the ground equipment in the primary and back-up stations that control and track America's newest missile—TIROS.

In TIROS as in SAGE, Digital Computer Intervention and Display System and other leading electronic projects, Lambda Power Supplies are specified because Lambda equipment has consistently proven its reliability.

This same Lambda quality is the reason Lambda Power Supplies are consistently selected *first* by engineers in independent surveys. To find out more about Lambda Supplies, which are guaranteed for a full five years, send today for the Lambda Catalog. It gives data on Lambda's complete line of tube models ranging up to 525 VDC and transistor models up to 10 Amps.



The Tiros System

Sponsored: National Aeronautics and Space Administration
 Technical Direction: U. S. Army Signal Research and
 Development Laboratory
 Developed and Built: Astro- Electronic Products Division,
 Radio Corporation of America

LA104

LAMBDA ELECTRONICS CORP.

11-11 131 STREET • DEPT. 2 • COLLEGE POINT 56, N. Y. • INDEPENDENCE 1-8500

CIRCLE 89 ON READER-SERVICE CARD

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 ac. Terminal styles are solder hole, turret, and double tur-

ret. The basic switch meets the requirements of MIL-S-8743 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

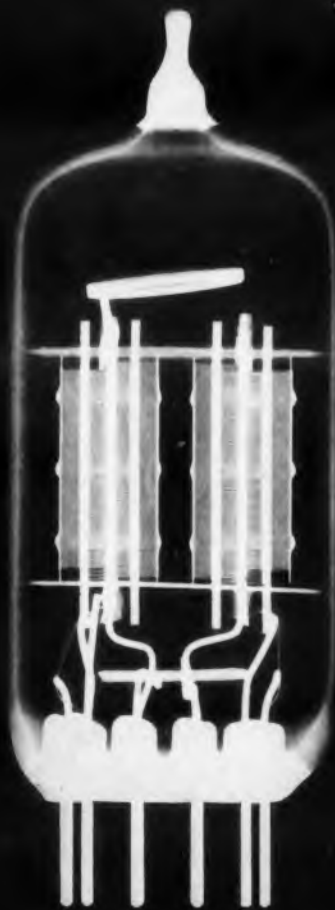
Come in two designs

Used to isolate airborne equipment from high-intensity environments, these two designs of electronic mountings together compose 15 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 1. 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.

RCA Presents the Versatile



...A NEW LOW-NOISE TWIN TRIODE

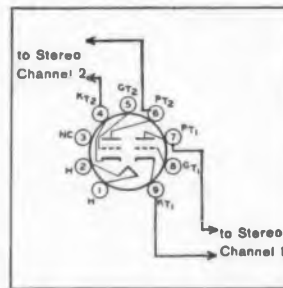
to improve performance and simplify the design of Audio Pre-Amplifier Stages

Low noise, high performance, moderate cost—provided by the new RCA-6EU7, a high-mu, nine-pin miniature twin triode designed especially for high-gain, resistance-coupled, audio pre-amplifier stages—in high fidelity amplifiers (monaural or stereo), amplifier kits, tape recorders, juke boxes, and public address systems.

Noise and hum are minimized by the use of double-wound, helical heaters, and a new base layout which keeps heater leads well away from the grid leads.

Low microphonism, high mechanical strength, and reliability are assured by a short, rugged cage which provides sturdy support for the tube electrodes.

New base arrangement also simplifies stereo layouts. The accompanying diagram shows how the basing arrangement facilitates the design of an amplifier using the two triode units for isolated stereo channels.



For technical information, contact the RCA Sales Representative at our office nearest you, or write directly to RCA Electron Tube Division, Commercial Engineering, Section E-18-DE, Harrison, New Jersey.

EAST: 744 Broad Street, Newark 2, N. J. **HUMboldt:** 5-3900. **MID-WEST:** Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill. **WHitehall:** 4-2900. **WEST:** 6355 E. Washington Blvd., Los Angeles 22, Cal. **RAYmond:** 3-8361.



The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA



from copper and steel . . .

from wire, strip, and bar stock . . . to . . .

COMPLETE SERVO ASSEMBLIES

We are not an assembly station. We are a manufacturer!

Steel and copper come into our factory. Housings are turned and gears are hobbled from the solid stock. Laminations are stamped from strip steel. Copper is wound right off the reel.

Every operation between raw stock and servo assembly is performed in our own plant, under our own supervision. And because we exercise this complete control over manufacture, we can honestly vouch for the quality and reliability of every motor, generator, synchro, and gear train carrying our name.

Undivided responsibility isn't a new idea by any means, but it is increasingly difficult to find in this age of overspecialization. If you'd care to sample the benefits of this integrated approach, why not call on us now?



SERVO ASSEMBLY - Type 9 motor generator driving two Type 11 CT synchros through a slip clutch and a gear train having ratio of 1500 to 1.

DAYSTROM, INCORPORATED

TRANSICOIL DIVISION

WORCESTER • MONTGOMERY COUNTY • PENNSYLVANIA

NEW PRODUCTS

Variable Resistance 423 Transducer

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

Weights 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 -60 to +250 F. Resonant frequency is

◀ CIRCLE 96 ON READER-SERVICE CARD

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 mg

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.

keep an
accurate
graphic
record

OF RESEARCH, DESIGN,
TEST DATA

two channels



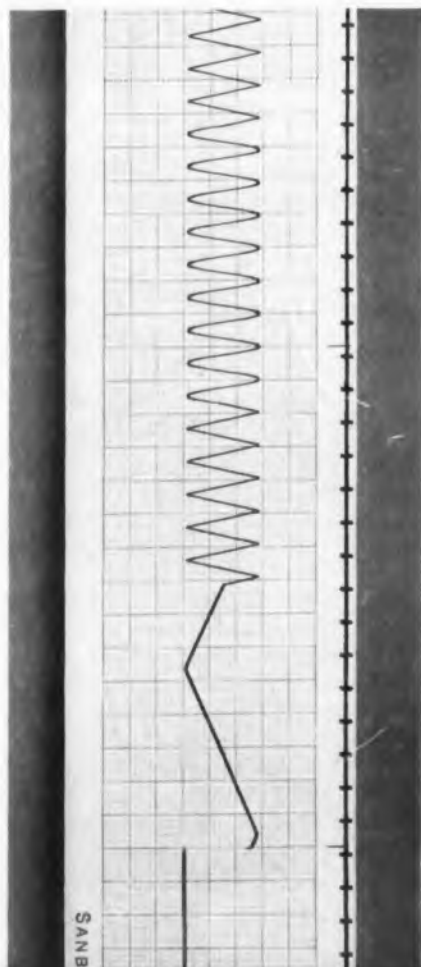
For General Purpose DC Recording — Model 320

For recording two variables simultaneously, the Model 320 provides a versatile, transistorized amplifier for each input signal. The rugged 2-channel recorder assembly has heated stylus recording on two 50 mm wide rectangular coordinate channels, 4 pushbutton chart speeds, and 6 inches of visible chart. The Recorder can be placed vertically, horizontally or at a 20° angle.

MODEL 320 SPECIFICATIONS

Sensitivity: 0.5, 1, 2, 5, 10, 20 mv/mm and v/cm
Frequency Response: 3 db down at 125 cps, 10 mm peak-to-peak
Common Mode Voltage: \approx 500 volts max.
Common Mode Rejection: 140 db min. DC
Calibration: 10 mv internal \approx 1%
Output Connectors for each channel except external monitoring 'scope or meter
Price: \$1495

NEW SANBORN PORTABLE DIRECT WRITING RECORDERS FOR IN-PLANT, LABORATORY OR FIELD RECORDING



Two models of this 21 lb. brief case size recorder are available — Model 301 for AC strain gage recording, Model 299 for general purpose DC recording. Both provide immediately visible, inkless traces by heated stylus on 40 division rectangular coordinate charts . . . frequency response to 100 cps . . . 5 and 50 mm/sec chart speeds . . . approx. 4 inches of record visible in top panel window.

single channel

MODEL 301 SPECIFICATIONS

The amplifier section of the Model 301 is an all-transistorized carrier type with phase sensitive demodulator. The power supply and internal oscillator circuits are also transistorized.
Sensitivity: 10 uv rms/div (from transducer)
Attenuator Ratios: 2, 5, 10, 20, 50, 100, 200
Carrier Frequency: 2400 cps internal
Transducer Impedance: 100 ohms min.
Calibration: 40 uv/volt of excitation
Output Connector: for external monitoring 'scope or meter
Price: \$750

MODEL 299 SPECIFICATIONS

Combines the dependability of transistors with the high input impedance of vacuum tubes for reliable broad-band DC recording.
Sensitivity: 10, 20, 50, 100, 200, 500 mv/div and 1, 2, 5 and 10 v/div
Input Resistance: 5 megohms balanced each side to ground
Common Mode Voltage: \approx 2.5 volts max. at 10 mv/div sensitivity increasing to \approx 500 volts max. at other sensitivities
Common Mode Rejection: 50:1 most sensitive range
Calibration: 0.2 volt internal \approx 1%
Output Connector: for external monitoring 'scope or meter
Price: Model 299 (with zero suppression) \$700
Model 299A (without zero suppression) \$850

All prices are F. O. B. Waltham, Mass., within continental U. S. A. and are subject to change without notice.

Contact your Sanborn Sales-Engineering representative for complete information, or write the main office in Waltham. Sales-Engineering representatives are located in principal cities throughout the United States, Canada and foreign countries.

SANBORN  **COMPANY**

INDUSTRIAL DIVISION
175 Wyman Street, Waltham 54, Mass.



**8 major missile systems
now rely on American-Standard
AIR-MOVING UNITS**

Military or commercial application, you can choose from many unit sizes and designs to prevent breakdowns from self-generated heat in sensitive electronic equipment. All can be modified; or new units built to your requirements. Write, detailing your needs, or send for Bulletin 5412. American-Standard* Industrial Division, Detroit 32, Michigan.



A twin fan unit which combines high volume, lightweight construction, and minimum size.

*American-Standard and Standard are trademarks of American Radiator & Standard Sanitary Corporation



AMERICAN-Standard
INDUSTRIAL DIVISION

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CIRCLE 98 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 programmer 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 job 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.

When you want 'em ... you've got 'em!

Good-All
CAPACITORS

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450 Narberth Ave. Narberth, Pa.

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ELECTRONIC DESIGN • May 11, 196

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.

GOOD-ALL 601PE

CAPACITORS

"fit" like a disc
PLUS...



...Temperature STABILITY

Identical to high quality tubular capacitors and far superior to that attainable with high capacity discs.

MILITARY APPLICATIONS—Widely used in military equipment; also well suited to high quality civilian instrumentation where space is critical.

Tailored for TRANSISTORS

Wafer-thin shape..permits great flexibility in tight chassis layouts. The 601PE is competitive in price with ceramic discs in the range of .1 MFD and above.

SPECIFICATIONS

Insulation Resistance—Greater than 75,000 megohms when measured at 100 volts D.C. at 25°C. for a maximum of 2 minutes.

Capacity Tolerance—Standard tolerance is 20%.

Winding Construction—Extended foil (non-inductive) MYLAR Dielectric.

Lead Variations—Formed or straight leads.

Dissipation Factor—Less than 1% at 1,000 cycles per second at 25° C.

Dielectric Strength—100 volts D.C. for 1 to 5 seconds through a minimum current limiting resistance of 100 ohms per volt.

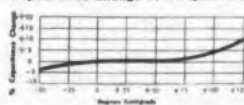
Temperature Range—May be operated at full rated voltage to 85° C. Derate to 50% when operating at 125° C.



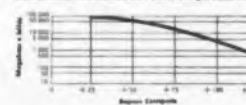
DIMENSIONS 50 VDC Rating

CAP. (MFD)	A	E	F
.01	.310	.187	.562
.022	.359	.187	.562
.047	.531	.191	.406
.068	.531	.203	.453
.1	.531	.218	.500
.15	.650	.235	.525
.22	.671	.260	.650
.33	.728	.306	.687
.50	.812	.312	.750

Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



TYPE 602 with
PLATFORM
BASE also
available



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Write for detailed literature



GOOD-ALL ELECTRIC MFG. CO. OGALLALA, NEBRASKA

CIRCLE 100 ON READER-SERVICE CARD

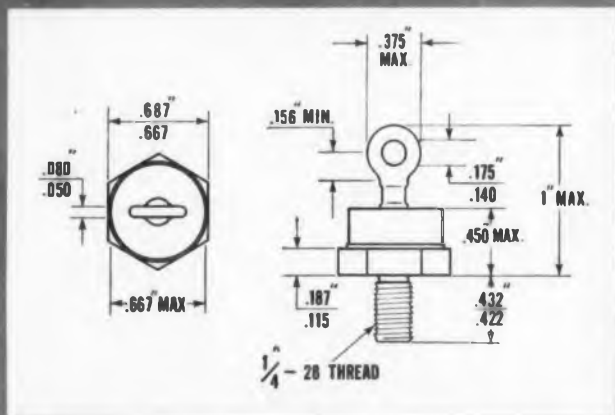
MORE NEWS ABOUT SILICON POWER RECTIFIERS

The NEW Fansteel 35 AMP.



1N SERIES TYPE 4B

1N 1183	1N 1185	1N 1187	1N 1189
1N 1184	1N 1186	1N 1188	1N 1190



Full 35 amp. load in half-wave circuits; up to 105 amps in bridges. Operating temperatures up to 190°C junction temperature. Peak reverse voltages 50 to 600 V. Storage temperatures from -65°C to +175°C.

Also available to meet Military Specifications MIL-E-1/1135 (USAF)

Write for complete technical data

FANSTEEL

where reliability
dictates standards

E604A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 101 ON READER-SERVICE CARD

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 \$8 when ordered in quantities of 500.

Relays 437

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 μ v. 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 MI-PM368, which measures 4-1/4 in. in diameter and 2-1/4 in. in length, and the larger model PMI-M488, 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 Sea 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-M 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 98 has a 1.5-mil backing and type 99 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, 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 μ sec. This unit can also be used for all general purpose logical operations. The highly stable crystal clock produces a 40- μ sec, 2.5-v pulse every 100 μ sec. 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

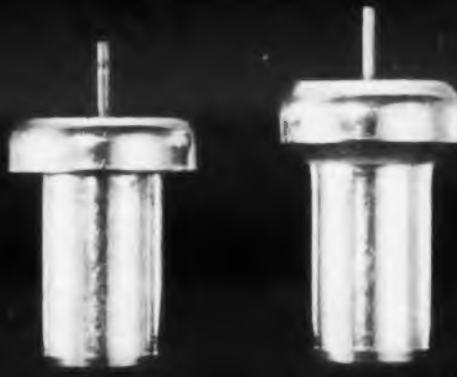
This electronic gear tester uses a recorder which can be calibrated to any ratio within the limit of recording tape. Gears can be checked in pairs or against a master gear. A master gear for each pitch is required together with a driving gear of the same pitch for the driving motor.

Scherr-Tumico Co., Dept. ED, 200 Lafayette St., New York 12, N.Y.

PROOF!

THAT FANSTEEL'S SHOULDER AND CURL DESIGN* PROVIDES THE BEST METHOD OF SEALING A TANTALUM ELECTROLYTIC CAPACITOR

*Pat. No. 2,744,217



This unretouched photo (twice actual size) shows a Fansteel "PP" type tantalum capacitor before and after being subjected to internal pressures of 600 psi. As shown, the test resulted in a stretching and deformation of the silver case, but no failure or leakage whatsoever in the seal.

What Every Designer and Engineer Should Know About This Seal



The shoulder and curl design of the silver case results in a spring action on the seal assembly at all times... and this downward pressure and tension remains constant throughout the capacitor's temperature range. Two gaskets—one above, one below the tantalum disk—create an air space, the only effective barrier against capillary action. Part of the upper gasket is formed into the curl for a perfect seal between case and gasket unaffected by varying temperatures. All gasket materials are carefully selected and controlled in their parameters so as not to interfere with the curl's spring action. There can be no loosening of this seal due to compression set. This is a perfect tantalum capacitor seal; it is a part of every Fansteel tantalum electrolytic capacitor.

Write for latest technical bulletins

FANSTEEL

where reliability dictates standards

C604A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U.S.A.

CIRCLE 102 ON READER-SERVICE CARD

MEASURES
VERY LOW
FREQUENCY
DOWN TO
0.05 cps

...or to
0.01 cps
with
corrections

BALLANTINE ELECTRONIC VOLTMETER

Model 316
Price: \$330.



— Since 1932 —

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Boonton, New Jersey

CHECK WITH BALLANTINE FIRST FOR LABORATORY AC VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC DC AND DC AC INVERTERS, CALIBRATORS, CALIBRATED WIDE BAND AF AMPLIFIER, DIRECT-READING CAPACITANCE METER, OTHER ACCESSORIES.

CIRCLE 103 ON READER-SERVICE CARD

FREQUENCY RANGE
0.05 cps to 30 KC, down to
0.01 cps with corrections

VOLTAGE RANGE
0.02 to 200 volts Peak-to-Peak

ACCURACY
3% throughout all ranges and
for any point on meter scale.

INPUT IMPEDANCE
10 megohms with average
capacitance of 30 μf .

RESPONSE
Peak-to-Peak.

FEATURES:

- Minimum pointer "Flutter" down to 0.05 cps.
- Reset switch for rapid measurements.
- Only one period of wave required for stable reading.
- Single logarithmic voltage scale and linear decibel scale.

Write for catalog
for complete information

NEW PRODUCTS

Transistor Tester

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.

559

... certain.

MAJOR MERGER IN SWITCH INDUSTRY

Controls Company of America Merges Hetherington Div. With ElectroSnap Corp. to form New Control Switch Division.

One of the precision switch industry's most complete product lines has come into existence with the announcement by Louis Putze, President of Controls Company of America, Schiller Park, Ill., that its subsidiary Hetherington, Inc., has been merged with ElectroSnap Corporation, Chicago. The ElectroSnap organization was recently merged with Controls Company of America.

"This merger is important to switch users", Mr. Putze stated.

WHAT'S IN IT FOR YOU?

You may now select from the industry's most versatile and complete line of precision snap-action switches, indicator lights, push-button switches, toggle switches, Switchlites, and environment-free limit switches. You can now make broader product groupings for greater quantity discounts. With this new single source, you will now deal with just one sales engineer for all your switch needs.

Three plant locations—Folcroft, Pa., Chicago, Ill., and El Segundo, Calif.—will provide regional engineering and manufacturing facilities to speed delivery and service.

Local sales offices with factory-trained personnel have been set up to provide on-the-spot application engineering in all major markets. An expanded nation-wide distributor organization will assure you of immediate delivery from local sources.

**ELECTROSNAP
HETHERINGTON**

CONTROL SWITCH
DIVISION

CONTROLS COMPANY OF AMERICA
4218 W. Lake Street • Chicago 24, Illinois
Telephone: VAn Buren 6-3100 • TWX No. CG-1400

CIRCLE 104 ON READER-SERVICE CARD

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.

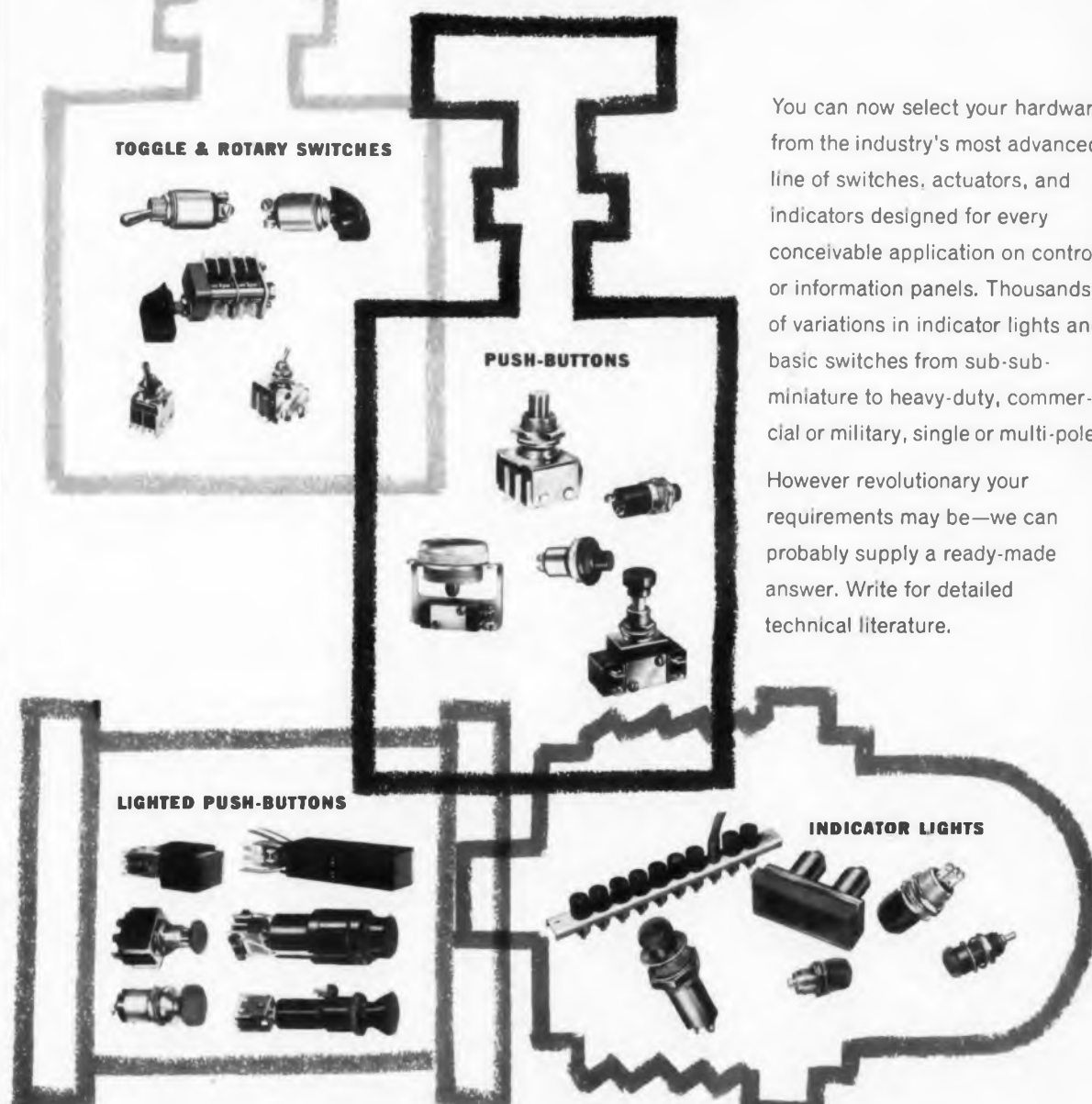
Price & Availability: Available from stock. Can be delivered 2 days after order received. Price is \$3.25 per unit; \$2.85 in quantities of 7 to 12; \$2.40 in quantities of 50 to 99.

LOOKING FOR

PANEL SWITCHES?

CONTROL SWITCH DIVISION

offers you the most versatile and complete selection anywhere



You can now select your hardware from the industry's most advanced line of switches, actuators, and indicators designed for every conceivable application on control or information panels. Thousands of variations in indicator lights and basic switches from sub-sub-miniature to heavy-duty, commercial or military, single or multi-pole.

However revolutionary your requirements may be—we can probably supply a ready-made answer. Write for detailed technical literature.

TOGGLE & ROTARY SWITCHES



PUSH-BUTTONS



LIGHTED PUSH-BUTTONS



INDICATOR LIGHTS



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TOGGLE & ROTARY SWITCHES
246

PUSH-BUTTON SWITCHES
247

INDICATOR LIGHTS
248

LIGHTED PUSH-BUTTONS
249

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WHICH LOOK-ALIKE HAS



Item "B"—The Littelfuse Miniature Fuse Extractor Post #342012.



Examine these features and learn why PDQ* is important in fuse extractor post design.

- 1 Test prod hole in knob—light tap by prod removes flash.
- 2 Knurled knob for sure grip.
- 3 Constant-tension beryllium copper coil and leaf springs for positive pressure contact.
- 4 Quick change bayonet lock.
- 5 Shortest behind panel length (1-11/32").
- 6 Double flat prevents turning and facilitates positioning.
- 7 One piece side terminal and top fuse contact—no soldered or welded joints, low voltage drop.
- 8 One piece knife edge bottom contact for low voltage drop.
- 9 Terminals designed for easy soldering.
 - High resistance to vibration and shock.
 - Molded of high impact Bakelite.
 - Conserves valuable behind panel space.
 - Can be modified to meet many military applications.
 - Standard posts meet MIL-P-14E type CFG.

Complete specifications available on request. Write to:

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Design Know-how
Quality Craftsmanship

LITTELFUSE
DES PLAINES, ILLINOIS

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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 28 v fixed phase and 40 v control phase, and rotor inertia is 0.47 g-cm². Impedances are 230 deg, 190 + j131 for the 28-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.



VERSATILE MULTI-RANGE METER TESTER

Model M-2

... POWER SUPPLY ... LIMIT BRIDGE

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds 1/4% (current), 1/2 ohm or 1/2% (resistance). For 115V, 60 cycle AC. Complete — needs no accessories. Bulletin on request. Marion Instrument Division, Minneapolis-Honeywell Regulator Co., Manchester, N. H., U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario.

Honeywell

PIONEERING THE FUTURE **H** First in Control SINCE 1889

CIRCLE 107 ON READER-SERVICE CARD

If You Want a Thermostat That's Rugged ...



that operates dependably at settings as low as -40° F. and as high as $+300^{\circ}$ F. ...

G-V's C8 Series of hermetically sealed electrical thermostats is specially designed to meet the difficult operating conditions of electronic and aircraft applications. Operating points, regardless of settings, are not changed by exposure to temperatures ranging from -100° F. to $+300^{\circ}$ F. Shocks up to 150g for 3 milliseconds, vibration of 25g up to 1000 cps, and vibration of 10g up to 2000 cps do not damage these thermostats nor change their setting.

Write for complete technical and application data

G-V G-V CONTROLS INC.
LIVINGSTON, NEW JERSEY

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CIRCLE 105 ON READER-SERVICE CARD

Reliability in volume...

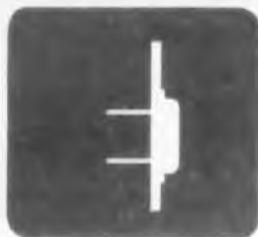


CLEVITE
TRANSISTOR
WALTHAM, MASSACHUSETTS





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

5 ampere

8 ampere

15 ampere

25 ampere

3 ampere Spacesaver

Amplifier Types

2 watt

4 watt

2 watt 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 . . .



Reliability in volume . . .

CLEVITE TRANSISTOR

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The guaranteed
terminal boards ...
made of
certified materials

CAMBION® terminal board materials include paper, cloth, nylon or glass laminates, bonded with phenolic, epoxy, melamine or silicone resins. All stock is strictly top grade — certified — and all boards are made and assembled under strictest quality control. Results are no cracks, strain or chips in boards, no damaged or insecurely mounted terminals. CAMBION board types are standard all-set, miniature all-set, standard ceramic, standard fiberglass and custom-made. Complete boards or separate sections available. Standard or special components assembled as required. For details, write Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Massachusetts.

CAMBION®

The guaranteed electronic components
CIRCLE 109 ON READER-SERVICE CARD

Furane's EPOXY SOLVENTLESS VARNISHES

For Impregnating
Motors, Transformers
and Wire-Wound
Devices



Resistant to acids, JP fuels and Skydrol, Furane's Epoxy Solventless Varnishes are outstanding dielectric materials that penetrate and insulate. Dimensionally stable, 100% solid Varnishes 3-A and 3-B aid in eliminating fire hazards and allow motors to operate at lower temperatures, with resultant greater efficiency, economy and long life.

Low initial viscosity, ability to gel readily at 150° - 200°F., and a pot life of approximately 30 days make Furane's Solventless Varnishes easy and economical to use. Approved on MIL Specs, they have outstanding resistance to both thermal and mechanical shock.

For concise technical information on these and other Furane Epoxies, call or write for Electrical and Physical Properties Chart. On special problems, request our Application Questionnaire for an exact solution.

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DEPT. ED 4516 BRAZIL ST. • LOS ANGELES 39, CALIF. • CHAPMAN 5-1151
CIRCLE 110 ON READER-SERVICE CARD

CIRCLE 105 ON READER-SERVICE CARD

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

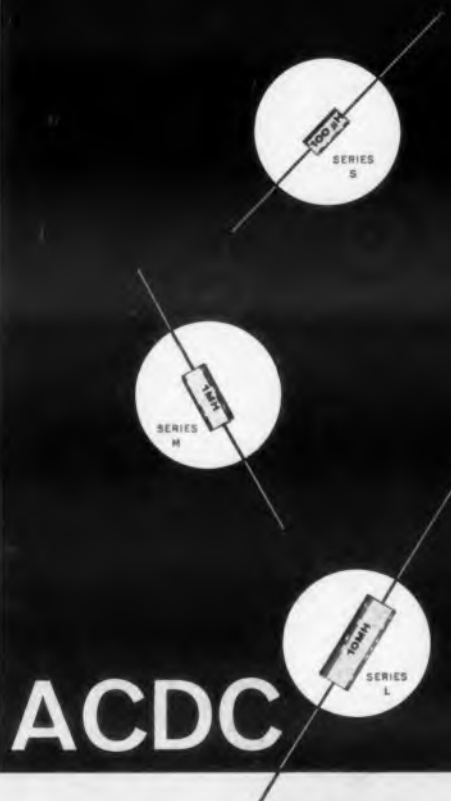
Life is 3000 to 5000 hr



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.

A COMPREHENSIVE
LINE OF 125° C
HIGH RELIABILITY CHOKES



ACDC

small encapsulated
R.F. chokes

100,000 to 1 inductance range. Here is the widest range available — 0.1 μ H to 10 MH!

Miniature to subminiature sizes. For example, a unit with an inductance of 100 μ H measures only .0122 cubic inches.

125°C.—the operating temperature range of these units is -55°C to +125°C.

Excellent environment features. ACDC chokes are epoxy encapsulated for resistance to moisture and immersion. All units are designed to meet MIL-C-15305A, Grade 1, Class B.

Do your application engineering with a minimum of experimental work. New technical and performance data including description of electrical parameters in Bulletin 125-A.

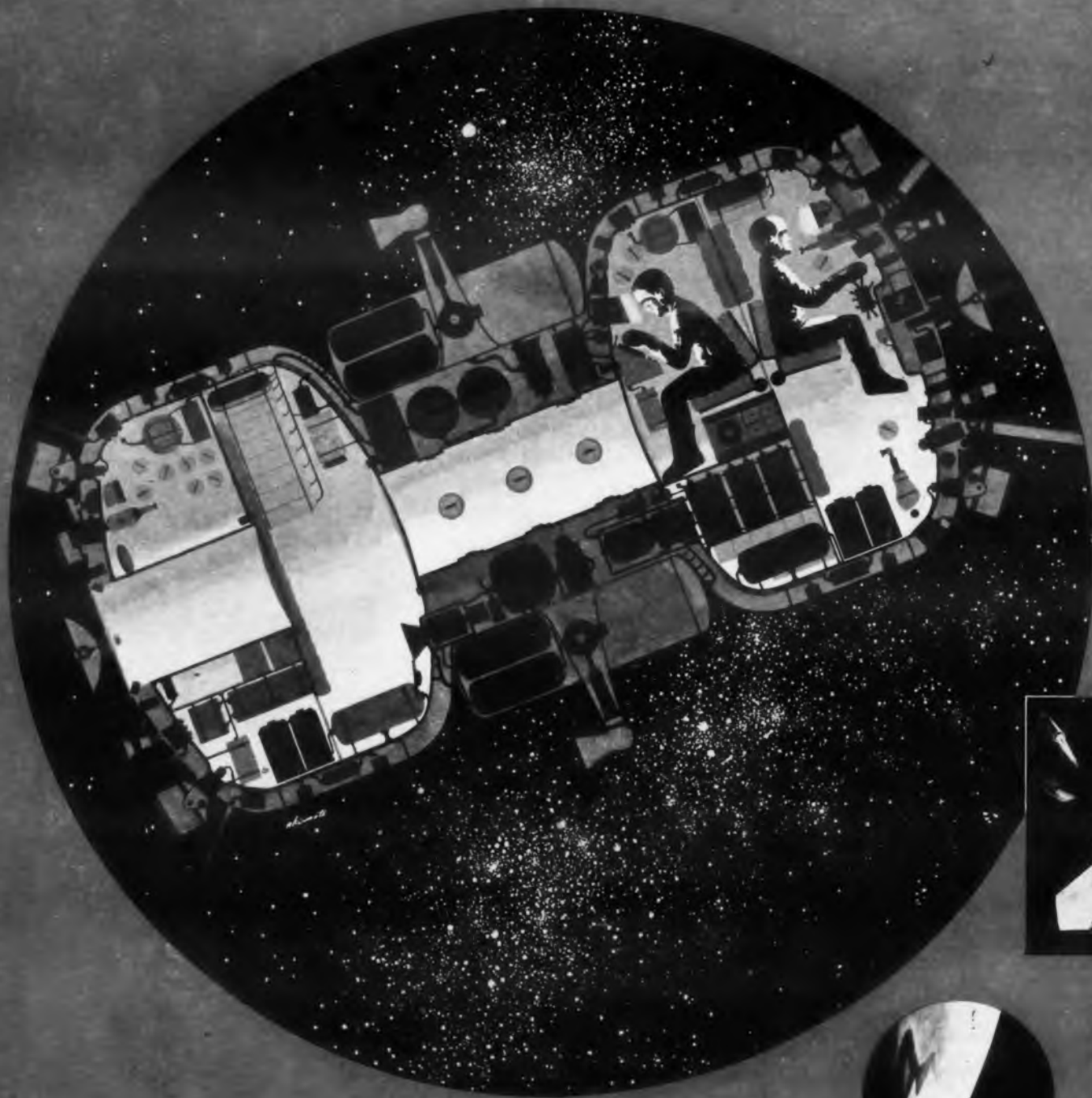
Chokes now available from stock.

ACDC ELECTRONICS, INC.

2979 N. Ontario St., Burbank, Calif.
New name for NYT Electronics

CIRCLE 111 ON READER-SERVICE CARD

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

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII


CIRCLE 902 ON CAREER INQUIRY FORM, PAGE 261



THIS IS YOUR FIRST LOOK AT CEC'S TWO NEWEST CONNECTORS




HIGH-ENVIRONMENT CIRCULAR TYPE designed to meet MIL-C-26500. This is CEC Series 600, 700, 800 for critical altitude, temperature, and reliability requirements of high-performance aircraft, missiles, and space vehicles. Resilient silicon-rubber seals provide liquid immersion resistant assembly. Available with 24, 31, and 55 removable, crimp-type contacts and choice of square flange or jam-nut receptacle mounting. Write for Bulletin CEC 4005-X1.



RACK AND PANEL RECTANGULAR TYPE with die-cast aluminum shell. CEC 500L Series with crimp-type contacts designed to meet MIL-C-26636. Available in 48- and 63-contact configurations with sizes 16 and 20 contacts. Two standard RG58/U coaxial contacts are included in the 48-contact connector. Insulator blocks of both new connectors are high-strength, glass-filled Diallyl Phthalate. Write for Bulletin CEC 4006-X1.

CEC also manufactures a full line of rectangular connectors (Series 500C) which feature snap-in, crimp-type contacts. This series is available in a wide variety of mounting configurations with 26 to 104 contacts. Write for Bulletin CEC 4004-X25.



A complete line of accessory tools for easy crimping, insertion, and removal of contacts is available.

Electro Mechanical
Instrument Division

CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

NEW PRODUCTS

Constant-Current Power Supplies 551

Supply 1 μ a to 500 ma



This series of programable constant-current power supplies covers the range of 1 μ a 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

ARNOLD transistorized power supply



a regulated
lightweight
inverter,
built to
aircraft
and missile specs.

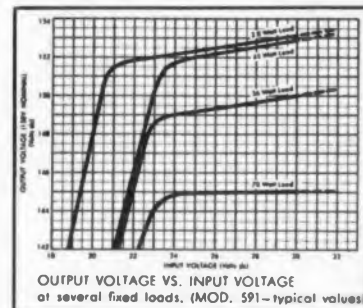
FEATURES

- Constant output voltage as battery discharges.
- 1/5 weight, 1/2 size of comparable dynamotors.
- Withstands short circuit indefinitely.
- Withstands input voltage transients of 70 volts for 0.1 sec. and 60 volts, indefinitely.
- Output voltage drift only 1.5% from -55° to $+71^{\circ}$ C.

SPECIFICATIONS

D. C. OUTPUT Model 591-A
Input Voltage: 24-30 VDC
Output Voltage: Any from 25-1200 VDC
Output Power: 60 watts regulated
Regulation: Line: $\pm 0.5\%$ for 6V variations
Load: $\pm 1.0\%$ for $\frac{1}{2}$ L to FL
Ripple: 0.3% RMS
Size & Weight: 3" OD x 3 $\frac{3}{16}$ " high; 22 oz.

A. C. OUTPUT Model 591-AC
Input Voltage: 24-30 VDC
Output Voltage: 115 VAC, 400 cps, 1 phase
Output Power: 50 V.A. square wave
Regulation: Frequency: $\pm 0.5\%$
(line & load) Voltage: $\pm 2.0\%$
Size & Weight: 3" OD x 3 $\frac{3}{16}$ " high; 22 oz.



Write or phone for literature



**ARNOLD
MAGNETICS
CORPORATION**

6050 W. Jefferson Blvd.
Los Angeles 16, Calif.
VERMONT 7-5313

CIRCLE 115 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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 programmed 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.



new freedom for TV-IF designers thanks to 6 new **Amperex AMPLIFRAME*** tubes

NOW all AMPLIFRAME IF tubes are automatically mass-produced for maximum uniformity and lower cost

NOW Ampliframe tubes will provide 55% higher gain-bandwidth product than conventional IF tubes

NOW compare the performance of Ampliframe tubes with conventional IF types and consider what this added design freedom means to you

IF	GAIN	BANDWIDTH
3 x AMPLIFRAME	3500	4.5 mc
3 x Conventional	3500	2.5 mc
2 x AMPLIFRAME	1200	2.5 mc
2 x Conventional	350	2.5 mc

OUTSTANDING FEATURES SHARED BY THE 6 NEW AMPEREX TV-IF AMPLIFRAME TUBES

- 9-pin construction; 2 cathode leads
- internally shielded
- low microphonics
- internally neutralized screen grid



specifications

AMPLIFRAME Type 6EJ7 sharp cut-off pentode
transconductance—15,000 micromhos at 10mA
grid voltage for 625 micromhos: 9.5 V
heater current 300 mA; heater voltage 6.3V
low capacitances—input 10 μ f; output 3 μ f;
plate to control grid <0.005 μ f

AMPLIFRAME Type 4EJ7
controlled warmup series-version of 6EJ7
heater current 450 mA; heater voltage 4.4 V
AMPLIFRAME Type 3EJ7
controlled warmup series-version of 6EJ7
heater current 600 mA; heater voltage 3.4 V

AMPLIFRAME Type 6EH7 remote cut-off pentode
transconductance—12,500 micromhos at 12mA
heater current 300 mA; heater voltage 6.3 V
AMPLIFRAME Type 4EH7
controlled warmup series-version of 6EH7
heater current 450 mA; heater voltage 4.4 V
AMPLIFRAME Type 3EH7
controlled warmup series-version of 6EH7
heater current 600 mA; heater voltage 3.4 V

*AMPLIFRAME, a new concept in electron tubes, designed and mass produced exclusively by Amperex, incorporate the unique frame grid...the closest approach to the Ideal "Physicists' grid"—electrical characteristics but no physical dimensions. The frame grid results in:
• higher transconductance per milliamperes • tighter G_m and plate current tolerance • low transit time • low capacitances • lower microphonics • rugged construction

ask Amperex



for Ampliframe applications assistance on RF and IF TV circuitry.

