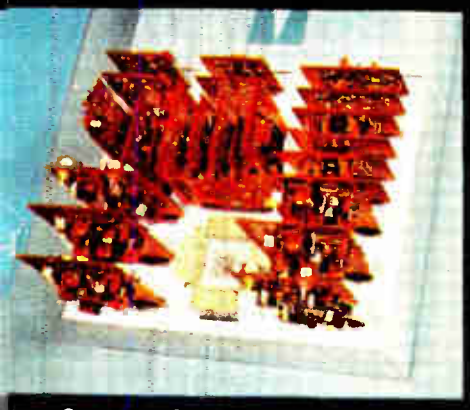
JULY 31, 1959

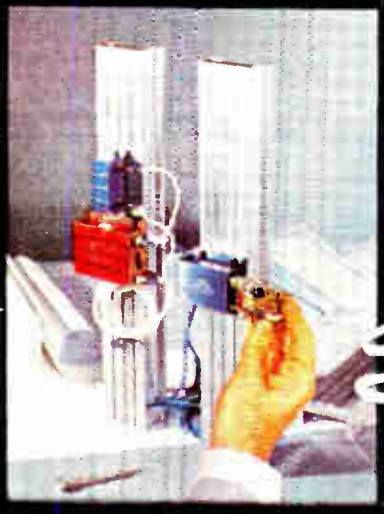
electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 31 PRICE SEVENTY-FIVE CENTS

ICBM Programmer



Computer Components



Accelerometer Package

Mesa Transistor Emits Light

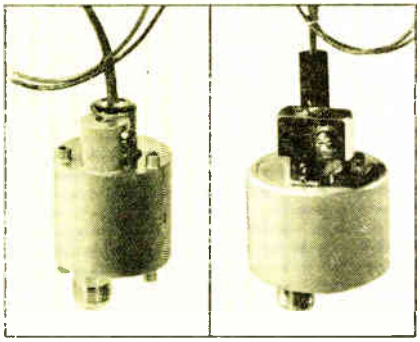
Special TRANSISTORIZING ELECTRONIC

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 1, No. 5

NEW RAYTHEON MICROWAVE TUBE DEVELOPMENTS

Miniature pulsed magnetrons for missile beacon applications are ruggedly constructed with integral magnets. The RK-7461 is tunable from 9,300 to 9,500 mc and has minimum peak power output of 60 watts. It is 1¼" in diameter and 2½" long, and weighs only 6 ounces.



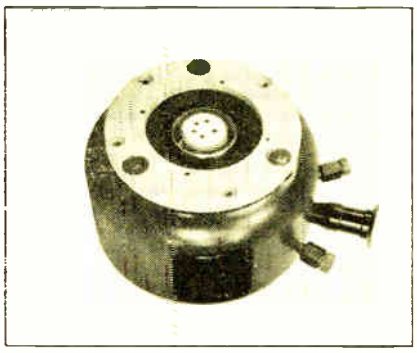
RK-7461 QK-735

The QK-735 is tunable from 5,400 to 5,900 mc with minimum peak power output of 400 watts. 1½" in diameter and 3¼" long, it weighs 8 ounces.

CIRCLE 182
Reader Service Card

* * *

Designed for electronic countermeasures and FM/CW operations, the QK-625 BWO provides a minimum CW power output of 180 watts and a nominal CW power output of 250 to 350 watts over the 2,500 to 3,000 mc band. The tube is voltage tunable over the entire range with tuning sensitivity of approximately 0.4 mc/volt. Liquid-cooled, the QK-625 BWO is equipped with an integral



permanent magnet, and can be mounted in any position.

CIRCLE 180
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* * *

Small-signal gain of up to 35 db in microwave relay links is achieved by means of a new compact traveling wave tube amplifier -- the QK-542. This permanent-magnet focused CW tube has nominal saturated power output of 5 watts over 5,900 to 7,400 mc. An integral UG 344/U waveguide-type flange is supplied as standard. With an optional coaxial output coupler the QK-542 covers 4,000 to 8,000 mc.

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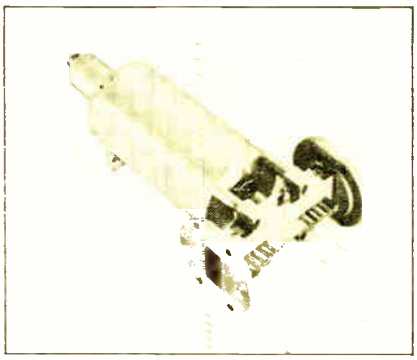

Ideal for linear accelerators and high-power radar systems. The QK-783 and QK-622 Amplitrons operate over the 2,700-2,900 mc and 2,900-3,100 mc bands, respectively, at a peak power of 3 megawatts and a typical efficiency of 75%. Because no heater is required, these tubes are capable of exceptionally long life. RF gain is 8 db under rated conditions, and as high as 12 db at lower peak power outputs. Phase pushing figure is less than 0.5 degrees for a 1% variation of anode current.

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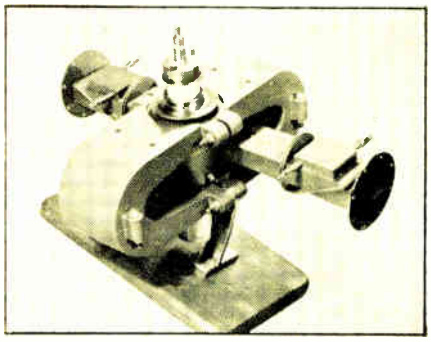

* * *

Compiled as a Raytheon service to the field, new Consolidated Data Booklet contains comprehensive information about principal unclassified magnetrons, klystrons, backward wave oscillators and special purpose tubes manufactured by Raytheon. Characteristics presented include maximum ratings, typical operating values, band or frequency ranges and other essential data for microwave engineers and purchasing departments.

CIRCLE 184
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A Leader in Creative Microwave Technology

RAYTHEON

electronics

JULY 31, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 31

Issue at a Glance

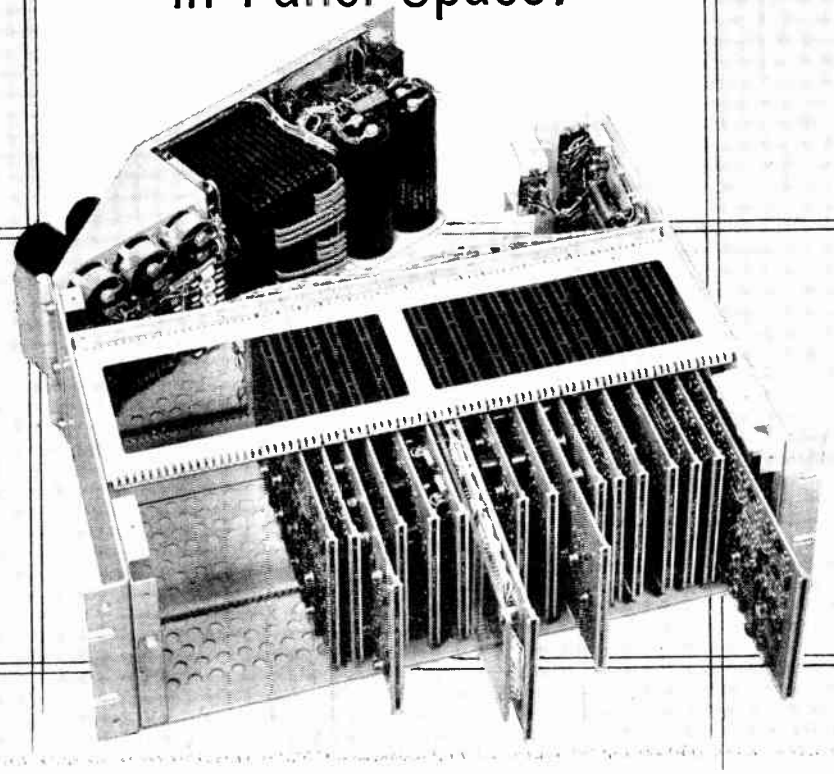
Business

Engineering

Departments

Magnetic Core Buffer Memory Sets New Design Standards for Data Handling Systems

80% Saving in Panel Space!



Requires only 5¼" of Space in a 19" Rack

From General Ceramics—Four new magnetic core buffer memories that are setting new design standards among data handling system designers requiring increased efficiency in smaller physical packages.

Now available in either random access or sequential designs:

144 M4A — 144 characters in 9x16 array with a word length of four bits.
144 M8A — 144 characters in 9x16 array with a word length of eight bits.
512 M8A — 144 characters in 16x32 array with a word length of eight bits.
1024 M8A—1024 characters in 32x32 array with a word length of eight bits.