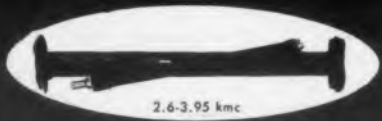
Amperex Electronic Corp.
230 Duffy Avenue
Hicksville, L.I., N.Y.



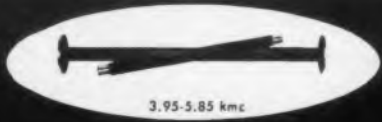
12-250 mc



.02-2.6 kmc



2.6-3.95 kmc



3.95-5.85 kmc



5.85-8.20 kmc



7.05-10.0 kmc



8.2-12.4 kmc



12.0-18.0 kmc



18.0-26.5 kmc



26.0-40.0 kmc

Noise Generators

For Precise Measurement of Noise Figure at all frequencies from 12 mc to 40 kmc.

The AIL Type 70 Series of Noise Generators provide:

- Most complete frequency coverage available
- Secondary standard of relative excess noise temperature
- Useful for both automatic and manual measurements

Broad Selection

- Eight waveguide units covering 2.6 to 40 kmc
- One coaxial unit covering 0.2 to 2.6 kmc
- Two Diode Units each covering 12 to 250 mc
- Relative excess noise temperature: 15.3 db
- Accuracy: ± 0.25 db: 50 ohm output
- Hot-Cold Body Standard available

All gas discharge types utilize an argon tube and have an output of 15.28 ± 0.25 db.

Maximum Usability . . . As your frequency requirements vary, your high standard of quality control may be maintained by merely adding to your selection of AIL Type 70 Noise Generators to cover the additional ranges. This is possible because of the common power and connector requirements on all models.

With the exception of the Type 70 Hot-Cold Body Standard Noise Generator, all models may be powered by the Type 74 Automatic Noise Figure Indicator for continuous automatic measurements or by the Type 71 Power Supply for manual measurements.

Write for complete descriptive literature.

AIRBORNE INSTRUMENTS LABORATORY

DEER PARK, LONG ISLAND, NEW YORK

A DIVISION OF CUTLER-HAMMER INC.

CIRCLE 117 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.



Is there a thinner pressure-sensitive tape that's better-performing... and at a lower cost?

Yes, there is such a tape, and it's made with Du Pont "Mylar"® polyester film. For most applications, tough, durable pressure-sensitive tape of "Mylar" actually cost less, per linear foot or yard, than tapes made of other materials. That's because "Mylar" permits tape manufacturers to use thinner gauges without any loss in performance.

And what about performance? Here are some of the outstanding properties of "Mylar" found in pressure-sensitive tape:

THIN, YET STRONG
... average tensile strength of 20,000 psi.
DURABLE
... under both high and low temperature use.



BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

DU PONT
MYLAR
POLYESTER FILM

FLEXIBLE
... gives snug wrap over irregular surfaces.
HIGH DIELECTRIC STRENGTH
... average 4,000 volts per mil.
DIMENSIONALLY STABLE
... can be used in areas of high humidity.
MOISTURE-RESISTANT
... resists mildew, most chemicals.
RESISTS EDGE FRAYING
... has great tear and impact strength.
RESISTS HEAT AND COLD
... can be used in class B insulation systems.
NO PLASTICIZER
... can't dry out or embrittle with age.
You name the job... electrical insulating, color coding, masking for electro-

plating, harness-wrapping coils... and you're sure to find pressure-sensitive tape of "Mylar" can improve performance while lowering costs. What's more, this thinner tape can help decrease weight and size of finished products without any loss in performance!

Pressure-sensitive tape of "Mylar" can now be obtained in a wide variety of gauges, widths, colors, and with different adhesives. Ask your supplier to help you evaluate all the factors involved in cost and performance of tape made with "Mylar". Or, send today for a list of tape manufacturers and a booklet on properties and applications.

®MYLAR® is Du Pont's registered trademark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)
Film Dept., Room N-14 Nemours Building, Wilmington 98, Delaware.

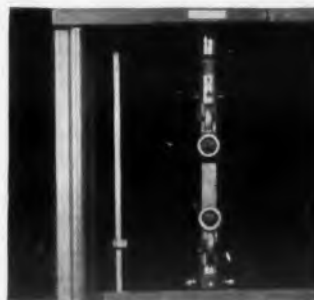
Please send me information on the advantages and uses of pressure-sensitive tape made with "Mylar" (MB-6).

Please send me information on properties, applications and types of "Mylar" available (MB-11).

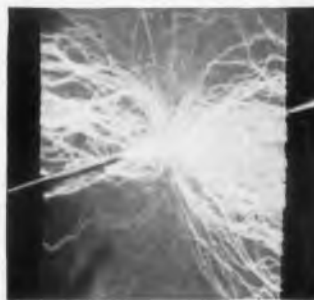
Application _____
Name _____
Firm _____
Address _____
City _____ State _____

CIRCLE 118 ON READER-SERVICE CARD

"MYLAR" offers a unique combination of properties valuable for electrical design



HIGH TENSILE STRENGTH. "Mylar" is the strongest plastic film. Instron tester shows an average strength of 20,000 lbs. psi.

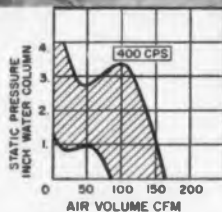


HIGH DIELECTRIC STRENGTH. Average of 4,000 volts per mil... average power factor of 0.003 at 60 cycles.

For 400 CPS Cooling Applications



AXIMAX-3



For airborne and missile cooling applications, the AXIMAX-3 when turning at 20,000 rpm will deliver 165 cfm at free delivery. This performance is possible although the fan is only 2.8" in diameter, 2.3" in length and weighs a mere 14 ounces.

Variation in driving motors include constant speed and Altivar designs. The latter automatically vary their speeds inversely with density and thereby approach constant cooling with a minimum of power drain and noise.

Mounting is simplified by the provision of "servo" clamping rims at either end of the barrel. Airflow can be reversed by turning the fan end-for-end. Electrical connection is made to a compact terminal block. Power requirement is 400 cps, 1 or 3 phase.

Write today for complete technical details to . . .



ROTRON mfg. co., inc.

WOODSTOCK, NEW YORK

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 119 ON READER-SERVICE CARD

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.

Somers

HOT TIN



PLATED



THIN STRIP

for precision
electronic
manufacturing



SMOOTH,
UNCONTAMINATED
SURFACE



READILY
SOLDERABLE,
HIGH ADHERENCE



GUARANTEED FREE
OF BURRS, SLAG, PITS

Somers special process provides pure tin, 80-20 tin-lead and 60-40 coatings of .00002 to .00008 and .0002 to .0003 on Thinstrip[®] copper, brass, bronze, and other alloys from .012" to .002" thin, 1/8" to 1 1/2" wide. Write for confidential data blank or field engineer for analysis of your special problem — no obligation, of course.

FOR EXACTING STANDARDS ONLY



Somers Brass Company, Inc.
116 BALDWIN AVE., WATERBURY, CONN.
CIRCLE 120 ON READER-SERVICE CARD

Telescoping Antenna

For rocket and missile use

678



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

For tuning vhf-uhf circuits

489



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.

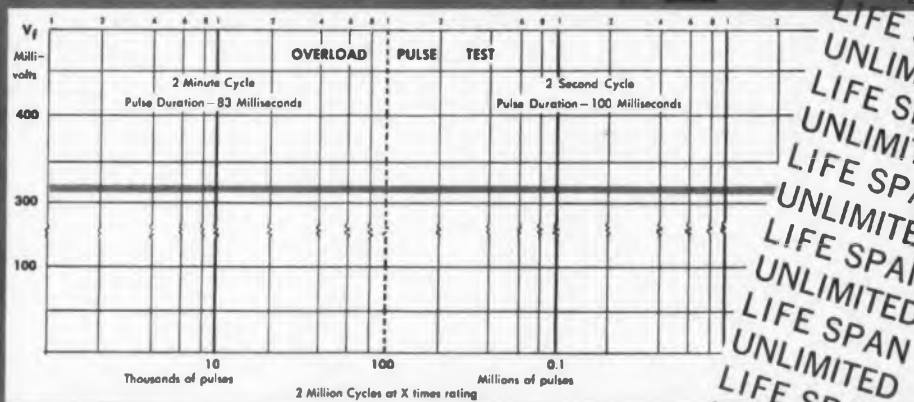
Availability: The unit will be available in small quantities by May.

The only Selenium Rectifier Stack with no artificial barrier layer

ANOTHER ACHIEVEMENT OF GENERAL INSTRUMENT CORPORATION

RADIO RECEPTOR

Tri-Amp



visible proof
of Tri-Amp's
unlimited life span

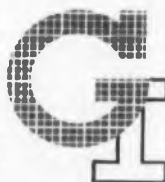
Day after day this life test continues in the Radio Receptor laboratories—with surge currents ten to fifteen times the rating of ordinary rectifiers! Ordinary cells deteriorate when run within rated limits, but Tri-Amp operates at these high current densities without detectable signs of deterioration due to age and usage.

And these results are not confined to tests—in actual performance Tri-Amp proves again and again it is one of the most effective forms of rectification available to modern industry! It has a true P-N junction formed by a closely controlled diffusion process involving the use of cadmium-selenide and tellurium. We'll be glad to send you more complete information on this important development. Write today to Section ED-5

CHECK LIST OF

Tri-Amp SUPERIORITY

- Better overload characteristics.
- High current ratings.
- Lower forward voltage drop.
- No sudden failures.
- No special protective devices required.
- Smaller size.
- Operate in parallel or in series without special precautions.



RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

240 Wythe Avenue, Brooklyn 11, N. Y., EVergreen 8-6000

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY, INC., THE HARRIS TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT—F. W. SICKLES OF CANADA, LTD. (SUBSIDIARIES)

CIRCLE 121 ON READER-SERVICE CARD

NEW

CUT ASSEMBLY TIME IN HALF!



RELIABLE CRIMP ASSEMBLY

RF CONNECTORS

NO SPECIAL TOOLS

WEATHER PROOF

COMPLETE FAMILY

MINIATURE BNC TYPES!

FAST CONNECT & DISCONNECT

SUPERSTRONG CABLE RETENTION

IMPROVED CABLE STRAIN RELIEF

QUICK INSPECTION

PDQ

Now, PDQ RF

LOW VSWR

Availability Lists let IPC customers know current stocking position of every standard RF connector. RF delivery is PDQ from IPC!

AVAILABLE NOW!

INDUSTRIAL PRODUCTS-DANBURY KNUDSEN

a Division of Amphenol-Borg Electronics Corporation

33 East Franklin, Danbury, Connecticut



CIRCLE 122 ON READER-SERVICE CARD

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-



No one is immune to our #1 health problem








Mental illness hospitalizes MORE people than polio, heart, tuberculosis, cancer—all other diseases combined. Outside the hospital 1 in 10 need psychiatric help. Next—let's Conquer Mental Illness!!

Give at the Sign of the Ringing Bell





Hermetic Seal Corp. Glass-to-Metal and Ceramic-to-Metal Seals for *EVERY* Electronic Use!

-  Crystal Bases
-  Vac-Tite Connectors
-  Multiple Headers
-  Diode Closures
-  Transistor Stems
-  Single Lead Terminals
-  Refrigerant Seals

Hermetic Seal Corporation is your prime source for seals in all sizes, terminations and shapes to fit your specifications. Hermetic is the pioneer in this specialized field and the originator of more than 10,000 different seals. Precision quality-control from design, manufacture and precious metal plating is assured.



HERMETIC SEAL CORP.

43 River Road, North Arlington, N. J.
CIRCLE 140 ON READER-SERVICE CARD

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

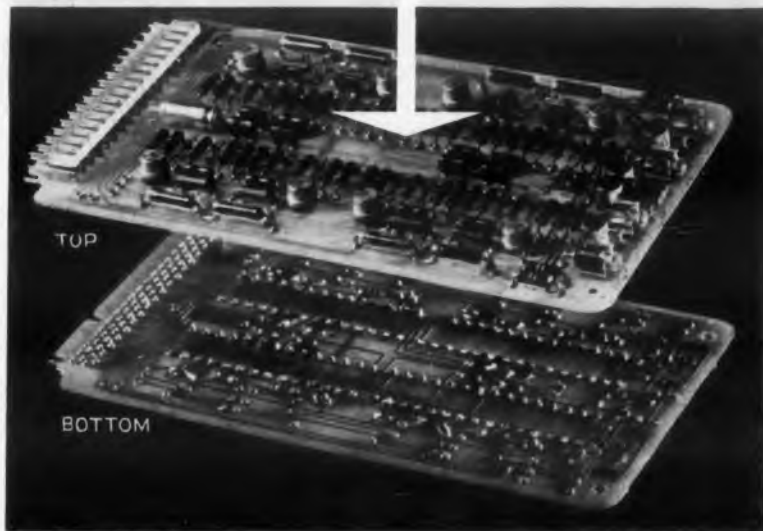
Installed in the circuit of a batch type operation, model 7003 elapsed time controller provides timed, automatic regulation of temperature or pressure. Ranges are 100 F to 1000 F and 30 in. mercury vacuum to 7500 psig. Time ranges are 1, 5, 12, and 24 hr; minimum setting of each timer is equal to 4% 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 >



Enlarged cross section of United Funnel Flange Eyelet showing greater soldered area which lends greater strength.



New United Funnel Flange design improves reliability of soldered connections

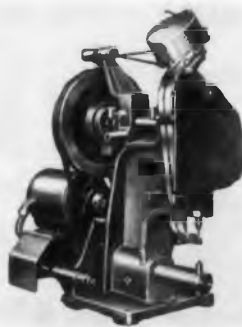
Greater mechanical strength due to greater soldered area of funnel eyelet

WHY UNITED FUNNEL FLANGE EYELETS ARE SUPERIOR . . . The funnel design permits easy insertion of leads. When soldering, the solder fills the funnels and flows around the outside of the eyelet on both sides of the etched circuit. This increases the soldered areas and seals the lead and the funnel eyelet tightly to the circuit. The unique design of the funnel eyelet permits entrapped gases to escape and makes it possible to achieve an unusually solid, dependable connection.

More uniform circuitry is also realized with United Funnel Flange Eyelets which are made from electrolytic copper. This material has a coefficient of expansion in the same order as that of the copper in the etched circuit.

United Funnel Flange Eyelets meet MIL Standard No. 202 for vibration, shock, thermal cycling, and humidity. Wide choice of sizes and lengths meet needs of hole sizes and board thicknesses. Also available in brass. Special plating, and packing to order.

Free: Send us a sample of your board for free insertion of funnel flange eyelets for your testing and evaluation or write for complete specifications of sizes available.



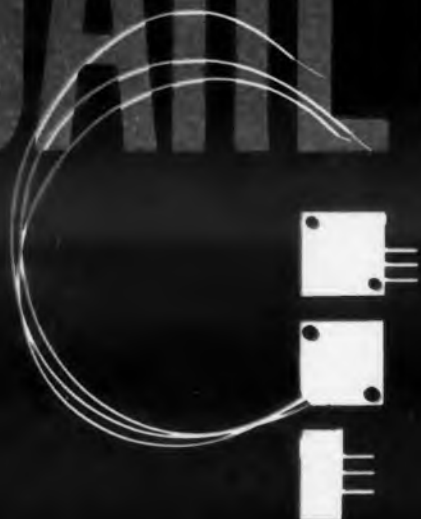
High speed automatic setting of Funnel Flange Eyelets with United Eyeletting Machine Model G.

United
UNITED SHOE MACHINERY CORPORATION

140 Federal Street, Boston, Mass.
Liberty 2-9100

SEE US AT THE DESIGN ENGINEERING SHOW BOOTH 424, NEW YORK COLISEUM, MAY 23-26

SQUARETRIM



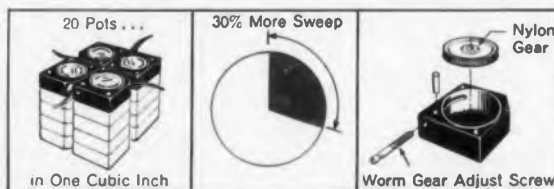
RUGGED, SUBMINIATURE, PRECISION TRIMMERS...

FOR BETTER STACKING... exclusive square shape permits stacking as many as 20 pots in one cubic inch.

FOR MORE ACCURATE TRIMMING... 30% more turns in resistance element plus 45:1 adjustment ratio provides more accurate trimming than possible with conventional trimmer designs.

FOR MECHANICAL AND THERMAL STABILITY... exclusive worm gear adjusting device helps to assure rugged mechanical stability, and unique circular mandrel eliminates expansion-contraction effects for thermal stability.

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.



DAYSTROM, INCORPORATED
PACIFIC DIVISION
9320 Lincoln Boulevard, Los Angeles 45, Calif.



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SQUARETRIM**

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CIRCLE 124 ON READER-SERVICE CARD

◀ 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 8, Ohio.

Price & Availability: Price is \$27 to \$46 for 10,000. Units are in stock.

ONE INTEGRATED SOURCE

for Ceramic-to-Metal Seals



Standard types of Alite high voltage bushings are available in various sizes and configurations.

In all phases of planning for ceramic-to-metal seals—from design to finished assembly—you can rely on ALITE for the know-how and "do-how" required to produce highest quality ceramic-metal components for critical applications.

High alumina Alite is the ideal material for making rugged, high performance hermetic seals and bushings. It has superior mechanical strength, high temperature and thermal shock resistance, plus reliable electrical characteristics. Our complete high temperature metalizing and bonding facilities assure delivery of the finest seals available—mass-spectrometer tested for vacuum-tightness.

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Davilla, Ohio

New York Office
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12F-1

CIRCLE 126 ON READER-SERVICE CARD



To assure the accuracy of Honeywell magnetic heads, gap scatter, gap width, and track to track spacing are checked with this optical measuring microscope to accuracies of 0.00001 in.

Honeywell Custom Drum Heads in the quantities you need . . . the quality you demand



This special head is typical of the designs precision-produced in quantities each week by Honeywell's Industrial Systems Division.

Looking for a reliable high volume source of instrumentation magnetic heads? Honeywell can meet your quantity needs. The Honeywell name assures you the quality you demand for computer, business machine or other precision requirements. Standard analog and digital multi-track heads, and single track drum heads are available. Honeywell, with years of experience in magnetic tape and drum systems, is well qualified to supply heads to meet your specific requirements . . . including read, write, multi-purpose and other high performance heads. Your Honeywell field engineer will be glad to review your requirements and provide you with a quotation and recommendations. Call him today. MINNEAPOLIS-HONEYWELL Regulator Company, Industrial Systems Division, 10721 Hanna Street, Beltsville, Maryland.

75th
PIONEERING THE FUTURE
YEAR

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H First in Control
SINCE 1888

CIRCLE 775 ON READER-SERVICE CARD

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.

Zipertubing 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-3400B, model 7508 magnetic storage drum has 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 480,800, 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

MICRO-MINIATURE CERAMIC CAPACITORS
OFFER A PACKAGE DENSITY
OF 432,000 PARTS PER CUBIC FOOT
excellent for complete assembly encapsulation



actual size

The reliability built into the "VK" Capacitor is a hard, tested fact — backed by the name and reputation of the company that made the "VITRAMON" monolithic porcelain capacitor a synonym for capacitor reliability.

A minutely controlled process, continuous life and environmental testing, plus 100% tests for Dissipation Factor, Insulation Resistance and Capacitance guarantee that each "VK" Capacitor in your circuit will perform as predicted. Pre-production lot-by-lot qualification tests on all materials used, craftsmanship of the highest order and ten years of experience dedicated exclusively to the manufacture of high-reliability capacitors assure that these tiny units will function predictably under the most punishing conditions to which a component of this type is subject

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INCORPORATED

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VK*

CAPACITORS

Square precision molded cases in only two sizes and a single standard 0.2" lead spacing for all values simplify circuit design, guarantee uniformity, facilitate handling, give greater mechanical stability.

The DAPON** resin used in "VK" Capacitor cases assures environmental reliability through every stress to which such components are susceptible.

ENVIRONMENTAL CHARACTERISTICS

Moisture Resistance: Operational in 95% relative humidity at 200 vdc. When tested in accordance with MIL-STD-202A, Method 106, with rated voltage applied, Insulation Resistance is greater than 10,000 megohms at 95% relative humidity. Dissipation Factor is less than 2.5%, and capacity change less than 10% at 25°C and 50% relative humidity.

Temperature and Immersion: When tested in accordance with MIL-STD-202A (with maximum temperature extended to 150°C), Method 102A (test condition C) and Method 104A (test condition B), Insulation Resistance is greater than 10,000 megohms, Dissipation Factor is less than 2.5% and capacity change is less than 10%.

Temperature Shock: "VK" Capacitors show no evidence of electrical damage when subjected to 10 cycles of alternate immersion in silicone oil at 160°C and water at 0°C ($\pm 10^\circ\text{C}$) for a minimum duration of ½ minute each bath.

Vibration: No evidence of physical damage has been found when tested per MIL-STD-202, Method 204 (test condition B) when ¾ in. lead mounted and vibrated for four hours in each of three mutually perpendicular planes (10 cps to 2,000 cps) at 15 G's. **Shock:** When ¾ in. lead mounted and subjected to 3 shocks of one millisecond duration in each of 3 mutually perpendicular planes at 100 G's per Method 202A of MIL-STD-202, "VK" Capacitors show no evidence of physical damage.

Altitude: When tested in accordance with MIL-STD-202, Method 105A (test condition D) requiring a minimum of 100,000 feet, "VK" Capacitors suffer no electrical breakdown at 150% of rated voltage.

Life: Following 1,000 hours at 150°C and 200% of rated voltage, measurements at 1 kc and 25°C show a Dissipation Factor less than 2.5% and an Insulation Resistance greater than 10,000 megohms.

Conforms to requirements of MIL-C-11015B

*Trade Mark

**Trade Mark of Food Machinery and Chemical Corp.



HICKOK Dynamic Beta[®] TRANSISTOR TESTER MODEL 870

Tests transistors as recommended by manufacturers at specified I_c , V_{ce} and I_b • checks Collector Saturation Voltage (V_{ce-SAT}) • provides low voltage, high current tests—excellent for switching transistors • controls provide maximum set-up flexibility combined with speed-engineered layout for volume testing of transistors • Complete with roll chart giving test data for over 1,150 transistors.



HICKOK MODEL 850 TRANSISTOR ANALYZER

Tests under actual circuit conditions and is ideal for use as a "breadboard" in transistor research and experimentation.

The new Hickok Model 870 portable transistor tester—two transistor testers in one—measures large signal DC Beta on power transistors as well as small signal AC Beta on low and medium power transistors. It features variable collector current and collector voltage. (Beta tests are meaningless unless tests are made at specified current and voltage values.) Collector test current is variable up to 2 amperes, permitting Beta measurement on power transistors rated at 5 amperes or more.

Write for complete details and specifications on Hickok Transistor Testers. Ask for Form TT-604.



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THE HICKOK ELECTRICAL INSTRUMENT CO.

10525 Dupont Avenue • Cleveland 8, Ohio
CIRCLE 128 ON READER-SERVICE CARD

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 Macrowave 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.

GUDELACE[®] is engineered for problem-free lacing



It's no accident that Gudelage is the best lacing tape you can buy. Excellent is engineered into Gudelage. A sturdy nylon mesh is meticulously combined with the optimum amount of special microcrystalline wax. Careful selection of raw materials and superior methods of combining them give Gudelage outstanding strength, toughness, and stability. Gudelage is the original flat lacing tape which distributes stress evenly over a wide area. It is engineered to stay flat; it will not stretch out of shape when pulled. Gudelage's nonskid surface prevents slipping, eliminating the too-tight pull that causes strangulation and constricts flow. Durability and dependability make Gudelage your most economic buy with no cut insulation, fingers, or feeling.

Write for Data Book with specifications on Gudelage and Gudebrod's complete line of braided lacing tapes and dial cords—Temp-Lace, Stur-D-Lace and Gude-Glass.

GUDEBROD BROS. SILK CO., INC.

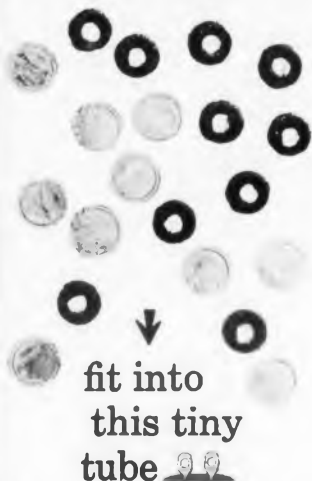
Electronic Division
225 West 34th Street, New York 1, N.Y.

Executive Offices
12 South 12th Street, Philadelphia 7, Pa.

CIRCLE 129 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1964

These 10 toroids
and 10 capacitors



fit into
this tiny
tube



a lumped-constant
delay line only
 $1/10^{\text{th}}$ the size of
equivalent lines

Here's high performance in minimum size. Valor lines are phase and frequency compensated, using sub-miniature toroids for the inductive elements, and temperature-compensating disc capacitors for the capacitive elements. These delay lines exhibit very low distortion and insertion loss. Units are manufactured in large quantities, with characteristics precisely reproducible.

wide range of characteristics

Delay: 0.1 μs to 1 millisecond
Impedance: 25 to 4000 ohms
Rise Time: 30 to 1 delay-to-rise-time ratio, typically

Valor lines are replacing conventional lines up to 10 times the weight and volume. Off-the-shelf deliveries. Bulletin DL-1159.

Valor INSTRUMENTS, INC.
13216 Crenshaw Blvd., Gardena, Calif.

Transistorized Power Supplies and Pulse Generators • Voltage Regulators • Transistor Checkers • Delay Lines • Pulse Transformers.

CIRCLE 130 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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 systems; 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 Ω .

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.

Sealectro PRESS-FIT[®] TEFLON* TERMINALS

reduce costs



Sealectro "Press-Fit" quality assures lower production costs because every terminal is made right from the finest materials and inspected with precise care before it is shipped to you. Every one, every time, works the way it should...PRESS, AND THE JOB IS DONE! No nuts, no bolts, no washers, no rejects due to sloppy parts.

Sealectro, and only Sealectro, goes the limit to assure you the best terminal-in-place. Sealectro maintains a complete customer-engineering service devoted solely to the purpose of guaranteeing you the very best terminations at the lowest possible costs.

THE ONE AND ONLY "PRESS-FIT" TEFLON TERMINAL



Only Sealectro manufactures "Press-Fit" terminals. Proved in more installations than all other teflon-insulated type terminals combined, "Press-Fit" offers you the choice of over 1000 standard configurations, plus choice of 10 EIA colors, and complete design, development and manufacturing capabilities to meet any requirements

WRITE FOR COMPLETE CATALOG...

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139 HOYT STREET • MAMARONECK, N. Y.

PRESS-FIT[®]
TEFLON TERMINALS

CONHEX[®]
RF CONNECTORS

British Branch: Sealectro Corporation,
Marsham Factory Estate, Lyan Road,
Walton-on-Thames, Surrey, England.

CIRCLE 131 ON READER-SERVICE CARD

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 μ sec 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.

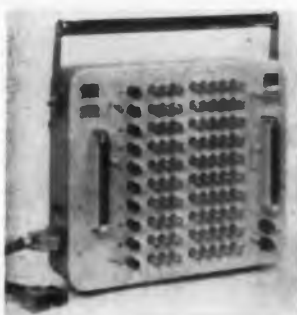
Transistor Specialties, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

Price: \$1450.

Tape Simulator

660

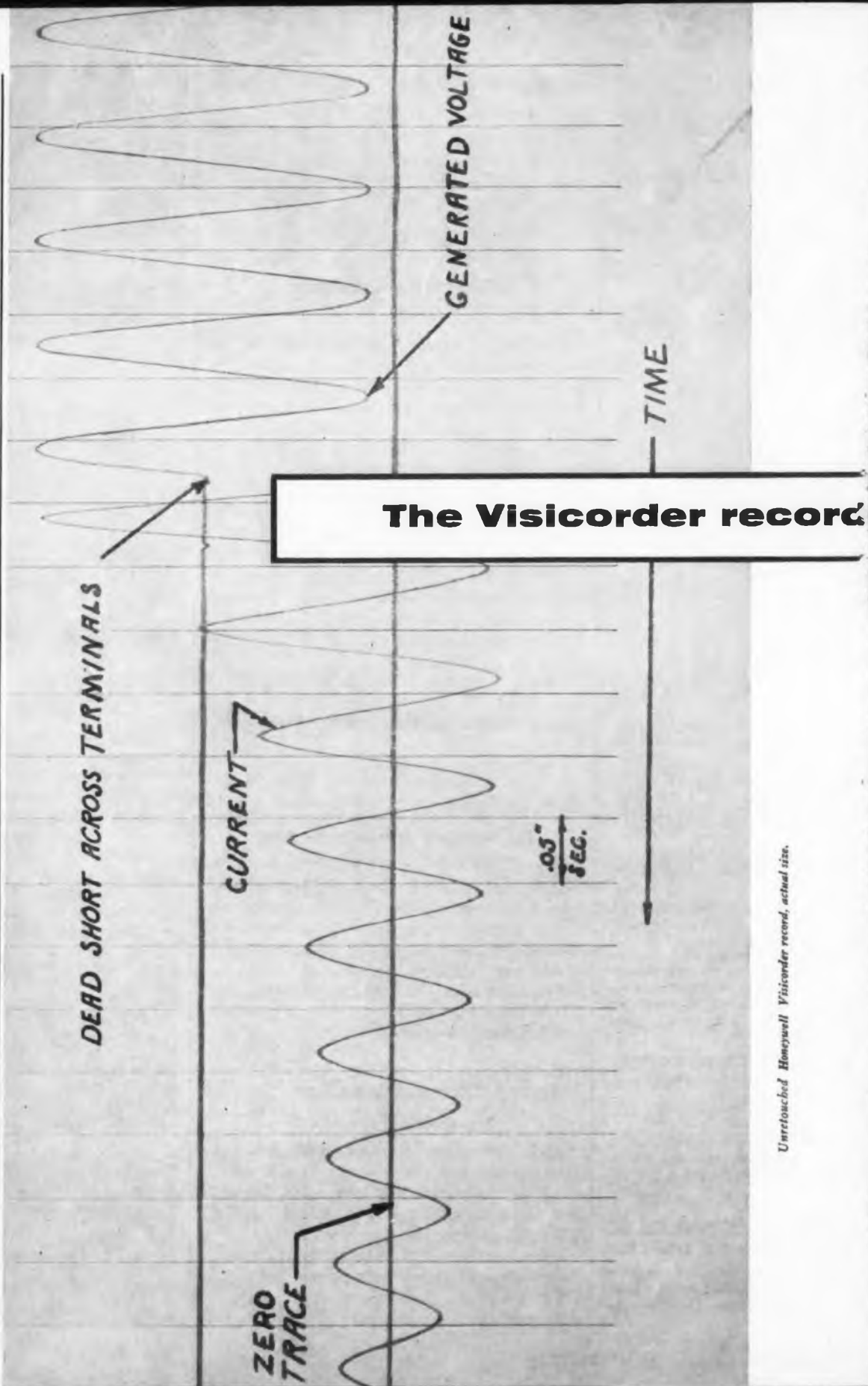
Handles 80 bits



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 check-out 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.



Unretouched Honeywell Visicorder record, actual size.

study of the drop in voltage load on an Allis-Chalmers alternating current generator was directly recorded by a Model 906 Honeywell Visicorder.

This transient reactance test, made by design engineers at the Allis-Chalmers Norwood Works, generator was operated at full voltage, and then a load short was applied to the terminals. When a sudden load is thrown upon a generator, the voltage drops because of the inherent characteristics of the generator. This voltage "nose-dive" is so rapid that a voltage regulator cannot immediately correct the voltage and bring it up to normal. Because of this time delay while the regulator is coming up, motor contacts and other devices on the line may drop out, lights may blink objectionably, and electronic devices may function erratically. For these reasons, these studies of time as related to generator characteristics are very important to better generator design. The Visicorder's ease of operation, calibration, and immediate readability made 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.

Generator voltage load-drop

Honeywell Visicorder is the pioneer, completely proven, and unquestioned leader in the field of high-frequency, high-sensitivity, direct-recording, a-violet oscillography. Here are some of the reasons why Visicorders provide the most accurate log recordings available: constant flat response; sensitivity of galvanometers; grid-lines simultaneously recorded with traces to guarantee exact reference regardless of possible paper shift or linkage; flash-tube timing system for greater accuracy of time lines; superior optics for maximum clarity of traces.

No matter what field you are in . . . research, development, computing, rocketry, product design, control, nucleonics . . . the high-frequency (DC to 5000 cps) Visicorder Oscillograph will save you time and money in data acquisition.

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: write for Bulletins 1108, 1012, and HC906B.

Minneapolis-Honeywell Regulator Co.
Industrial Products Group, Heiland Division
5200 E. Evans Avenue, Denver 22, Colorado



Recent Models of the 906 Visicorder incorporate time lines and grid lines and record up to 14 simultaneous channels of data.



The NEW Model 1108 Visicorder, with many automatic features and the convenience of pushbutton controls, is ideal for intermediate uses requiring up to 24 channels of data.



The Model 1012 Visicorder is the most versatile and convenient oscillograph ever devised for recording as many as 36 channels of data.

Honeywell



Industrial Products Group

75th
PIONEERING THE FUTURE
YEAR

CIRCLE 132 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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.

147

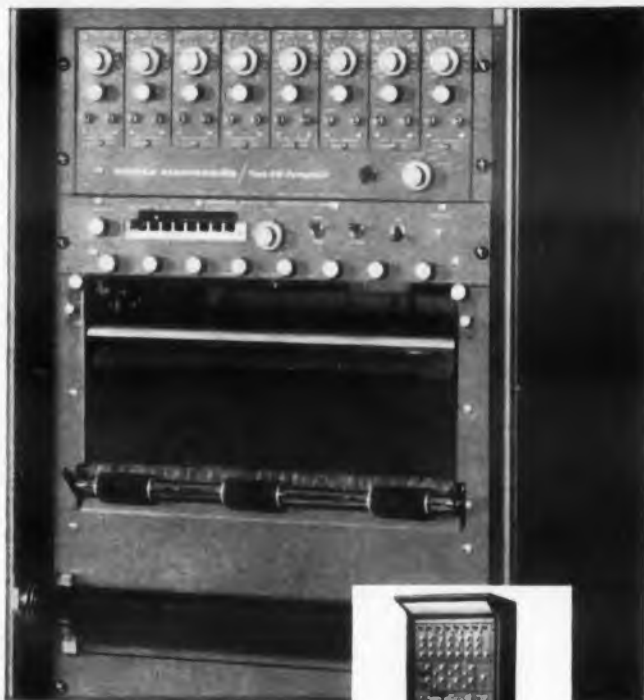
THE OFFNER TYPE
all transistor

RD DYNOGRAPH

**simpler
more economical**

**same performance
same versatility**

**for your low — and
medium gain applications**



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. sensitivity¹.

Frequency Response: To beyond 200 cps, $\pm 10\%$ 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.

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.



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, Moett 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.

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!**

See Transitron at the AFCEA Show, Booths 157-158

VERY FAST SWITCHING MICRO-DIODE			
TYPE	PIV	Er @ 5 MA	RECOVERY TIME
TMD-50	50V	0.75V	4 μ sec
FAST SWITCHING MICRO-DIODE			
TYPE	PIV	Er @ 20 MA	RECOVERY TIME
TMD-24	50V	0.85V	0.3 μ sec
TMD-25	100V	0.85V	0.3 μ sec
TMD-27	200V	0.85V	0.3 μ sec
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	Er @ 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	Er @ 1 MA	DYNAMIC RESISTANCE	
TMD-40	0.55V	60 OHMS	

For further information, write for Bulletin:

PB-71A (High Conductance), PB-71B (Fast Switching),
PB-71C (Very Fast Switching), PB-71D (Stabistor),
PB-71E (Regulators); AN 1358A Application Notes.

Transitron

electronic corporation • wakefield, massachusetts

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DeMambo Radio Supply Co., Inc.
Wagonquin 4-9000

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DeMambo Radio Supply Co., Inc.
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WASHINGTON, Tacoma
C & G Radio Supply Co.
Broadway 3-3181

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CONTACT THE TRANSITRON FIELD OFFICE
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CHICAGO 6641 W. North Avenue, Oak Park, Ill..... Village 8-5556
CLEVELAND 1625 Detroit Avenue, Lakewood, Ohio..... Academy 1-9191
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KANSAS CITY 31st and Trost Streets..... Valentine 1-1819
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electronic corporation
wakefield, massachusetts

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CIRCLE 134 ON READER-SERVICE CARD

CIRCLE 135 ON READER-SERVICE CARD ➤

NO DOUBT ABOUT IT—
"SCOTCH" BRAND Sandwich Tapes
wear 10 times as long without errors

IN THAT NARROW LITTLE LIFELINE OF DATA known as magnetic tape, a miss is magnified into a mile. A missed bit, or one picked up by error is confusing, frustrating and time-consuming. If you're in doubt about the kind of performance you're getting, perhaps "SCOTCH" BRAND Sandwich Tapes can solve some of your tape and equipment problems.

The exclusive construction of the Sandwich Tapes combats the causes of error because it eliminates the source—oxide rub-off and head build-up. Tests prove it wears a minimum of 10 times as long as ordinary tapes before it errs. As a by-product, you can rely on it to drastically reduce maintenance and replacement costs on equipment.

The Sandwich is constructed as shown in the diagram at the right. The famous "SCOTCH" BRAND high potency oxide coating is sandwiched between a tough polyester base and a 50 micro-inch layer of plastic. Since the oxide is never in contact with the head, tape movement is smooth and low in friction—easy on both tape and equipment. Oxide can't rub off and distort valuable data.

Yet, the real meat of this remarkable Sandwich is the "SCOTCH" BRAND high potency oxide coating. Even under the protective plastic, the oxide's potency is quite sufficient to pick up 500 pulses per inch—and give desirable high-frequency response in many AM, FM and PDM applications. Sandwich Tape is but one of the developments to come out of 3M research—the same research responsible for "SCOTCH" BRAND Video Tape—the first video tape in commercial use.

Whatever your application—you'll find the right tape for reliable, error-free performance in the "SCOTCH" BRAND line-up. Check them all. *High Resolution Tapes 158 and 159* pack more bits per inch, offer either standard or extra-play time. *New Heavy Duty Tapes 198 and 199* offer good resolution and exceptional life even in poor environments. *High Output Tape 128* gives top output in low frequencies, even in temperature extremes. And *Standard Tapes 108 and 109* remain the standard of instrumentation.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

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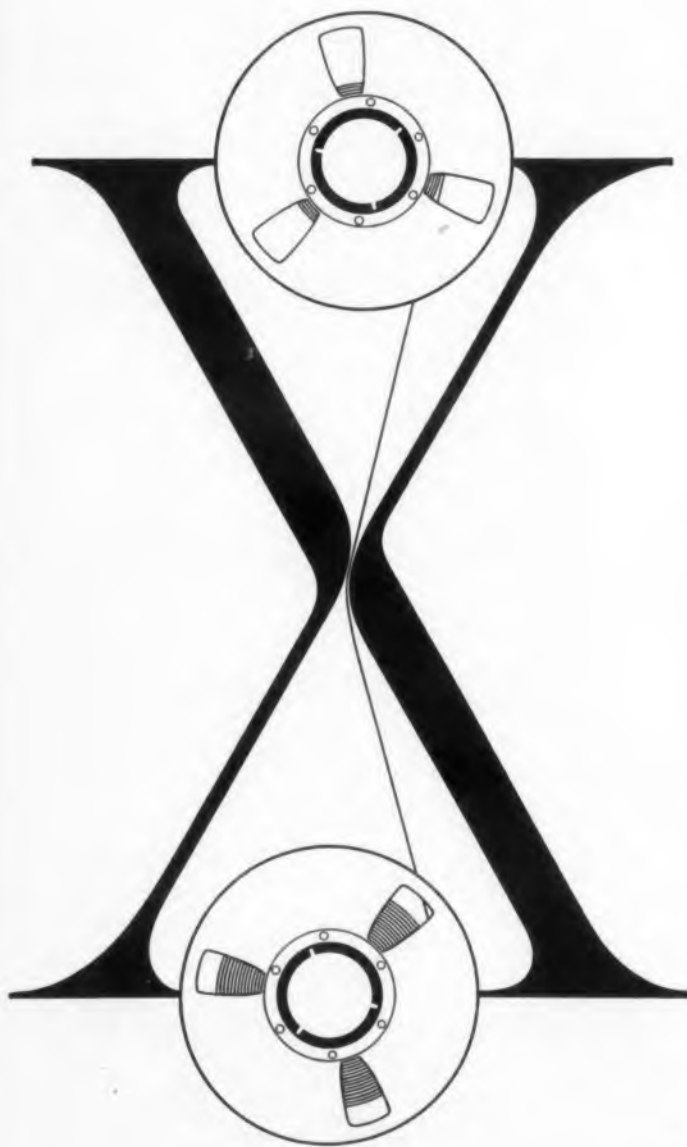
"SCOTCH" is a registered trademark of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario.

SCOTCH BRAND MAGNETIC TAPE
 FOR INSTRUMENTATION

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



PLASTIC PROTECTIVE LAYER



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.

Cerbet Hairspring Co., Dept. ED, Thomaston, Conn.

Opposed-Head Electronic Micrometer

461

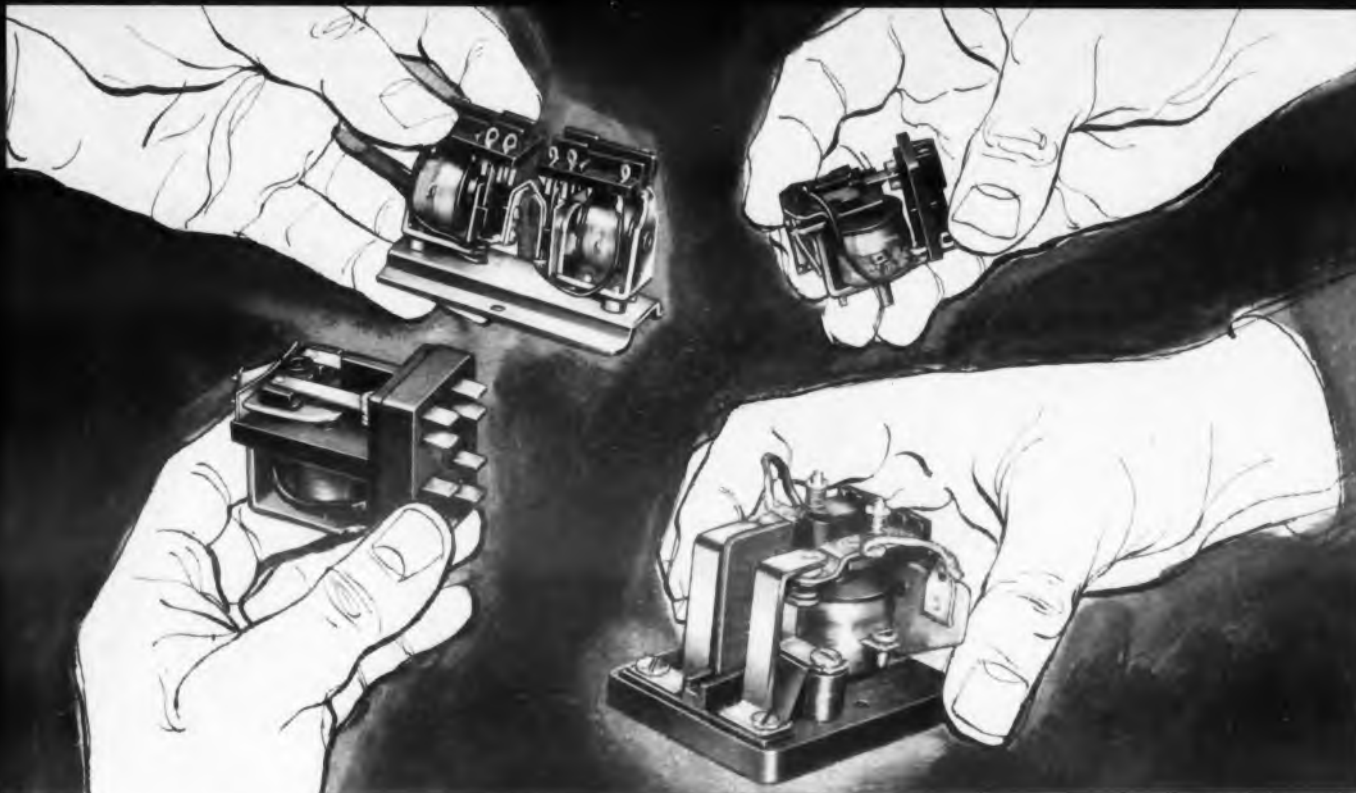
Model VDR permits pressureless measurement from two sides to the centerline of a fragile or compressible part. It automatically displays measurements to 20 millionth of an inch.

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).



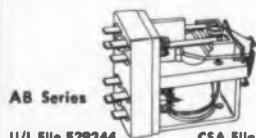
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More than 40 different standard P&B relays in 450 different coil voltages and contact arrangements are available from the leading Electronic Part Distributors in your area. For special applications, call your nearest P&B sales engineer.



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 amp, 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 amp, 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.



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 volt 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



KB Series
Latching Relay

let NEWARK carry your P&B RELAY INVENTORY

We're Relay Specialists—Over 400 types of P&B relays are available right off of our shelves.

Fast Delivery—Orders received today are shipped tomorrow.

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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CLAREED®

FITS
INTO
YOUR
DESIGN!

PACKAGED TO MEET YOUR REQUIREMENTS



Here five relays, each containing two switches, are mounted on a printed circuit board. This assembly may be inserted directly into your equipment or enclosed in a flat pack container.

These six switches are clustered to form the core of a single electromagnetic coil, and encased in a cylindrical steel container.

ACTUAL SIZE

Basic element of CLAREED relays is this switch capsule. A pair of magnetically operated contacts is hermetically sealed in an atmosphere of inert gas. The capsule combines extreme simplicity with high reliability and long life. It has excellent low-level characteristics.

CLAREED Sealed Contact Reed relays put you . . . the designer . . . in the driver's seat. They are simple in design, flexible in assembly. They are packaged and mounted to comply with your mechanical design configuration . . . even on your own circuit board. CLAREED relays are ideal components for transistor-drive applications, computers, data-processing and other high speed equipment.

Contacts are hermetically sealed in inert gas. Tens of millions of operations are assured since contact contamination is completely precluded. Hundreds of millions of operations are possible when operated up to $\frac{1}{2}$ rated load.

If you use relays, it will pay you to know all about CLAREED . . . an entirely new concept in relay design. Address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario. Cable Address: CLARELAY. Send for Bulletin CPC-5.

CLARE

When only the best is good enough

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 Fiberglass 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.

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CIRCLE 141 ON READER-SERVICE CARD ▶



ENGINEERING FACTS ABOUT

TEFLON[®]

FLUOROCARBON RESINS

®

No. E-9
in a series:
FEP resin
DESIGN
PROPERTIES



NOW COMMERCIALY 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 dis-

play excellent weatherability.

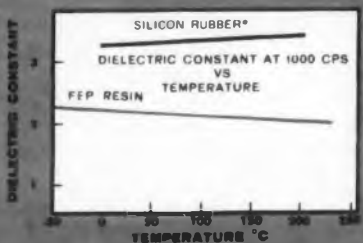
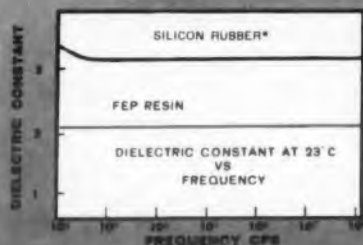
And because TEFLON 100 FEP resin is melt-processible, it can be extruded as jackets for wire and cable . . . as long, continuous lengths of wire insulation . . . and rapidly fabricated into complex shapes.

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.

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

OVER

Now... melt-processible FEP resin for jacketing ... extrudable wire insulation ... complex shapes



*TYPICAL LOW MOISTURE ABSORPTION 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.	$4.6-5.9 \times 10^{-5}$

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^{16} 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.

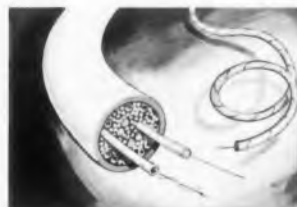
FOR MORE INFORMATION... about the properties and applications of TEFLON fluorocarbon resins—in particular, the new FEP resin—just drop us a line, mentioning your area of interest. Address: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department T-164, Room 2526, Wilmington 98, Delaware. **IN 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 μ a; 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 μ f to 0.01 μ f and 0.001 to 0.15 μ f. 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

ELECTRONIC DESIGN • May 11, 1960



4 reasons why you should buy Hughes high voltage silicon cartridge rectifiers

To meet your requirements for IN1730-34, IN2382-85, IN596-98 and IN1406-13 rectifiers... Hughes offers you a universal series with the following advantages over competitive devices:

1 Better High Altitude Performance—

Since the case is insulated and provides a long leakage path between leads, the probability of flashover or corona at high altitudes is reduced.

2 Improved Circuit Performance—

Fewer diodes are required in each unit to obtain the PIV ratings... thereby lowering losses, which in turn, provide better voltage regulation and higher efficiencies.

3 Savings in Space.

The case material is a plastic of high dielectric strength, making it possible to mount units in close proximity to each other.

4 Greater Dependability—

These assemblies utilize series strings of Hughes hermetically sealed glass diodes... packaged in a non-combustible cartridge. All internal connections are welded together to insure shock and vibration resistance.

These standard Hughes units are available in voltage ratings from 600 to 10,000 volts. In addition, Hughes offers you many custom assemblies designed to meet your special requirements.

ORDER TODAY! To obtain delivery of Hughes Cartridge Rectifiers just call or write the Hughes Semiconductor Sales Office or Distributor nearest you. Or, for a complete Cartridge Rectifier data sheet (Number: D.S. 82) please write Hughes, Semiconductor Division, Marketing Department, Newport Beach, California.

For export write: Hughes International, Culver City, Calif.



Creating a new world with ELECTRONICS

HUGHES

©1960 HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION

CIRCLE 142 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 $\pm 5\%$. 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.

NOW THERE'S A

PRICES CUT UP TO 50% ON GENERAL ELECTRIC SILICON LOW-CURRENT RECTIFIERS

*Let's say you need 1500 PIV
service. This is the way
you've probably been doing it:*



*5 units [1N1694] with
300 PIV at 75¢ = \$3.75*

*There was an easier way,
but it cost more:*



*3 units [1N1696] with
500 PIV at \$1.35 = \$4.05*

But not any more!

*Now you can do it the easier
way, at less cost than the
old way:*

*3 units [1N1696] with 500
PIV at a new low price of
85¢ = \$2.55*

*EVEN
GREATER SAVINGS
ON 1N500 SERIES!*

BETTER WAY TO BUY SILICON RECTIFIERS!

General Electric's new low prices on low current rectifiers let you use fewer units with higher PIV's for less cost; also give you greater safety margin to handle voltage transients

Until now it was more economical to buy silicon rectifiers with low PIV ratings and string them together in series. But since General Electric has lowered prices as much as 50 percent, there's a new and better way to specify rectifiers.

You can buy fewer, but higher-rated rectifiers to get the PIV rating you want in series circuits at less cost. You also save size, weight and installation costs.

You can buy greater safety against voltage transients (more PIV) at the same or less cost than before. For example:

1N1095 (500 PIV), old 100-lot price...\$3.50

1N547 (600 PIV), new 100-lot price...\$2.45

You save 30%, and get a higher-rated rectifier.

Check the sample price reductions listed at right and see how much you stand to save. In general, the higher the PIV, the greater the saving—with the most sizable reductions at the high end of the 1N540 line. All 500 PIV units are now priced at 400 PIV levels. Reductions apply to MIL-spec rectifiers, too.

This is just one of the many ways General Electric helps you build greater reliability into your circuits. G.E. sets its PIV ratings after derating at least 20%, which means an additional safety margin at no extra cost. All General Electric medium and high-current silicon rectifiers now carry transient

PIV's so you buy only the continuous rating you need and still get full protection against occasional voltage transients.

G-E medium and high-current rectifiers can be worked right up to maximum current and temperature ratings, even on highly cyclical loads. They are completely free of soft-solder joints which so often fail as a result of thermal fatigue. And new I_t ratings now give you a precise basis for picking the right fuse.

Put all these extra advantages to work for you. Call your G-E Sales Representative or Authorized Semiconductor Distributor for more information. *In Canada:* Canadian General Electric Co., 189 Dufferin St., Toronto, Ont. *Export:* International General Electric Co., 150 E. 42nd St., N. Y., N. Y.

Here are some sample price reductions
(for quantities of 100 or more):

MODEL	PIV	OLD PRICE	NEW PRICE (NET)
1N538	200	1.05	.90
1N539	300	1.35	1.20
1N540	400	2.00	1.80
1N1095*	500	3.50	1.80
1N547	600	4.30	2.45
JAN USAF 1N538	200	1.55	1.40
JAN 1N540	400	2.50	2.30
JAN 1N547	600	4.80	2.95

*Note that 500-PIV units are now priced the same as 400 PIV.

GENERAL ELECTRIC

Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

CIRCLE 143 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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

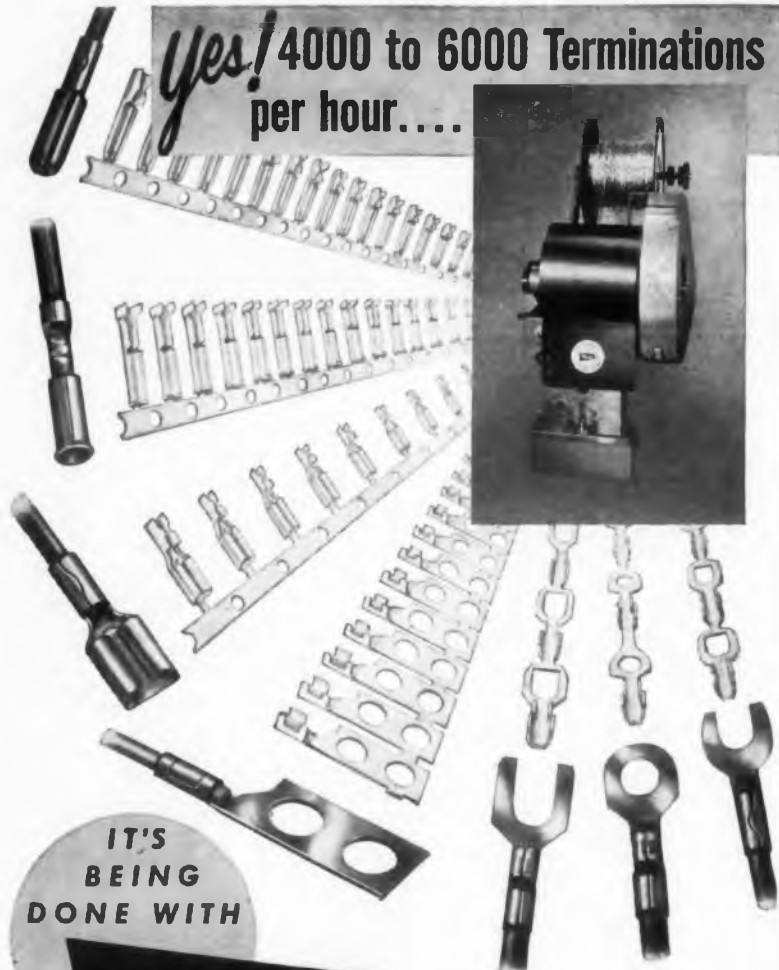


Series 1360 precision dials provide accurate and reliable performance due to these characteristics: absence of noise, lack of jumping or stepping action, and few ambiguities in reading and setting. Contoured brake arms lock settings in place without interfering with reading or setting. The series includes five models in various color combinations.

Amphenol-Borg Electronics Corp., Borg Equipment Div., Dept. ED, 120 S. Main St., Janesville, Wis.

155

Yes! 4000 to 6000 Terminations
per hour....



IT'S
BEING
DONE WITH

Malco

**CHAIN
TERMINALS AND
MALCOMATIC®
ELECTRO-CRIMP MACHINES**

This combination saves unlimited man-hours, speeds assemblies, reduces rejects and cuts production costs:

- 1 Malco quality terminals and receptacles are furnished on convenient spools—for electrical, electronic and military applications.
- 2 Malcomatic Electro-Crimp Machines assure fast, consistent and uniform crimping—are convenient, safe, fool-proof and easy to operate even for unskilled operators.

Photograph shows Malcomatic Electro-Crimp Machine Model M2—back feed type. Side feed type also available.

Malco

Request Bulletin 581. Send prints-specs for prompt quotation.

MANUFACTURING COMPANY
4027 West Lake Street Chicago 24, Illinois

CIRCLE 144 ON READER-SERVICE CARD

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.



• ENCAPSULATED UNDER VACUUM,
STONITE COILS LOCK OUT
CORRODING MOISTURE... END
SHORT CIRCUITING HAZARDS

Stonite
CUSTOM-MADE
COILS

Designed and engineered to specifications, Stonite coils meet precise requirements in today's burgeoning industry.

SPECIFY

Stonite

These influentials tell why:

- BOUNDLESS EXPERIENCE. QUALITY CONTROL
- WIDEST, MOST VERSATILE RANGE OF APPLICATIONS
- CONTINUOUS PROCESSING CHECKS, RIGID INSPECTIONS
- FINEST MATERIALS. WINDING SERVICES, ADVANCED TOOLING
- WIDEST SIZE RANGE. ANY QUANTITY

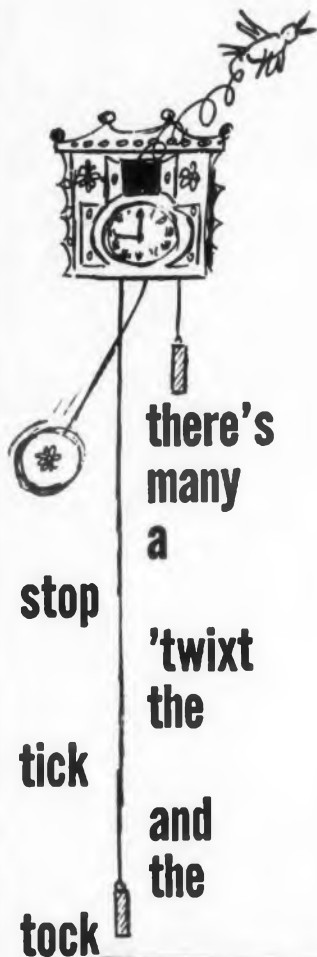
PAPER SECTION • FORM WOUND • LAYER BOBBIN
PRECISION WINDING • HIGH TEMPERATURE COILS
COPPER AND ALUMINUM CONDUCTORS
Round—Square—Rectangular
Also Round, Square, Rectangular tubing

Write, describing your requirements and request a representative call. Ask for latest Stonite illustrated brochure.

Stonite

COIL CORP.
YARDVILLE 4, NEW JERSEY
JUNiper 7-7323

CIRCLE 145 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960



Model PT-244
Pulse Timer
... \$1899

The Crosby-Teletronics Model PT-244 Pulse Timer is a highly sophisticated clock . . . or a paired trigger generator, to be exact. By providing a fixed and delayed pulse, it measures delays up to 10,000 microseconds with an accuracy of ± 0.01 microseconds making it ideal for delay line measurement, calibration of radar circuitry, and pulse generation. Results are read directly from a combination of decade counters and a digital dial.

The unit is a full size module in the Crosby-Teletronics Modular Instrumentation System (described in brochure #249). It may be used with the system's Modular Rack Adapter for rack-mounting.

Want complete specifications? Just write! We'll get them to you by return mail.

**Crosby
Teletronics
Corporation**



54 Kinkel Street, Westbury, L. I., N. Y.

CIRCLE 146 ON READER-SERVICE CARD

Hermetically-Sealed Switch

Weights 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

Is a 16-track model

634



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.

619 Important facts to know about laminated plastics



A few Taylor composite laminates (left to right): copper-clad section; sandwiched copper component; Taylorite vulcanized fibre-clad part; laminated tube, copper inserts.

Composite Laminates Open Up New Design Opportunities

While the great variety of commercially available laminated plastics satisfy most electrical and mechanical requirements, there are applications that can benefit from the combination of properties provided by composite laminates. Recent advances in bonding techniques have made it possible to bond virtually any compatible material with a laminate. These can be supplied as clad or as sandwiched materials. And they can be molded into many shapes to fit design requirements. Taylor is presently supplying to order the following composite laminates:

- **Copper and laminated plastics.** Clad for printed circuits and formed shapes. Sandwiched for special applications.
- **Taylorite® vulcanized fibre-clad laminates.** These combine the high strength of laminated plastics with the superior hot-arc-resistance of vulcanized fibre. They are being used in both high and low-voltage switchgear applications. Also in applications where the high impact strength of vulcanized fibre may be advantageous.
- **Rubber-clad laminates.** Almost any type of natural or synthetic rubber may be used as the cladding material. These laminates are widely used for condenser tops in wet condensers to protect the laminate against highly alkaline electrolytes. They also have application in any part where sealing or chemical resistance is needed.
- **Asbestos-clad laminates.** For applications where high heat- and arc-resistance are required.
- **Laminate-clad lead.** Lead sheets sandwiched between Grade XX pa-

per-base laminates have been used for X-ray shields. The laminate provides strength and contributes to the high shielding properties of the lead.

- **Aluminum-clad laminates.** These have been used extensively for engraving stock. They also offer possibilities as printed-circuit material and as plate holders for X-ray machines.
- **Beryllium copper-clad laminates.** Beryllium copper is nonmagnetic and a good conductor—properties that give these laminates possibilities in many applications.
- **Stainless steel-clad laminates.** Applications where nonmagnetic properties are required. Also in certain corrosive environments where the resistance of stainless steel to attack is an asset.
- **Magnesium-clad laminates.** These laminates have been produced in 108-in.-long sheets for use as screens for X-ray operators. Weight was a factor.

Our design and production engineers are constantly developing new materials, new applications, and new procedures for fabricating laminated plastics. Our experience is yours for the asking. And if you have a problem requiring assistance or more information on composite laminates, write us. Also ask for your copy of Taylor's new guide to simplified selection of laminated plastics. Taylor Fibre Co., Norristown 48, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

CIRCLE 147 ON READER-SERVICE CARD



Now...solve TWT space and temperature problems

**Magnetically shielded,
temperature compensated TWTs**

Sylvania research offers you two new S-band traveling-wave tubes of the permanent magnet focused type—TW-4002F and TW-956H—which give you these unique advantages:

Magnetically shielded—not affected by proximity to magnets and magnetic materials such as other TWTs, solenoids, and hardware. This permits close packing without hazard of performance loss.

Temperature compensated—they operate from -65°C to $+72^{\circ}\text{C}$ with minimum degradation of performance, and without requiring heater blankets.

Periodic PM focusing—they do not require weighty, space-and-power consuming solenoids.

Broad band—they have a relatively flat frequency response over an octave, from 2.0 to 4.0 KMC.

Electrically superior characteristics—at room temperature they have the following specifications:

TW-4002F—small signal gain is 37 db minimum; CW rf power output (saturation) is 10 milliwatts minimum

TW-956H—gain with 0.1 milliwatt input is minimum 37 db; CW rf power output (saturation) is 2 to 5 watts

COMPACTNESS—they are about 15" long, have 1.4" capsule diameter, weigh 3 pounds

RUGGEDNESS—specially designed for airborne and missile applications

Sylvania Electric Products Inc.—Special Tube Operations
500 Evelyn Ave., Mountain View, Calif.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



CIRCLE 148 ON READER-SERVICE CARD

TW-956H—1/2 ACTUAL SIZE



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 $\pm 0.5\%$ for each channel and $\pm 1\%$ differential at the recorder output. Meter accuracy is $\pm 1\%$, stability is $\pm 0.1\%$ per channel per day, range is 1, 10, and 100 m μ amp and 1 and 10 μ amp. 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 20μ



Model PT-3 transistorized voltage detector has an input sensitivity of less than 20μ and an output response time of 10μ sec. 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 $1-5/8 \times 2-5/8 \times 2-3/8$ in.

Anadex Instruments, Inc., Dept. ED, 14734 Arminta St., Van Nuys, Calif.

Price & Availability: \$148; from stock.

Solid State Reliability IN A 10 mc Counter



The CMC 700 Series is the only major breakthrough in counting, timing and frequency measuring equipment in the past 10 years. Here is the first successful application of transistors to high frequency counting and timing. Transistors perform all the functions in CMC's 700 series that required 63 tubes in old style counting equipment. These are the most reliable counters ever made.

TRUE DIGITAL LOGIC CIRCUITRY

By answering an obvious need for a completely new, up-to-date approach to counting and timing instrumentation, CMC has produced solid state instruments with greatly simplified circuitry, using logic "and" and "or" gates.

LIGHT AND SMALL, LOWER POWER DRAIN

Each 700 series instrument weighs only 27 pounds, measures 7 inches high, 17 inches wide, and 14 inches deep. Power consumption is a meager 46 watts, 1/10 the amount for vacuum tube models.

DO ALL THESE JOBS

Measure frequency from dc to 10 mc, time interval from 0.1μ sec, ratio 1 cps to 1 mc and unlimited multiple period selection. Frequency converters available for higher frequencies. The counter also generates time interval marker pulses from 1 μ sec to 1 second. Data can be presented on standard decades or inline Nixie tubes. The 700 series will operate digital recording equipment, punches, inline readouts, and other data handling gear.

These Features, Too—Decade count-down time base — frequency divider circuits never need adjustment. Accuracy, ± 1 count \pm oscillator stability. Sensitivity, 0.25 v rms; input impedance, 25 k ohms/volt.

And The Price—Higher than vacuum tube models. But you can save the difference on down time in the first year. Model 727A Universal Counter-Timer, \$2,750; Model 707A Frequency-Period Meter, \$2,575; Model 757A Time Interval Meter, \$1,975. Rack mount optional at no extra cost. All prices f.o.b. Sylmar, California.

More Information Available — Your nearby CMC engineering representative will be happy to arrange a demonstration and provide you with complete technical information. Or you may write Department 36.



**Computer
Measurements Co.**

A Division of Pacific Industries

12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

CIRCLE 149 ON READER-SERVICE CARD

ANOTHER VARIAN HIGH-VACUUM FIRST



VACION® Pump now available in a complete system

used for evacuating and processing products requiring clean, ultra-high vacuum such as vacuum tubes and semiconductor products. The Varian #V-10738 system includes a 40 liter/second VacIon Pump, a bake-out oven and controller, pressure gauges, roughing pump, and necessary power supplies in a convenient console "package." This spares your engineering department the trouble and expense of becoming ultra-high-vacuum specialists in order to make one installation (or just a few).

Varian systems are built around the revolutionary electronic VacIon Pumps which provide ultra-high-vacuum without use of fluids, moving parts, or hot filaments. They are totally free from contamination sources and will operate completely unattended. The total system is all metal and has been carefully engineered by Varian's high-vacuum specialists to the same high quality as the VacIon Pump itself.

Where a standard system does not solve your problems completely, Varian will design a custom system for your specific needs. For customers desiring to engineer their own systems, Varian furnishes VacIon Pumps and system components separately as desired, with pumping speeds of 1 liter/second to 10,000 liters/second.

Write for comprehensive technical data.
Address Vacuum Products Division.

1 LITER/SECOND VACION®
PUMP ON KANAN AIRCRAFT
COMPANY NEUTRON GENERATOR



VARIAN associates
PALO ALTO 21, CALIFORNIA

Representatives throuot the world



KLYSTRONS, WAVE TUBES, GAS SWITCHING TUBES, MAGNETRONS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, NMR & EPR SPECTROMETERS, MAGNETS, MAGNETOMETERS, STALOS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

CIRCLE 150 ON READER-SERVICE CARD

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.

LIGHTWEIGHT



RUGGED



YARDNEY SILCAD® BATTERIES

Only $\frac{1}{2}$ the size, $\frac{1}{3}$ the weight of ordinary nickel-cadmium and lead-acid batteries... yet rugged enough for the most adverse conditions!

This is one reason industry is now designing with the long-life, maintenance-free YARDNEY SILCAD — economical, compact, rechargeable power for missiles, rockets, satellites and drones... for guidance, control, telemetering, storing energy supplied by solar energy converters... for such airplane and helicopter applications as engine starting, emergency lighting, power and communications... for portable ground power... and numerous commercial applications.



**YARDNEY
ELECTRIC
CORP.**

"Pioneers in Compact Power"®
60-50 LEONARD STREET, NEW YORK 13, NEW YORK

Patents granted and pending.
© 1960 by Yardney Electric Corp.

CIRCLE 151 ON READER-SERVICE CARD

HIGH VOLTAGE SCHERING BRIDGE



measure
dissipation
factor and
capacitance
of
electrical
insulating
materials

Schering Bridges are used to measure power factor and capacitance of electrical insulating materials while subjected to high voltage stress. From these measured values and the physical dimensions of the sample and test electrodes, dielectric constant, loss factor and other values may be calculated. Units are self-contained and easy to operate and service. Available as a General Purpose Bridge and also as a Cable Test Bridge.

FEATURES:

- Wide capacitance range—General Purpose Bridge from 0.0000025 to 1.0 mfd. Cable Bridge from 0.0000025 to 2.0 mfd.
- Built-in shunts for testing large capacitances without additional equipment.
- High Accuracy... $\pm 0.2\%$ capacitance accuracy and 2.0% or better tangent accuracy.

DISSIPATION FACTOR and CAPACITANCE STANDARD



External checking standard in Schering Bridge operation. Usable up to 10KV. Consists of vacuum air capacitor with guard ring with a nominal capacitance of 100 μmfd ; 3 metal film resistors of nominal values of 3.3K, 33K and 300K, which can be selectively switched in series with the vacuum capacitor. Capacitor can also be used without series resistance.

Write for complete
technical details...



**Industrial
Instruments Inc.**

89 Commerce Road, Cedar Grove, Essex County, N.J.

DC Power Supply

625

For missile checkout and launching equipment



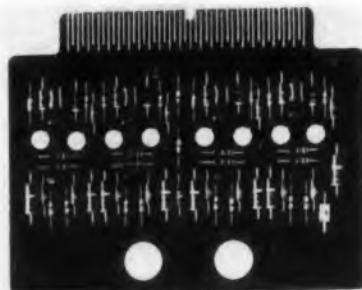
Model M-1520 power supply is for driving transistorized circuits in missile checkout and launching equipment. Measuring 10.5 x 7.125 x 6 in., the supply has a line static regulation of $\pm 0.1\%$ for changes from 27.5 to 31.5 v and line dynamic regulation of ± 0.05 v for input transients of 70 v dc lasting 0.2 sec. Static load regulation is $\pm 0.4\%$ 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.

AIRPAX CUSTOM MAGNETICS



Airpax engineers design advanced data and process control equipment for industrial and military applications. The illustration shows a magnetic amplifier Proportional Logic Network. High gain, highly reliable PREAC magnetic amplifiers drive the proportional coincidence gates producing, in effect, a two dimensional servo drive.

Custom design falls naturally into the capabilities of the highly skilled group of Airpax engineers. Each a specialist in a particular field, the composite effort of the group will result in the solution of your most complex problem.

Ask for the Special Magamp Bulletin.

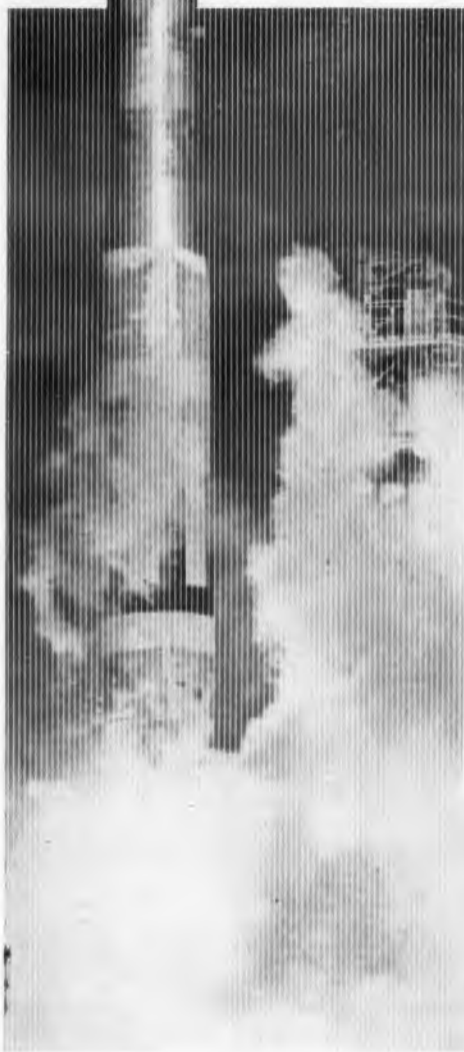


SEMINOLE DIVISION • FORT LAUDERDALE, FLORIDA

CIRCLE 153 ON READER-SERVICE CARD

Honeywell Accelerometers

Proven in Air Force Minuteman and Titan Tests



Honeywell accelerometers undergo a saw-tooth shock force of 100 G's for six milliseconds during test at the Environmental Test Laboratory of Avco's Research and Advanced Development Division.

Honeywell Linear Accelerometers, Model 515, were selected by Avco for the flight test instrumentation system of the Air Force TITAN and MINUTEMAN ICBM re-entry vehicles. The Avco Test Program included shock, random vibration, simulated transportation vibration, acoustic noise, standard acceleration, peak longitudinal and lateral acceleration, and high and low temperature tests. "Honeywell's Linear Accelerometers endured our Flight Proof Test Program without structural failure and were given our Flight Proof Test Certification" stated Mr. Paul Myslicki of Avco's Environmental Test Laboratory.

Type LA-500 series Linear Accelerometers are potentiometer output devices that feature constant damping and linear response. These reliable instruments are fluid damped and are designed to operate between -65°F and $+175^{\circ}\text{F}$. Inherently insensitive to cross coupling accelerations, these non-pendulous instruments are provided with mechanical stops to prevent damage from input accelerations beyond the specified range. Write for Bulletin LA-500 to Minneapolis-Honeywell, Boston Division, Dept. 10, 40 Life Street, Boston 35, Mass.



Honeywell
Linear
Accelerometer

Type 500,
shown approx.
 $\frac{1}{2}$ size

- Full Scale Range: ± 1 to ± 60 G
- Threshold: 0.02 G
- Potentiometer Resistance: 1,000 to 14,000 ohms
- Damping Ratio: 0.75 ± 0.35 typical
- Natural Frequency: 5 to 19 cps
- Cross-axis Sensitivity: $\frac{1}{2}\%$ of full scale
- Shock: to 50 G
- Vibration: MIL-E-5272
- Size: $1\frac{1}{16}$ " diameter, $3\frac{1}{4}$ " long
- Weight: 1 lb.

75
PIONEERING THE FUTURE

Honeywell

H Military Products Group
SINCE 1885

CIRCLE 154 ON READER-SERVICE CARD

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 $\pm 0.01\%$

Model 43 transistorized digital-to-analog converter has an over-all accuracy of $\pm 0.1\%$. 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

For microwave signals

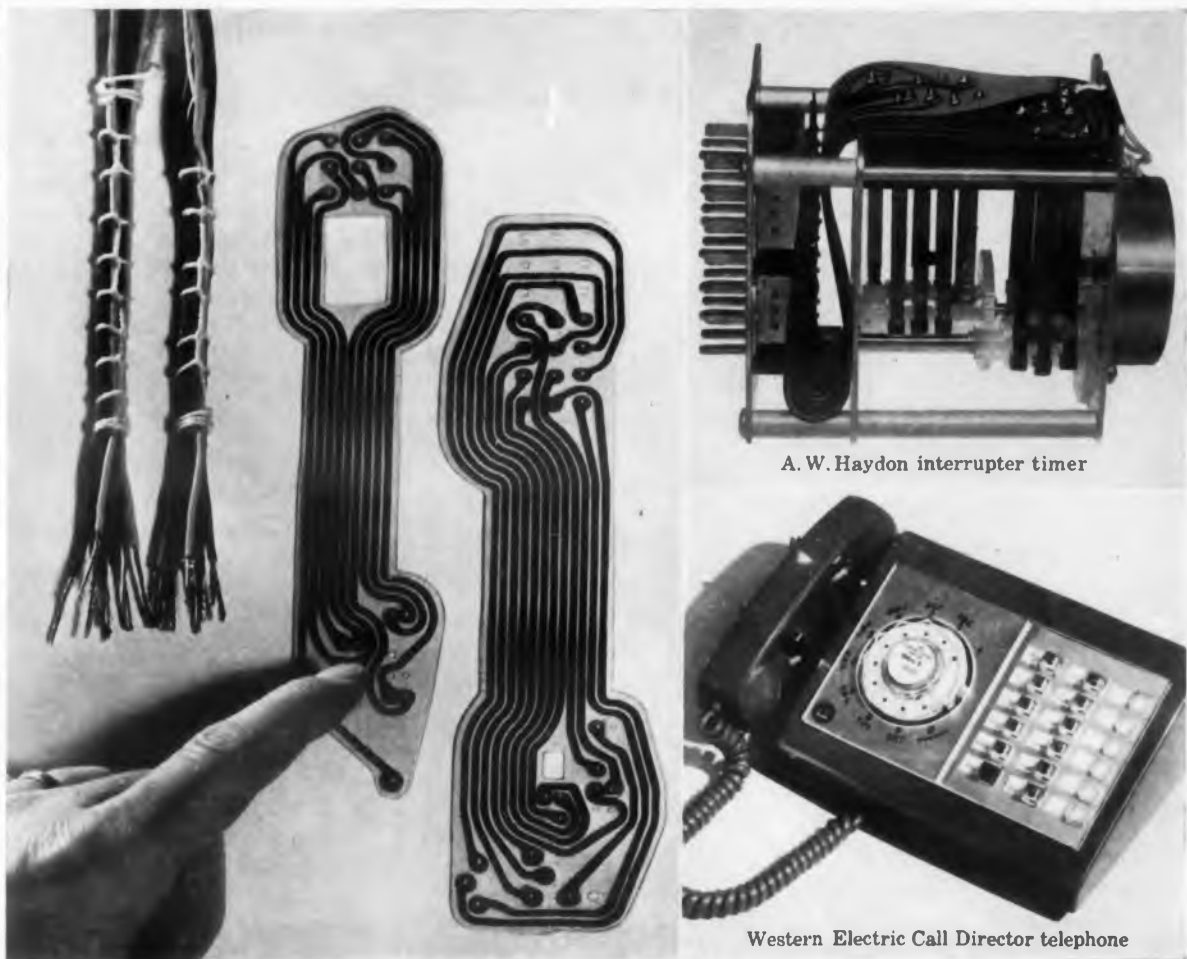


These balanced crystal mixers heterodyne two microwave frequencies in the same band to obtain an if difference frequency at the push-pull or push-push outputs. The mixers suppress local oscillator noise. Applications are in the front end of radar receivers and in laboratory instrumentation. Sizes range 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.