Design Features Include—

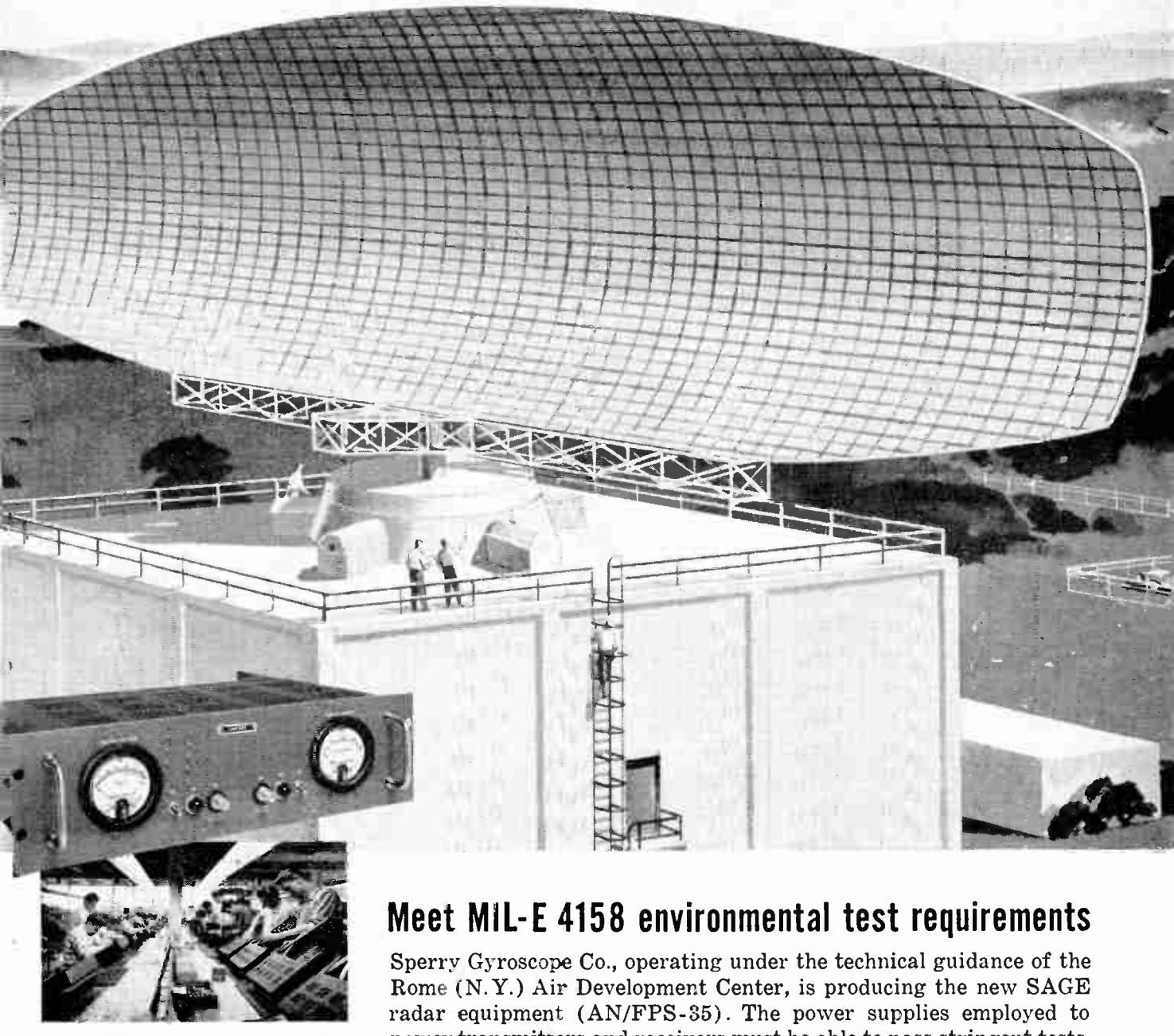
1. **SPACE-SAVING**—Require only 5¼" of standard rack space . . . permit smaller overall system design.
2. **VARIABLE CHARACTER AND BIT LENGTHS**—Unique design of driver circuit permits circuitry of existing data handling system to be enlarged without costly redesign.
3. **HIGHER OPERATING TEMPERATURE RANGE**—Contributes to miniaturized system design because memory functions satisfactorily under higher ambient temperature conditions.
4. **EASE OF MAINTENANCE**—All components are within easy reach. All circuits are on plug-in cards except power supply which is hinged across the back; swings out for easy accessibility.
5. **EXTRA FEATURES**—All units are equipped with an electronic clear and output register at no extra cost.

Complete detailed technical information will be supplied promptly on request. Please address inquiries to Dept. E.

GENERAL CERAMICS
ORIGINATOR OF THE SQUARE LOOP FERRITE

Applied Logics Division
GENERAL CERAMICS CORPORATION
KEASBEY, NEW JERSEY, U.S.A.

Lambda Power Supplies specified for newest radar installation



"Off-the-shelf" Lambda power supplies —modified only with special panels, MIL meters and tubes—will be part of the complex radar equipment housed in the 85-foot tower at Thomasville, Alabama, one of four identical installations.

Meet MIL-E 4158 environmental test requirements

Sperry Gyroscope Co., operating under the technical guidance of the Rome (N.Y.) Air Development Center, is producing the new SAGE radar equipment (AN/FPS-35). The power supplies employed to power transmitters and receivers must be able to pass stringent tests.

Sperry's choice: Lambda's COM-PAK,® already widely used as a component in many rocket and missile programs.

All Lambda stock industrial power supplies are made to MIL quality and *guaranteed for five years.* They are pictured and described in a new 32-page catalog. Write for your copy.

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CIRCLE NO. 3 READER SERVICE CARD

electronics

July 31, 1959 Vol. 32, No. 31

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SHOPTALK . . . editorial

THE RIGHT TO KNOW. Today many an electronics engineer's working papers come in two parts: his degree and his security clearance. Loss of the latter can mean loss of a lot of bread and butter, as more than one engineer has found out.

International tension has inspired a vast program of security procedures for companies doing classified government work. The program was never authorized by Congress or by an executive order of the President. It was designed primarily by the military services.

Techniques of gathering information about individuals included interviewing friends, family and neighbors. Private citizens also came forward and divulged information, often with the promise that their identity would remain secret. Sometimes undercover agents were called upon.

Administrative officers considered the information and either granted or denied access to classified information. Review boards heard appeals and made final rulings. Sometimes information from informers resulted in a clearance being taken away. The machinery for appealing such a decision was particularly cumbersome.

If an individual had time, money, friends and a desire to fight, he could appeal a decision. He could bring witnesses to testify on his behalf and deny charges. But he could not confront the informers who had presented information. Review boards could rule against an employee although a preponderance of the evidence presented at a hearing was favorable to him.

Aside from the effect of such procedure upon the individual, when scientists and engineers are denied access to knowledge of modern developments in their field their industry as a whole eventually suffers.

It is important that the Department of Defense in particular recognize the danger of too much security and pay more than lip service to Presidential directives that indicate using the lowest possible security classification. This must be done as soon as possible—before our electronics industry finds itself far behind the rest of the world.

W W MacDonald

Editor

Coming In Our August 7 Issue . . .

THE GOLDEN WEST. In ten years, the west coast has experienced phenomenal growth as an electronics center. From a mere $158 million in sales chalked up by the small coastal area which then comprised western electronics industry, production has mushroomed until the region now includes eleven western states, with total sales edging near the $2 billion mark. Next week, Pacific Coast Editor Hood describes the factors responsible for this amazing expansion, and tells of some of the technical developments arising out of this dynamic segment of our industry.

FLIGHT CONTROL BUMPS. In flight control systems, several error signals usually feed each servo loop. Since all the error signals may not be desired simultaneously, various switching techniques are employed for changing the modes of servo operation. Such switching may cause undesirable transient responses to be transmitted to the aircraft surfaces, with resultant undesirable motion. L. D. Fry of General Electric Co. in Johnson City, N. Y. tells how a transistorized adder-attenuator amplifier eliminates or reduces transient motion of the aircraft.

SPRAGUE® RELIABILITY in these two dependable wirewound resistors

MINIATURE

Blue Jacket®

VITREOUS-ENAMEL POWER RESISTORS

Sprague's new improved construction gives even greater reliability and higher wattage ratings to famous Blue Jacket miniature axial lead resistors.

A look at the small *actual sizes* illustrated, emphasizes how ideal they are for use in miniature electronic equipment with either conventional wiring or printed wiring boards.