623



A. W. Haydon interrupter timer

Western Electric Call Director telephone

DC Accelerometer

Measures 1.5 x 0.8 x 0.8 in.

605



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 $\pm 1\%$. 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.

Correct wiring connections made twice as fast! 2 Flexprint® Cables replace 22 wires in A.W.Haydon's interrupter timer...

in one of Western Electric's convenient unattended office telephone systems — utilized by both the familiar push-button control telephones and the exciting new Call Director telephones (shown). The multi-function interrupter timer performs 12 automatic switching functions within the Western Electric system.

The A. W. Haydon Co., Waterbury, Conn. switched from conventional wiring to FLEX-PRINT cables to speed up accurate location of connections and simplify soldering of 44 terminals. Result: *wiring time cut in half.*

Total costs of wiring can be cut as much as 50% when FLEXPRINT circuits replace conventional wiring in electrical and electronic assemblies. Let's see how. Etched and insulated to match your exact requirements, these flat, flexible circuits come in one piece, ready for immediate attachment. No selection of color-coded wires... no cutting to length... no harnesses to lace. Conductors and terminations are accurately positioned for high-speed soldering techniques. 100% reproducibility results in consistently uniform wired assemblies. Costs of quality control testing, trouble-shooting and rework are reduced.

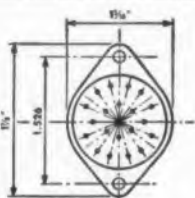
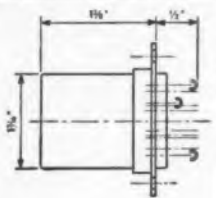
CIRCLE 155 ON READER-SERVICE CARD

New design engineers' digest describes how FLEXPRINT wiring also fits into product-improvement and miniaturization programs... shows actual Flexprint circuits now in use... suggests new applications... tells you how easy it is to get started with these modern flexible printed circuits. Write for copy:

FLEXPRINT®
SANDERS ASSOCIATES, INC.
PRODUCTS DIVISION
SANDERS ASSOCIATES, INC.
CANAL STREET
NASHUA, NEW HAMPSHIRE
TUxedo 3-3321

The First...

**wedge
action
relay**



NEW MARK II RELAY

Insures **ULTRA-reliability** under most extreme environmental and operating conditions.

Revolutionary new **WEDGE ACTION** supersedes and surpasses "Wiping Action."

Contact pressure constantly increases during over-travel.

- Temperature range: - 65°C to 200°C.
- Contact bounce: NONE.
Operating vibration: 5 to 2,000 cps, 30 G's.
Operating shock: 100 G.
- Contact rating: dry circuit to 2 amps.
- Extremely low contact resistance.

BRIEF DESCRIPTION: Six pole, double-throw, hermetically sealed. Meets and exceeds specifications MIL-R-5757C and MIL-R-25018.

PAT. NO. 2,866,048

Write for illustrated literature.

ELECTRO TEC CORP. SLIP RINGS • SWITCHES
RELAYS

P. O. BOX 370, SOUTH HACKENSACK, N. J. BLACKSBURG, VA., ORMOND BEACH, FLA.



CIRCLE 156 ON READER-SERVICE CARD

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 programming and remote sensing. Regulation is better than 3 mv and ripple is less than 500 μ v 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.

TOUGH



... AS A TURTLE'S BACK



**ARMAG-PROTECTED
DYNACOR®
BOBBIN CORES
AT NO EXTRA COST!**

Tough-as-tortoise-shell Armag armor is an exclusive Dynacor development. It is a thin, non-metallic laminated jacket for bobbin cores that replaces the defects of nylon materials and polyester tape with *very definite advantages*—and, you pay no premium for Armag extra protection.

Tough Armag is suitable for use with normal encapsulation techniques on both ceramic and stainless steel bobbins. It withstands 180°C without deterioration—is completely compatible with poured potted compounds—has no abrasive effect on copper wire during winding—fabricates easily to close-tolerance dimensions—inner layer is compressible to assure tight fit on bobbin—does not shrink, age or discolor.

Write for Engineering Bulletins DN 1500, DN 1000A, DN 1003 for complete performance and specification data covering the wide range of Dynacor low cost Standard, Special and Custom Bobbin Cores—all available with Armag non-metallic armor.

TRADEMARK

DYNACOR

DYNACOR, INC.

A SUBSIDIARY OF SPRAGUE ELECTRIC CO.

CIRCLE 157 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

NEW!

ELECTRONIC TEST EQUIPMENT

PHASE SHIFTER

Models PS60 & PS400

For measurement and comparison of phase angles or as a secondary phase standard

**SPECIFICATIONS**

RANGE..... 0-360° (continuously variable)
 ACCURACY..... ± 1 degree
 FREQUENCY..... (Higher accuracies available)
 60 CPS for PS 60
 400 CPS for PS 400
 (other frequencies available)

FREQUENCY STANDARD

A SELF-CONTAINED FORK STABILIZED FREQUENCY SOURCE

- Accurate
- Stable
- Low Distortion
- Variable output voltage
- Compact



Model 1400

SPECIFICATIONS

ACCURACY..... Available to .005%
 DISTORTION..... Less Than 1%
 FREQUENCY..... 400 CPS or 1000 CPS
 (Other Freq. Avail.)
 Dimension..... 6.9x6 inches
 Power Supply..... 115 volts, 60 CPS

OTHER MODELS AVAILABLE

MODEL 600 DESCRIPTION: Utilizes scaling circuits to provide tuning fork accuracies at frequencies below the range of precision tuning forks.
 LOW FREQUENCY STANDARD

AUTOMATIC HI-POT TESTER

Model A

FAST, ACCURATE, DIELECTRIC TESTING FOR MULTI-CONDUCTOR DEVICES

DESCRIPTION: The function of this instrument is to apply in programmed sequence a known voltage between the various conductors under test for a specific period of time and to indicate breakdowns when and where they occur.

SPECIFICATIONS

TEST VOLTAGE..... 0-2000 Volts RMS
 TEST TIME..... 2-120 seconds
 NUMBER OF TEST TERMINALS..... 11

NULL DETECTOR

Model 60B



A sensitive battery operated null detector ideal for shering bridges or other applications where complete isolation from power lines is desirable.

- Long Battery Life • High Harmonic Rejection • Shielded against external fields

SENSITIVITY: † microvolt for 1% deflection

Write for Catalogs
 Reps in Principal Cities

INDUSTRIAL TEST EQUIPMENT CO.
 55 E 11th ST - NEW YORK 3 - GR 3-4684

CIRCLE 158 ON READER-SERVICE CARD
 ELECTRONIC DESIGN • May 11, 1960

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.

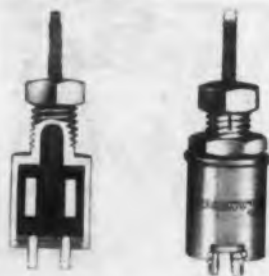
Accurate Specialties Co., Inc., Dept. ED, 37-11 57th St., Woodside 77, N.Y.

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 μ h 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 4-1/4 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.

from Army Ballistics Missile Agency

re: Fenwal Electronics

subject: Taking the temperature of EXPLORER VII

Gentlemen:

In connection with the Explorer VII satellite launching in October . . . the heat balance experiment conducted by Dr. V. E. Soumi provided 5 extra information channels for use by the Army Ballistic Missile Agency

The channels were used for temperature measurements on: a) a portion of the skin of the satellite, b) the solar cells, c) the 20 mc transmitter, d) the storage batteries, and e) the Geiger-Muller tube in the Van Allen experiment.

The sensing device used for all five measurements was a thermistor probe manufactured by Fenwal Electronics, Inc. (Type G-188). All probes matched one another so closely that only one calibration curve was required for all measurements and for all spares . . .

Sincerely,

Gordon L. Harris
 GORDON L. HARRIS

Public Information Officer



MORAL: Investigate Fenwal Electronics Thermistors. Their "new applications ceiling" is virtually unlimited — temperature or liquid level measurement, time delay, remote control, switching — you name the problem, Fenwal Electronics can help. For new Thermistor Catalog EMC3 and complete information, write



51 MELLETT ST., FRAMINGHAM, MASS.



CIRCLE 159 ON READER-SERVICE CARD

SIZE 8

SYNCHROS · SERVO MOTORS · MOTOR TACH GENERATORS

400 Cycle: Many for 125°C operation . . . Higher for special applications

Many Immediately Available From Stock in Small Quantities

SIZE 8



SYNCHROS

Highly Stable. Minimum Error
Variation from -55°C to +125°C

OSTER TYPE	CLASS	INPUT VOLT-AGE	INPUT CUR-RENT AMPS	INPUT WATTS	OUTPUT VOLT-AGE	PHASE SHIFT (° LEAD)	ROTOR RESIST-ANCE (OHM)	STATOR RESIST-ANCE (OHMS)	Z ₁₀ OHMS	Z ₅₀ OHMS	Z ₁₅₅ OHMS	NULL VOLT-AGE (MV)	MAX. ERROR FROM E.Z. (MIN.)
4253-01*	LZ-CT	11.8	.087	.21	23.5	9.0	157.0	24.0	212+j722	28+j119	263+j69	30	±7
4269-01*	Diff	11.8	.087	.21	11.8	9.0	35.0	24.0	37+j139	28+j124	47+j13	30	±7
4273-01**	XMTR	26.0	.100	.54	11.8	8.5	34.0	12.0	48+j255	12+j45	82+j31	30	±7
4277-01*	HZ-CT	11.8	.030	.073	22.5	8.5	316.0	67.0	500+j1937	79+j350	594+j182	30	±7
4261-01**	Resolver	26.0	.043	.39	11.8	15.0	162.0	22.0	208+j612	34+j159	243+j77	30	±7

*Stator as Primary **Rotor as Primary

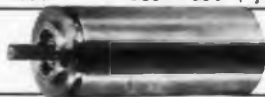
SIZE 8



SERVO MOTORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO. LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC ²
5004-01	26V	288 = 226 + j176	.15	6200	2.0	.47	0.863	1.2	22,500
	26V	294 = 238 + j174							
5004-02	26V	288 = 226 + j176	.15	6200	2.0	.47	0.863	1.2	22,500
	36V	526 = 409 + j332							
5004-03	26V	288 = 226 + j176	.15	6200	2.0	.47	0.863	1.2	22,500
	40V	715 = 582 + j415							
5004-09	26V	230 = 190 + j131	.20	6200	2.5	.47	0.863	1.2	30,000
	40V	519 = 399 + j332							

SIZE 8



MOTOR TACH-GENERATORS

OSTER TYPE	RATED VOLTAGES	Z = R + jX	IN. OZ. STALL TORQUE	RPM NO. LOAD SPEED	WATTS PER PHASE	GM. CM. ROTOR INERTIA	LENGTH IN. MAX.	WEIGHT OZ.	T/I RATIO RAD/SEC ²	GENERATOR VOLTAGE	INPUT WATTS	OUTPUT VOLTS PER 1000/RPM
6204-01	26V	230 = 190 + j131	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25
	40V	519 = 399 + j332										
6204-03	26V	230 = 190 + j131	.20	6000	2.5	.65	1.728	2.5	21,800	26	2.5	.25
	26V	230 = 190 + j131										

Oster

The Size 8 400 Cycle Servo Motor Tach Generators listed above have 150° max. cont. frame temperature, 110 MA input current, ±5° phase shift and Null Voltage (Total R. M. S.) of 15 millivolts.

OTHER PRODUCTS INCLUDE:

Resolvers
Computers
Indicators

Servo Mechanisms
Servo Torque Units
DC Motors

John Oster

MANUFACTURING CO.

Avionic Division
Racine, Wisconsin

EASTERN OFFICE 310 Northern Blvd. • Great Neck, Long Island, New York
Phone: HUnter 7-9030 • TWX Great Neck N. Y. 2980

WESTERN OFFICE 5333 South Sepulveda Blvd. • Culver City, California
Phone: EXmont 1-5742 • UPion 0-1194 • TWX S. Mon. 7671

Engineers For Advanced Projects:

Interesting, varied work on designing transistor circuits and servo mechanisms.
Contact Mr. Robert Burns, Personnel Manager, in confidence.

CIRCLE 160 ON READER-SERVICE CARD

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

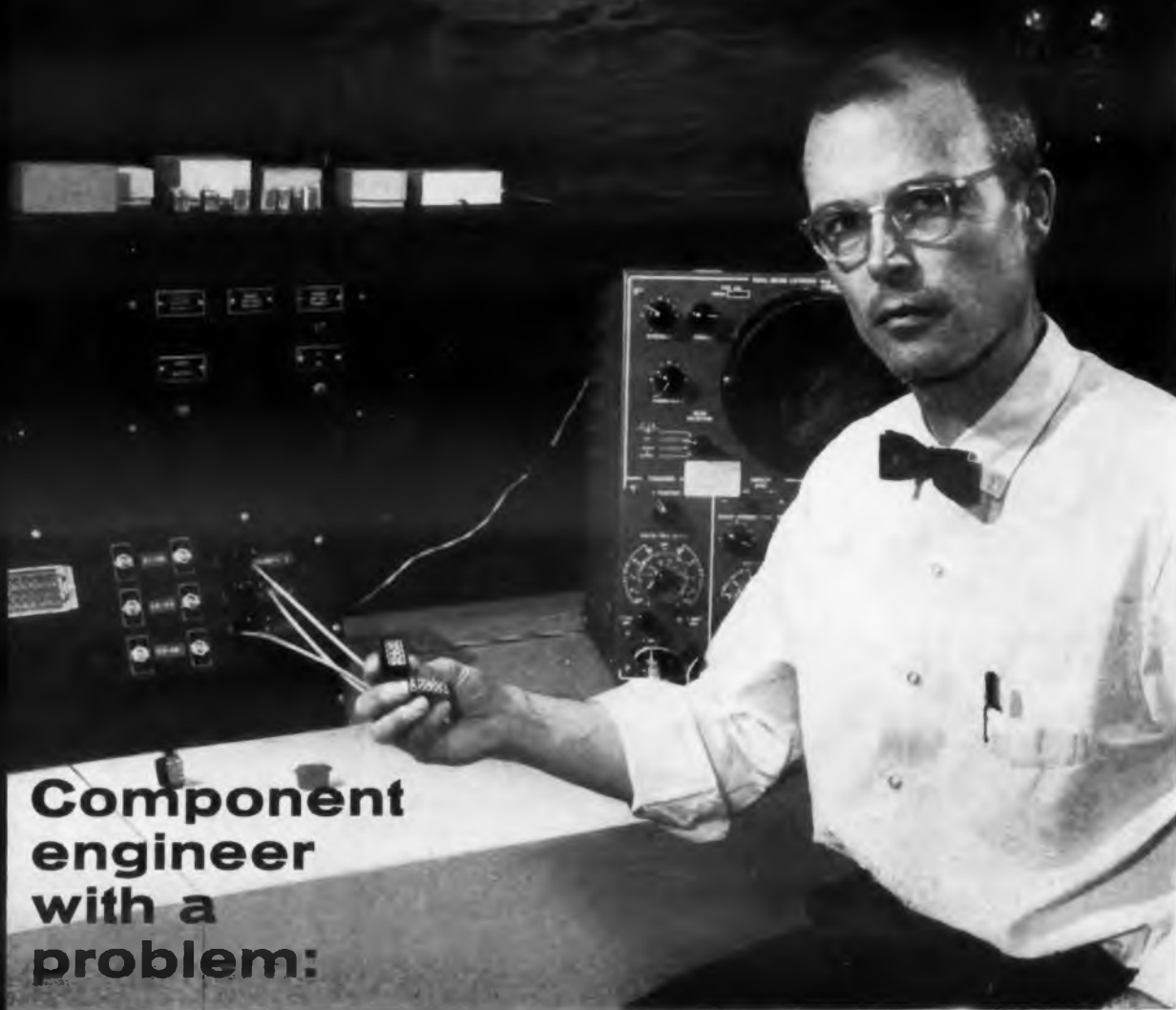
For frequencies from 100 to 10,000 mc



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.



Component engineer with a problem:

"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

excruciating 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 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.

Name _____
Address _____
City _____
State _____

GENERAL  ELECTRIC

GENERAL ELECTRIC SEALED RELAYS—UNMATCHED FOR RELIABILITY

CIRCLE 161 ON READER-SERVICE CARD



SOURCE for EXCELLENCE

Building upon the good reputation earned in two generations
to bring you increasing satisfaction in products and service

HYGRADE Fabric Base Sleeveings

The most comprehensive line of fabric base insulating sleeveings; braided of fiberglass or organic yarns, and impregnated or coated with varnishes, plastics and silicone rubber.



FLEXITE Extrusions — a broad line of tubings extruded of vinyl, polyethylene, nylon, silicone rubber, Teflon and other plastics; and extruded shapes including triangular-guide-line wrapping tape of permanently resilient silicone rubber.



FLEXLEAD Insulated Wire and Cable
Teflon and silicone rubber insulated high temperature lead wire, coaxial cables, twisted pairs, and special constructions of wire and cable for high temperature applications.



Sample lengths, data, and prices on request;
phone, write, or wire — you'll get action!

L. FRANK **MARKEL** & SONS
SINCE 1922



SOURCE for EXCELLENCE in
Insulating Tubings, Sleeveings, and Lead Wire

NORRISTOWN, PENNSYLVANIA
CIRCLE 162 ON READER-SERVICE CARD

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

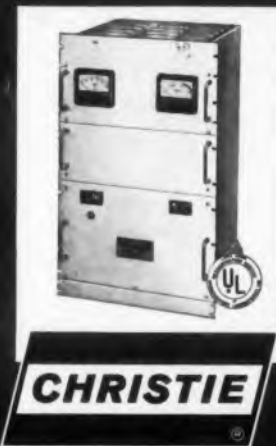
643

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

D-C POWER

Precisely Regulated for
Missile Testing, Battery
Charging and General Use



SILICON POWER SUPPLIES

Over 200 standardized and militarized models up to 1500 amps... 6 to 135 volts. CHRISTIE'S QUALITY CONTROL is approved by the leading aircraft and missile manufacturers.

Write for
Power Supply Bulletin AC-60
Battery Charger Bulletin BC-60

**CHRISTIE
ELECTRIC CORP.**

3416 W. 67th Street
Los Angeles 43, Calif.

CIRCLE 163 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

STRAPLOCK* CABLE CLAMPS

- SAVE TIME
- REDUCE INSTALLATION COSTS
- SIMPLIFY ASSEMBLY



Just push Straplocks into place and you're ready to lay cables or wires immediately—without time-consuming bundling or lacing. Straplocks require only a mounting hole for fast, easy manual installation, eliminate "blindspot" problems, quickly adjust to various sizes and align perfectly. They provide an ideal vibration-proof clamp for fastening cables or wires to cabinets, panels or sheet metal surfaces.

SPECIFIED AS ORIGINAL EQUIPMENT
IN AUTO INDUSTRY



STRAPLOCK
CABLE CLAMPS

Ford Motor Company now uses Straplocks for installing electrical cables in new autos and trucks. In typical application above, lighting cable is anchored quickly and economically. Straplocks resist engine heat, oil, grease and battery acid.

Molded from tough Nylon, Straplocks resist oils, greases, common solvents and severe temperatures from -65° to $+300^{\circ}$ F. Absence of any metal in their construction and mounting requirements assures complete insulation. They are especially suited for aircraft, missile, automotive and heavy appliance applications.

Request literature and technical data.

STRAPLOCK SAMPLE KIT

Prove to yourself how Straplocks save time, reduce installation costs. Special introductory kit containing 200 W-1 Straplock Cable Clamps and handy installation tool costs only \$4.50. Order today!



*Patented

WHITSO, INC.

9326 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 164 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960

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

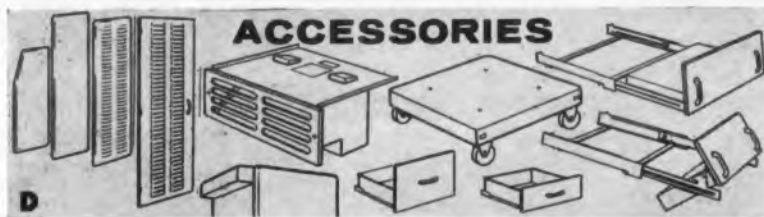
Portable



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.

THE AMCO MODULAR INSTRUMENT ENCLOSURE SYSTEM



TWO COMPLETELY NEW LINES ADDED IN STEEL AND ALUMINUM TO GIVE 3 COMPLETE MODULAR FRAME LINES IN ONE OVER-ALL SYSTEM

- A Amco Custom Line.** Removable multi-panels and cowlings based on 19" increments of width. Custom, single-unit appearance for frames mounted in series—ideally suited for complex console arrangements. The 19 $\frac{1}{8}$ " width of frame saves space in series mounting of frames. Constructed of double-channel 16 gauge cold-rolled steel. Conforms to EIA mounting standards.
- B Amco Semi-Custom Line.** Removable multi-width cowlings provide a semi-custom, single-unit appearance for frames mounted in series. Extra rugged, wide box-type channel frames provide greater internal mounting area. 19" wide panels of any thickness can be recessed—from a flush-mounted position to any desired depth. Box type channel construction of 14 gauge cold-rolled steel. Conforms to EIA mounting standards.
- C Amco Aluminum Line.** This system of aluminum box extrusions and cast corners allows easy assembly of cabinets in any size from 7" to 20" in height, width or depth. Corners and extrusions

lock together by hand with built-in locking device. All sizes are standard. Ideal for stocking and odd-ball sizes. Cast and hardened corners of 356-T6 aluminum as described in Federal Spec. QQ-A-596a. Extrusions of 6061-T6 aluminum as described in Federal Spec. QQ-A-270a.

- D Amco Accessories.** A full line of Amco integrated accessories such as blowers, chassis slides and mounts, lighting, doors, drawers, dollies and many more available for A, B and C shown.

Cost savings. All the above—or any part thereof—may be ordered under one combined discount schedule base determined by order dollar value. Orders received at one time with one delivery date may also be combined. Free pre-assembly by Amco provides additional savings in time and installation.

3 week delivery on all standard parts. We welcome inspection of our plant and facilities. Send for your free literature now.

Factory-trained representatives in all principal U. S. cities and in Canada



AMCO ENGINEERING CO.

7333 W. Ainslie Street, Chicago 31, Illinois

CIRCLE 165 ON READER-SERVICE CARD

NOW, pick only the parameters you need, order by model number!

16 NEW! Low cost all-electronic totally-transistorized DIGITAL MULTIMETERS

Now in a single 5¼" or 8¾" x 19" panel Digital Multimeters for measuring any combination of AC/DC volts, AC/DC ratios, and resistance, with new pre-amps for higher sensitivities, optional electrical output and print command capabilities!



**FLIP-TOP BOX
CONSTRUCTION
FOR EASY
MAINTENANCE.**

- 50 readings per second, average
- Inline "SUPER-NIXIE" readouts
- 0.01% accuracy
- 1000 megohm input impedance
- Automatic, manual and remote ranging
- Automatic polarity
- Twin Zener diode internal reference
- Front panel sensitivity control
- Etched circuits, plug-in card construction
- Will operate directly in multi-point scanning and print-out data logging systems without any additional circuitry or auxiliary equipment.

Electro Instruments, Inc.

CIRCLE 166 ON READER-SERVICE CARD



MODEL 840
DC Volts / DC Ratios



MODEL 841
DC Volts / DC Ratios / Resistance



MODEL 842
DC Volts / DC Ratios / AC Volts



MODEL 843
DC Volts / DC Ratio / AC Volts / Resistance



MODEL 844
DC Volts / Ratio / DC Pre-Amplifier



MODEL 845
DC Volts / Ratio / Resistance / DC Pre-Amplifier



MODEL 846
DC Volts / Ratio / AC Volts / DC Pre-Amplifier



MODEL 847
DC Volts / Ratio / AC Volts / Resistance / Pre-Amplifier



MODEL 848
DC Volts / Ratio With Electrical Outputs



MODEL 849
DC Volts / DC Ratios / Resistance
With Electrical Outputs



MODEL 850
DC Volts / DC Ratios / AC Volts
With Electrical Outputs



MODEL 851
DC Volts / DC Ratio / AC Volts / Resistance
With Electrical Outputs



MODEL 852
DC Volts / Ratio / DC Pre-Amplifier
With Electrical Outputs



MODEL 853
DC Volts / Ratio / Resistance / DC Pre-Amplifier
With Electrical Output



MODEL 854
DC Volts / Ratio / AC Volts / DC Pre-Amplifier
With Electrical Outputs



MODEL 855
DC Volts / Ratio / AC Volts / Resistance
Pre-Amplifier With Electrical Outputs

Many variations of these basic models including AC ratiometers, milliohmmeters, microvoltmeters and specialized measuring instruments tailored to individual systems requirements are available in the same physical configurations. Ask your EI sales office or representative for complete specifications today!

3540 AERO COURT
SAN DIEGO 11, 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 $\pm 3\%$, and are rated at 200 v dc. Characteristic impedance is within $\pm 5\%$. 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.

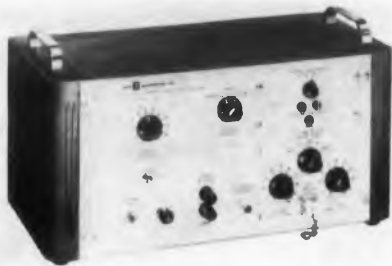
U.S. Semiconductor Products, Dept. ED, 3540 W. Osborn Road, Phoenix, Ariz.

Availability: Immediate shipment, up to 999 pieces, is from stock.

Pulse Generator

708

Gives pulse widths from 10 to 100 μ sec



Model 1051 pulse generator provides positive or negative pulses in any one of four fixed widths: 10, 20, 50, or 100 μ sec. 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 μ sec. 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.



Now in magnesium and aluminum

FOUR MAGNESIUM DEVELOPMENTS ANSWER DESIGNERS' PROBLEMS

New Dow developments in magnesium provide solutions to critical problems for aircraft, missile and electronics designers. Among them are: a special bend sheet; new close sheet tolerances; precision extrusions; elevated temperature alloys.



Heated dies are not necessary with Special Bend sheet.

NEW SPECIAL BEND SHEET bends easily on standard bending equipment at room temperature. This AZ31B-O Special Bend sheet can be cold-bent

without cracking through an angle of 90 degrees around a mandrel radius equal to the bend factor times the nominal sheet thickness . . . bend factor for .040" to .100" sheet thickness is 2.0! And tensile yield strength meets the requirements of Federal Specification QQ-M-44.

NEW CLOSE SHEET TOLERANCES can now be obtained on standard gauges when required. For example, on .090" gauge, 48-inch-wide sheet, tolerances can now be held as close as plus or minus .002". Standard tolerances run plus or minus .004". These closer tolerances help to cut down on weight



Magnesium gives greater rigidity for equal weight than other metals.

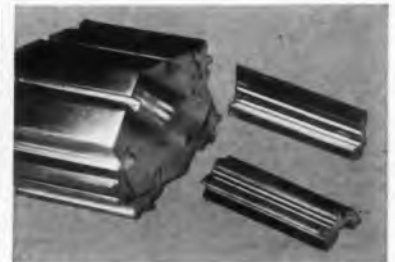
penalty, so important in missile and aircraft design.

PRECISION MAGNESIUM EXTRUSIONS from Dow give you exact-tolerance parts without costly multiple machining operations. Sharp V's, deep notches, thin slots, accurate serrations . . . all can be economically produced in Dow's Madison, Illinois, extrusion plant.

LARGE EXTRUSIONS. A huge 13,200-ton press easily handles large sections, stepped extrusions, combined extrusion forgings and single unit extrusions to replace fabrications. This giant can handle sections of up to a 30-inch circumscribed circle!

ELEVATED TEMPERATURE ALLOYS are available from Dow for extruded and rolled products. These alloys have excellent static and creep properties, some up to or above 700°F. Because of magnesium's high specific heat, it's an excellent heat sink for instruments and components!

Compared pound for pound with other metals, magnesium permits the use of heavier-gauge, more rigid sections for extra structural strength . . . and substantial weight savings!



Dow precision-extrudes magnesium in almost any cross-sectional shape.

For more information on these products, and on Dow's fabrication facilities for magnesium and aluminum, contact the nearest Dow sales office, or write THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Merchandising Department 1002BC5-11.

See "The Dow Hour of Great Mysteries" on NBC-TV



THE DOW METAL PRODUCTS COMPANY

Division of The Dow Chemical Company

CIRCLE 167 ON READER-SERVICE CARD

Less than .005" Runout on a 24" Shaft...



Holtzer-Cabot Solves Fractional H.P. Motor Problems

Holding runout tolerances on a motor shaft extending 24" beyond the motor frame poses a difficult design problem. To reduce runout, many manufacturers have resorted to complicated and expensive outboard bearings and shaft supports. To avoid this problem, one such company* came to Holtzer-Cabot, which in cooperation with the company's engineers, developed a motor with a special extended end cap and a heavier shaft. The result: less than .005 runout at one inch from the end of the 24" shaft.

Write for Information! Holtzer-Cabot specializes in the design and manufacture of fractional horsepower motors for all types of applications. For complete details on Holtzer-Cabot motors for specific applications, and a copy of "Key Factors in Selecting AC Motors for Instrument Service" write direct or use Readers Service Card.

*Name on request



HOLTZER-CABOT

MOTOR DIVISION

National Pneumatic Co., Inc., Boston 19, Mass.

CIRCLE 168 ON READER-SERVICE CARD

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, bi-quinary, or other 4-level binary codes. A 180-v



NEW SERIES of Antenna SLIP RING Assemblies

12 to 500 RINGS

A standardized line of large Slip Ring assemblies, designed for a multiplicity of instrumentation, control and power circuit applications. First production assemblies are in use on radio telescopes, radar and tracking antennas and human centrifuge installations.

Assemblies vary from 12" to 72" in length, are either shaft or flange ball-bearing mounted and may be specified with hermetically sealed housings. Noise levels are held to a minimum. So are intercircuit losses, cross-talk and radiation, through proper shielding.

For complete information, write:



SLIP RING COMPANY of AMERICA

3612 West Jefferson Blvd., Los Angeles 16, Calif.

CIRCLE 169 ON READER-SERVICE CARD

DO YOU WANT TO

GENERATE  PULSES

DELAY  PULSES

WIDEN  PULSES

REGISTER  PULSES

COUNT  PULSES

SUM  PULSES


DO BINARY LOGIC


DRIVE TRANSISTOR CIRCUITS

New NAVCOR Series 300—completely transistorized 5" x 6" card modules available from stock to efficiently perform all major pulse generating and programming functions.

Write for Series 300 Bulletin


NAVIGATION COMPUTER CORP.
1621 SNYDER AVE., PHILADELPHIA 45, PA.
PHONE: HOward 5-7700

CIRCLE 170 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960

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 μ f, and in voltages from 10 to 15,000 vdc. 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.



General Electric can solve your special heating problems

Whatever your thermal conditioning problem, General Electric can design and build specialty heating products with a high degree of reliability. Here are good reasons why:

GENERAL ELECTRIC EXPERIENCE in specialty heating dates from World War II, when we fabricated such items as heated flying suits and camera covers. We are now producing reliable heating equipment for the sophisticated requirements of today's aircraft and missiles. Some examples: we are currently working on products designed to thermally condition propellants, batteries, electronic components, hydraulic systems, and airborne cameras. And these products can be molded or tailored to any shape desired.

UP-TO-DATE MATERIALS, coupled with our extensive design and fabrication experience, enable us to build durable, lightweight heaters that will withstand severe vibration or shock. These materials are flexible over a wide range of temperatures, and possess a high degree of resistance

to water, oil, and chemicals. The illustration demonstrates the molding of a high temperature plastic material.

FOR MORE INFORMATION, contact D. R. Barbour, Manager-Engineering, Specialty Heating Products Section, General Electric Co., Coxsackie, N. Y. (Phone Coxsackie 6-5631), or mail coupon. 142-1

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Specialty Heating Products Section
Coxsackie, New York
Please send bulletin GEA-6283A on "G-E Specialty Heating Equipment."
 for immediate project
 for reference only

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POSITION _____
COMPANY _____
CITY _____
STATE _____

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 171 ON READER-SERVICE CARD

NEW PRODUCTS

Continuously Variable Delay Line 706

Delay is 0.5 μ sec



Designed for printed board mounting, model 72-17 continuously variable delay line has a delay of 0.5 μ sec. Other typical characteristics are: impedance, 1000 ohms; rise time, 0.1 μ sec; maximum attenuation, 10%; maximum voltage, 500 v peak; and resolution, less than 0.001 μ sec. 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 $\pm 5\%$ 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 $\pm 10\%$. 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

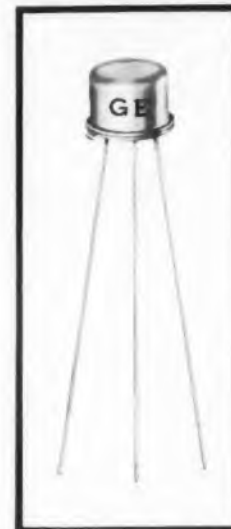
698

Holds 32 modules



Able to hold 32 digital modules, type BL-11 T-block has a taper-pin plugboard panel for

2N1289



FIRST HIGH SPEED GERMANIUM NPN TRANSISTOR • FOR HIGH SPEED COMPLEMENTARY SWITCHING HIGHER BETA, VOLTAGES AND HEAT DISSIPATION

Typical Electrical Characteristics (25°C)			Absolute Maximum Ratings (25°C)		
Forward Current Transfer Ratio ($I_C = 10$ ma, $V_{CE} = 1V$)	h_{FE}	150	Temperature Range		
Forward Current Transfer Ratio ($I_C = 25$ ma, $V_{CE} = 1V$)	h_{FE}	130	Storage	T_{STG}	-65 to $+85$ °C
Base to Emitter Voltage ($I_C = 10$ ma, $I_B = .5$ ma)	V_{BE}	.25 volts	Operating Junction	T_J	-55 to $+85$ °C
Collector Saturation Voltage ($I_C = 10$ ma, $I_B = .5$ ma)	V_{CE}^{SAT}	.2 volts	Voltage		
Collector Cutoff Frequency ($I_E = 5$ ma, $V_C = 1V$)	f_{cb}	60	Collector to Emitter	V_{CE}	15 volts
Collector Capacitance ($I_E = 5$ ma, $V_C = 1V$, $f = 2$ mc)	C_{ob}	6 μ lf	Emitter to Base	V_{EB}	5 volts
Collector Cutoff Current ($V_{CE} = 15$ V, $I_E = 0$)	I_{CO}	2 μ a	Collector to Base	V_{CB}	20 volts
Emitter Cutoff Current ($V_{EE} = 5$ V, $I_C = 0$)	I_{EO}	2 μ a	Collector Current	I_C	50 ma
Rise Time	t_r	60 m μ sec	Dissipation	P_{AV}	75 mw
Storage Time	t_s	200 m μ sec	(*Derate 1.2 mw/°C)		
Fall Time	t_f	60 m μ sec			

RELIABILITY BASED ON TWO YEARS OF MANUFACTURE

Based on the meltback technology from which have come a number of very reliable transistors, the new 2N1289 is believed to be the first germanium NPN transistor to meet the needs of high-speed computers. Thorough characterization provides all the necessary data for "worst case" designs.

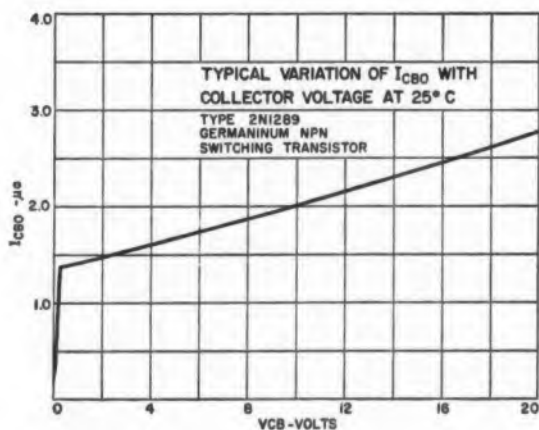
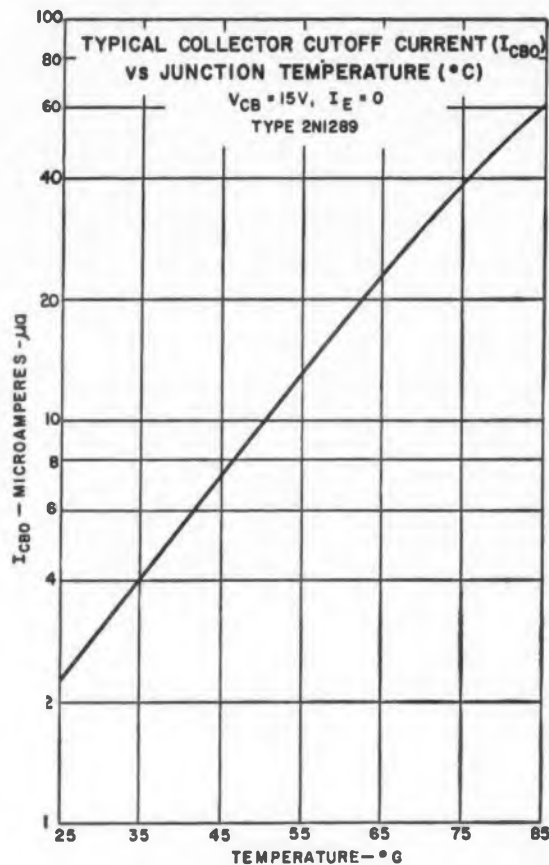
The 2N1289 features a typical alpha cutoff frequency of 60 mc, and a 10 ma beta of 150. Voltage ratings are high. Emitter cutoff current and collector cutoff current are measured at 5 and 15 volts, respectively. Also, the transistor provides a high-gain bandwidth product which is virtually independent of operating point.

High voltages, together with a constant-gain bandwidth product, allow the 2N1289 to be used in a wide variety of complementary switching circuits with just about any PNP high-speed transistor. This device performs best out of saturation.

Backing up the 2N1289 is more than two years of manufacturing experience with meltback transistors. Over 100,000 of these transistors have been tested to severe mechanical and electrical standards. The survival rate has averaged greater than 99 percent.

Your G-E Semiconductor Sales Representative has complete details on the 2N1289. Call him to get all the facts on performance characteristics that make this device perform capably and reliably in high-speed computer circuits. Semiconductor Products Dept., Electronics Park, Syracuse, N. Y. In Canada: Canadian General Electric Company, 189 Dufferin St., Toronto, Ont. Export: International General Electric Co., 150 E. 42 St., New York 17, N. Y.

See your G-E Semiconductor Distributor for fast delivery at factory-low prices.



GENERAL ELECTRIC

CIRCLE 172 ON READER-SERVICE CARD

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. Repeatability 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.

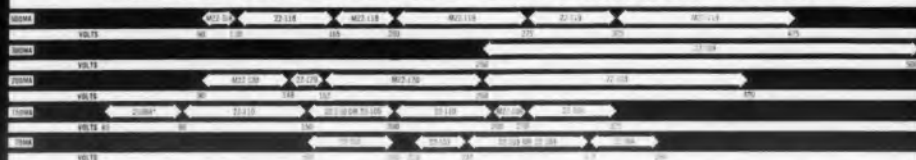
Beckman Scientific and Process Instruments Div., Dept. ED, Fullerton, Calif.

DRESSEN-BARNES STOCKS DC POWER MODULES

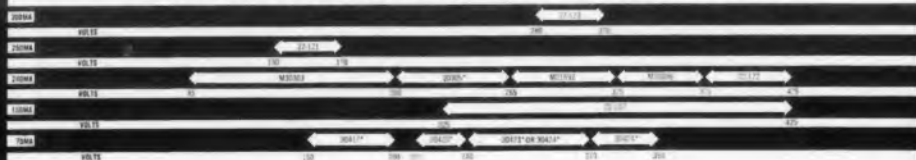
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To double current ratings - connect two modules in parallel. Contact factory for instructions.
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22-102, Etc. = D/B Model Number. M = Modified standard. * = Special.

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CIRCLE 173 ON READER-SERVICE CARD

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.

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CIRCLE 175 ON READER-SERVICE CARD

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 67th 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 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.



Standards Lab Accuracy from the Cubic Model MC-1B CALORIMETRIC WATTMETER



EASY TO USE • DIRECT
READING TO 600 WATTS
WIDE FREQUENCY RANGE
PRIMARY STANDARD
ACCURACY

The MC-1B, consisting of a Liquid Circulator and a Calorimetric RF Termination, is a precision instrument suitable for simple operation by non-technical personnel in production or field areas, yet providing primary standard accuracy for check-out of magnetrons and radar systems.

The Liquid Circulator contains a float-type flow meter, with a visual monitor of the fluid flow rate, control valves, pump assembly, reservoir and heat exchanger, all parts of nonferrous materials to prevent contamination of the fluid, distilled water.

The RF Termination is suited for the measurement of power in the microwave region, with adapters available for achieving an RF match greater than 1.15 in VSWR from 2600 to 26,500 mcs . . . without problems associated with the excitation and propagation of higher waveguide modes.

Features include a good RF match with the Termination, metered fluid flow, precision temperature readings and well designed control of heat transfer.

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DC Motors Cool running, quiet operating motors in especially compact designs where space requirements are rigid.

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stitching together a giant radome



Radome designed and built by Long Sault Woodcraft Limited, St. Andrews East, Quebec, for the United States Air Force RADC.

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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 μ a at 150 C, and 5 μ a 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 translator 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-Glax 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 μ f. 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.

How to determine high-frequency characteristics of precision film resistors

Specify with confidence from this complete line of time-proved TI resistors

MOLDED

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDM $\frac{1}{2}$	$\frac{1}{2}$	RN60B	10 Ohm-1 Meg	350
CDM $\frac{1}{4}$	$\frac{1}{4}$	RN65B	10 Ohm-1 Meg	500
CDM $\frac{1}{2}$	$\frac{1}{2}$	RN70B	10 Ohm-5 Meg	750
CDM 1	1	RN75B	10 Ohm-10 Meg	1,000
CDM 2	2	RN80B	50 Ohm-50 Meg	2,000

MIL-LINE

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CD $\frac{1}{4}$ R	$\frac{1}{4}$	—	10 Ohm-1 Meg	350
CD $\frac{1}{2}$ R	$\frac{1}{2}$	RN10X	10 Ohm-1 Meg	500
CD $\frac{1}{2}$ PR	$\frac{1}{2}$	RN15X	10 Ohm-3 Meg	650
CD $\frac{1}{2}$ MR	$\frac{1}{2}$	RN20X	10 Ohm-5 Meg	750
CD $\frac{1}{2}$ SR	$\frac{1}{2}$	—	50 Ohm-10 Meg	850
CD1R	1	RN25X	10 Ohm-10 Meg	1,000
CD2R	2	RN30X	50 Ohm-50 Meg	2,000

HERMETICALLY SEALED LINE

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDH $\frac{1}{4}$ M	$\frac{1}{4}$	—	10 Ohm-500K	250
CDH $\frac{1}{4}$ R	$\frac{1}{4}$	RN60B	10 Ohm-1 Meg	350
CDH $\frac{1}{2}$ R	$\frac{1}{2}$	RN65B	10 Ohm-1 Meg	500
CDH $\frac{1}{2}$ P	$\frac{1}{2}$	—	10 Ohm-3 Meg	650
CDH $\frac{1}{2}$ A	$\frac{1}{2}$	RN65B	10 Ohm-3 Meg	650
CDH $\frac{1}{2}$ M	$\frac{1}{2}$	RN70B	10 Ohm-5 Meg	750
CDH $\frac{1}{2}$ S	$\frac{1}{2}$	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1,000
CDH 2	2	RN80B	50 Ohm-50 Meg	2,000

†All values available in 1% tolerance, nominal lead length 1.5 in.

TECHNICAL SILICON RESISTORS

Type No.	Wattage Rating	Dimensions Length	Body Diameter	Average Temperature Coefficient %/°C	Resistance Tolerance %
TM $\frac{1}{4}$	$\frac{1}{4}$	0.585"	0.200"	+0.7	± 10
TM $\frac{1}{2}$	$\frac{1}{2}$	0.406"	0.140"	+0.7	± 10
TC $\frac{1}{2}$	$\frac{1}{2}$	TO-5	Transistor	+0.7	± 10

* TRADEMARK OF TEXAS INSTRUMENTS INCORPORATED
† Other resistance values and tolerances available on special order.

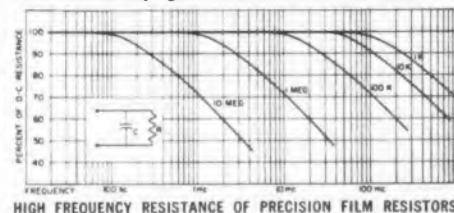


For a more detailed discussion of this subject, contact your nearest TI sales office for a copy of "High-Frequency Characteristics of Precision Film Resistors."

In high frequency applications, precision film resistors are superior to composition or wirewound resistors; skin effect of the thin film is negligible.

OHMIC VALUE vs FREQUENCY

Precision film resistors of a given physical size have the same distributed capacitances regardless of their ohmic value. As the frequency increases, the shunting effect of the distributed capacitance causes the effective parallel resistance to decrease. The reactance of the stray capacitance becomes a relatively good shunt when it approximates the ohmic value of the resistor. The smaller the ohmic value of a precision film resistor (for a given physical size), the higher its usable frequency range.

**INDUCTANCE CONSIDERATIONS**

The inductance caused by helixing the higher value resistors is negligible throughout the "useful" range of frequencies at which the resistance is greater than 60% of its d-c value.

When resistors under 500 ohms are measured using high frequency meters, the reactive component of the equivalent parallel circuit appears inductive because of lead and binding post inductance. However, the resistor itself is capacitive.

TI TYPE	SIZE (WATT RATING)				
	$\frac{1}{4}$	$\frac{1}{2}$	1	2	5
MIL-LINE (CD)	0.2	0.1	0.25	0.5	0.6
MOLDED (CDM)	0.3	0.25	0.45	0.7	0.7
HERMETICALLY SEALED (CDH)	0.3	0.25	0.45	0.75	0.8

CAPACITANCE IN μ of OF TI PRECISION FILM RESISTORS

CAPACITANCE CONSIDERATIONS

The average measured capacitance of Texas Instruments Precision Film Resistors is determined primarily by the end cap-to-cap capacitance which is proportional to the dielectric constant of the core and encapsulating material.

MOUNTING

Precision film resistors of 200 ohms or less perform satisfactorily at 5000 mc and higher if placed in a well-designed coaxial mount. A coaxial mount constructed from a standard UG-18B/U Type N plug can be used effectively. In conventional terminals, correct mounting of the body of the resistor off the circuit chassis and the use of short leads will minimize the stray capacitance and lead inductance.

Specify TI precision resistors!

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BY *Therm-O-Disc*



TYPE A—Adjustable

- Slow make or break contact;
- For operating temperatures up to 550°F.
- Resistive load—1500 watts at 120 VAC

TYPE HL

- Single pole, single throw or double pole, single throw
- Manual or automatic reset
- Preset, snap action, non-adjustable
- For operating temperatures up to 300°F.
- Resistive load—40 amperes at 125 VAC 25 amperes at 250 VAC



TYPE 11T-11

Best suited for controlling temperatures in air streams
same ratings as TYPE 11T-21



Designed for surface mounting
also available for watertight mounting

- High ratings with minimum size
- Single pole, single throw or single pole, double throw
- Preset, snap action, non-adjustable
- For operating temperatures up to 350°F.
- Blade or screw terminals, exposed or enclosed disc
- Resistive load—6000 watts at 240 VAC 3000 watts at 120 VAC
- Inductive load—10 amps, full load at 120 VAC 5 amps, full load at 240 VAC



TYPE 11T-21

TYPE AF & AL

- For fan motor or limit control
- 3" or 7" sensing element
 - Snap action—adjustable
 - For operating temperatures up to 300°F.
 - Fan or limit rating—1/2 h.p. at 120/240 VAC and 125 volt amperes at 120/240 VAC



TYPE WA

Best suited for controlling temperatures in air streams
same ratings as TYPE WC



TYPE WC

Designed for surface mounting
(with or without mounting bracket)

- Preset, snap action, non-adjustable
- Single pole, single throw
- For operating temperatures up to 350°F.
- Blade or screw terminals, exposed or enclosed disc
- Resistive load—2500 watts at 240 VAC 1650 watts at 120 VAC
- Inductive load—4.4 amps, full load at 120 VAC 2.2 amps, full load at 240 VAC



TYPE 20T

- Refrigeration and air conditioning control
- Hermetically sealed in all-metal case
- Single pole, single throw
- For operating temperatures up to 200°F.
- Resistive load—1000 watts at 120/240 VAC



Detailed information on request
Minimum production order quantity accepted—25



THERM-O-DISC, Incorporated Mansfield, Ohio

CIRCLE 181 ON READER-SERVICE CARD

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 non-inverting 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 $\pm 10\%$ 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 μ sec 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.

Q: What is a Kodak Ektron Detector?

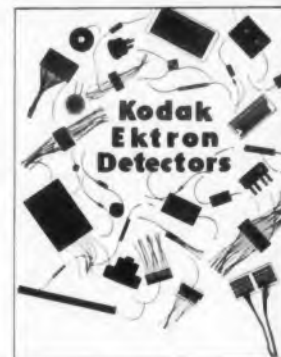
A: It is a photosensitive resistor. The photosensitive area can be laid down in any pattern. Response extends to 3.5 microns in the infrared. Unaffected by vibration; high signal-to-noise ratio.

Q: What can it be used for?

A: For such applications as an infrared sensor in weapons systems, and in instrumentation for process control, analysis, and safety.

Q: How can I get the facts about spectral response, types, availabilities, and the like?

A: By writing for a new brochure called "Kodak Ektron Detectors."



Write to:

Apparatus and Optical Division
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

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New... Revolutionary BLIND FASTENER with THREADS

MOLLY
JACK NUT



ACTUAL SIZE OF SMALLEST JACK NUT

The **ONLY** Blind Fastener
Which Grips **ANY** Material
From 0" to 3/16" Thick

MOLLY JACK NUT
IS EASY TO INSTALL.

- 1 Insert Jack Nut into hole. Needs only 1/8" expansion space.
- 2 Run in screw to collapse spider anchor backing by exerting pull on threads.
- 3 Jack Nut now is installed and ready to receive attachment screw.

Ask Your Industrial Distributor or
Write for FREE Brochure

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ELECTRONIC DESIGN • May 11, 1964



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MODEL NR-ESSM
automatic eyelet
attaching machine

This revolutionary machine, supplied as a complete installation, is obsoleting manual eyelet attaching and soldering. Leading manufacturers, in many cases using batteries of them, find Segal's new Model NR-ESSM is a completely dependable automatic method of making continuous electrical circuits of the printed elements on opposite sides of a board — or a single side if desired. Stakes and fuses 30 eyelets or more a minute, top and bottom, with never a reject.

There are other models for cold staking flat and funnel type eyelets, and for feeding and staking tube pins and turret terminals with equal reliability. All are highly economical. Segal can improve your eyelet attaching production. Write section ED-5.

Edward Segal Manufacturers of eyeletting machinery,
special hoppers and feeding devices
132 LAFAYETTE STREET, NEW YORK 13, N. Y.

CIRCLE 185 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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 Farndale 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.

LERMER PLASTIC CONTAINERS



Exceptional printing makes the difference...

Helps make the sale!

- Printed or decorated up to 4 colors on crystal clear, transparent or opaque colors
- Largest line of **RIGID** plastic containers
- 1/5 the weight of glass—greatly reducing ever-increasing shipping and handling costs
- Lightweight and shatterproof—with rigid wall protection
- Economical—with customer re-use value
- Also made of new high density polyethylene—Poly-Opal*. Are chemically inert, stain resistant and have lower permeability to moisture and gases than conventional polyethylene.

*T. M.

Write for full-color catalog, samples and prices.

LERMER PLASTICS, INC.



572 South Avenue
Garwood, New Jersey

PIONEERS AND SPECIALISTS IN
PLASTIC CONTAINERS SINCE 1919

CIRCLE 186 ON READER-SERVICE CARD

**the highest,
the coldest,
the hottest**

... IN THE SMALLEST SPACE!

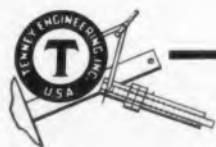


Tenney-mite STRAT environmental chamber

Altitudes to 200,000 ft., temperatures from -100° F to +350° F, in only 4 square feet of floor space. Now, any company can own a combined altitude and temperature test chamber . . . without sacrificing much valuable floor space. And the investment, too, is reasonable.

Only Tenney Engineering, world's largest and most experienced creator of environmental equipment, could produce the Tenney-mite Strat. Write for further information.

Write for a descriptive catalog and complete information on Tenney's research and development, engineering consultation, and design services.



Tenney
ENGINEERING, INC.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

1090 SPRINGFIELD ROAD, UNION, NEW JERSEY • PLANTS: UNION, NEW JERSEY AND BALTIMORE, MARYLAND
CIRCLE 187 ON READER-SERVICE CARD

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, 175 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.

SOLA AC and DC voltage regulation

Continuous, automatic, maintenance-free

Sola Constant Voltage Transformers and Regulated DC Power Supplies provide dependable, regulated output voltage. Their output regulation is unaffected by wide variations in input voltage.

Sola CV Transformers are static-magnetic regulators with completely automatic, continuous regulating action. Their response to variations in input voltage is usually 1.5 cycles or less. They have no moving or renewable parts

and require no maintenance.

Each Sola Regulated DC Power Supply incorporates a constant voltage transformer in combination with a semi-conductor rectifier and a high-capacitance filter section. This combination makes the power supply compact, dependable, and efficient; and assures sustained output voltage in the face of pulse or intermittent loads, or heavy, short-time overloads.

Sola Constant Voltage Transformers



Standard Sinusoidal Type provides voltage regulation of $\pm 1\%$ with primary voltage variations as great as $\pm 15\%$. With less than 3% total rms harmonic content in their output voltage wave, these units are desirable for use with equipment having elements sensitive to power frequencies harmonically related to the fundamental. Available in nine ratings, 60va to 7.5kva.



Normal-Harmonic Type also provides $\pm 1\%$ regulation at somewhat less cost. This group has an average of 14% total rms harmonic content in its output voltage wave, and is suited to equipment not extremely sensitive to voltage wave shape. The series includes those mechanical designs specially engineered for use as built-in components. Nineteen stock ratings range from 15va to 10kva.



Adjustable Sinusoidal Type provides $\pm 1\%$ regulated voltage output—one output adjustable from 0-130 volts and one fixed at 115 volts. Has less than 3% total rms harmonic content in output voltage. Portable for use in shop or laboratory, or mount on standard relay rack.



Electronic Power Type regulators provide $\pm 1\%$ regulated filament voltage at 6.0 and 6.3-volt levels; or a combination of plate and filament voltages regulated $\pm 3\%$ for $\pm 15\%$ input variations. Filament regulators are available in ratings from 2.3 to 25 amps. One model is specially designed for portable lab or shop bench use; it has a 30va rating. Combination plate/filament regulators, in three stock sizes, are designed to operate with commonly-used rectifier tubes.



Custom-designed units can be supplied in production quantities in ratings from 1va to 25kva to suit individual specifications. Custom designs can include special mechanical structures, various voltage ratios, special frequencies, compensation for frequency variations, multiple output voltages, three-phase service. Units can be manufactured to military specifications.

For additional information on Sola Constant Voltage Transformers, write for Circular 31E-CV

Sola Constant Voltage DC Power Supplies

For intermittent...variable
...pulse...or high-current loads



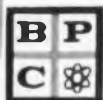
Fixed-output-voltage designs are available in six stock models with ratings from 24v @ 6a to 250v @ 1a. They are extremely compact, light-weight, and moderately priced in proportion to their power output and performance.



Adjustable-output designs provide a considerable range of regulated dc test voltages. Accessory handles offer portability and permit self-stacking. Six models are available with outputs ranging from 5v @ 7a to 400v @ 0.6a.

For additional information on Sola DC Power Supplies, write for Circular 31E-DC

SOLA



Sola Manufactures: Constant Voltage Transformers, Regulated DC Power Supplies, Constant Voltage Mercury Lamp Transformers and Fluorescent Lamp Ballasts

SOLA ELECTRIC CO.

A Division of Basic Products Corporation

4633 West 16th Street, Chicago 50, Illinois, Blshop 2-1414 • In Canada, Sola Electric (Canada) Ltd., 377 Evans Avenue, Toronto 18, Ontario

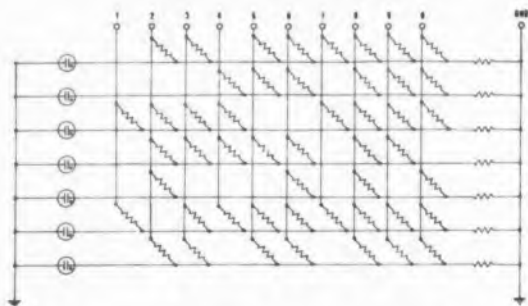
CIRCLE 188 ON READER-SERVICE CARD

This G-E Glow Lamp...

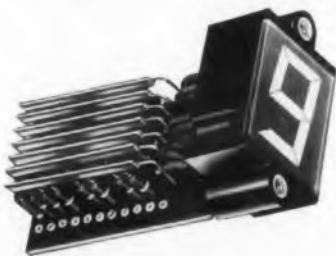


NE-2E

in this circuit...



lets this I.D.E.A. Readout...



send a message—by the numbers!

Here's the model SGS-101 Digital Readout, made by I.D.E.A. Inc., Indianapolis, Indiana. The numeric readout is accomplished through the use of cut-out lines which, when lighted, give a visual reading of any numeral from "1" through "0". General Electric NE-2E Glow Lamps function as circuit elements in the logic matrix, in addition to providing the illumination on the face of the readout.

Why the G-E NE-2E Was Chosen. The formed-tip construction used on the NE-2E provides better end-on brightness than can be obtained with the random-tipped NE-2 types. Decreased overall length ($\frac{3}{4}$ " rather than $1\frac{1}{16}$ ") also makes the lamp appealing for this application. Since the NE-2E is designed primarily for indicator rather than circuit component usage, lamps are seasoned and selected by I.D.E.A. Inc. before installation in the logic matrix.

The I.D.E.A. Digital Readout is one example of how a General Electric Glow Lamp performs its intended function—and a little bit more. You'll find the same flexibility and dependability in the G-E Glow Lamp you choose for your own circuitry. For latest glow lamp engineering specifications write: General Electric Co., Miniature Lamp Dept. M-013, Nela Park, Cleveland 12, Ohio. Ask for: Specification sheet #3-092 "G-E Glow Lamps for Circuit Component Use".

Progress Is Our Most Important Product

GENERAL  ELECTRIC

CIRCLE 189 ON READER-SERVICE CARD

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-programmed, 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



PRECISION

ELECTRONIC

ADJUSTABLE-SPEED DRIVES

- **SPEED RANGE** Infinitely adjustable from less than 36 rpm to more than 3600 rpm while delivering full rated torque. Continuous duty rating at all speeds.
- **REGULATION** Both line and load regulation is better than $\frac{1}{2}$ of 1% of rated speed.
- **HORSEPOWER** Various models from $\frac{3}{4}$ hp down to $1/200$ hp. Motors of $\frac{1}{4}$ hp and larger are totally enclosed.
- **REMOTE CONTROL** A 10-turn potentiometer provides precise adjustment at any convenient location.
- **GEARED MOTORS** Motors are available with integral gear reducers.
- **BRAKING-REVERSING** Relay-controlled braking and reversing models available.
- **MAINTENANCE** Fully encapsulated construction results in long service life. Plug-in construction requires only a screwdriver for servicing.
- **OTHER MODELS** Servo-Tek manufactures drives with silicon rectifiers and adjustable autotransformers, as well as other thyatron drives with less exacting specifications. Write for information including details of your proposed use.

IMMEDIATE DELIVERY

Servo-Tek

PRODUCTS CO.
INCORPORATED

Main Office

1086 Gaffle Road, Hawthorne, N. J.

Western Office

14736 Armita Street, Van Nuys, Cal

CIRCLE 190 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

JERROLD

R. F. Test Equipment

Quantitative Measurements Using Sweep Frequency Techniques



Model 900A—THE MOST VERSATILE SWEEP GENERATOR \$1,260.00

CENTER FREQUENCY—VHF 0.5 to 400 MC
UHF 275 to 1000 MCS—SWEEP WIDTH—
up to 400 MCS—FLATNESS— ± 0.5 db over
widest sweep!



Model 707—ULTRA FLAT SWEEP GENERATOR \$795.00

Featuring $\pm 5/100$ db flatness—Plug-in osc. heads*; variable sweep rates from 1/min. to 60/sec.; all electronic sweep fundamental frequencies; sweep width min. of 1% to 120% of C.F.

*Heads available within the spectrum 2 to 265 MCS

Models 601/602—PORTABLE GENERAL PURPOSE \$295.00

COVERAGE—Model 601—12 to 220 MCS. Model 602—4 to 112 MCS—FLATNESS — ± 0.5 db
OUTPUT—up to 2.5 V RMS
WIDTH—1% to 120% of C.F.



Model FD-30 \$250.00

High speed DPDT coaxial switch permitting oscilloscope measurements without calibration—all measurements referenced continuously against standard attenuators.



Model AV-50

Variable Precision Attenuator \$150.00
Long life rotary switches; dual wiping silver contacts on "Kel-F" dielectric. 0-62.5 db in $\frac{1}{2}$ db steps; DC to 500 MCS.

Write for catalog and technical Newsletter series on measurements using sweep frequency techniques. Prices and data subject to change without notice.

JERROLD ELECTRONICS CORPORATION
Industrial Products Division Dept. IFE-33
The Jerrold Building, Philadelphia 32, Pa.
Jerrold Electronics (Canada) Ltd., Toronto
Export Representative: Rock International, N.Y. 16, N.Y.

CIRCLE 191 ON READER-SERVICE CARD

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.



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 2 1/2 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

2 NEW GENERAL-PURPOSE OSCILLOSCOPES

introduce **TEKTRONIX QUALITY** to the
DC-to-450 KC RANGE



The Tektronix Type 503 and Type 504 are the first of a family of new oscilloscopes for the DC-to-450 KC application area.

- Both feature high reliability, simple operation, light weight.
- Each excels in performance characteristics in its class.
- Both now established as production instruments.



CAREER OPPORTUNITIES now exist at Tektronix in the following fields: Instrument design, Circuit design and engineering, Cathode ray tubes, Electron physics, Solid state and semi-conductor devices. For information write to Irving Smith, Personnel Director.

Tektronix, Inc.

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

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TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations. In Europe please write Tektronix Inc., Victoria Ave., St. Sampson's, Guernsey C.I., for the address of the Tektronix Representative in your country.

CIRCLE 193 ON READER-SERVICE CARD

TYPE 503

The Type 503 is a differential-input X-Y oscilloscope with the additional features—linear sweeps, dependable triggering, sweep magnifier, bright trace, amplitude calibrator—desirable for general-purpose applications.

FREQUENCY RESPONSE

dc to 450 kc

VERTICAL AND HORIZONTAL AMPLIFIERS

Differential input at all attenuator settings.

1 mv/cm to 20 v/cm in 14 calibrated steps.

Continuously variable between steps, and to approximately 50 v/cm uncalibrated.

Constant input impedance at all sensitivities (standard 10X probes can be used).

SWEEP RANGE

1 μ sec/cm to 5 sec/cm in 21 calibrated steps.

Sweep time adjustable between steps, and to approximately 12 sec/cm uncalibrated.

SWEEP MAGNIFICATION

X2, X5, X10, X20, and X50 Magnification.

AMPLITUDE CALIBRATOR

500 mv and 5 mv peak-to-peak square-wave voltages are available from front panel.

3-KV ACCELERATING POTENTIAL

5-inch Tektronix crt provides bright trace, 8-cm by 10-cm viewing area.

EASY TRIGGERING

Fully automatic, amplitude-level selection on rising or falling slope of signal, or free-run (recurrent). AC or DC coupling, internal, external, or line.

REGULATED POWER SUPPLIES

All critical dc voltages electronically regulated, plus regulated heater supplies for the input stages of both amplifiers.

SIZE AND WEIGHT

13 1/2" h, 9 3/4" w, 21 1/2" d — approximately 29 lbs.

TYPE 504

The Type 504 has the basic features desirable for most general-purpose applications — sensitive vertical amplifier, linear sweeps, easy triggering, amplitude calibrator.

FREQUENCY RESPONSE

dc to 450 kc

VERTICAL AMPLIFIER

5 mv/cm to 20 v/cm in 12 calibrated steps.

Continuously variable between steps, and to approximately 50 v/cm uncalibrated.

Constant input impedance at all sensitivities (standard 10X probe can be used).

SWEEP RANGE

1 μ sec/cm to 0.5 sec/cm in 18 calibrated steps.

Sweep time adjustable between steps, and to approximately 1.2 sec/cm uncalibrated.

AMPLITUDE CALIBRATOR

500 mv and 25 mv peak-to-peak square-wave voltages are available from front panel.

HORIZONTAL INPUT

0.5 v/cm, with variable attenuator.

3-KV ACCELERATING POTENTIAL

5-inch Tektronix crt provides bright trace, 8-cm by 10-cm viewing area.

EASY TRIGGERING

Fully automatic, amplitude-level selection on rising or falling slope of signal, or free-run (recurrent). AC or DC coupling, internal, external, or line.

REGULATED POWER SUPPLIES

All critical dc voltages electronically regulated, plus regulated heater supplies for the input stages of the vertical amplifier.

SIZE AND WEIGHT

13 1/2" h, 9 3/4" w, 21 1/2" d — approximately 29 lbs.

Rack-mounting models will be available, of course!

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 5×10^{-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, 80 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

724

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 1N2864, 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

714

Weights 30 g

Model DAC-94 digital-to-analog converter, constant current generator, delivers 0.01 μ a 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 weighs

30 g. Over the temperature range of -20 to $+140$ F, linearity of the unit is $\pm 2\%$ for output voltages to 20 mv. Models delivering 0.1 μ a 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.



Model QM6.3-32. Miniature Transistorized Regulated D-C Supply features regulation to $\pm 0.05\%$ for combined line and load variations. This is one of more than 180 miniature component-type power packs offered by Sorensen. They include, in addition to highly regulated d-c supplies, dc-to-ac inverters and dc-to-dc converters.



Model Q12-15A. One of the 15 Sorensen Q Series high-precision transistorized low-voltage supplies, features voltage regulation to $\pm 0.05\%$ for combined line or load variations. Models for 6, 12, 28 vdc out, with power capacities up to approximately 240 watts. Similar QR Series features precision regulation with wide output voltage adjustment range. Two models: 0-75vdc at 2 amps max and 0-36vdc at 4 amps max.



Model 2150-5 (Control Section). This is just one of a tremendous variety of Sorensen high-voltage d-c supplies, high-voltage a-c and a-c/d-c testers, and electrostatic generators. Models completely cover the voltage range from 1000 to 600,000 volts. Power outputs range up to 60 kilowatts.

3 out of 400 power supplies

listed in the **BIG, NEW SORENSEN "Power Supply Handbook and Catalog"**

32-pages of important specifying data on...

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More than 400 models are covered . . . plus important technical selection and application data. Write for your copy of the new Sorensen catalog today. Sorensen & Company Inc., Richards Avenue, South Norwalk, Connecticut. O 12



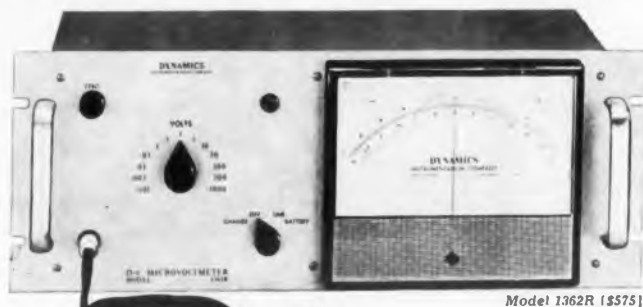
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**CONTROLLED
POWER
PRODUCTS**

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D-C Microvoltmeter



Model 1362R (\$575)

ELIMINATES THE POWER LINE
FROM LOW-LEVEL MEASUREMENTS IN SENSITIVE CIRCUITS

Totally Isolated and Fully Insulated from Rack and from Power Line.
12 Hours Continuous Operation from Permanent Nickel-Cadmium Battery.
Over 100 Megohms Input Impedance on All Ranges.
Automatic Recharge When Operated on Power Line.
Withstands 1000 volts Overload on Any Range.
2-Year Warranty (both Parts and Labor).

DYNAMICS
INSTRUMENTATION COMPANY

583 Monterey Pass Road, Monterey Park, California

All-Transistor
Design

Reliable
Low-Voltage
Circuitry

Accuracy $\pm 1\%$ (fs)

Extra-long
Mirror Scale (7.2")



Model 1362 (\$550)

CIRCLE 195 ON READER-SERVICE CARD

NEW PRODUCTS

Insulation Material

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

Depth is 1.5 in.



These digital readouts can be instantly snapped in and out of their mountings. Available in both 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

Come in three types

These three laminates are: a melamine resin impregnated glass cloth laminate for use when high humidity is a problem; graphite fabric and asbestos base laminates designed for short-time applications at 5000 F; and a new grade of XXX material, copper clad for printed circuit use.

Continental-Diamond Fibre Corp., Dept. ED, Newark, Del.

Rotary Switches

Modular design

Designed for switching multiple circuits in T broadcasting operations, series VSD modular rotary switches are remotely controlled and adaptable to various methods of control within T



Mystik Mylar Tape is composed of a smooth, thin, highly flexible polyester film backing and an instant adhering silicone adhesive. Consistent performance under exacting electrical, and limited space conditions. (Thermal limits, -80 to +325°F.). One of the most effective electrical insulating tapes.

Other Mystik Brand electrical tapes:
7000-G: For extreme temperature demands (-110 to plus 550°F.). Tightly woven Fiberglass® backing. Superior electrical qualities.

7100-G: Same characteristics as 7000-G with silicone adhesive on two sides.

Write for complete information
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2635 N. Kildare Ave., Chicago 39



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Preformed solder, all shapes and sizes engineered to your needs; rings, washers, discs, coils, pellets, others. Flux filled or solid types, all alloys including rare metals.

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ELECTRONIC SUPPLY GUIDE

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ELECTRONIC DESIGN • May 11, 1960

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 $\pm 0.75\%$. 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.

A NEW LINE OF

AEL

MICROWAVE COMPONENTS



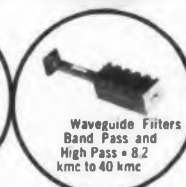
CIRCULARLY POLARIZED HORN ANTENNAS

X band to Ka band

New . . . from AEL . . . The first complete line of circularly polarized horn antennas to operate over this broad microwave band. On request this frequency range can be extended downward to 4000 MC with existing designs or can be built to customer specifications. Horns are cast aluminum with teflon front cover and are built to Mil-specs.



Coaxial crystal detector mounts • 50 mc to 12 kmc



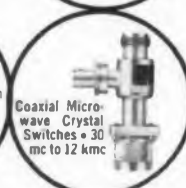
Waveguide Filters Band Pass and High Pass • 8.2 kmc to 40 kmc



Conical Helix and Log Periodic Antennas Broad Band 40 mc to 12 kmc



Waveguide Crystal Detector Mounts • 8.2 kmc to 40 kmc, aluminum high tangential sensitivities



Coaxial Microwave Crystal Switches • 30 mc to 12 kmc



Waveguide Dummy Loads • Low VSWR Lightweight—High Power—High Efficiency



**AMERICAN ELECTRONIC
LABORATORIES, INC.**

121 N. 7th ST.,
PHILADELPHIA 6, PENNA.

In Canada contact: Conway Electronic Enterprises Regd., Toronto, Canada

CIRCLE 199 ON READER-SERVICE CARD

DESIGN DECISION



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



We have the facilities; the know-how is free

Consider these three, of many, reasons why it is to your advantage to let us fabricate your laminated plastics parts.

First, we have the facilities for the job. Saws, millers, drills, lathes, punch presses, planers, sanders. Hundreds of them. Many are standard machine tools modified to machine laminated plastics quickly and easily.

Others are special, designed primarily for the high-speed production possible with laminated plastics.

Second, behind the machines are people who know practically every trick in the book for turning out a first-class job fast. They also know what to avoid doing.

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terms of money, in headaches, in possible errors, waste or delays. Call a Synthane representative near you for a quotation—you'll find him in any principal city or write Synthane Corp., 42 River Road, Oaks, Pa.

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a new member to the family

The addition of the new "BC" Relay enables Hi-G to fill any micro-miniature requirement in the B and BC series.

B SERIES — DPDT

Dimensions: .4 x .8 x .875 high
Sensitivity: 200 to 300 MW at pull-in at 25°C

BC SERIES — DPDT

Dimensions: .4 x .8 x 1.275 high
Sensitivity: 25 MW at pull-in at 25°C, 40 MW at 125°C

B and BC SERIES

Contact Rating: Dry circuit to 2 amperes at 115 V AC or 32 V DC, 100,000 operations min.
Temperature: -65°C to +125°C standard
Vibration: 20G to 2000 CPS standard or better, please specify

Shock: 50G standard or better, please specify
Four standard header styles — hook, plug-in, 1½" or 3" leads, standard.
Five enclosure styles — plain, side strap, top stud, side stud, brackets.
Also available are 60 CPS or 400 CPS versions in BR and BCR types.

Send your micro-miniature relay requirements for prompt engineering evaluation — today.

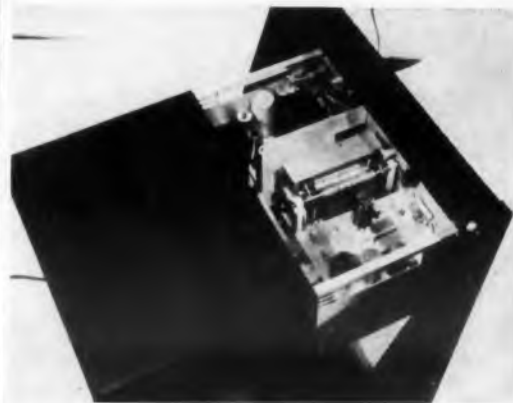


Hi-G

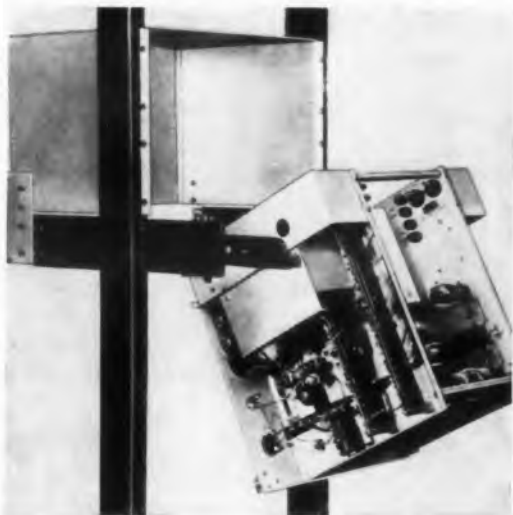
INC.

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



THE ONLY COMPLETE LINE OF BALANCED ROTARY RELAYS

BRADLEY FIELD, WINDSOR LOCKS, CONN.

CIRCLE 201 ON READER-SERVICE CARD

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.



"IN A STEW" OVER ELECTRONIC CONTROL? UAP PACKAGING TECHNIQUES CAN HELP YOU!

You are encouraged to contact UAP at the very outset of projects involving electronic control. Concurrent with your overall design of the electronic package, UAP engineers will apply their specialized capabilities to specific problems involving *temperature, mechanical or mass flow control*. Cited below is a successful defense project involving concurrent UAP-customer teamwork.

UAP supplied Hazeltine Corporation, one of the nation's large defense contractors, with 13" x 10" cold plates for center-mounting within electronic guidance equipment. Areas were provided so small components could be mounted to the cold plate surface between larger power units. The cold plate dissipates 570 watts from varying heat concentration areas. Cold plate temperature does not exceed 173° F., with plate air-in temperature of 150° F. This permits use of less expensive electronic components. The entire package is contained in a UAP pressurized case.