Get complete data on these dependable minified resistors, **write for Engineering Bulletin 7410.**

TAB-TYPE BLUE JACKETS: For industrial applications, a wide selection of wattage ratings from 5 to 218 watts are available in Sprague's famous Tab-Type Blue Jacket close-tolerance, power-type wirewound resistors. Ideal for use in radio transmitters, electronic and industrial equipment, etc. **For complete data, send for Engineering Bulletin 7400A.**

NEW SMALLER SIZE

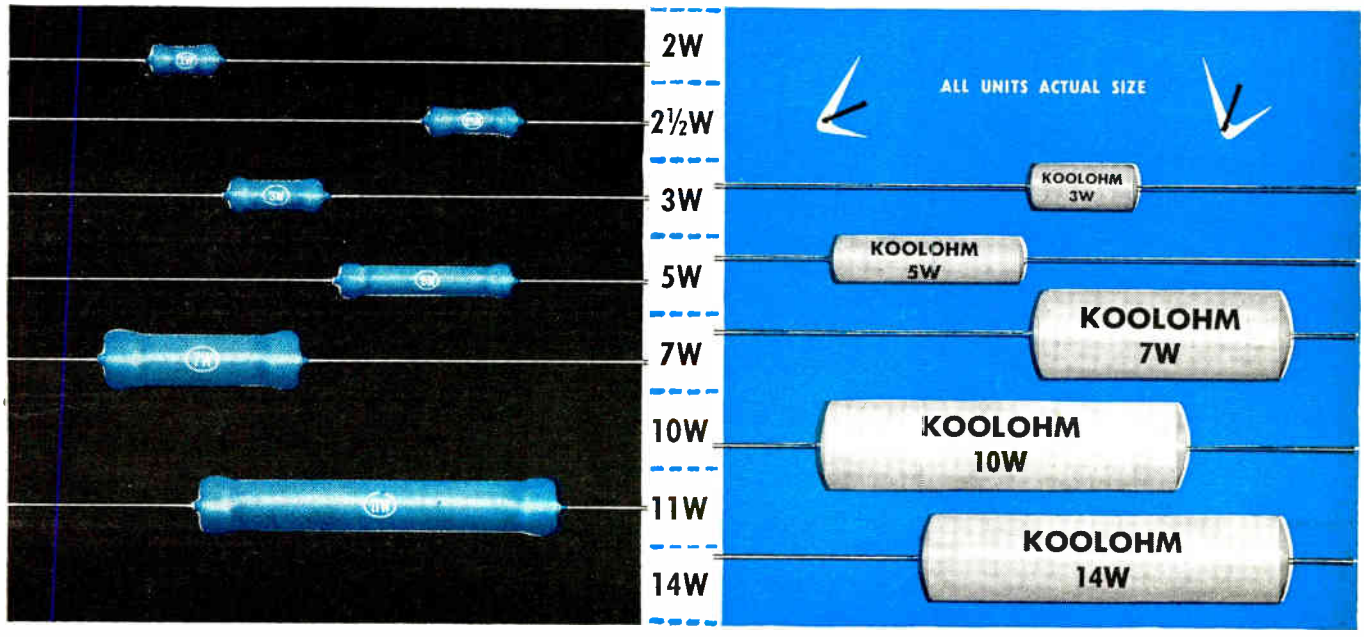
KOOLOHM®

INSULATED-SHELL POWER RESISTORS

New Koolohm construction features include welded leads and winding terminations—Ceron ceramic-insulated resistance wire, wound on special ceramic core—multi-layer non-inductive windings or high resistance value conventional windings—sealed, insulated, non-porous ceramic outer shells—*aged-on-load* to stabilize resistance value.

You can depend upon them to carry maximum rated load for any given physical size.

Send for Engineering Bulletin 7300 for complete technical data.



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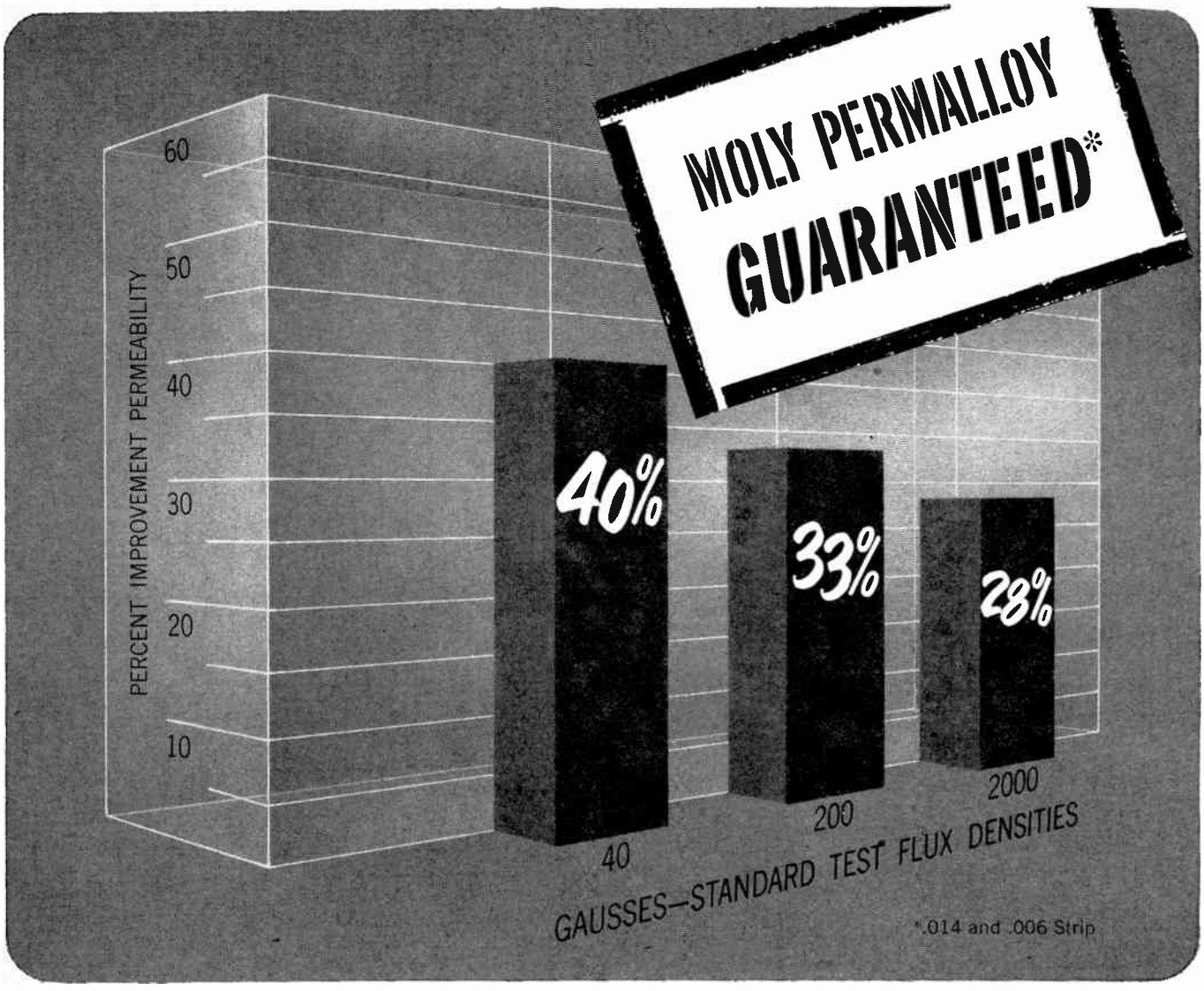

GUARANTEED PERMEABILITY OF MOLY PERMALLOY...

at values higher than old average specifications

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum with *guaranteed* permeability values. And the new guarantees are much higher than the old typical values. This exceptionally high quality means absolute uniformity for the user—new consistency and predictability for magnetic core performance.

Improved permeability of A-L Moly Permalloy is the result of Allegheny's program of production research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. Research is continuing on silicon steels including A-L's famous Silectron (grain oriented silicon steel), plus other magnetic alloys.

Another plus in dealing with Allegheny Ludlum is the operation of complete lamination fabrication and heat treatment facilities. A-L's years of experience in producing quality laminations result in practical know-how in solving problems common to core materials.

This working knowledge is available to all. Give us a call for prompt technical assistance on *any* problem involving electrical steels, laminations, or magnetic materials. Write for more information on A-L Moly Permalloy. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. E-191.***

WSW 7279

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Westinghouse
Silicon

POWER

transistor!

Greater than 99% efficiency when used to handle 1.5 kw of power in a low-frequency DC switch! Power loss is only 10-15 watts when handling 1.5 kw. That's just one of the impressive specifications established by a remarkable new semiconductor device—the Westinghouse Silicon Power Transistor.

This Power Transistor is remarkable in other ways, too . . .

- It is the first power transistor available in voltage ranges above 100 volts.
- It has power dissipation capability of 150 watts made possible by the low thermal resistance of .7°C/watt.
- It can operate at higher temperatures than germanium (150°C., compared to 85°C).
- It has astonishingly low saturation resistance—less than .5 ohms at 5 amperes and .75 ohms at 2 amperes, an achievement made possible through extensive research and development of hyper-pure Siemens-Westinghouse Silicon.
- It is 100% power-tested under actual maximum rated specifications before leaving the plant.
- It is encapsulated in a rugged, all-welded case.