UAP can meet your requirements too! Send them to:
UNITED AIRCRAFT PRODUCTS, INC., Dayton, Ohio
(Contractual Engineering Offices: California, Gardena FA 1-4810; New York City MU 7-1283; Dayton, Ohio BA 4-3841; Canada, Montreal OX 7-0810)
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CIRCLE 202 ON READER-SERVICE CARD



U-522277 Forced Air Cooling System



good reasons for letting
KNAPIC grow your
Silicon Crystals

- HIGHEST QUALITY
- UNLIMITED PRODUCTION CAPACITY
- LOWEST COST PER GRAM
- NO CAPITAL INVESTMENT
- NEW MATERIAL RESEARCH
- SPECIFICATIONS TO ORDER

KNAPIC specializes in Silicon and Germanium Crystals for Semiconductor, Solar Cell and Infrared uses

Major manufacturers of semiconductor devices have found that Knapic Electro-Physics, Inc. can provide production quantities of highest quality silicon and germanium monocrystals far quicker, more economically, and to much tighter specifications than they can produce themselves.

The reason? Knapic Electro-Physics are *specialists* with accelerated experience in growing new materials to specification.

Why not let us grow your crystals too?

Check These Advantages

- Extremely low dislocation densities.
- Tight horizontal and vertical resistivity tolerances.
- Diameters from 1/4" to 2". Wt. to 250 grams per crystal. Individual crystal lengths to 10
- Low Oxygen content 1×10^{17} per cc., 1×10^{16} for special Knapic small diameter material.
- Doping subject to customer specification, usually boron for P type, phosphorous for N type.
- Lifetimes: 1 to 15 ohm cm.—over 50 microseconds; 15 to 100 ohm cm.—over 100 microseconds; 100 to 1000 ohm cm.—over 300 microseconds. Special Knapic small diameter material over 1000 microseconds.

Specification Sheets Available

... Also manufacturer of large diameter silicon and germanium lenses and cut domes for infrared use

CIRCLE 203 ON READER-SERVICE CARD



Dislocation density, Knapic silicon monocrystals grown by a modified Czochralski technique: Crystal diameter to 3/4" — None; 3/8" to 3/4" — less than 10 per sq. cm.; 1/4" to 3/8" — less than 100 per sq. cm.; 1/8" to 2" — less than 1000 per sq. cm.



Knapic Electro-Physics, Inc.

875-40 Industrial Ave., Palo Alto, Calif. • Phone DAvenport 1-6644

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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.

DRAFTING TRENDS



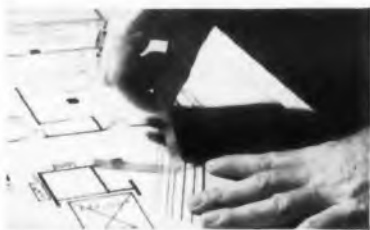
A GLUTTON FOR PUNISHMENT. The image, pencil or ink, on POST Polytex stays put. Won't rub, flake or peel off accidentally, yet can be erased. Duralar pencil lines bond to the surface readily. Soiled originals can be washed with water and detergent!

New POST-perfected Polytex takes pen or pencil perfectly

You already know that drafting films offer the advantages of tremendous durability and dimensional stability. Now, thanks to an exclusive, precision process, Post offers a drafting film with superlative drafting characteristics. The surface of Post 126 Polytex is unmatched for ink receptivity, has a coating that stands up, erasure after erasure. Ink lines won't pull off when cellophane tape is applied firmly over them and then suddenly yanked off. Transparency is excellent.

If you prefer pencil, use a Post Duralar lead for permanence. Plastic-based Duralar lines actually bond themselves to the Polytex surface. Drawings won't easily smudge or smear . . . can even be washed with soap and water.

By using new Polytex, with DuPont Mylar base, you avoid the drawbacks which show up in some



TAPE TEST proves remarkable adhesion of inked lines to the surface of POST 126 Drafting Film, lines which do not feather out or spread.

films . . . a drawing surface too slick to retain a pencil or pen line . . . too soft for use with hard pencil after erasures.

Enjoy the flexibility and long life of a drafting film with an ideal drafting surface. Try new 126 Polytex Drafting Film.

For more information, see your local Post Blueprinter, or write Frederick Post Company, 3644 N. Avondale Avenue, Chicago 18, Illinois.



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CIRCLE 204 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

DESIGN

High-Frequency Cable Length Nomogram

R. J. Plugge
The Martin Co.
Baltimore, Md.

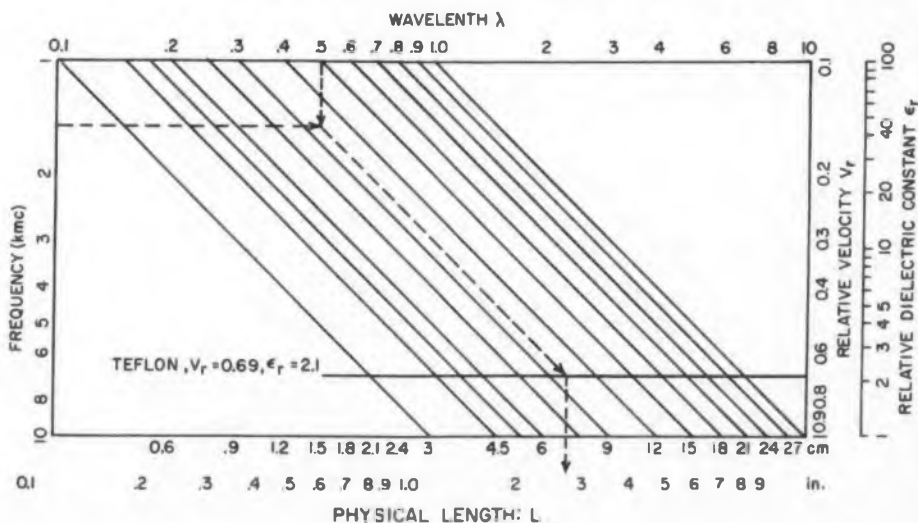
LENGTHY calculations can be eliminated when converting electrical length lines to physical lengths values using the nomogram shown. Although the chart is inadequate for exact computations, the time-saving advantage should be of help when reasonable approximations are permissible.

Illustrative example: Determine the physical length of a 0.5λ line using Teflon dielectric at 1.5 kmc.

Solution: Draw a horizontal line from 0.5λ . 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 ($\epsilon_r = 2.1$) 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. ■ ■





NOW . . . REGULATE 1KV WITH THIS HERMETIC SEAL Miniaturized AC REGULATOR

NOW . . . nearly a kilowatt of AC power can be regulated by this special Hermetic Seal Unit weighing less than 10 pounds. Built to Mil-E-5400 and Mil-E-5272 specifications, it is primarily magnetic assuring high reliability for critical aircraft and missile power regulation requirements. For regulating three-phase power, a package of three units performs efficiently. Write for literature describing electrical and mechanical characteristics of this entire family of AC Regulators.

SPECIFICATIONS: MODEL NO. VRAC-104

ELECTRICAL CHARACTERISTICS: ENVIRONMENT CONDITIONS:

INPUT: 108 to 122 volts
 FREQUENCY: 380 to 420 cycles
 OUTPUT: 115V \pm 1V from 2 to 8 amperes
 RESPONSE: < 100 ms / 9V_N increments
 DISTORTION: 5% max over input voltage and frequency range (exclusive of source)
 OPERATING TEMPERATURE RANGE:
 —55°C to +71°C
 DUTY CYCLE: Continuous

Altitude: to 50,000 ft.
 Humidity: 95% 50°C 360 hours
 Shock: 15 g's
 Vibration: 10 g's 5 to 500 cycles

MECHANICAL CHARACTERISTICS:

Size: 5" x 5" x 12"
 Weight: Less than 10 lbs.

WRITE FOR BULLETIN NPB-106

HST Special Products Division designs and produces customized regulators, power supplies, servo amplifiers, and other special packaged electronic components for industrial and military uses. Write us your requirements; we will gladly submit recommendations and quotations without obligation.

SPECIAL PRODUCTS DIVISION

2925 Merrell Road Dallas 29, Texas Phone Fleetwood 7-4348

CIRCLE 205 ON READER-SERVICE CARD

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-

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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, Wis.

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.



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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



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ELECTRONIC DESIGN • May 11, 1960

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.

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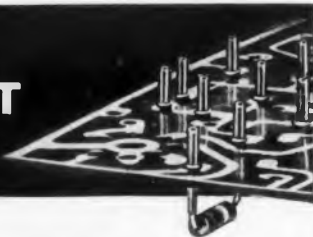
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NEW LITERATURE

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.

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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

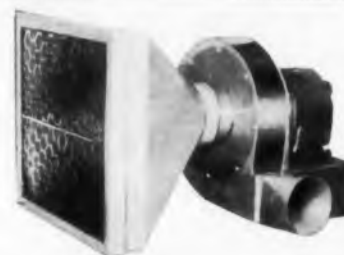
Four-page bulletin No. 2A, entitled "Excitation of Magnetic Pickups With Gears," describes factors to be considered in the excitation of magnetic pickups. Curves that show the change in magnetic pickup output are included. Electro Products Laboratories, Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.

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.

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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. Aero-vox 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.



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ELECTRONIC DESIGN • May 11, 1960

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. Coming 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 pre-amplifiers 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

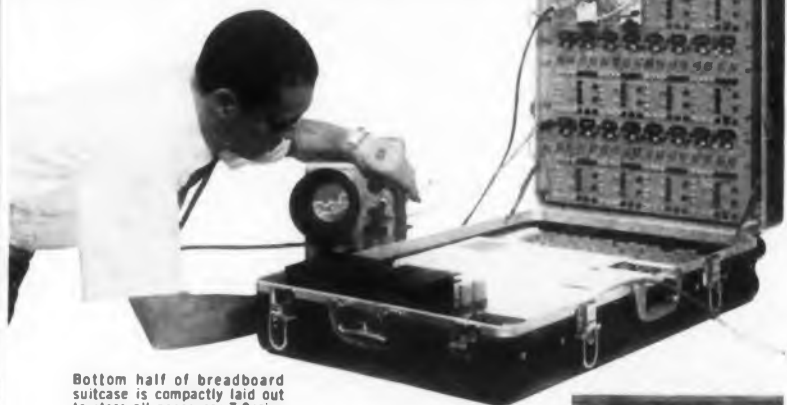
This 24-page handbook lists semiconductors of 9 manufacturers in sequences by parameter and function, and by transistor and diode type number. A section of dimensioned mounting diagrams is included. Radio Shack Corp., I & G Div., Boston 17, Mass.

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... Complete transistorized EECO Digital System Breadboard

Designers who want to go places fast systemswise can be sure of getting there on time with an EECO suitcase. It's packed with a complete and integrated breadboarding system designed around mutually compatible EECO T-Series Germanium circuit modules, N-Series transistorized decades, and R-Series Minisig® sensitive indicators.

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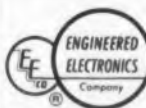
Bottom half of breadboard suitcase is compactly laid out to store all necessary T-Series circuit modules, circuit cards, patch cords, and compatible power supplies.

EECO T-Series breadboard equipment is available in both suitcase and rack-mounted types. Breadboard Kits of any degree of complexity can be built up in stages, according to the specific panels and number of circuits incorporated. Compatible interconnections between racks or suitcases further enable the designer to expand the equipment into a complete systems development console. Compatible solid-state, convection-cooled power supplies are also available in two different models: ZA-720 is a dual 12-volt, 5-amp supply; ZA-721 is a 12-volt, 1-amp plug-in power supply.

FEATURES

- Permits rapid formulation of digital electrical systems.
- System may be operated slowly to permit inspection of its mode of operation, or over-speed to indicate system derating.
- Operation may be analyzed with a minimum of test equipment.
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- Minimizes wiring errors and the inclusion of defective parts.
- Circuit cards provide a means for rapidly visualizing the system, and facilitate drawing a circuit diagram.
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A request, on your company letterhead, will bring detailed information on the flexibility of the EECO T-Series Breadboarding equipment, and a demonstration if desired.



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Circuit cards are selected according to the system it is desired to breadboard and placed on the panel in alignment with the jack pattern. Corresponding T-Series circuit modules are plugged in above each card.



Circuit interconnections are made by patching through holes in the circuit cards. Resulting pattern of symbol cards and patch cords shows a schematic and bill of materials for the system, once it is checked out.

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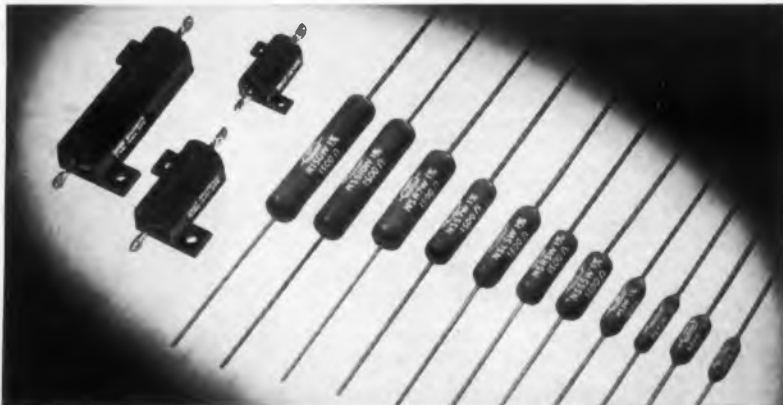
WHAT IS "IMPERVOHM"? . . . It is a new non-porous silicone encapsulant representing a significant moisture seal "break through," which has been developed exclusively for SAGE Characteristic "G" and "V" Power Resistors.

WHAT ARE ITS ADVANTAGES? . . . Because of its unusual characteristics attributed to optimum balance of resin and precise filler particles, this new coating requires no compromise in offering:

- Improved heat endurance (-65°C to +350°C).
- Superior resistance stability (0.1%) after severe moisture cycling.
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- New ruggedness in ultrasonic solvent wash not previously available. These features signify an insulating achievement unmatched in the power resistor field.

WHERE DO SAGE "IMPERVOHM"-SEALED RESISTORS EXCEL? Component and Circuit Design Engineers will be wise to specify SAGE in all applications demanding critical sensitiveness to moisture and temperature extremes. They will also take advantage of the insulation ruggedness these Resistors offer for printed circuit assembly as well as for metal chassis contact mounting. Of special significance in all cases is long life environment protection.

YOU PAY NO PREMIUM FOR "IMPERVOHM" PROTECTION . . . This remarkable coating is now "Standard" on SAGE Resistors—conventionally wound types "S" and "CS" and non-inductively wound types "NS" and "NCS."



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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.

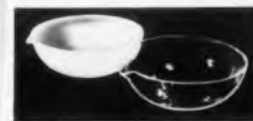
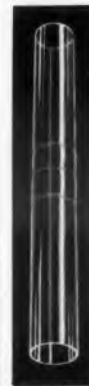
Fasteners

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.

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ELECTRONIC DESIGN • May 11, 1960

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 nong geared electric motors from 1/2000 to 25 hp are listed in this catalog, 28 pages. In addition, thyatron 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.



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CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 261

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

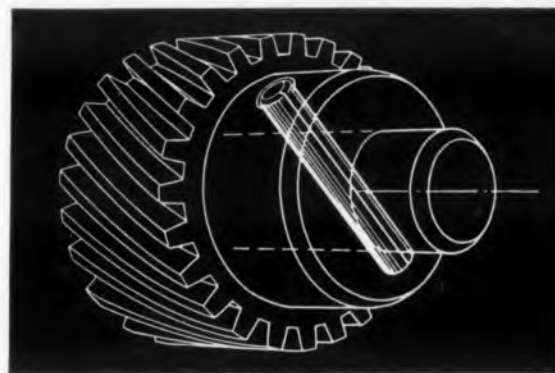
The K-100 series control chassis are described in this two-page bulletin, No. 100-A. Block diagrams for two models in the series are included, in addition to a dimension drawing, general description and operation data. Datec Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

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



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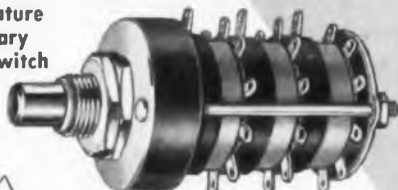
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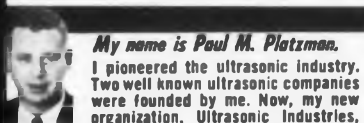
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ELECTRONIC DESIGN • May 11, 1960

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.



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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 Nav-Ships 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.

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CIRCLE 236 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960



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

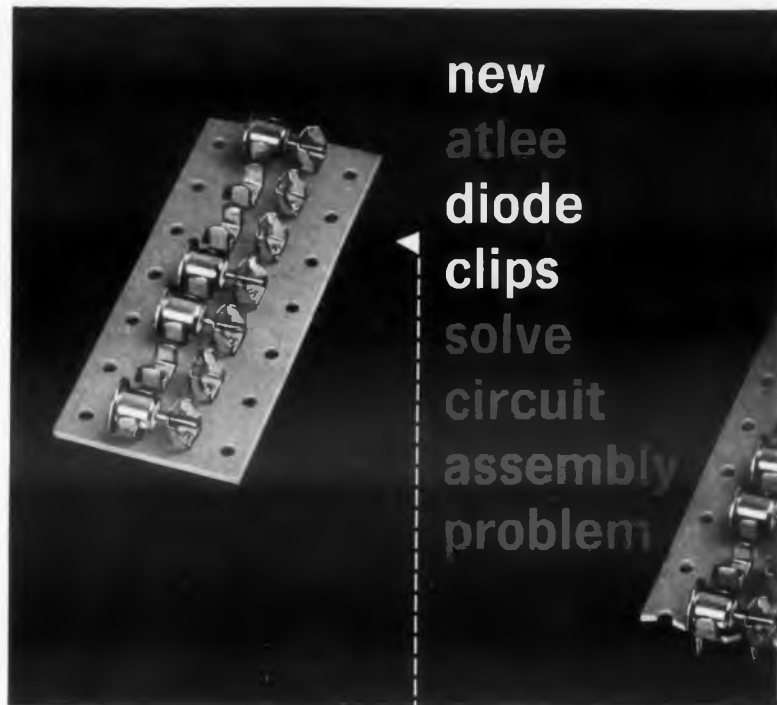
This four-page folder, No. 1159, discusses the use of printed circuits. The types of insulating materials and the current capacity in relation to width of copper conductive pattern are described. The booklet also lists the choice of metals available for the conductive pattern as well as the types of 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.



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diode
clips
solve
circuit
assembly
problem

Assembly and service of circuits containing solid-state diodes or rectifiers is greatly simplified by the use of these new mounting devices. Components are quickly snapped into place, or removed by a simple twist, without disturbing soldered connections.

ELECTRICAL CONTACT is positive under all conditions of shock and vibration. Special design of case clip and Wyr[®] clip assures penetration of surface film or oxide, maintains lowest contact resistance to component body and soldering lead.

CIRCUIT CONNECTIONS are not disturbed by replacement or removal of the component. Printed circuit connection is made through the attachment rivets or eyelets. Soldered connection is made to integral lugs passing through the mounting surface.

COMPONENT SECURITY is certain, and not changed by repeated insertions and withdrawals. Severe vibration and shock cause no visible shifting, no change in contact resistance. Yet a gentle twist removes the component for replacement or substitution.

These new **atlee** clips accommodate diode or rectifier cases from .245" to .270" O.D. In spring-tempered phosphor bronze, they are available separately in bulk for attachment by rivets or eyelets, or ready mounted in strips as illustrated. Write today for details — and learn how little it costs to eliminate a lot of trouble!

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One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.



Specifications:

Input: 105 to 125V AC, 45 to 420 cps. single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance



Designed primarily as a component power supply, units are widely used in computers, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above, Model =1R 90-1; 85-95 V; 0-100 ma; Price \$145.00) Prices on other units range from \$100 to \$200.

All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
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Reliable short circuit protection
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CIRCLE 238 ON READER-SERVICE CARD

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 supplies 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.

Now 2 to 3 week delivery on popular BUORD* items...



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Mark 7 Mod 0	Size 15 Servo Motor
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TRANSISTORIZED



ACTUAL SIZE
7/8" DIA. x 2 1/8" SEATED

IF YOU USE BINARY COUNTERS . . . You should select from Walkirt's big assortment of proved reliability, encapsulated counters. We make NPN and PNP types, Germanium or Silicon, in many physical configurations. We'd like you to compare our circuit performance and our price list with any other counter. For example, compare these brief specifications of the type PM7253 "ECONOMY LINE" binary pictured.

- MAX. FREQUENCY.....Over 800 KC
- RISE TIME.....Less Than 0.25 μ S
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- HAS "SET" AND "RESET" TERMINALS

Write for technical information on DIGITAL and LOGIC circuitry.



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CIRCLE 239 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960

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, Arnac 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-band, 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.

MASSA Announces 40 MM AMPLITUDE with RECTILINEAR INK RECORDINGS



Portable
two channel Meterite
Model BSA-250

- 40 mm amplitude • Frequency Response, DC to 120 cps • Rectilinear recordings on economical ink chart paper (save more than \$3000 in 200 operating hours over other rectilinear charts, running at an average chart speed of 50 mm/sec.) • Choice of interchangeable plug-in preamplifiers* • Transistorized driver amplifiers with individual power supplies • 6 Chart speeds .5 to 200 mm/sec. • Event marker with internal push button control.

MORE DATA

PER DOLLAR

Eight channel recording system,
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- Transistorized driver amplifiers with individual power supplies • 18 speeds push button controls .5 cm/hr to 200 mm/sec.

* PREAMPLIFIERS — All Massa Recording Systems are designed to accept a wide choice of plug-in Preamplifiers to satisfy every recording requirement.



ACTUAL REPRODUCTION ON 40 MM CHART PAPER

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CIRCLE 240 ON READER-SERVICE CARD

BIRD

"Termaline" 50 ohm Coaxial Line LOAD RESISTORS



82-A
(500 Watts)

- SERIES 80-82**
- Frequency Range: DC to 4000 mc
 - Power Range: 20 to 2500 Watts
 - Non-Radiating
 - VSWR: 1.1 max. to 1000 mc.

APPLICATIONS

Accurate termination for 50-ohm coaxial systems, as dummy antennas, during adjustment, alignment and testing.



80A
(20 Watts Max.)



81
(50 Watts)



81-B
(80 Watts)

SPECIFICATIONS

MODEL	MAXIMUM POWER (In Still Air)	FREQUENCY RANGE	MAX. VSWR	INPUT CONNECTOR	WEIGHT	MAXIMUM DIMENSIONS		
						HEIGHT	LENGTH	WIDTH
80-A	20 W	0-1000 mc	1.1	"N" Female	2 lbs.	4 1/2"	4 3/8"	1 1/2"
81	50 W	0-4 kmc	1.2	"N" Female	4 lbs.	4 1/2"	9 3/4"	2 3/32"
81-B	80 W	0-4 kmc	1.2	"N" Female	4 lbs.	6 1/32"	9 3/4"	3 1/8"
82-A	500 W	0-3.3 kmc	1.2	Coplanar Adapter to UG-21 B U Supplied. RG-17, RG-19 cable assemblies available.	17 lbs.	8 7/8"	18 1/2"	5 1/8"
82-AU	500 W	0-3.3 kmc	1.2	LC Jack mates with UG-154 U plug on RG-17 U cable.	17 lbs.	8 7/8"	19 1/8"	5 1/8"
82-C	2500 W Water cooled	0-3.3 kmc	1.2	Coplanar Adapter to UG-21 B U Supplied. RG-17, RG-19 cable assemblies available.	26 lbs.	8 7/8"	20 1/8"	5 1/8"

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Coaxial
RF Filters



Coaxial
RF Switches



"Termaline"
RF Absorption
Wattmeters



"Thurlina"
Directional
RF Wattmeters



BIRD ELECTRONIC CORP.
 CHurchill 8-1200 (Cleveland)
 30303 Aurora Road, Solon, Ohio
 Western Representative:
 VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 241 ON READER-SERVICE CARD

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.

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in plain and etched
tantalum foil
electrolytic capacitors



No more need to over-specify! **ie1** offers 10 case sizes—twice as many as other manufacturers.

- Smaller sizes are available for most ratings.
- Low voltages (to 3WVDC)—both plain and etched foil.
- Extremely close tolerances, down to $\pm 10\%$ on plain foil if desired.
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All electrical connections welded. Lead wires have high resistance to stresses, bending. Cases fit tightly, for maximum vibration resistance, high reliability.

Prompt service on special capacitors. Engineering service available for adapting standard capacitors or designing new ones to meet special needs. **ie1** also offers a full line of miniature and sub-miniature aluminum foil electrolytic capacitors.

Write for bulletin 41858, International Electronic Industries, Inc., Box 9036-K, Nashville, Tennessee.

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where reliability replaces probability

CIRCLE 242 ON READER-SERVICE CARD
ELECTRONIC DESIGN • May 11, 1960

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

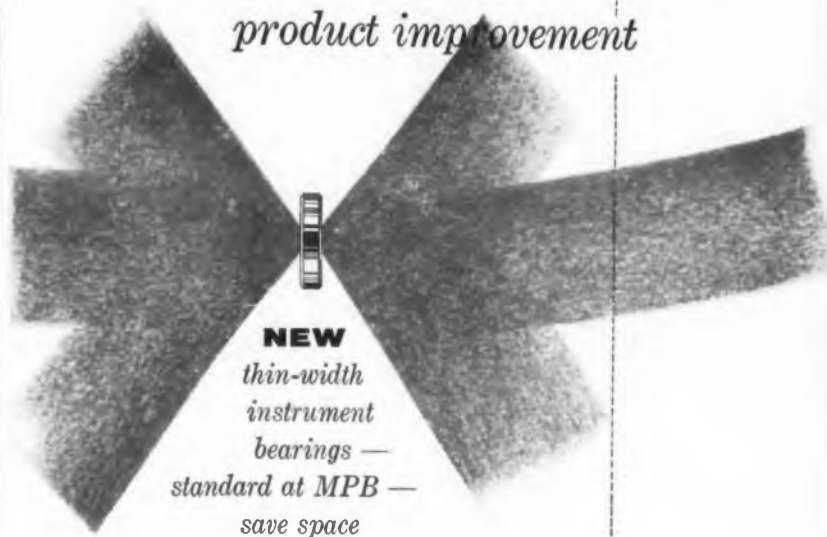
Engineering data on type CY ac magnetic starters, available in a full range of sizes from size 0 through 4, are included in this eight-page illustrated bulletin. An arc quenching principle is fully described and diagrammed. The Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.

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.

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NEW
thin-width
instrument
bearings —
standard at MPB —
save space
and increase
power

Featuring a high ratio of O. D. to width, these new MPB high-precision bearings were originally designed for use in synchros of maximum reliability. Further developed under the MPB policy of working with customers to solve miniaturization problems, the thin-width newcomers have proved ideal for servos, potentiometers, gear trains, motors and other instruments.

In applications like these, a thin-width bearing may also function as a motor end cap, while the motor housing serves as the bearing's outer ring seat. This saving of space results in widely varied product improvement. For example, small power units can use the longer stators or rotors without increasing overall unit length or diameter, thus gaining increased power from the same space.

Your own products may gain exceptional, perhaps unexpected, advantages from the use of MPB thin-width bearings. Made to ultra-precision tolerances of ABEC Class 7, they are available in nine sizes, with O.D.'s from .2750" to .5000" and bores .0937" to .1875". The new thin-width instrument bearings are not "Specials"; they are a standard series without price premium.

An MPB Sales Engineer will be glad to discuss your application with you. For engineering assistance and/or new bulletin write to Miniature Precision Bearings, Inc., 905 Precision Park, Keene, N. H.

MPB Helps you
perform miracles in miniaturization

CIRCLE 243 ON READER-SERVICE CARD

INDIANA



GENERAL CORPORATION

a new symbol of magnetic progress

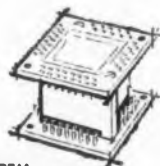
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This trademark is the calling card of a new leader in science-age materials — Indiana General Corporation. It is born of a union between two established leaders — The Indiana Steel Products Company in permanent magnets . . . the General Ceramics Company in ferrites and memory systems. Together, as Indiana General Corporation, they serve you better by placing at your disposal the brains and resources of two scientifically oriented concerns. Research and development have been the backbone of both of the original companies; both have records of significant achievement in their particular fields.

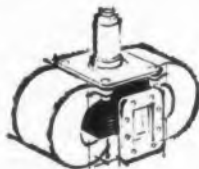
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INDOX V ceramic permanent magnet provides high energy level . . . reduces speaker length and weight.



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New microstack unit for coincident current memory systems saves 90% of space required by conventional stack, yet is more reliable.



MAGNETRON
Powerful Hyflux ALNICO V magnets improve performance in many types of micro-wave equipment.



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CIRCLE 244 ON READER-SERVICE CARD

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. Filters 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.

BASIC BUILDING BLOCKS FROM KEARFOTT



20 SECOND SYNCHRO

This synchro, just one of a broad line offered by Kearfott, provides the extreme accuracy required in today's data transmission systems. Kearfott synchro resolvers enable system designers to achieve unusual accuracy without the need for 2-speed servos and elaborate electronics. By proper impedance, matches up to 64 resolver control transformers can also operate from one resolver transmitter.

TYPICAL CHARACTERISTICS	SIZE 25	
	Transmitter	Control Transformer
Type Resolver		
Part Number	Z5161-001	Z5151-003
Excit. Volts (Max.)	115	90
Frequency (cps)	400	400
Primary Imped.	400/80°	1500/80°
Secondary Imped.	260/80°	14000/80°
Transform. Ratio	.7826	1.278
Max. Error fr. E.Z.	20 seconds	20 seconds
Primary	Rotor	Stator

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT



PRECISE ANGLE INDICATOR

Consisting of an angle position indicator, motor and servo amplifier, this small, versatile, rack panel mounted unit provides angular position indications for laboratory, production and field use. Input signals proportional to unknown angular position of synchro device being measured are resolved as an error voltage, which is amplified and used to drive an internal servo loop to null. Counter mechanism then provides direct visual readout of angular position.

TYPICAL CHARACTERISTICS

Input Signal: S₁, S₂, and S₃ of external synchro transmitter.
Repeatability: Within 0.6 minute in either a clockwise or counterclockwise direction for any angular position.
Readability: 0.5 minute through full range from zero to 360°
Rotation is continuous.
Accuracy: ± 6 minutes in the standard unit. Other accuracies available on request.
Sensitivity: 0.5 minutes maximum.
Slewing Speed: Phase sensitive, 180° in 7 seconds.
Input Voltages: 115 volts, single phase, 400 cycles, 23 VA max
Size: Standard Rack Mounting—1 3/4" x 9 1/2" x 8 1/2"
Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT



FLOATED RATE INTEGRATING GYROS

Specifically designed for missile applications, these Kearfott miniature gyros operate efficiently at unlimited altitudes. Their outstanding accuracy and performance make them superior to any comparably-sized units on the market. Hermetically sealed within a thermal jacket, these gyros are ruggedly designed and completely adaptable to production methods. Performance characteristics that are even more precise can be provided within the same dimensions.

TYPICAL CHARACTERISTICS

Mass Unbalance:
Along Input Axis: 1.0°/hr maximum untrimmed
Standard Deviation (short term):
Azimuth Position: 0.05°/hr
Vertical Position: 0.03°/hr
Drift Rate Due to Anisoelectricity
Steady Acceleration:
015°/hr./g² maximum
Vibratory Acceleration:
008°/hr./g² maximum
Damping:
Ratio of input angle to output angle is 0.2
Characteristic Time:
0035 seconds or less
Weight: 0.7 lbs.
Warm-Up Time:
10 minutes from -60°F
Life: 1000 hours minimum
Write for complete data.

Tachometers



Servo Valve



Ferrites



Engineers: Kearfott offers challenging opportunities in advanced component and system development.

CIRCLE 245 ON READER-SERVICE CARD



KEARFOTT DIVISION

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COUCH ROTARY RELAYS

Start with a unique and simple design — manufacture within a narrow range of tolerances — specify performance on the *conservative* side — this is how Couch solves the problem of supplying relays that meet the present and future needs of our aircraft and missile programs.

The record shows that this technique is successful: many thousands of Couch CVE type rotary relays are providing consistent flight insurance in complex systems under the most severe environmental conditions.

IMPORTANT SPECIFICATIONS

Contacts: 4PDT (dry circuit to 10 amps)

Size: 1 1/2" D x 1 1/2" H

Weight: 3.2 oz. max.

Pull-in power: 1/2 watt

Ambient temperature: -65° to +125°C

Vibration resistance: 20G's, 5 to 2000 cps

Shock resistance: 75G's operating, 200G's non-operating

Write for complete specifications.



COUCH ORDNANCE, INC.

A Subsidiary of S. H. Couch Company, Inc.

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CIRCLE 751 ON READER-SERVICE CARD

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.

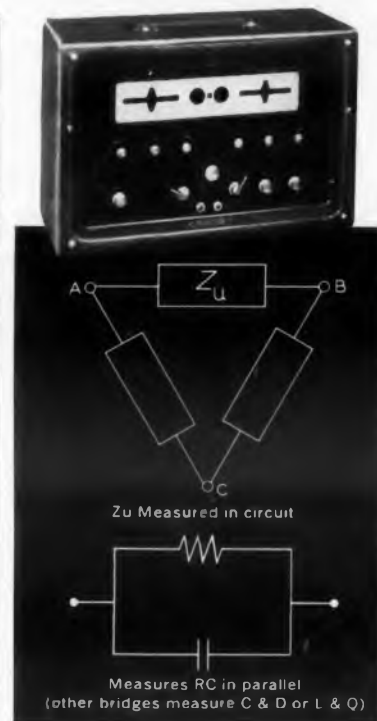
Traveling-Wave Tubes

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.



Wayne Kerr Universal Bridge
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ACCURACY, RANGE, VERSATILITY

Two, three or four-terminal measurement of impedance or transfer admittance.

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ELECTRONIC DESIGN • May 11, 1960

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- Pacific Division - Cucamonga, Calif. - YUkon 2-2688
- Central Division, Lanesboro, Pa. Ulysses 3-3500
- Southern Division, Miami, Fla; - Wilson 5-2164

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.

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Complete corner

Structural member between spaced portion of shield

Double ended for adjacent panels

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*Radio Frequency Interference

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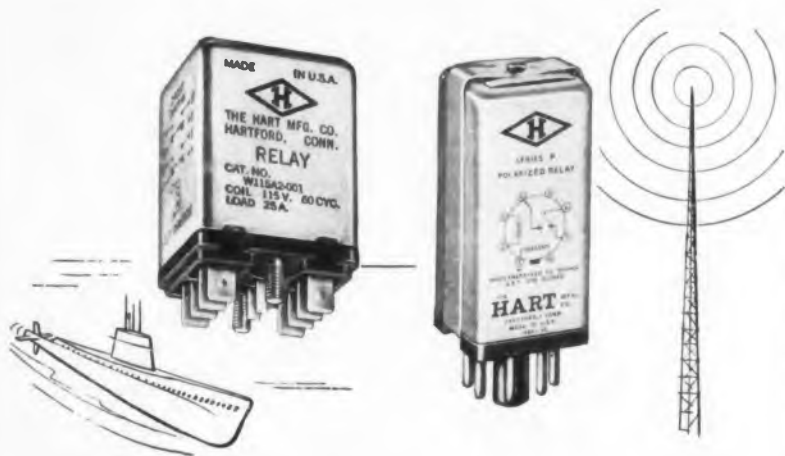
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CIRCLE 754 ON READER-SERVICE CARD



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Unless, of course, you're one of the increasing number of engineers who've already selected "Diamond H" relays for a spot where they just have to work despite all sorts of adverse conditions.

Hart makes relays of three basic types: miniature, hermetically sealed, aircraft-missile relays (Series R/S); high speed, sensitive, polarized relays (Series P), and general purpose AC, DC relays (Series W).

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CIRCLE 755 ON READER-SERVICE CARD

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 diametral 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.

The elements of instrument housing design

Good housing design provides effective accommodation of instruments. Chassis and components should be stably secured, well protected and easily accessible for service and repair. In a console, the human factors of easy visibility and comfort should be considered.

Falstrom has the engineering skills, experience and facilities to fabricate instrument housing in any metal or alloy to close tolerances. Send blueprints for prompt quotation or call PRescott 7-0013 for a Field Sales Engineer.

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CIRCLE 756 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960

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 . . . 1 3/4-inch slide . . . saves space

2 NEW Chassis-Trak Slides

NEW . . . lightweight, extra-thin slide

Engineering progress at Chassis-Trak, keeping pace with the equipment mounting needs of the electronics industry, has resulted in two new slide designs. They are:

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Ideal for light-duty slide applications—loads up to 50 lbs. Chassis-Trak "pencil thin" design plus an overall height of only 1.687" saves cabinet space, permits easy mounting without cabinet modification. Cadmium-plated cold-rolled steel construction. Phenol epoxy coating provides permanent dry lubrication. Tilt and non-tilt styles in eight standard lengths—10, 12, 14, 16, 18, 20, 22 and 24 inches.

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Newly developed model for special equipment mounting problems. Exceptionally compact (1" high, 1/2" wide), yet supports up to 150-lb. loads. Saves space without sacrificing heavy-duty strength. Low in cost, easy to install. All stainless steel construction. Precision roller and ball bearings for effortless operation.

Check with Chassis-Trak engineers for the solution to your rack or cabinet application. Slides available in tilt, non-tilt, and tilt-lock models. Supports up to 275 lbs.



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CIRCLE 758 ON READER-SERVICE CARD

NOW in 50 WATTS for **MINIATURE** and **SUBMINIATURE PRODUCTION SOLDERING JOBS**

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1/4" TIP

Designed with 50 watt input, these fine soldering irons will give greater productivity and do industry's most exacting soldering jobs easier, faster, better. SLOTTED STAINLESS STEEL CASINGS MAKE THE HANDLES REALLY COOL, ending operator complaints. There's no waiting or fumbling with these light, flexible tools—they're always ready. American Beauty soldering irons are known the world over for their dependability, durability and efficiency. Learn more about these fine soldering tools today.

YOU CAN'T BEAT A SOLDERED CONNECTION

WRITE FOR DESCRIPTIVE CATALOG SHEET, FORM NO. 222-CT

Shown below are other shapes and tip-size irons available in the BANTAM "X" series.



204-B

AMERICAN ELECTRICAL HEATER COMPANY

DETROIT 2, MICHIGAN

CIRCLE 757 ON READER-SERVICE CARD

ELECTRONIC DESIGN • May 11, 1960



Well, we're
proud as a
peacock
of our JM
capacitors!

Choose from 49 EIA values. All have these characteristics:

Working voltage: 500 VDC

Insulation Resistance: 50,000 megohms minimum (500 VDC test)

Q Value: 100 minimum

Body Dimensions:

0.1 to 10.0 mmf. 1.60 ± .005 dia. x .400 max. L
10.0 to 18.0 mmf. 1.87 ± .005 dia. x .230 max. L

Leads:

No. 20 AWG Copper, heavily tinned to insure good solderability. 1% ± 1/8 lang

Tolerance Color Code:

Under 10.0 mmf 10.0 mmf and Over

20% None	20% Black
10% Silver	10% White
5% Gold	5% Green

Jeffers Fixed Composition JM Capacitors are ideal for a broad range of circuit applications. They offer operating stability, moderate Q—and those other two indispensable characteristics, dependability and economy! Use them as coupling capacitors between RF amplifiers, AVC circuits, oscillators, IF stages—and in many other circuits where low capacitance is a requirement.

The insulated JM body consists of a molded thermosetting resin with a ceramic dielectric material dispersed throughout. The firmly embedded lead wires serve as electrodes.

For all the facts about the Jeffers line of JM Capacitors, write today!