HERE ARE A FEW OF THE APPLICATIONS . . .

• Inverters and converters • Data processing circuits • Servo output circuits • Series regulated power supplies • As a low frequency switch • In class A amplifiers.

Available in 2 and 5 ampere collector ratings in production quantities now. For complete specifications and details, contact your local Westinghouse representative.

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Westinghouse Electric Corporation, Semiconductor Department Youngwood, Pa.

Clock assembly work steps along quickly with Gardner-Denver 12E air screw driver.

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Gardner-Denver believes there's no substitute for men—it has been our philosophy of growth for 100 years. Your Gardner-Denver air tool specialist has helped many uncover ways to speed the production pace . . . lower costs. He's a good man to know.

How high-speed air tools save clock assembly time

This manufacturer uses air power to put clock assemblies together in a hurry. The main spring in this high-speed production: Gardner-Denver air screw drivers. At a touch screws spin tightly to preset torque . . . a cushion clutch eliminates runaway bits and over-torquing. In seconds the operator is ready for the next assembly.

Leading manufacturers everywhere keep production in time with air tools—Gardner-Denver drills, screw drivers, nut setters, ratchet wrenches, multiple drilling and fastening machines. They're fast, safe, easy to operate. Write today for air tool bulletins.

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"PACKAGING" MICROWAVES FOR MOUNTAIN TOPS

"TJ" radio-relay station at Black Mesa, Arizona

In Arizona, the telephone company faced a problem. How could it supply more telephone service between Phoenix and Flagstaff—through 135 miles of difficult mountain territory?

Radio offered the economical answer: a new microwave radio-relay system recently created at Bell Telephone Laboratories. Operating at 11,000 megacycles, it was just right for the distance, and the number of conversations that had to be carried.

But first other problems had to be solved: how to house the complex electronic equipment; how to assemble and test it at hard-to-reach relay stations way up in the mountains; and how to do it economically.

On-the-spot telephone company engineers had some ideas. They worked them out with engineers at the American Telephone and Telegraph Company and at Bell Telephone Laboratories. The result: a packaged unit.

The electronic equipment was assembled in trailer-like containers at convenient locations and thoroughly checked out. The complete units were then trucked up the mountains and lifted into position.

The system, now operating, keeps a watch on itself. When equipment falters, a relay station switches in standby equipment, then calls for help over its own beam.

The new Phoenix-Flagstaff link illustrates again how Bell System engineers work together to improve telephone service. Back of their efforts is the constant development of new communications systems at Bell Telephone Laboratories.

BELL TELEPHONE LABORATORIES *World center of communications research and development*

25 AMP 100 VOLT POWER TRANSISTORS

Motorola 2N1166 and 2N1167 PNP germanium transistors offer • more usable power output than any other transistor • low saturation resistance (0.012 ohms-typical) for lower dissipation • high current gain • welded hermetic seal • excellent Beta linearity.

These new high-power transistors can be used to reduce the size and weight of transmitters without sacrificing power output, to extend the life expectancy of DC-DC converters and for a wide number of other high current switching and audio applications. Both units are available from stock. For engineering quantities contact your authorized Motorola Semiconductor distributor.

ANOTHER MOTOROLA FIRST

MOTOROLA'S COMPLETE RANGE OF INDUSTRIAL POWER TRANSISTORS gives you power for every purpose. Three separately designed series, produced under individual specifications, enable you to select devices best suited for your specific application.

POWER TRANSISTOR	Type Number	Maximum Ratings BV_{CBO} volts	Maximum Ratings BV_{CES} volts	Typical Electrical Characteristics h_{FE} @ I_C amps	
25 AMP TO 100 VOLTS	2N1167*	100	75	25	25
	2N1166	100	75	25	25
	2N1165*	80	60	25	25
	2N1164	80	60	25	25
	2N1163*	50	35	25	25
	2N1162	50	35	25	25
	T_J = 90°C				
10 AMP TO 100 VOLTS	2N630*	100	75	18	10
	2N629*	80	60	18	10
	2N628*	60	45	18	10
	2N627*	40	30	18	10
	T_J = 90°C				
3 AMP TO 80 VOLTS	2N375	80	60	22	3
	2N618	80	60	35	3
	T_J = 95°C				

*Supplied in TO-3 package with solder terminals.

NOTE: all twelve of the above transistors have welded hermetic seals and are designed to meet or exceed mechanical and environmental requirements of MIL-T-19500A.

FOR COMPLETE TECHNICAL INFORMATION regarding Motorola power transistors contact your nearest Motorola Semiconductor regional office.

Regional Offices:

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WHitney 5-7500
from New York WI 8-6828

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HOllywood 2-0821

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"DEPENDABLE QUALITY - IN QUANTITY"

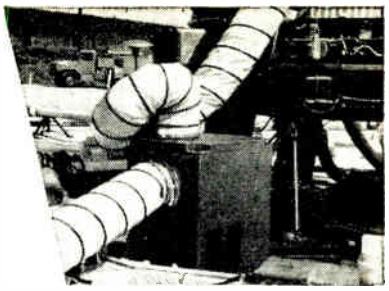
MOTOROLA SEMICONDUCTORS

MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

Vital equipment in this Jupiter missile is protected 24 hours a day, month after month, by a specially designed Ellis and Watts refrigerated-type Dehumidifier. In the various compartments of the Jupiter missile this E-W Unit constantly maintains perfect environmental conditions during long periods of standby and storage. Without this specialized Dehumidification Unit, moisture and condensation could cause deterioration of vital equipment and one of our most important weapons would never even get off the ground !

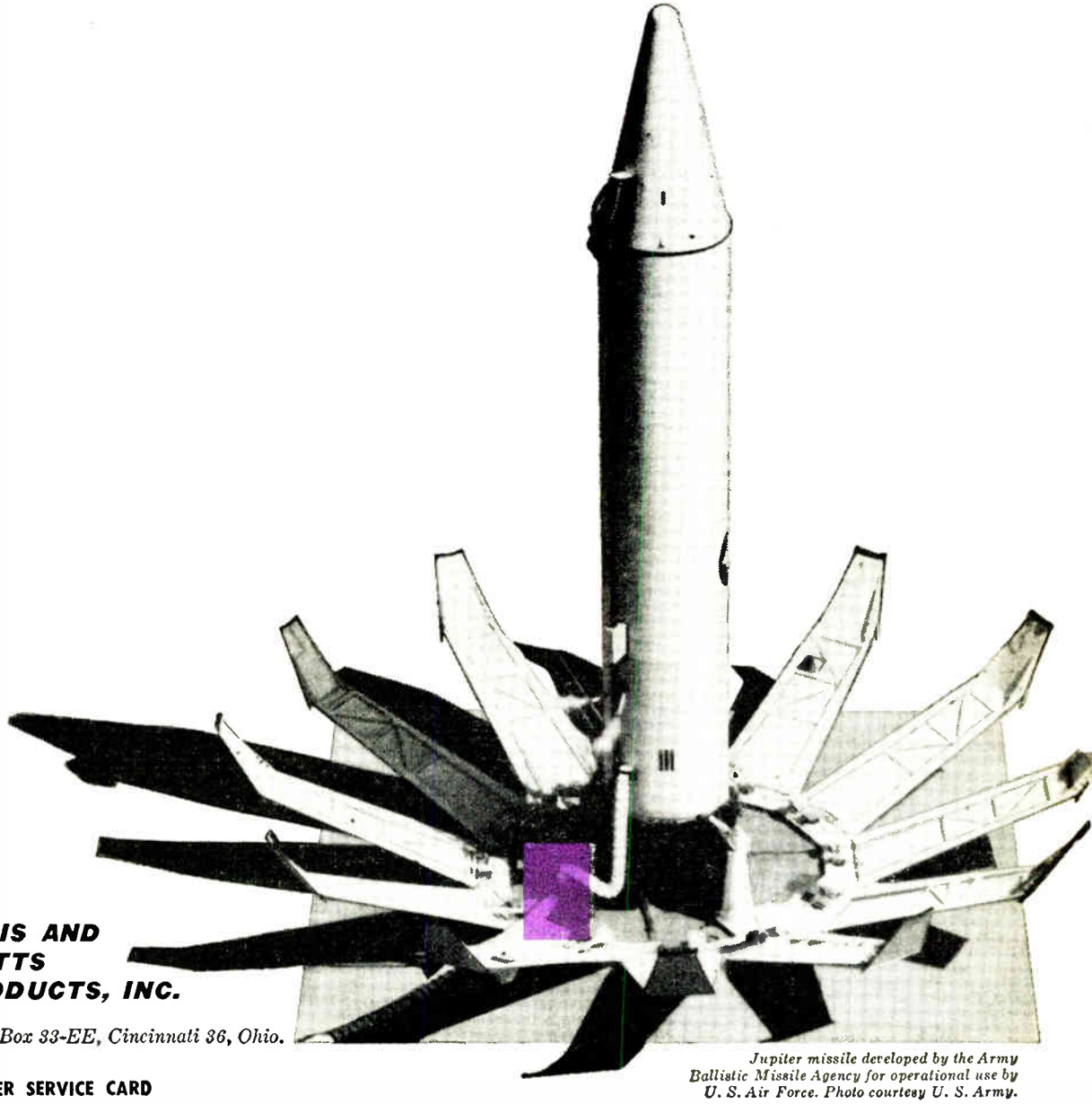
Designing and building specialized dehumidification units for electronic or mechanical gear is our business at Ellis and Watts. Units of any capacity, configuration, control requirements or functions can be designed and built to any applicable military or commercial specifications. And, Ellis and Watts units will function perfectly in any climate conditions on earth.

For additional information on specialized dehumidification units for electronic or mechanical gear, write for bulletin 135-E.



E-W refrigerator-type Dehumidifier, developed especially to protect vital equipment in the Jupiter missile.

without E-W dehumidifiers, the Jupiter would drown in its own sweat!



Jupiter missile developed by the Army Ballistic Missile Agency for operational use by U. S. Air Force. Photo courtesy U. S. Army.

ELLIS AND WATTS PRODUCTS, INC.

P. O. Box 33-EE, Cincinnati 36, Ohio.

CIRCLE NO. 13 READER SERVICE CARD

WASHINGTON OUTLOOK

WASHINGTON—THE NAVY, which will buy at least $600 million worth of electronic equipment this year, is under heavy pressure from the House Armed Services Investigations Subcommittee and the General Accounting Office to tighten up its procurement practices.

It is a foregone conclusion that the Navy will buckle in and clamp new controls on contracting—just as the Air Force has been doing in recent weeks as a result of similar pressures.

This is what can be expected: tighter evaluation and verification of contractor cost estimates; greater reluctance to get into fixed-price and incentive-price contracts without adequate cost and production experience or some vestige of competition between contractors; more scrutiny over prime contractor profits on work subcontracted out to other plants; a closer look at the rental of government-owned production facilities.

GAO has pinpointed "deficiencies" along these lines in a scathing report to Congress on Navy procurement contracting. It said special audits of 12 major contracts show the Navy was "overcharged" a total of $12.2 million over the past two years.

GAO makes some wide-ranging and specific recommendations:

(1) That in negotiating spare parts procurement the Navy review all the contractor's orders to assure "economies possible from large-volume production."

(2) That repricing rights be inserted in contracts where "recent experienced costs are not available or where adequate data are not furnished to support estimated increases in costs."

(3) That the Pentagon tote up total requirements in advance for items produced by a sole source and coordinate buying as a means of keeping prices in line.

(4) That contracting officers verify cost estimates by "independent review of the records from which the contractors derive the information."

(5) That in more cases the Navy buy components not from prime contractors but directly from producers who now act as the prime's suppliers.

- **Under prodding from the House Appropriations Committee,** the Army has toted up latest figures on the Nike-Hercules missile project to show how the Army is "reducing concentration" of business with the principal prime contractor.

  The Army figures show this: Western Electric's share of the work (including work done by Bell Labs) amounted to some 37 percent of the total cost of the project—which ran to $550 million last year. Western Electric earns 10 percent gross profit on production in its own plants, and its profit on production by Douglas Aircraft (the major subcontractor) ranges from 3 to 6 percent, depending on whether the items require further processing by Western Electric.

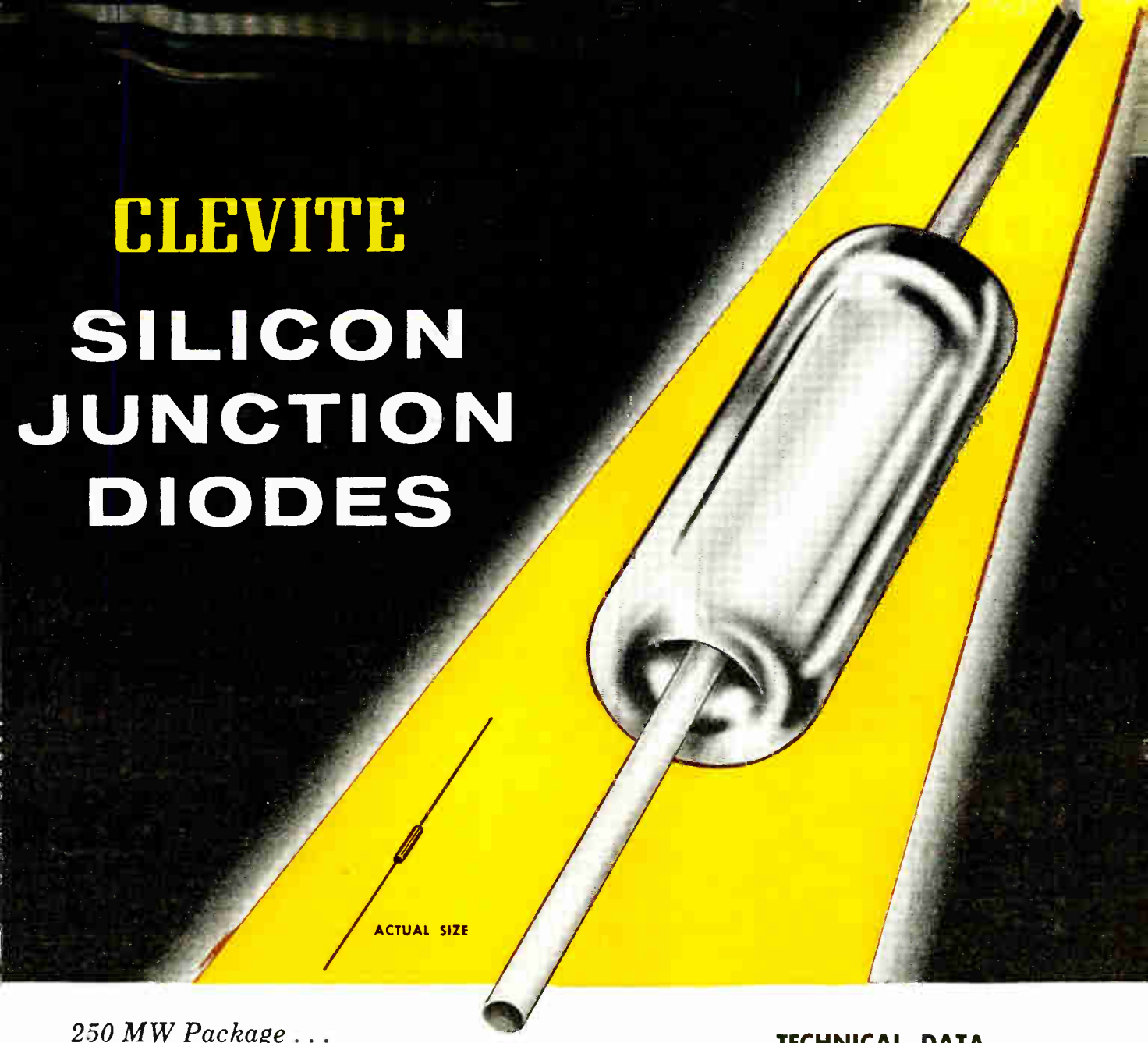
  Western's profit on the project's other subcontract work by some 5,000 different companies varies between 3 and 10 percent. The rate in each case depends on the subcontract's size, the extent of Western's engineering assistance, and whether the item is a component or subassembly furnished direct to Western or direct to the Army. Twenty-three percent of the project is awarded on Army prime contracts to companies other than Western Electric and its subs.

- **The Pentagon's Advanced Research Projects Agency** is rushing work on Project Courier, the 500-lb communications satellite. Latest contracts on the project have been awarded to ITT for ground-based communications stations; Philco for the satellite's communications system; Radiation, Inc., for ground-based antennas.

  First attempt to launch the satellite, which is designed to transmit and receive up to 200 100-words-per-minute messages between two or more ground stations, will be made within a year.

CLEVITE

SILICON JUNCTION DIODES



250 MW Package . . .
Fast Switching and General Purpose Types
Featuring . . .

- MECHANICAL RELIABILITY — Rugged, hermetically sealed, subminiature packages. Designed to meet both military and commercial requirements.
- ELECTRICAL SUPERIORITY — Excellent high temperature operation . . . thermally stable . . . high forward conductance . . . efficient rectification.
- PRODUCT UNIFORMITY — Tight manufacturing controls.