JEFFERS ELECTRONICS DIVISION

Spear Carbon Company
Du Bois, Pennsylvania

Capacitance in mmf Standard Values in			Color Bands			Max. Body Length
20%	10%	5%	1st	2nd	3rd	
.10	.10		Brown	Black	Gray	.400
	.12		Brown	Red	Gray	.400
.15	.15		Brown	Green	Gray	.350
	.18		Brown	Gray	Gray	.281
	.20		Red	Black	Gray	.281
.22	.22		Red	Red	Gray	.281
	.24		Red	Yellow	Gray	.281
	.27		Red	Violet	Gray	.281
	.30		Orange	Black	Gray	.281
.33	.33		Orange	Orange	Gray	.281
	.36		Orange	Blue	Gray	.281
	.39		Orange	White	Gray	.281
	.43		Yellow	Orange	Gray	.281
.47	.47		Yellow	Violet	Gray	.281
	.51		Green	Brown	Gray	.281
	.56		Green	Blue	Gray	.281
	.62		Blue	Red	Gray	.281
.68	.68		Blue	Gray	Gray	.281
	.75		Violet	Green	Gray	.281
	.82		Gray	Red	Gray	.281
	.91		White	Brown	Gray	.281
1.0	1.0	1.0	Brown	Black	White	.281
	1.1		Brown	Brown	White	.281
	1.2		Brown	Red	White	.281
	1.3		Brown	Orange	White	.281

Capacitance in mmf Standard Values in			Color Bands			Max. Body Length
20%	10%	5%	1st	2nd	3rd	
1.5	1.5	1.5	Brown	Green	White	.281
	1.6		Brown	Blue	White	.281
	1.8		1.8	Brown	Gray	White .281
	2.0		2.0	Red	Black	White .261
2.2	2.2	2.2	2.2	Red	Red	White .230
	2.4		2.4	Red	Yellow	White .230
	2.7		2.7	Red	Violet	White .230
	3.0		3.0	Orange	Black	White .230
	3.3		3.3	Orange	Orange	White .230
	3.6		3.6	Orange	Blue	White .230
	3.9		3.9	Orange	White	White .230
	4.3		4.3	Yellow	Orange	White .230
4.7	4.7	4.7	4.7	Yellow	Violet	White .230
	5.1		5.1	Green	Brown	White .230
	5.6		5.6	Green	Blue	White .230
	6.2		6.2	Blue	Red	White .230
	6.8		6.8	Blue	Gray	White .230
	7.5		7.5	Violet	Green	White .230
	8.2		8.2	Gray	Red	White .230
	9.1		9.1	White	Brown	White .230
10.	10.	10.	10.	Brown	Black	Black .230
	12.		12.	Brown	Red	Black .230
	15.		15.	Brown	Green	Black .230
	18.		18.	Brown	Gray	Black .230

CIRCLE 759 ON READER-SERVICE CARD

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

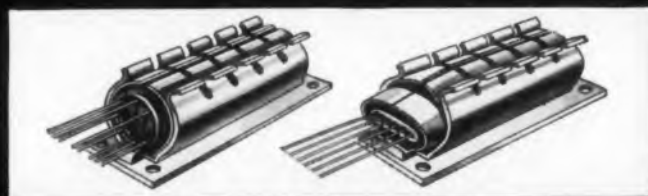
Environmental test equipment that duplicates global climatic conditions, large and small test cabinets, baths, ovens, and steam humidity chambers are among the units described in this 41-page catalog, No. 560. It includes illustrations, descriptions, applications, and a temperature conversion chart from 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

AUGAT'S REVOLUTIONARY ELASTACLAMP*

The answer to more effective cooling of subminiature tubes!



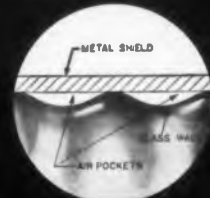
Heat-dissipating subminiature tube shield with elastic thermal conductor



Enlarged section of Elastacamp's inner carriage

Resilient elastomer will completely conform to pronounced irregularities of glass surface thus reducing dangerous hot spots.

Tubes protected from severe shock and vibration by rubber-like elastomer which cushions glass.



Enlarged section conventional heat-dissipating tube shield.

For additional information write for bulletin No. 559.

AUGAT BROS., INC.

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*Trademark

CIRCLE 760 ON READER-SERVICE CARD

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 environmental 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.

FAIRCHILD
SENSING
DEVICES
PROVEN
IN FLIGHT



SIDEWINDER STRIKES... AND KILLS!



THANKS TO A FAIRCHILD ACCELEROMETER

When the pilot of this McDonnell F3H actuates the firing key, long slender heat-seeking U. S. Navy Sidewinders streak from their wing racks—track down and demolish even the most devious enemy.

A compact fire control computer—designed and produced by Hazeltine Corporation for the U. S. Navy—is located in the F3H fuselage after the cockpit. An important component in this computer is a FAIRCHILD TA-100 ACCELEROMETER.

Specifically designed for applications that require measurement of missile or aircraft maneuvering accelerations, the TA-100 is oriented in the F3H to sense accelerations in a plane normal (perpendicular) to the major axis of Sidewinders in their racks. Excessive G's in this plane—caused by intricate, high-speed air tactics—could divert Sidewinder from finding its target. When this condition exists, the TA-100 accelerometer causes a warning light to flash on the pilot's instrument panel—advises him to correct aircraft performance before firing.

Fairchild TA-100 Accelerometer (Type 940) is only 2 1/4" x 1 1/4" x 1 1/2", measures sustained accelerations from 0 to ± 1/2 G to 0 to ± 50 G. A pendulous device, it consists of a mass supported on a torsion type spring and a precision potentiometer whose wiper is actuated by the mass. Electrical output is directly proportional to linear acceleration. Oil-filled, the damping factor is held within close tolerances through -55° to +100°C. Overall accuracy—including linearity, hysteresis and repeatability—is better than 1%.

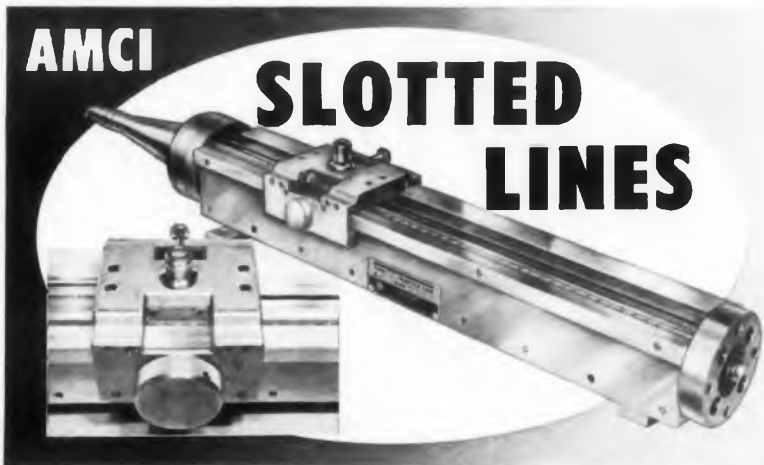
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CIRCLE 762 ON READER-SERVICE CARD

AMCI SLOTTED LINES



FEATURES

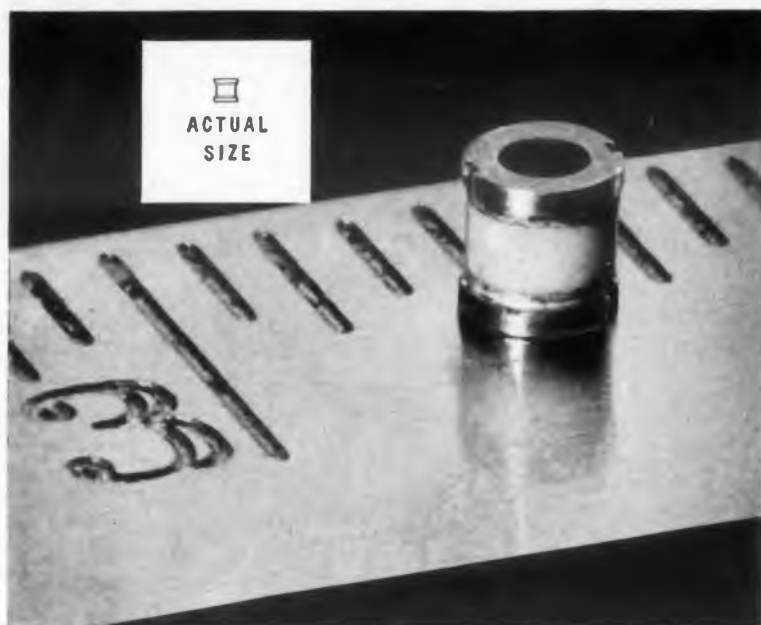
- **Rated residual SWR** — under 1.010; rated error in detected signal — under 1.005.
- **Several models** covering various bands from 50 to 4000 mc.
- **Engraved scales and verniers** permit one to read the probe position to 0.01 centimeters.
- **Optional accessory:** a rack and pinion carriage drive than can be engaged or disengaged at will.
- **Precision tapered reducers** are available for use in making accurate measurements in a wide range of rigid and flexible coaxial transmission lines.

Write for complete information on AMCI Slotted Lines.



CIRCLE 761 ON READER-SERVICE CARD

NEW SILICON "PILL" VARACTOR



GREATLY REDUCES THE PACKAGE AS A FACTOR IN CIRCUIT DESIGN

specifically developed for:

- amplifiers at the higher microwave frequencies (1000 mc and above)
- travelling wave parametric amplifiers
- microwave computers as sub-harmonic generators
- amplifiers in which stray susceptance effects must be minimized
- applications of varactors to stripline circuits
- modulators for frequency synthesis

	TYPE NUMBER	*CAPACITANCE TOLERANCE (Zero Bias)	CUT-OFF FREQUENCY (MIN.)
Experimental quantities are available with these nominal specifications	MA-4253X	— 1.4 μ f max.	120
	MA-4254X	— 1.4 μ f max.	100
	MA-4255X	— 2.0 μ f max.	60
	MA-4256X	1.2 — 2.5 μ f max.	50
	MA-4257X	2.5 — 4.0 μ f max.	30

*Package shunt capacitance \sim 0.2 μ f. Series lead inductance $<10^{-9}$ henries.

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BURLINGTON, MASSACHUSETTS
BRowning 2-3000 • TWX Burlington, Mass. 942.



CIRCLE 763 ON READER-SERVICE CARD

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 pack-

ages 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.

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ELECTRONIC DESIGN • May 11, 1960

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 transistor regulated supplies; modular mag-amp regulated supplies, and unregulated supplies. Rack mounting kits for modular supplies are also described. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

Capacitors**515**

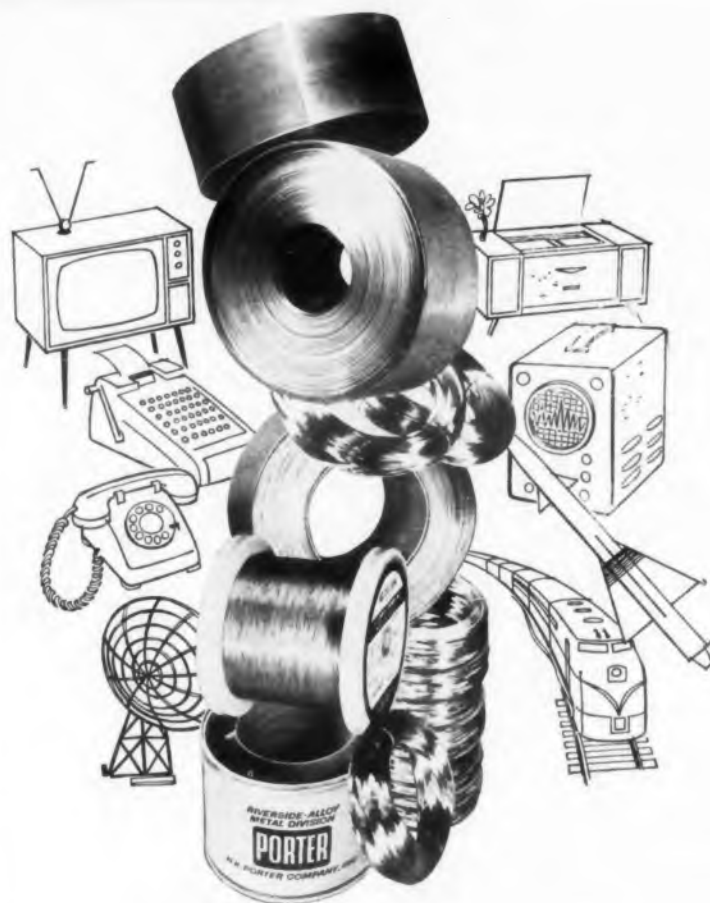
Complete electrical specifications, temperature characteristic graphs, and construction details are included in this 16-page capacitor catalog. Among the units described are: kraft and foil; mylar and foil; metallized mylar; high voltage midguts; kraft-mylar and foil; film and foil; polystyrene and foil; metallized paper; and metallized teflon. Electron Products Technical Information Service, 2065 Huntington Drive, San Marino, Calif.

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.

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. Jordan Controls, Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.

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NEW LITERATURE

Voltage Regulators 517

The four-page Bulletin 3200, "Fincor" model F-26 series, describes voltage regulators for ac generators and generator-excitors. 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 read-out 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

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ELECTRONIC DESIGN • May 11, 1960

(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 principal 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. G59 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 pho-

tographs 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.

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... Tumbler-lock KEY RESET. ONLY A
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Prevents unauthorized tampering wherever this counter is located. Accurate counts up to 1000 per minute.



The temperature of things is so important to some people that a few degrees one way or another is a calamity: it has to be plus or minus a few tenths of a degree, or else. This group includes Deutsche beer drinkers, those who watch over crystal oscillator ovens, certain environmental test boxes, delay lines, and the Miami® tourist trade. To them, we offer a solution.

It's a Sigma Magnetic Amplifier Relay, one-half of a resistance bridge, and a built-in DC power supply — all neatly packaged and ready to go as soon as a thermistor and reference resistor are connected to complete the bridge. In operation, a temperature change unbalances the

bridge, energizing the relay through the magnetic amplifier. What you do with the relay output — for corrective action or indication — is up to you. (The contacts are SPDT and available for switching 1 amp. or 5 amp. loads.)

The reason you supply the thermistor is that you know how much mounting space there is, what temperature range has to be monitored, and how much power the thermistor can safely dissipate. The woods are full of thermistor suppliers and the "Series 8000 Thermistor Temperature Control" Bulletin contains a useful guide to thermistor selection.

Compared to other ways you could detect and do something useful with changes as small as 0.1°C, this device is guaranteed free of locking contacts, delicate mechanisms and other life-shortening elements. It also provides resettable control, as well as accurate "remote" control even when fairly long leads from the thermistor are used.

Since this temperature control is about 83% magnetic amplifier, this seems like a good place to give a plug to Sigma Magnetic Amplifier devices in general. We can sell you regular and souped-up 60 cycle models, and have in development a 400 cycle type in a hermetically sealed case. All are rugged, microwatt-sensitive switches particularly useful as current, voltage or resistance comparators for monitoring or controlling light intensity, radiation level, pressure, vacuum, line voltage, etc. Bulletins on any are available on request.

* In South Braintree, the temperature today is 270°F.



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with 1 Oscillator

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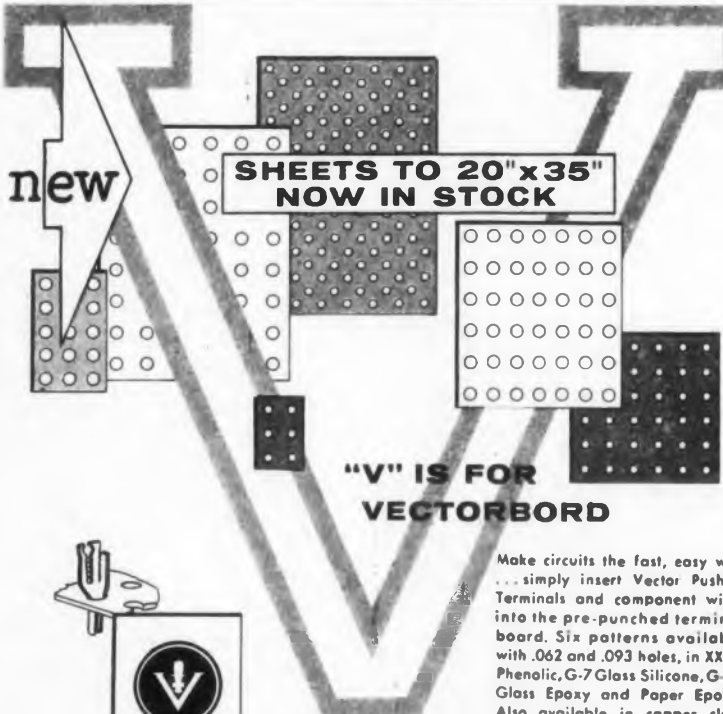
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CIRCLE 771 ON READER-SERVICE CARD

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 \$0.35 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.



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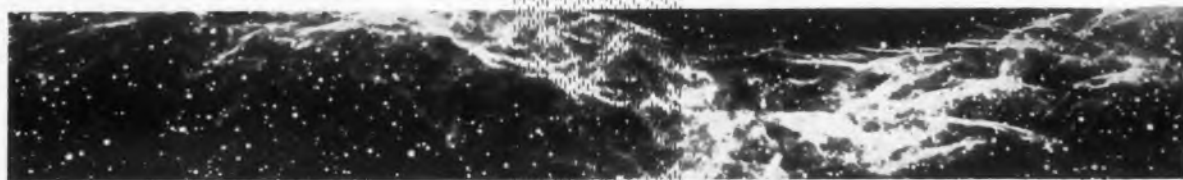
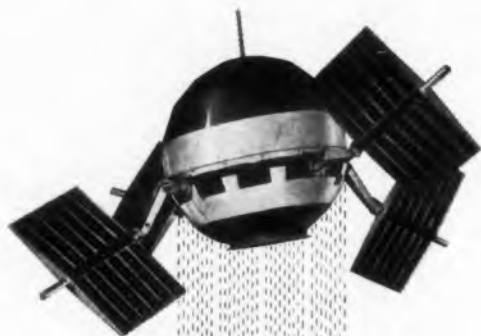
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**Pioneer V
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Is Vaulting
Through Unexplored Space
Toward The
Orbital Path of Venus**



At this moment Pioneer V, one of the most advanced space probe vehicles ever launched, is on a course toward the path of Venus—26 million miles from earth. Blasted aloft March 11 by a Thor Able-4 rocket booster, this miniature space laboratory will reach its destination in about 130 days.

The project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, may confirm or disprove long-standing theories of the fundamental nature of the solar system and space itself.

Energy from the sun—captured by almost 5,000 cells mounted in the four paddles—is used to supply all of the electrical power to operate the sophisticated array of instrumentation packed into the 94-pound spacecraft which measures only 26" in diameter.

By combining a phenomenal digital electronic brain (teletbit) with a powerful radio transmitter inside the satellite, STL scientists and engineers expect to receive communications from Pioneer V at their command over interplanetary distances up to 50 million miles.

STL's technical staff brings to this space research the same talents which have provided over-all systems engineering and technical direction since 1954 to the Air Force missile programs including Atlas, Thor, Titan, Minuteman, and related space programs.

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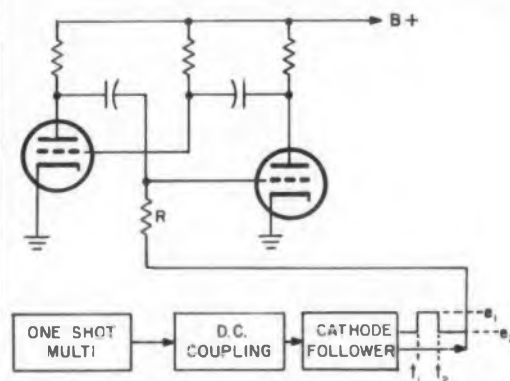
CIRCLE 903 ON CAREER INQUIRY FORM, PAGE 261

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-



The output frequency of a free-running multivibrator can be varied by adjusting the voltage to which the grid resistor R is returned.

running multi can oscillate in any one of 3 modes. **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.

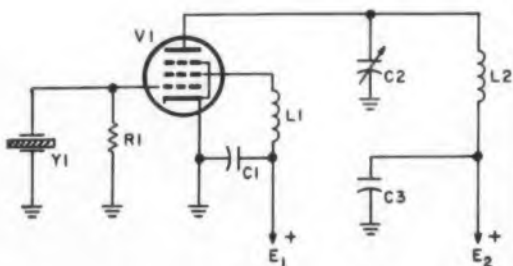
Crystal Oscillator Provides Good Load Isolation

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 anti-resonant 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.

PUTTING MAGNETICS TO WORK



Open your eyes to new amplifier designs!

See how to combine tape wound cores and transistors for more versatile, lower-cost, smaller amplifiers

Tie tape wound cores and transistors into a magnetic-transistor amplifier, and open your eyes to new design opportunities.

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How do you want to use this superb combination? As a switching amplifier—or a linear one? In an oscillator? A power converter (d-c to d-c or d-c to a-c)? You'll have ideas of your own—and if they involve tape wound cores, why not write us? Ours are Performance-Guaranteed. *Magnetics Inc., Dept. ED-81, Butler, Pennsylvania.*

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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

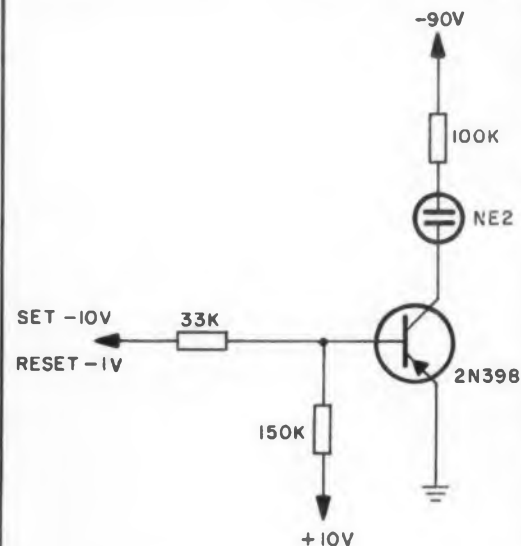


Fig. 1. Basic neon driver.

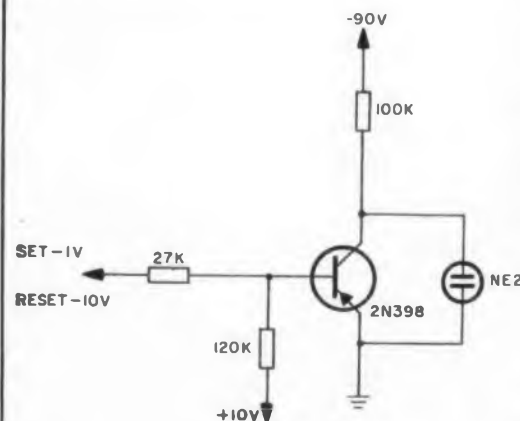


Fig. 2. A neon driver circuit which is not critical to I_{co} .

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 $200 \mu\text{a}$ 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, $db = 8.68 \log_e V_1/V_2 = 4.34 \log_e P_1/P_2$.

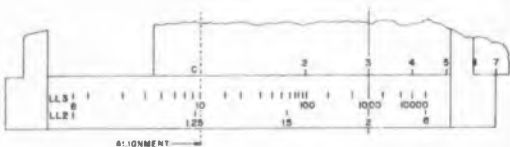
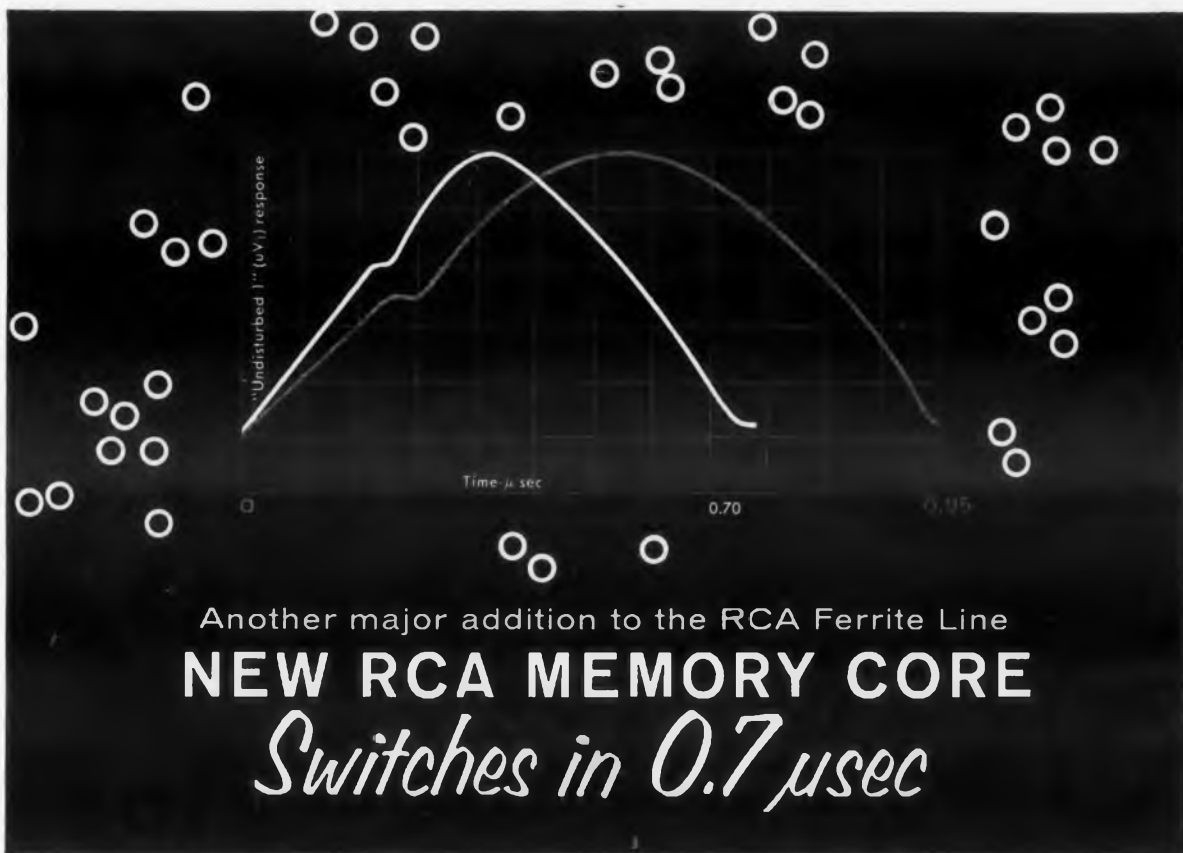


Fig. 1. For Voltage Ratios: — 2 on C scale is aligned with 10 on LL3 scale.



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.



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See chart for comparative operating characteristics. These

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							"Undisturbed 1" (uV1) (mv)	"Disturbed 0" (dV2) (mv)
226M1 (XF-4028)	Lower Drive	.050"x .030"x .015"	400	200	0.2	0.95	85	10
224M1 (XF-3018H)	Present Standard	.050"x .030"x .015"	500	250	0.2	0.95	75	8.5
227M1 (XF-4138)	Faster Switching	.050"x .030"x .015"	500	250	0.2	0.70	105	13



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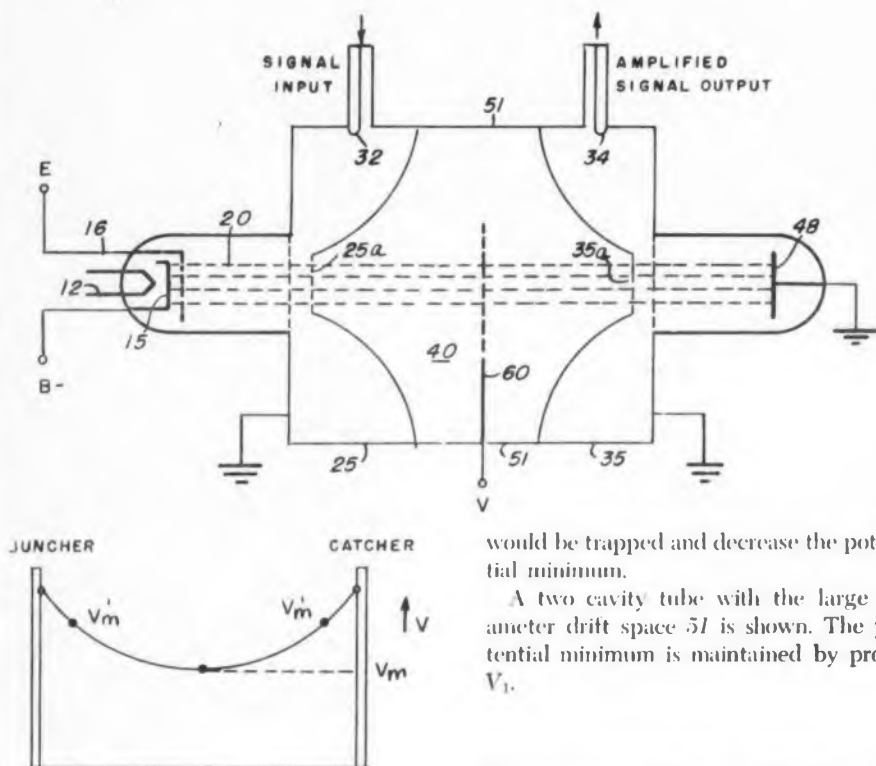
Free IERC Tube Shield Guide, listing TR Shields, is available by writing Dept. TR for your copy.

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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.

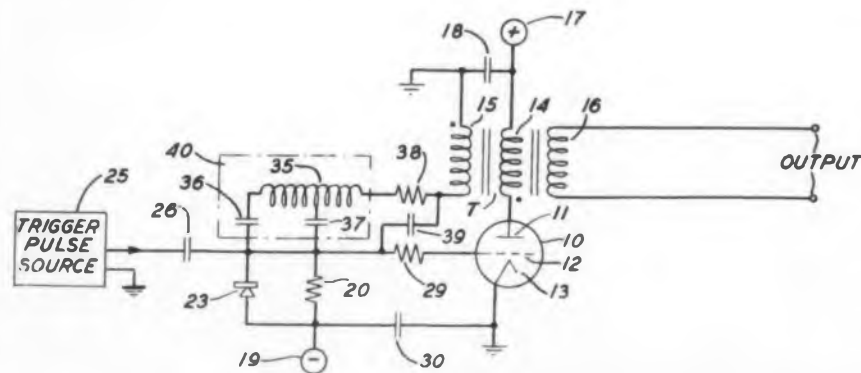
A two cavity tube with the large diameter drift space 51 is shown. The potential minimum is maintained by probe V_1 .

Quick Recovery Circuit for Blocking Oscillators

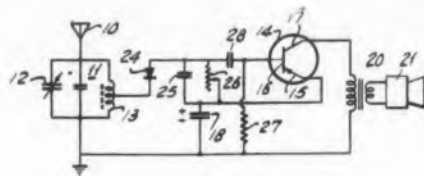
Patent No. 2,922,037. H. A. Reisc. (Assigned to Bell Telephone Laboratories)

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 μ secs to 1/2 μ sec.

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.



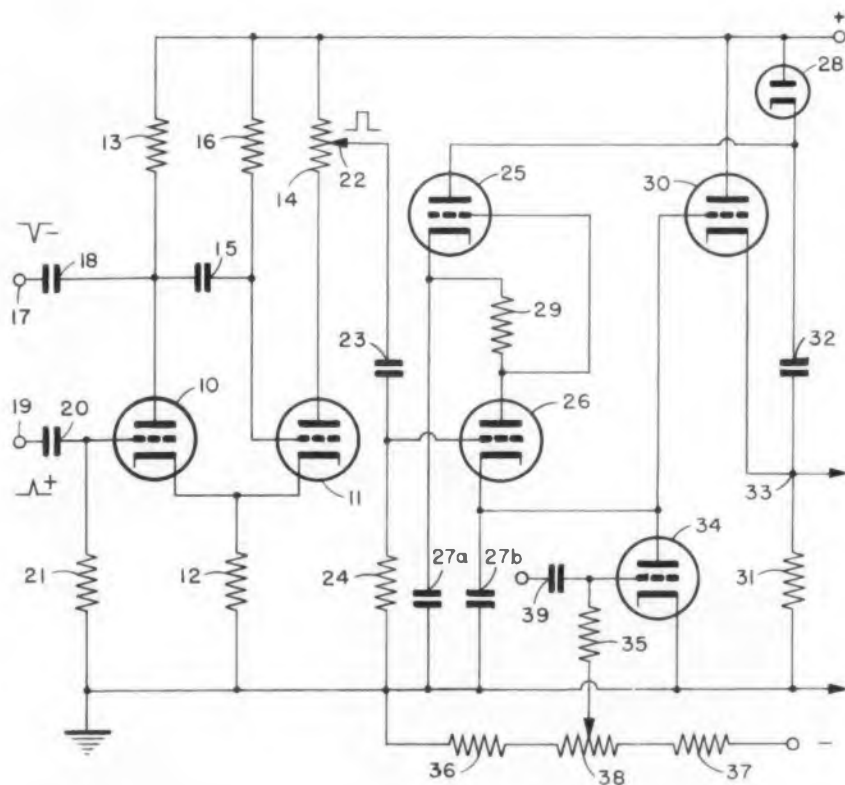
Passive Transistor Detector-Amplifier
Patent No. 2,918,573. H. E. Hollman. (Assigned to Dresser Industries, Inc.)

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.



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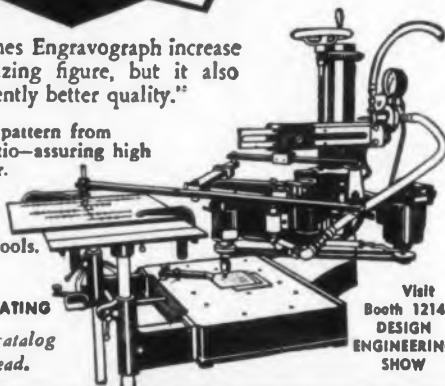
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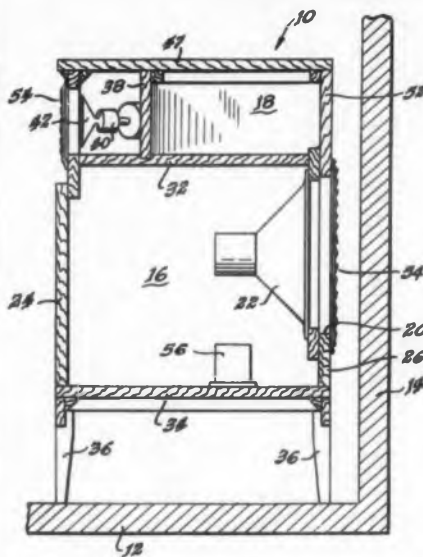
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PATENTS

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

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BOOKS

New Manual Collects Reliable, Well-Designed Transistor Circuits

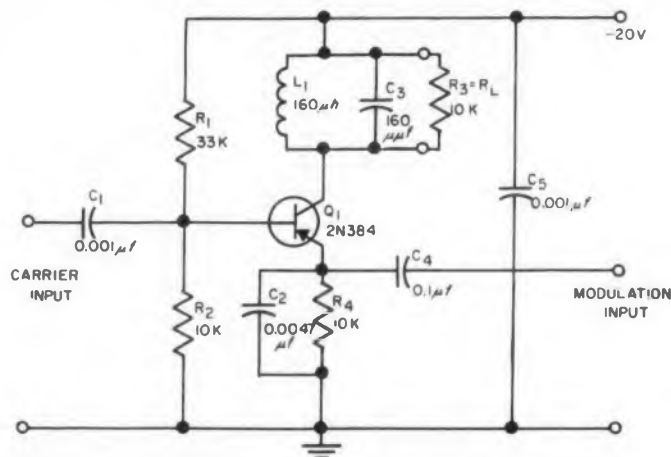


Fig. 1. Low-level modulator.

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:

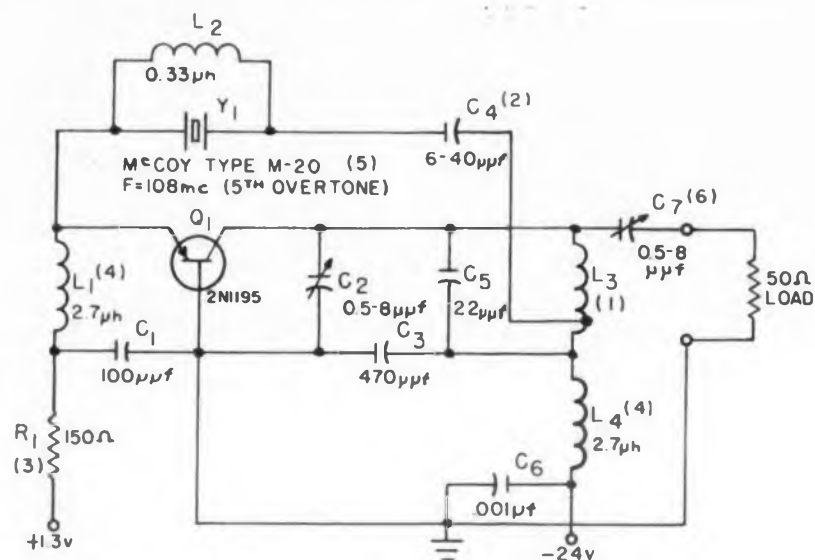
- Direct coupled amplifiers
- Low-frequency amplifiers
- High-frequency amplifiers
- Oscillators
- Switching circuits
- Logic circuits
- Ac to dc power supplies

■ 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 $\frac{1}{4}$ " dia. 2. Valve determines frequency. 3. Valve determines output. 4. L_1 & L_2 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 divider, 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

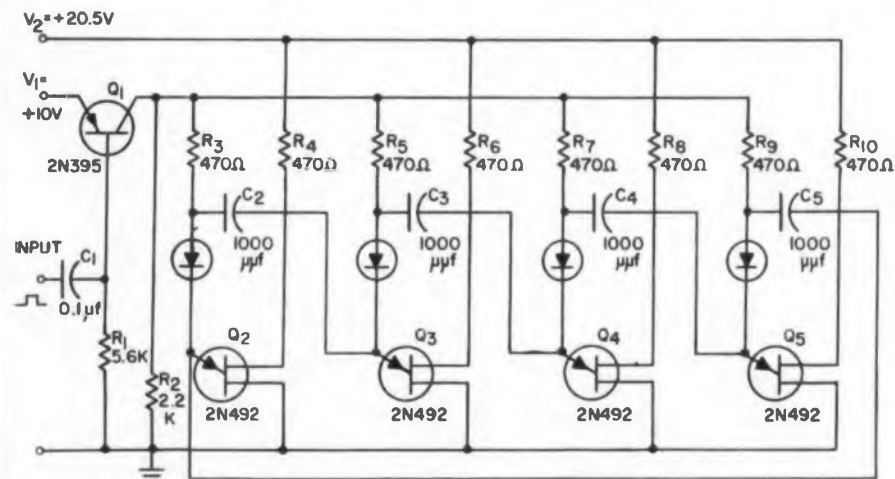


Fig. 3. Unijunction ring counter.