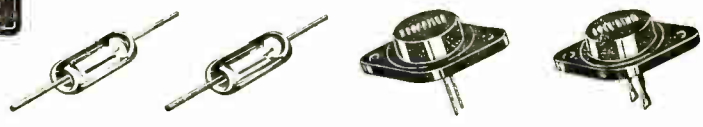
For details, write for Bulletin B217A-1 B217A-2

TECHNICAL DATA

Type	Max. DC Inver. Oper. Voltage	Forward Current @ Specified Voltage	Max. Inverse Current @ 25°C	Max. Inverse Current @ 150°C	Test Volts
1N457	60 V	20 ma @ 1.0 V	0.025 μa	5.0 μa	60 V
1N458	125 V	7 ma @ 1.0 V	0.025 μa	5.0 μa	125 V
1N459	175 V	3 ma @ 1.0 V	0.025 μa	5.0 μa	175 V
1N662	90 V	10 ma @ 1.0 V	20 μa	100 μa (@ 100° C)	50 V
1N663	90 V	100 ma @ 1.0 V	5.0 μa	50 μa (@ 100° C)	75 V
1N778	100 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	100 V
1N779	175 V	10 ma @ 1.0 V	0.5 μa	30 μa (@ 125° C)	175 V

OTHER CLEVITE DIVISIONS:

Cleveland Graphite Bronze • Brush Instruments
Clevite Electronic Components • Clevite Harris Products
Clevite Ltd. • Clevite Ordnance • Texas Division
Clevite Research Center • Intermetall G.m.b.H.



Silicon Junction Diodes | Germanium Diodes | Power Transistors | Solder Lug Power Transist

CLEVITE
TRANSISTOR PRODUCTS
241 CRESCENT ST., WALTHAM 54, MASS.
TWinbrook 4-9330

A DIVISION OF CLEVITE CORPORATION

WITH

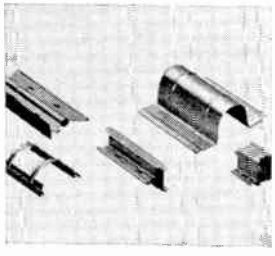
General Plate

COPPER-CORED ALIRON

Redesigned with improved heat dissipating anode material, General Electric Company's 6L6-GC audio power output tubes now offer important new advantages — maximum anode dissipation — or, rating increased 40 percent — cost one-third lower than comparable tubes — low distortion. And to obtain this improved value for their customers, General Electric Company used General Plate 5-layer copper-cored Aliron strip made available by Metals & Controls Division at the request of the Receiving Tube Department of the General Electric Company.

The copper, when combined with high emissivity aluminum-steel surfaces, results in a clad metal stock with improved heat conductivity . . . allows greater heat dissipation without danger of hot spots developing in tube anodes. The five layers are inseparably bonded together without intermediate brazing materials. Individual layer thicknesses are accurately controlled so that physical properties remain uniform.

Metals & Controls is constantly developing new clad metals which save weight, increase strength, conserve materials, improve performance and offer other advantages not found in single metals or alloys. Write for catalog GP-1 and get acquainted with General Plate Clad Metals.



OTHER GENERAL PLATE CLAD METALS USED IN TUBES

Copper-base Aliron — Aluminum on low-carbon steel on copper

Aliron® — Aluminum clad to both sides of low-carbon steel

Nifer® — Nickel clad to both sides of low-carbon steel

Alnifer® — Aluminum on low-carbon steel on nickel

METALS & CONTROLS

1307 FOREST STREET, ATTLEBORO, MASS., U. S. A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals


RCA presents:
NUVISTOR...
the new look in electron tubes
...OPENING A NEW WORLD
OF EQUIPMENT DESIGN...

OUT OF THE PAST

Man's knowledge and skills increase with every moment. Theory becomes reality. Principle becomes practice. These are the dynamics of this era. And, in this quest for new knowledge, for a finer way of life, Electronics has become one of man's most important tools. RCA has contributed steadily to the advancement of Electronics... has constantly endeavored to remove the limitations imposed by accepted materials, processes, and techniques.

A BRIGHT PROMISE FOR THE YEARS AHEAD

RCA now presents an entirely new concept in electron tubes... a concept that promises to be one of the most exciting advancements in electron-tube design.

NUVISTOR

... the new look in electron tubes that drastically reduces size, weight, mass, and power drain!

... the new design in electron tubes that promises dramatic improvements in quality, performance, and reliability!

NUVISTOR... *a new era in electron tubes!*

The **NUVISTOR** *concept promises tube structures that are truly rugged.*

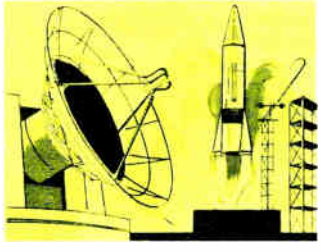
Each tube electrode is brazed to its supporting member, an open-ended conical structure. The platform for the structure is a strong ceramic base-wafer. Electrodes are extraordinarily small, lightweight cylinders. Neither mica nor glass is used. Spot welding is eliminated. This combination of strong structural assembly, brazed joints, all ceramic-metal construction, small size, extra low mass, and high-temperature processing has resulted in a tube design in a small envelope that holds promise of fine performance under thermal or mechanical shock and continuous vibration. For example, NUVISTOR triodes have been subjected to more than 1000 blows each of 850 g's for 0.75 millisecond. After such tests, no shorts were indicated...either permanent or temporary.

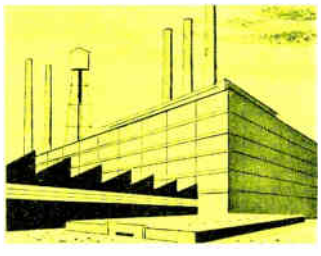
NUVISTOR *is given its start in a brazing furnace.*

Ceramics and strong metals such as steel, molybdenum, and tungsten--processed at high temperatures in brazing and vacuum exhaust furnaces--form the basic structure of the tube. Such high-temperature processing eliminates many of the gases and impurities that cannot be eliminated when tubes of conventional design are processed at temperatures limited by glass and mica. This new processing technique significantly reduces the residual gases that might contaminate the tube as the elements heat and age. And, because the tubes have been outgassed at high temperatures, they offer promise of operating at ambient temperatures considerably higher than conventional tubes can withstand. NUVISTOR tubes have been subjected to temperatures of 660° F...and continued to function. At normal operating temperatures, therefore, reliable operation over long periods of time can be anticipated.

NUVISTOR *can withstand the test of freezing cold.*

In several tests, NUVISTOR tubes continued to function when immersed in liquid nitrogen at a temperature of -320° F.



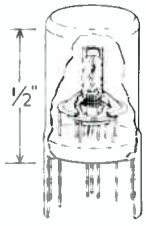


what **NUVISTOR** *will mean to defense electronics*

NUVISTOR seems destined to have significant impact upon equipment designed for military applications. NUVISTOR promises an extremely high level of performance and reliability never before anticipated from electron tubes produced in large quantities. Under unusual conditions of environment, the reliability of NUVISTOR promises to make radical improvements in "mean-time-to-failure hours". NUVISTOR tubes offer miniaturization capabilities that can significantly increase payload capacities of military vehicles. The electrical characteristics of NUVISTOR tubes make them suitable for many different services...hold out the prospect of designing a large number of circuits "around" just a few tube types. These NUVISTOR features can reduce requirements for replacement equipment and service personnel, can increase mobility of the equipped "arm".

what **NUVISTOR** *will mean to industrial electronics and entertainment products*

The high-performance capability of NUVISTOR and its inherent ability to function under difficult environmental conditions seem certain to stimulate new equipment designs for industry. Automation, electronic computers and business machines, closed-circuit television--in fact, the entire range of industrial electronics applications will be given a new platform from which to climb higher. In electronic equipment for home entertainment, more compact, more reliable, more attractive products are in store. New levels of performance can be expected in lightweight AM and FM radios, phonographs, hi-fi, and TV sets.



NUVISTOR small-signal TRIODE

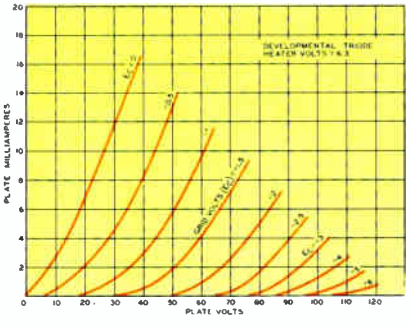
Ready now...on a limited sampling basis...for new equipment designs. First Nuvistor type to be sampled.

High-frequency amplifier performance...

The NUVISTOR triode has shown its mettle as a radio-frequency amplifier in experimental TV-tuner tests. Compared to miniature types 6BQ7-A and 6BN4-A in cascode and neutralized-triode VHF amplifiers, Nuvistor has provided improved gain and at least 1 db less noise measured at television channel 13. In addition, Nuvistor has indicated greatly reduced B+ power drain—about ⅓ the voltage and ½ the current used for the miniature types. Experimental cascode-type tuners using Nuvistors have demonstrated substantially higher performance than commercial tuners, even those using the latest commercial types of receiving tubes...and they required less heater power and only about one watt of B+ power input, as compared to about 7 watts for commercial cascode-type tuners.

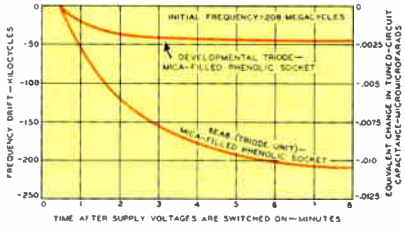
Oscillator performance...

The Nuvistor is a remarkably stable and efficient tube for local oscillator service. Oscillations are obtainable at more than 1000 megacycles with the Nuvistor triode in conventional molded-type sockets. Oscillator efficiency is essentially independent of frequency up to about 450 megacycles, and typical circuits start oscillating with 7 volts or less at the plate of the tube. The low power input needed for the oscillator, as well as amplifier and mixer circuits, helps reduce temperature rise and consequent frequency drift of tuned circuits. The tube itself is particularly stable. Note the accompanying graph which shows the warm-up drift of a 200-megacycle oscillator compared to type 6EA8, a notably good VHF tuner tube by present standards. Each type produces the same output voltage in a conventional circuit from which other causes of drift were removed—yet Nuvistor triode has less than ¼ the warm-up frequency drift of 6EA8.



◀ TYPICAL PLATE CHARACTERISTICS

OSCILLATOR FREQUENCY STABILITY CURVE ▼



TYPICAL DATA

ELECTRICAL:

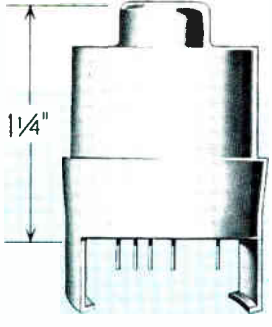
Heater, for Unipotential Cathode:	
Voltage (AC or DC)	6.3 volts
Current	0.14 amp

CHARACTERISTICS, CLASS A_1 AMPLIFIER:

Plate Voltage	40	75 volts
Grid Resistor	1	— megohm
Grid Voltage	--	−1.35 volts
Amplification Factor	31	31
Plate Resistance (approx.)	—	2600 ohms
Transconductance	12000	12500 μmhos
Plate Current	8.5	12.5 ma
Grid Voltage (approx.) for plate current of 10 μa	--	−6.5 volts

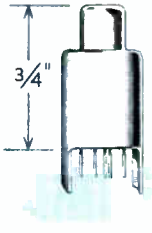
MAXIMUM RATINGS, DESIGN-MAXIMUM VALUES:

PLATE VOLTAGE	110 max. volts
GRID VOLTAGE	−55 max. volts
PEAK POSITIVE GRID VOLTAGE	2 max. volts
PLATE DISSIPATION	1.2 max. watts
PEAK HEATER-CATHODE VOLTAGE:	
Heater negative with respect to cathode	100 max. volts
Heater positive with respect to cathode	100 max. volts



NUVISTOR BEAM POWER TUBE

Now being developed...plate dissipation objective in the order of 30 watts; intended for beam-power applications in the entertainment, industrial and military fields.



NUVISTOR small-signal TETRODE

Ready soon for limited sampling... an amplifier tube for new equipment designs in entertainment, industrial, and military applications.

what NUVISTOR will mean to you...the designer of electronic equipment

Remember way back when all tubes were "radio tubes", and they earned the name "bottle". They were big, fragile, and relatively inefficient. Miniaturization was a vague dream. Rugged tubes were nonexistent. Portability really meant transportability. Design possibilities were limited. But, new developments in tube designs brought smaller envelopes, sturdier structures, the octal socket, the 7-pin and 9-pin miniatures...new techniques and new processes...electrical uniformity, reliability and efficiency! So, NUVISTOR takes its place in the progressive advancement of the electronics industry with new criteria for electron-tube efficiency and reliability. And you, the design engineer, will participate importantly as NUVISTOR ELECTRON TUBES open a new world of unlimited possibilities in equipment design.

For more details on NUVISTORS and for information on how you may obtain developmental samples of NUVISTOR small-signal TRIODE, call your RCA Field Representative at the Field Office nearest you.

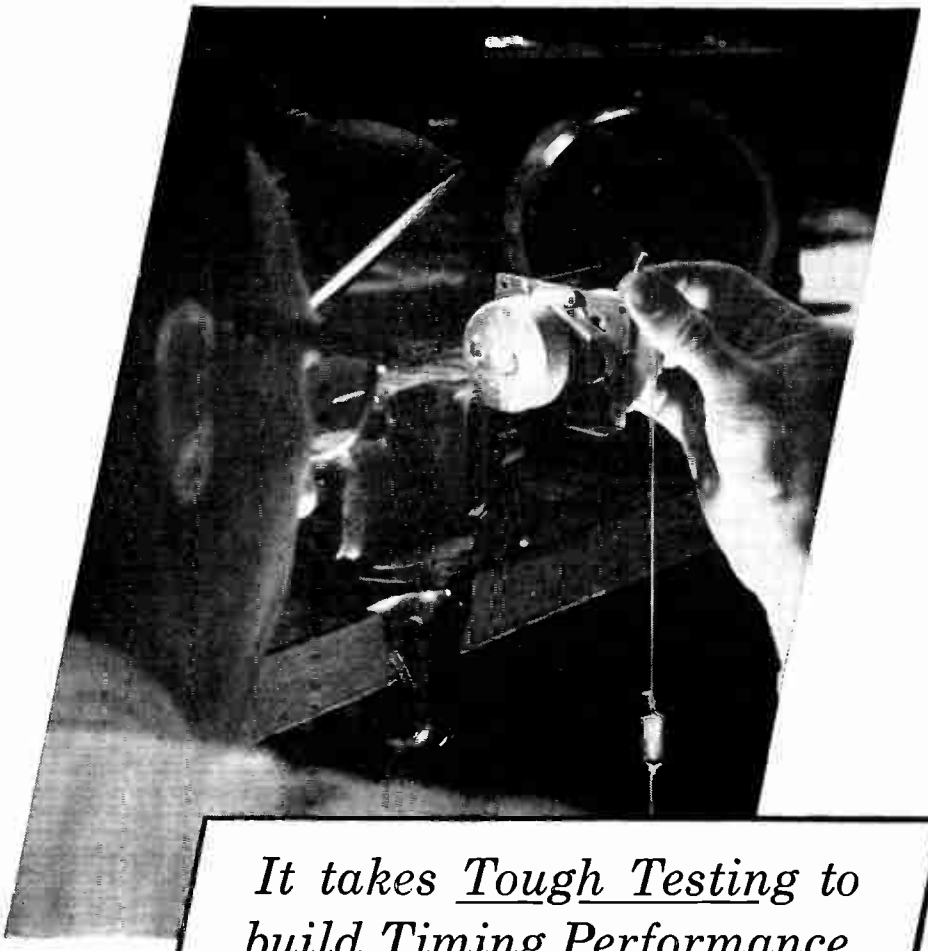
ENTERTAINMENT SALES
- Newark 2, N. J., 744 Broad Street, HUmbaldt 5-3900
- Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5600
- Chicago 54, Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
- Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361

INDUSTRIAL SALES
- Newark 2, N. J., 744 Broad Street, HUmbaldt 5-3900
- Detroit 2, Mich., 714 New Center Bldg., TRinity 5-5600
- Chicago 54 Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900
- Los Angeles 22, Calif., 6355 E. Washington Blvd., RAymond 3-8361

GOVERNMENT SALES
- Newark 2, N. J., 744 Broad Street, HUmbaldt 5-3900
- Dayton 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366
- Washington 6, D. C., 1625 "K" St., N.W., DIstrict 7-1260

RADIO CORPORATION OF AMERICA

Electron Tube Division — *Harrison, N. J.*



It takes Tough Testing to build Timing Performance

When you buy a Haydon Timing Motor or Timing Device, you buy high quality and superior performance, because every production model and every new design has *proved* itself by passing the toughest, most exhaustive series of tests that our engineers can devise.

Quality control at Haydon starts with a careful inspection of all in-coming materials. It continues throughout production — with all parts and assemblies gaged, inspected or physically tested after every operation that can affect the performance of the finished motor or device. Final step is an inspection of completed motors and timing devices. All units are performance tested for many hours under varying conditions and are checked for quiet operation. Percentage samples of each lot are checked for torque rating, timing accuracy, and accuracy and alignment of gears and shafts. In addition, all new designs and periodic samplings from production are subjected to special "life endurance" tests in which hundreds of units are run continuously under various load conditions. In some instances, units have now been running ceaselessly for more than 10 years . . . proving their ability to perform *millions of cycles without failure!*

When you submit your timing problems to Haydon, you can be certain that our teams of engineers and other Timing Specialists have the experience, knowledge and facilities to supply devices designed, produced *and* tested to meet your needs exactly and perform according to your specifications.

For further information, write now, outlining your timing requirements.