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4. A missile manufacturer uses READALL instruments in an automated "Missile Skin" milling machine.

5. These readout devices are being applied in nuclear reactor work for remote control and indication of rod position.

6. READALL instruments are now used in an electric power station monitoring system in Philadelphia.

7. READALL instruments are being used in display boards for the Air Defense Headquarters.

8. Another aircraft manufacturer uses READALL instruments in a flight simulator.

9. A branch of the military designed the READALL instruments into an airborne bomb-direction computer.

10. An aircraft systems manufacturer uses READALL instruments for display and print-out of data with a computer in a high altitude weather reconnaissance project.

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BOOKS

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 μ f 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.

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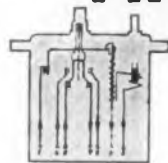
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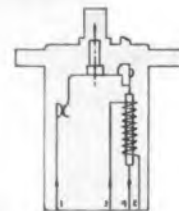
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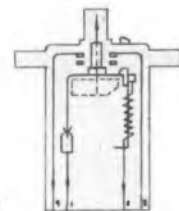
Two auxiliary circuits N.C., N.O., Shunt—Thermal Magnetic Circuit Breaker



Control of two circuits — Overcurrent Circuit Breaker



Series Trip — Overcurrent Circuit Breaker

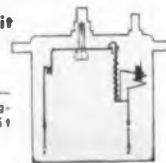


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ELECTRONIC DESIGN • May 11, 1960

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_2 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_1 , 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). ■ ■

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RUSSIAN TRANSLATIONS

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 μ sec. 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

$$\frac{dv}{dt} = \frac{i}{C}$$

where dv/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 μ sec. 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 (6J8 equiv) tube, (3).
- Stages for shaping 20, 50 and 100 μ sec pulses,

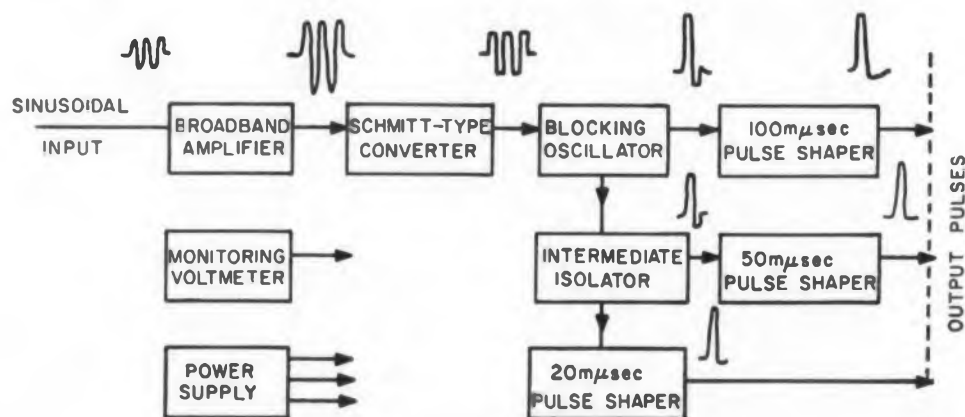


Fig. 1. Block diagram of the GMI-23 pulse generator shows separate outputs of 20, 50 and 100 μ sec.

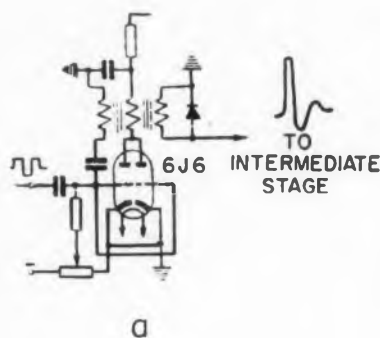


Fig. 2a. Millimicrosecond pulses are produced by this blocking oscillator.

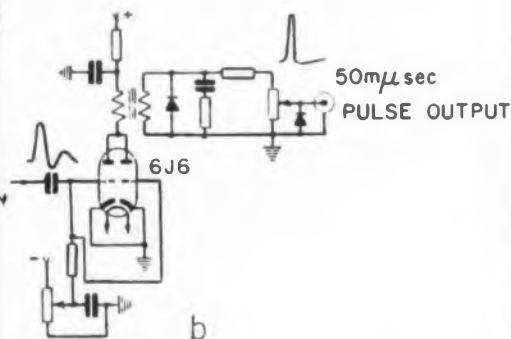


Fig. 2b. Output of blocking oscillator is fed to this circuit which produces a fixed-interval pulse of 50 μsec.

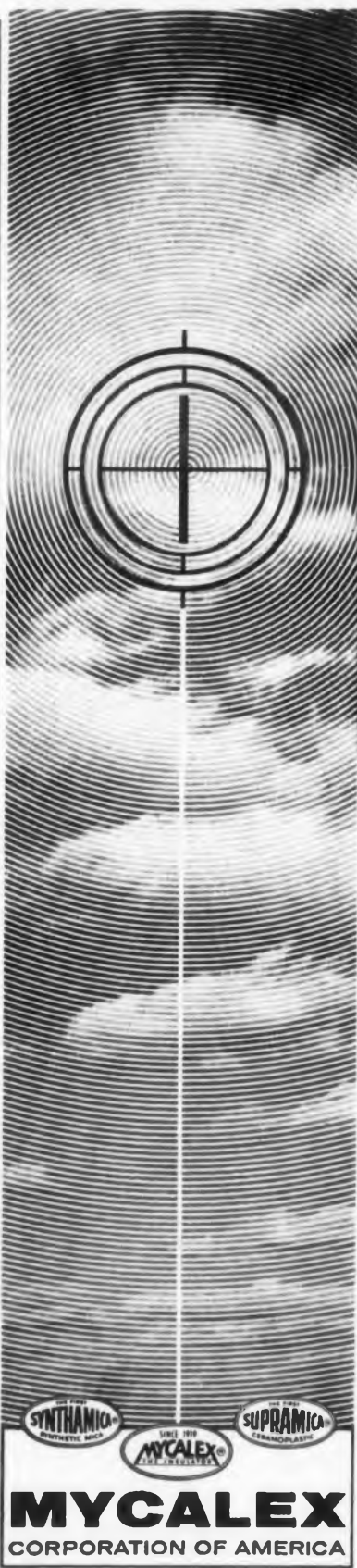
(4), (6), (7). These are amplifier stages with shock-excited tuned circuits. The tubes used are 6N6P (6J6 equiv).

- 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-μsec 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 μsec. 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 oscillator's 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



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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.

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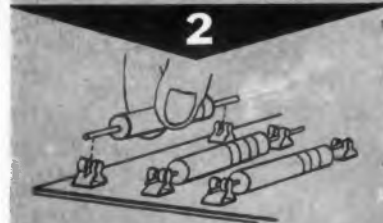
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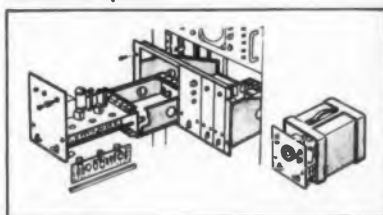
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ELECTRONIC DESIGN • May 11, 1960

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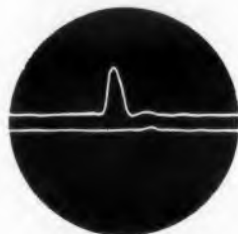
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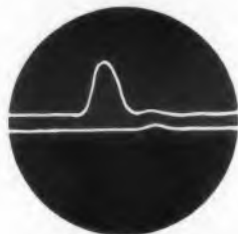
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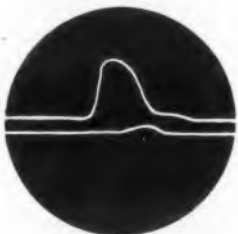
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a



b



c

Fig. 3. Pulse waveforms of (a) 20 μ sec, (b) 50 μ sec, (c) 100 μ sec, 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 μ sec stage is triggered by pulses shaped by the blocking oscillator. The 50 and 20 μ sec 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.

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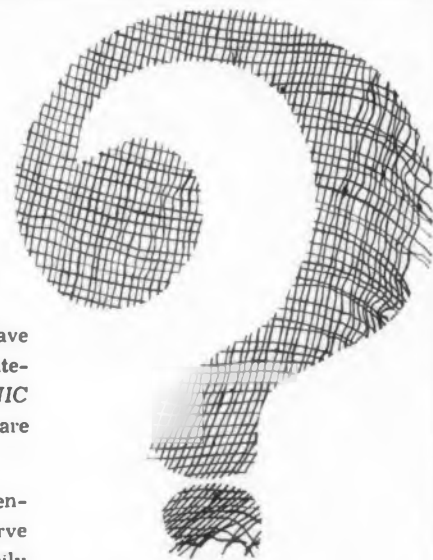
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GERMAN ABSTRACTS

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 $S_t = \Delta f/f$. 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 μ sec S_t is 5×10^{-1} /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-

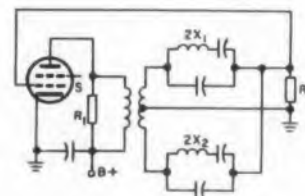


Fig. 1. Differential bridge circuit using two quartz crystals.

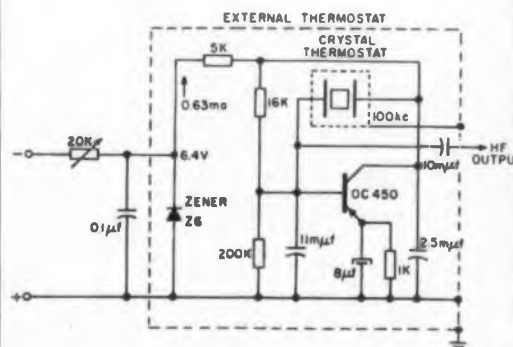


Fig. 2. Quartz crystal stabilized, transistor oscillator

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-ke quartz crystal with a special thermostat and a silicon OC 450 transistor Frequency comparison using a standard 200-ke atomic clock-controlled transmitter revealed that frequency variation of the transistor oscillator was below 1.5×10^{-6} 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, January 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.

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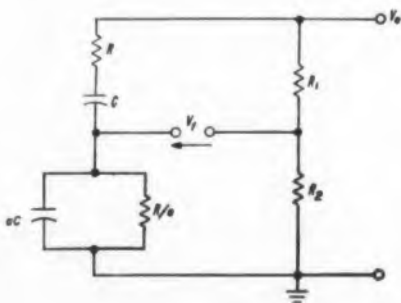


Fig. 1. Wien bridge.

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GERMAN ABSTRACTS

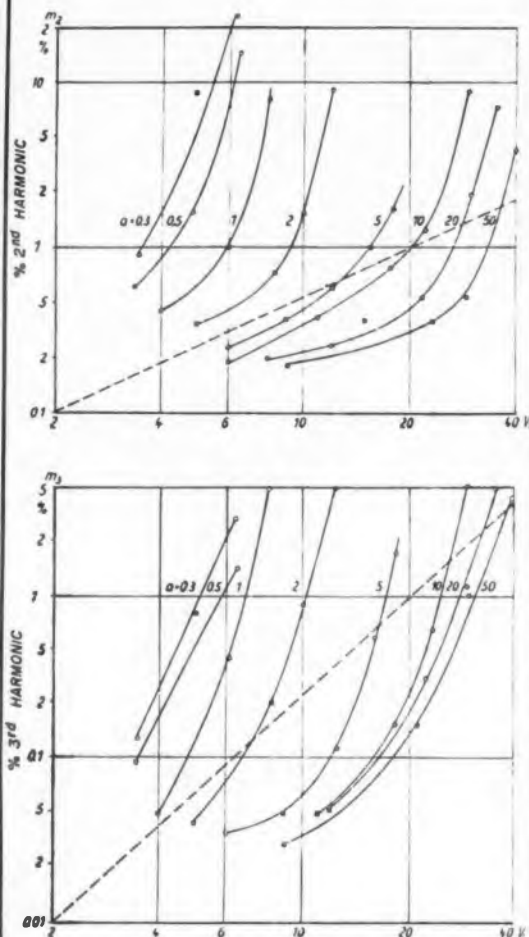


Fig. 2. Per cent harmonic content (second and third harmonic) as a function of output voltage for a Wien bridge oscillator with a as a parameter.

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-

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ELECTRONIC DESIGN • May 11, 1960

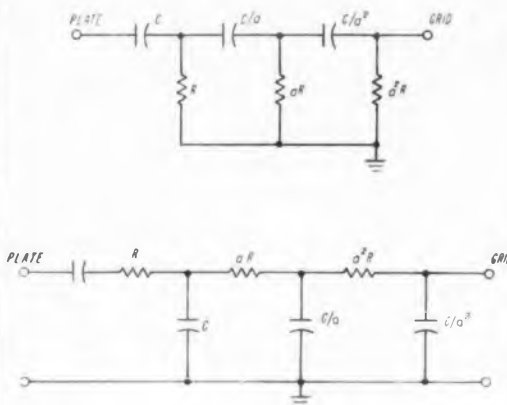


Fig. 3. Two phase shift networks. The plate leads to a blocking capacitor and the grid leak resistor is shown on the grid side.

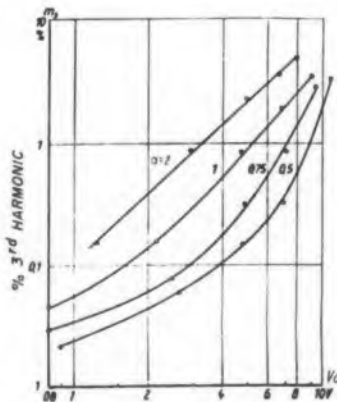
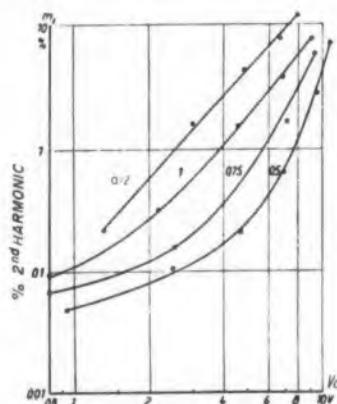
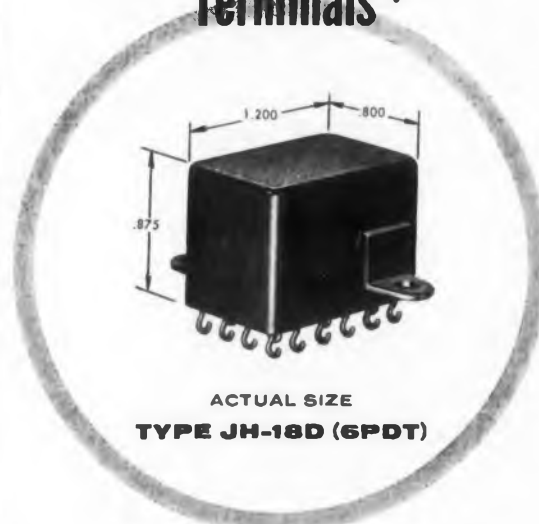


Fig. 4. Per cent second and third harmonic content as a function of output voltage in a phase shift oscillator with a as a parameter.

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.

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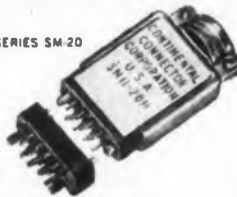


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GERMAN ABSTRACTS

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-ke to 2-mc range. It consists of a test stand, a modulated oscillator and an indicator cir-

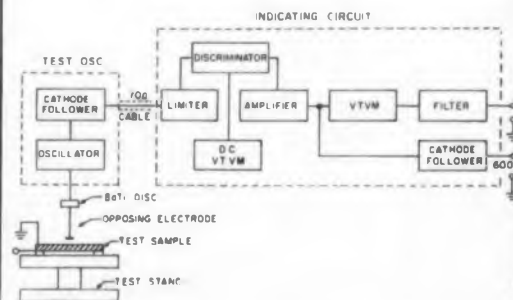


Fig. 1. Block diagram of measuring circuit.

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.

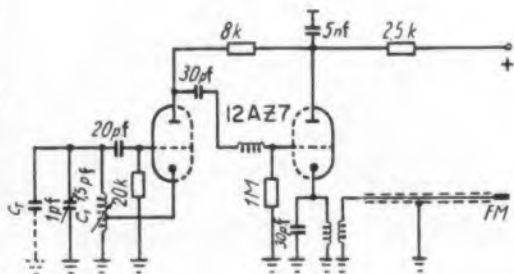


Fig. 2. Test oscillator. C_T represents the variable capacities under test.

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ELECTRONIC DESIGN

DIGEST of recent papers
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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 evaluation¹ 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.

E-W Custom Cooling

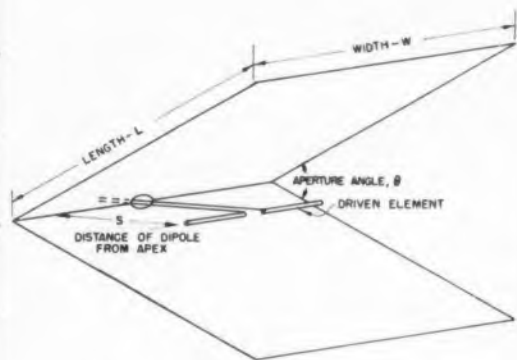


Fig. 2. Diagram of corner-reflector antenna.

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.

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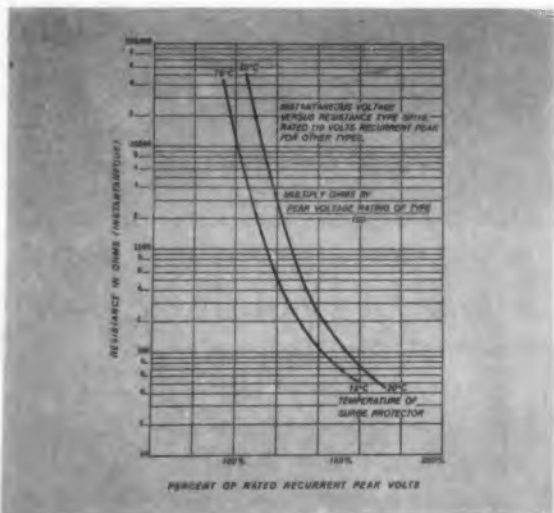


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SP130	300	210	26	5	3.15
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Surface Wave Antennas

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.



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Transistorized Power Supplies

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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.



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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, Fort 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.



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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.



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ELECTRONIC DESIGN • May 11, 1960

K-Band Mixer Diode

Gallium-arsenide diodes were developed with very low noise figures (10, 16, and 24 mc) 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.



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**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.



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Model 7 variable resistors are available with composition or wirewound elements, cased or hermetically sealed, with wire or printed circuit leads. The complete electrical, physical, and environmental characteristics of the Model 7 are described in CENTRALAB EP-906, available free on request.

SPECIFICATIONS:	Wirewound	Composition
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Minimum End Resistance	< 1% of total	< 1% of total
Power rating at 40°C	0.25 watt	0.2 watt
derated at 100°C	0.05 watt	0.02 watt
Rotational Torque	.5 to 3.0 in. oz.	
Component Density	9/cu. in.	
Adjustment	12½ or 25 turns	
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CIRCLE 904 ON CAREER INQUIRY FORM

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.

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A four-page folder describing briefly the overall picture of the work done by Consolidated Electro Dynamics and its subsidiaries is available.

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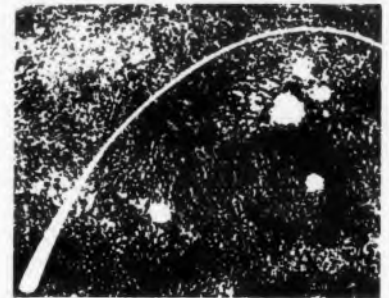


"Career Opportunities" is a six-page brochure on the McKiernan-Terry Corp., an organization of manufacturing engineers. They specialize in the design, engineering and manufacture of precision equipment for industrial and defense markets. Commercial products include construction equipment, materials handling 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.

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CIRCLE 906 ON CAREER INQUIRY FORM

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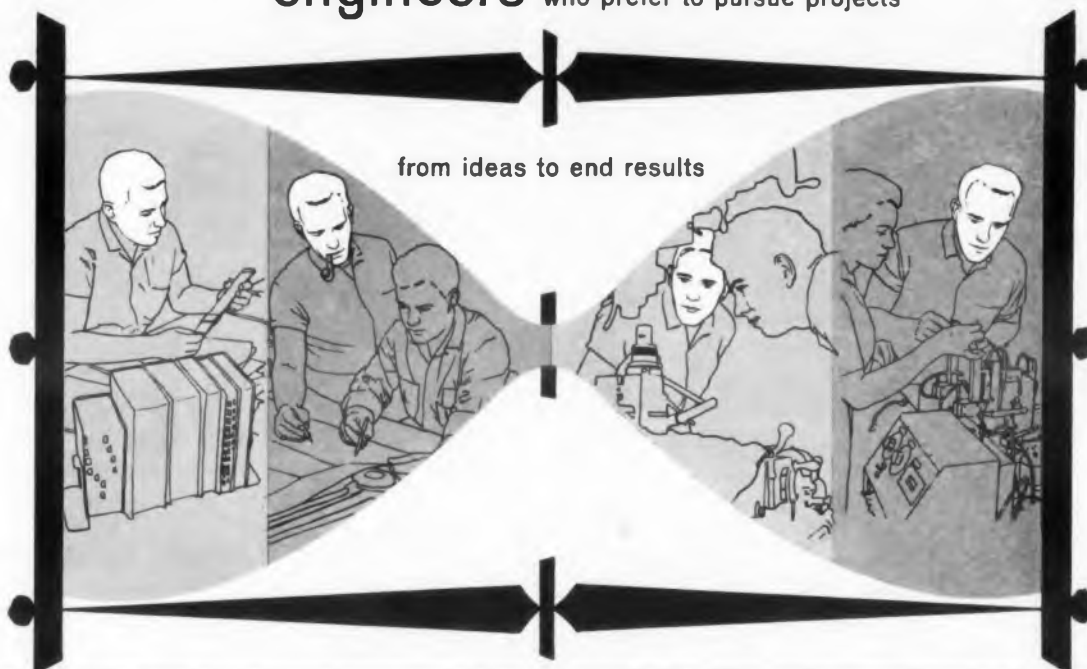
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ADVERTISERS' INDEX

May 11, 1960

Advertiser	Page
ACDC Electronics Inc.	127
AMP, Inc.	21
Ace Electronics Associates, Inc.	233
Adel Precision Products	222
Air Marine Motors, Inc.	23
Airborne Instrument Lab., Inc.	134
Airpat Electronics, Inc.	161
Alden Products Co.	242
Alford Mfg. Co.	221
Allied Control Co.	247
Allied Radio Corp.	107, 189
Amco Engineering Co.	169
American Electrical Heater Co.	219
American Electronic Labs., Inc.	189
American Standard Industrial Div.	122
American Time Products, Inc.	36
Amperex Electronic Corp.	133
Amphenol Borg Electronics Corp.	84, 138
Anaconda Wire & Cable Co.	between 104 & 105
Arnold Engineering Co., The	15
Arnold Magnetics Corp.	132
Assembly Products, Inc.	197
Atlee Corp.	209
Augat Brothers, Inc.	220
Babeck Relays, Inc.	65
Ballantine Laboratories, Inc.	126
Bamford Corp.	49
Beckman/Helipot	56
Belden Mfg. Company	98
Bendix Aviation Corp., Pacific Div.	103
Bendix Aviation Corp., Scintilla Div.	53
Bendix Aviation Corp., York Div.	262
Bird Electronic Corp.	212
Boonton Electronics Corp.	22
Bourns Inc.	85
Howmar Instrument Corp.	258
Brady, W. H., Company	176
Breeze Corporations, Inc.	82
Bristol Co., The	202
Bryant Computer Products Div.	30
Bud Radio Corp.	250
Bulova	7
CBS Electronics	33
Cadillac Associates, Inc.	189
Cambridge Thermionic Corp.	129
Cannon Electric Co.	92, 93
Celco Constantine Engineering Labs. Co.	217
Centralab, Div. of Globe-Union, Inc.	259
Chassis-Trak, Inc.	219
Christie Electric Corp.	188
Cicnil Corp.	224
Clare, C. P., & Company	152
Clarostat Manufacturing Company, Inc.	19
Clary Corp.	201
Clifton Precision Products Co., Inc.	Cover II
Cobehn, Inc.	196
Cohn, Sigmund Mfg. Co., Inc.	234
Community Engineering Corp.	206
Computer-Measurements Co.	159
Consolidated Avionics	210
Consolidated Electrodynamics Corp.	132
Consolidated Mining & Smelting Co.	199
Constantine Engineering Labs. Co.	217
Continental Connectors Corp.	248
Control Switch Division	126, 127
Coors Porcelain Co.	114
Cornell-Dubilier Electric Corp.	29
Couch Ordnance, Inc.	216
Crosby Teletronics Corp.	157
Cubic Corp.	177

Advertiser	Page
Davies Molding Co., Harry	246
Davies-Shea	247
Daystrom, Inc., Pacific Div.	140
Daystrom Transicoil Corp.	120
Dean & Benson Research	74
Donner Scientific Company	115
Dow Corning Corp.	100, 101
Dow Metal Products Co., The	171
Dressen-Barnes Corp.	176
Du Pont, E. I. de Nemours & Co.	135, between 152 & 153
Durant Manufacturing Company	225
Dynacor, Inc.	164
Dynamics Instrumentation Co.	188

E H Laboratories, Inc.	41
ESC Corporation	89
ETA Products Co. of America	238
Eastman Kodak Company	180
Edison Industries, Thomas A.	25
Eitel-McCullough, Inc.	32
Elastic Stop Nut Corp.	206
Electric Specialty Co.	78
Electro Instruments, Inc.	170
Electro Tec Corp.	164
Electronic Batteries, Inc.	242
Electronic Design	212, 243, 246, 266, 270
Electronic Designers' Catalog	96, 224
Electronic Engineering Corp.	243
Electronic Measurements, Inc.	77
Electronic Tube Corp.	205
Elgin National Watch Co., Electronics Div.	226
Ellis & Watts Products, Inc.	251
Engineered Electronics Company	203
Engineering and Science Aids	256
Eric Distributor Div.	89

Faber-Castell	18
Fairchild Controls Corp.	221
Fairchild Engine & Airplane Corp.	86
Fairchild Semiconductor Corp.	13
Fairmount Chemical Co., Inc.	239
Falstrom Co.	218
Fansteel Metallurgical Corp.	124, 125
Fastex Div., Illinois Tool Works	198
Fenwal Electronics	165
Film Capacitors, Inc.	256
Fluke, John Mfg. Co., Inc.	6
Food Machinery Corp.	255
Furane Plastics, Inc.	129

G-M Servo Motors	210
G-V Controls, Inc.	128
Garrett Corp., The	203
General Electric Co., Comm. Pdts. Dept.	267
General Electric Co., Miniature Lamp Div.	184
General Electric Co., Light Military	263
General Electric Co., Metallurgical Products Dept.	14
General Electric Co., Resistors	105
General Electric Co., Capacitors	42
General Electric Co., Semiconductor Products Dept.	154, 155, 174, 175
General Electric Co., Specialty Controls	167
General Electric Co., Specialty Heating Products Section	173
General Mills, Inc.	266
General Transistor Corp.	between 96 & 97
Gertsch Products, Inc.	256
Good-All Electric Mfg. Co.	122, 123
Goodyear Aircraft Corp.	31
Grant Pulley & Hardware Corp.	244
Grayhill, Inc.	207
Gremar Mfg. Co., Inc.	68
Gudebrod Brothers Silk Co., Inc.	144
Gurley, W. & L. E.	198

Handley, Inc.	43
Hart Manufacturing Company	218
Heiland Div. of Minneapolis Honeywell Regulator Co.	146, 147

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Heinemann Electric Co.	16
Heinz Mueller Engineering Co., Inc.	177
Hermetic Seal Corp.	139
Hermetic Seal Transformer Co.	196
Hewlett-Packard Company	69, 272, Cover III
Hickok Electrical Instrument Co.	144
Hi-G, Inc.	192
Holtzer-Cabot Motor Div.	172
Hopkins Engineering Co.	235
HRB Singer, Inc.	208
Hughes Aircraft Co.	153, 265

Ideal Precision Meter Co.	205
IMC Magnetics	249
Indiana General Corp.	214
Industrial Electronic Engineers	242
Industrial Instruments, Inc.	161
Industrial Test Equipment Co.	165
International Electronic Research Corp.	232

J F D Electronics Corp.	81
Jerrold Electronics Corp.	185
Jones, M. C. Electronics Co., Inc.	12

Kay Electric Co.	2
Kearfott, Div. of General Precision, Inc.	215
Keithley Instruments, Inc.	24
Kerr Corp., Wayne	216
Kester Solder Co.	188
Keystone Carbon Co.	97
Kinney Mfg. Div., The New York Air Brake Co.	108
Kintel, A Div. of Cohn Electronics, Inc.	5
Knapic Electro-Physics, Inc.	194
Kollsman Instrument Corp.	266
Krengel Mfg. Co., Inc.	197
Kulka Electric Corp.	234

Lambda Electronics Corp.	118
Ledex, Inc.	10
Lerner Plastics, Inc.	181
Librascope, Div. General Precision, Inc.	27
Littelfuse	128
Litton Industries	110
Lockheed Aircraft Corp., Missile & Space	130, 131
London Chemical Co., Inc.	200
Lord Mfg. Co.	111

McLean Engineering Laboratories	202
Magnetics Inc.	229
Malco Mfg. Co.	156
Mallory, P. R. Co., Inc.	95
Marconi	226
Marion Instrument Div., Minneapolis-Honeywell Regulator Co.	128
Markel, L. Frank & Sons	168
Markite Corp.	54
Martin Co.	between 104 & 105
Massa, Div. of Cohn Electronics, Inc.	211
Metallizing Industries, Inc.	198
Metronix, Inc.	200
Microwave Assocs., Inc.	222
Milgray Electronics, Inc.	109
Mincom Div. Minnesota Mining & Mfg. Co.	50
Miniature Precision Bearings, Inc.	213
Minneapolis-Honeywell Co., Boston Div.	162
Minneapolis-Honeywell Co., Industrial Div.	142
Minneapolis-Honeywell Co., Semiconductor Div.	257
Minnesota Mining & Mfg. Co.	40, 150
Model Engineering & Mfg. Co., Tri-Ohm Div.	223
Molly Corp.	180
Motorola, Inc.	79, 262
Mycalox Corp. of America	241
Mystik Adhesive Pkts., Inc.	188

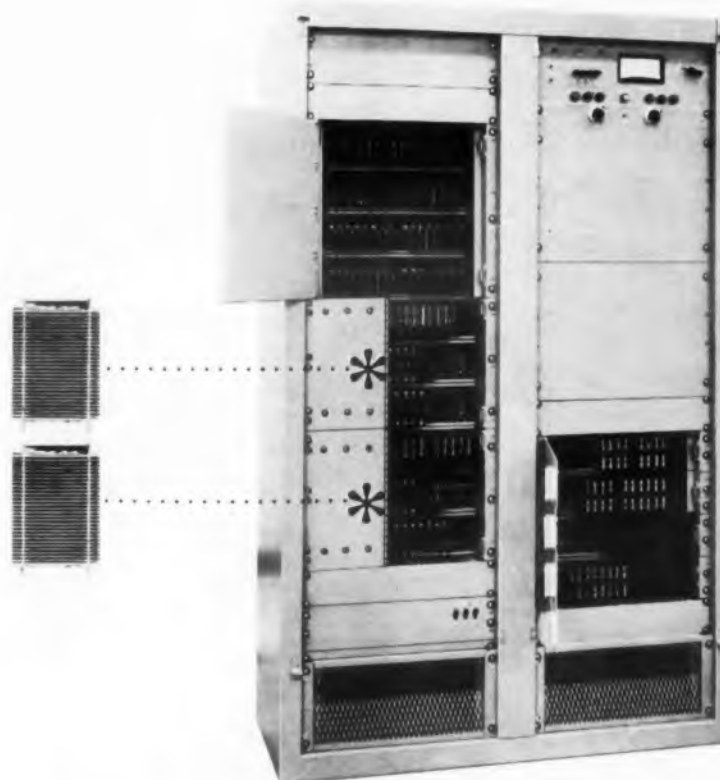
NJE Corp.	34
Narda Microwave Corp.	245
National Ultrasonic	246
Natvar Corp.	247
Navigation Computer Corp.	173
Newark Electric Corp.	151
New Hermes Engraving Machine Co.	234
Non-Linear Systems, Inc.	17
North Shore Nameplate	227

Oak Mfg. Co.	75
Offner Electronics, Inc.	148
Ohmite Mfg. Co.	83
Oster, John Mfg. Co.	166

Packard-Bell Electronics	37
Pacific Semiconductors, Inc.	90, 91
Penta Laboratories, Inc.	52
Perkin Engineering Co.	112, 113
Phelps Dodge Copper Products Co.	94
Philamon Laboratories, Inc.	230
Philco Corp.	264
Philco, Lansdale Div.	9
Polarad Electronics Corp.	between 24 & 25
Polytechnic Research & Development Co.	269
Porter Co., Inc., H. K.	201, 223
Post Co., Frederick	195
Potter & Brumfield	151
Power Sources, Inc.	240
Precision Paper Tube Co.	199

Radio Corp. of America	55, 119, 231, 268, Cover IV
Radio Receptor Co., Inc.	137
Ramsey Corp.	178
Rantec Corp.	3
Raytheon Co.	1
Reeves Instrument Corp.	207
Resistance Products Co.	235
Rome Cable Div. of Alcoa	185
Rotron Mfg. Co., Inc.	136
Rutherford Electronics Co.	8

Sage Electronics Corp.	204
Sanborn Co.	121
Sanders Assocs., Inc.	163
Sarkes Tarzian, Inc.	239
Schweber Electronics	13, 85
Sealectro Corp.	145
Segal, Edward	181
Sel-Rex Corp.	38
Servo-Tek Products Co., Inc.	184
Set Screw & Mfg. Co.	198
Shoekley Transistor Corp., Inc.	102
Sierra Electronics Corp.	104
Sigma Instruments	225
Signalite, Inc.	63
Simmons Fastener Corp.	178
Slip Ring Co. of America	172
Sola Electric Co.	183
Somers Brass Co., Inc.	136
Sonotone Corp.	243
Sorensen & Co., Inc.	187
Space Technology Laboratories	228
Speer Carbon Co., Jeffers Electronics Div.	220
Sprague Electric Co.	11
Stackpole Carbon Co.	35
Staedtler, J. S., Inc.	253
Standard Electronics Co.	235
Standard Pressed Steel	213
Stonite Coil Corp.	156
Sylvania Electric Products, Inc., Semiconductor Div.	51
Sylvania Electric Products, Inc., Special Tube Operations	158
Synthane Corp.	191



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Advertiser	Page
Taurus Corp.	209
Taylor Fibre Co.	157
Technic, Inc.	108
Technical Wire Products, Inc.	217
Technology Instrument Corp.	76
Tektronix, Inc.	186
Telemeter Magnetics, Inc.	271
Tenney Engineering, Inc.	182
Texas Instruments, Inc.	87, 108, 107, 179, 206, 267
Thermal American Fused Quartz Co., Inc.	204
Therm-O-Disc, Inc.	180
Tinnerman Products, Inc.	20
Transitron Electronic Corp.	149, 177, 181
Tru-Ohm Products	223
Tung-Sol Electric, Inc.	28

Ultrasonic Industries, Inc.	207
Union Switch & Signal Div., Westinghouse Air Brake Co.	236, 237
United Aircraft Products, Inc.	193
U.S. Stoneware	141
United Shoe Machinery Corp.	139

Valcor Engineering Corp.	254
Valor Instruments, Inc.	145
Varietyper Corp.	199
Varian Associates	160
Vector Electronics Co.	226
Vickers, Inc.	252
Vitramon, Inc.	143

Walkirt Co.	211
Wallson Associates, Inc.	208
Ward Leonard Electric Co.	88
Weekesser Co.	206
Westinghouse Electric Corp.	116, 117, 260
Weston Instruments, Div. of Daystrom, Inc.	39
Whitso, Inc.	169
Wiancko Engineering Co.	227

Yardney Electric Corp.	160
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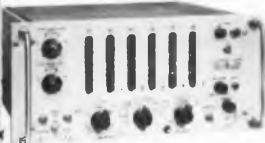


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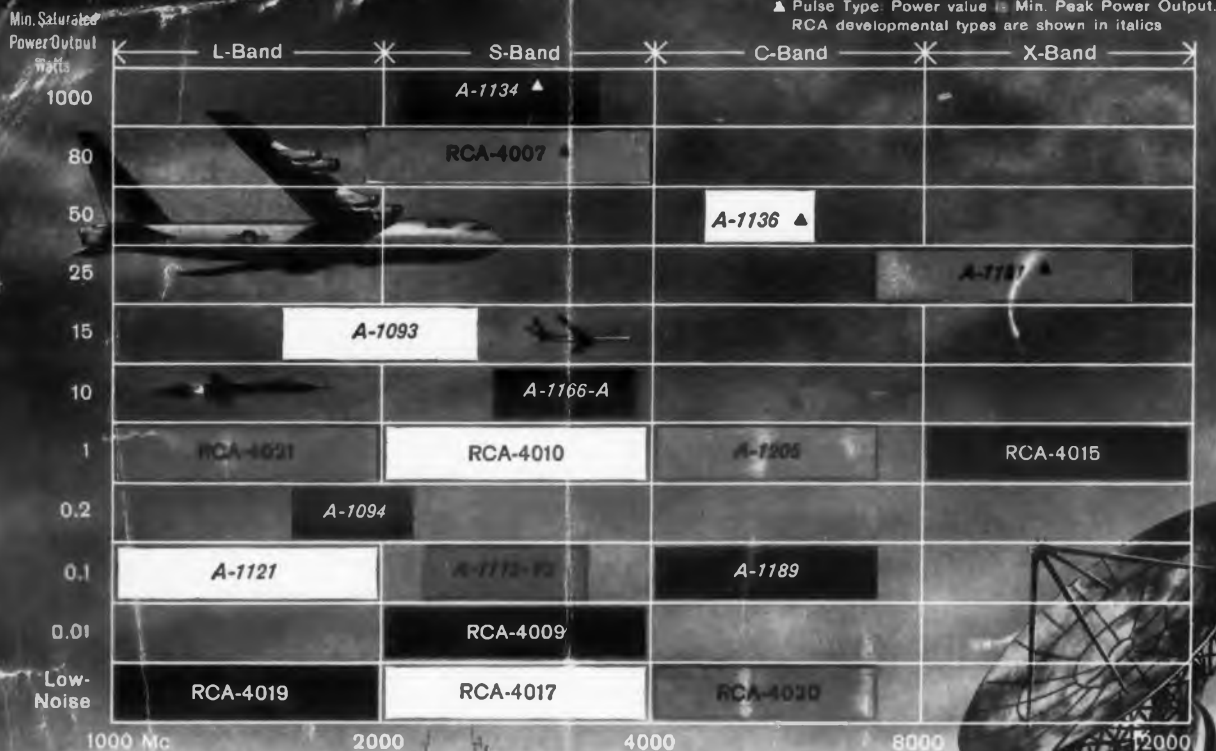
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