Haydon
AT TORRINGTON

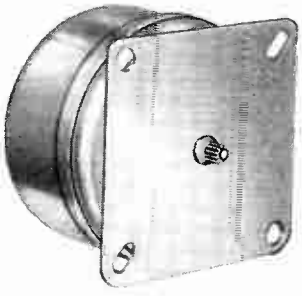
DIVISION OF
GENERAL TIME CORPORATION

2431 EAST ELM STREET
TORRINGTON, CONNECTICUT

Headquarters for Timing

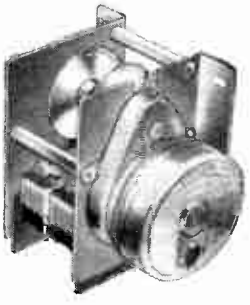
TIME DELAY TIMER

Provides time delay in ranges up to 9.5 minutes. Ideal for such applications as the protection of power tubes and/or operating preset operating cycles. Available in 120 or 240 volt, 50 or 60 cycle current.



400 CYCLE MOTOR

These split phase motors provide the military an accurate approach to timing control for military applications. Rotor speed is 3,000 RPM at 400 cycles, 115 volt normal. Two models are available — Heavy Duty with 18 gram millimeters torque at the rotor, and the Miniature with 5 gram millimeters at the rotor. These motors may be applied to Haydon gear trains if desired.

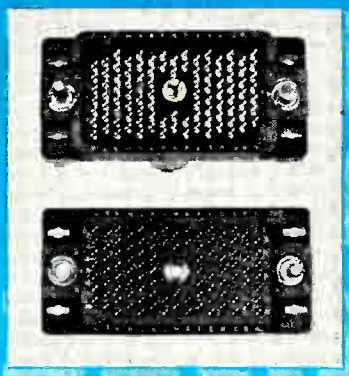


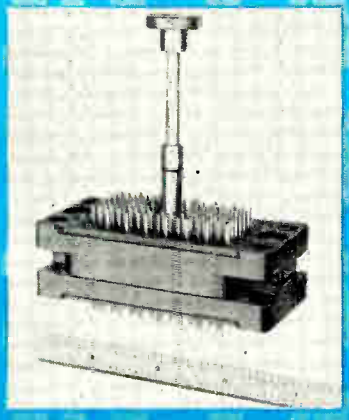
CYCLE TIMER

These units repeat a set cycle or sequence of operations as long as the motor is energized. Available in a wide choice of speeds, a broad range of timing intervals, and with a wide range of enclosed single pole, double throw switches for 120 and 240 volt operation, for 50 and 60 cycles.

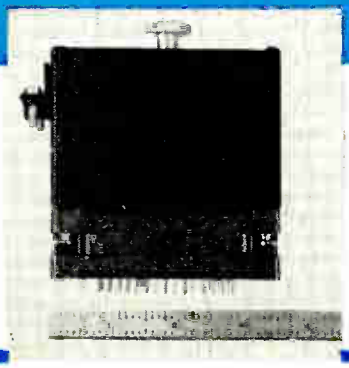
you specify RELIABILITY when you specify . . .

ELCO'S NEW SERIES 8007-8008 rack-and-panel or cable connectors





NOW! The latest application of the industry's most reliable contact — the Varicon — in a connector which provides the highest contact density! Series 8007 provides you with screw actuating device offering positive lock against vibration plus easiest engagement and disengagement. 75, 100 or 130 contacts. Series 8008, without screw actuating device, available with 80, 95, 110, 125, 140 contacts. Both series offered with or without covers. The instant removal of contacts; various contact terminations; intermixing of various contact types within a connector; all molded body; and 36 different polarizing position possibilities are but a few more of its many features. Want more information? Or data relating to our Tube-Sockets / Shields and Varicon Connectors . . . the industry's most reliable lines for transistorization and printed circuitry! Drop us a line on your company letterhead; we'll rush Bulletins and Catalogs by return mail.



See You at WESCON BOOTHS 520-522

IF IT'S NEW... IF IT'S NEWS... IT'S FROM

ELCO CORPORATION

"M" St. below Erie Ave., Phila. 24, Pa., CU 9-5500

Elco-Pacific: 2200 Centinela Ave., West Los Angeles 64, Cal., GR 8-0671

Dividends Make News

DIVIDEND ANNOUNCEMENTS by electronics firms are setting a brisk pace as the year passes midpoint. Some firms currently paying dividends are:

• **Raytheon,** Waltham, Mass., has voted a quarterly cash dividend of 68¾ cents per share on its 5½-percent preferred stock. The dividend, applicable to shares issued prior to June 1 of this year or which are issuable under the merger agreement between Raytheon and Machlett Laboratories, is payable on Sept. 1 to holders of record at the close of business on August 14.

• **Technology Instrument Corp.,** Acton, Mass., declared a 2-percent stock dividend today, July 31, payable to stockholders of record June 30. The firm says this dividend reflects earnings of about 40 cents per share based on unaudited earnings for the last half of its fiscal year. The firm makes acoustic noise generation systems, measurement and control instruments and displacement transducers.

• **Controls Company of America,** Schiller Park, Ill., announces that a quarterly dividend of 20 cents per share of common stock was voted early this month. Also under consideration is a stock distribution equivalent to 50 percent of the shares of common stock outstanding at the close of business on July 24. If approved, this issue will be payable on August 10.

• **North American Aviation, Inc.,** Los Angeles, has issued dividends totaling $1.20 per share in the fiscal year started last October. The most recent portion of this amount was issued this month at the rate of 40 cents per share on capital stock outstanding during the company's third fiscal quarter.

• **Avnet Electronics Corp.,** Westbury, N. Y., plans to issue a seven-percent stock dividend on August 15, payable to holders of record as of July 20. The firm, which makes electronic components for aviation and missile users, became publicly owned during the early part of this month with an offering of 175,000 shares at $5.75 a share. It has, in addition to its Westbury facility, a plant in Los Angeles and sales offices in New York, Waltham, Mass., and San Francisco.

• **Cenco Instruments,** Chicago, will send holders of common stock a dividend of ten cents per share on August 17. This most recent dividend declaration brings Cenco's total dividends for this year to thirty cents a share.

• **Hazeltine Corp.'s** recent acquisition of **Wheeler Labs** is part of its engineering and research expansion program. Both firms are on Long Island, N. Y. Hazeltine, long a manufacturer of government and civilian electronic equipment, has exchanged a block of its unissued common stock for all of Wheeler's outstanding shares. Wheeler will stay in missile and satellite work.

25 MOST ACTIVE STOCKS

WEEK ENDING JULY 17

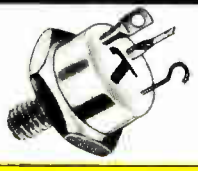
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	1,301	26⅛	24⅝	24⅞
Gen Dynamics	948	54⅜	50⅝	51⅜
Victoreen Instr	882	18½	14⅛	17⅞
Avco Corp	697	15⅝	14⅝	14⅝
RCA	552	69½	67⅜	68⅞
Intl Tel & Tel	516	38⅝	36¾	37⅛
Gen Electric	502	83¼	80⅝	81⅛
Univ Control	454	19⅜	17¾	18⅞
Beckman	435	67⅜	58	67⅜
Lear	388	16⅝	14⅝	14⅝
Westinghouse	381	97½	90½	91⅜
Reeves S'dcraft	376	11⅞	10⅜	10¾
Texas Instr	370	159½	139½	152½
Zenith Radio	355	128	116¼	121½
Gen Tel & Elec	354	73¼	71¼	71½
Cons Electrod	354	42¼	37	41¾
Burroughs	347	37⅜	36⅛	36⅞
Philco	338	30⅞	28½	28¾
Raytheon	337	56⅞	53¾	55
Dynamics Corp	323	10¾	9½	9⅝
Belock	290	20¾	18½	20
Standard Coil	282	19¼	17¾	17¾
Gen Transistor	262	90⅞	76	90⅞
Litton	257	127¾	117½	123¾
Siegler Corp	226	34⅜	32	33

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co.

5 EXCITING NEW SILICON TRANSISTOR

1. HI-POWER STUD-MOUNTED SILICON TRANSISTOR

A rugged package — easier to mount, with greater strength and lower thermal resistance. Has good beta linearity and switching characteristics good high frequency betas , low saturation voltage. Ratings up to 100 volts available.



Type	V_{cb} Max. Volts	I_c max. Amps	B Typical	R_{CS} Typical (Ohms)
2N1208	60	5	35	1.5
2N1209	45	5	40	1.5
2N1212	60	5	25	2.5

APPLICATIONS Regulated Power Supplies . . . High Current Switching . . . High Frequency Power Amplifiers

Send for Bulletin No. 1355M

2. CORE SWITCH

Improved switching speed and input characteristics. High-current capabilities with good power handling ability (5w @ 100°c). Rated and tested at 60v.

Type	V_{cb} Max. Volts	(β) Min.	Typ. Input Voltage (Volts)	Typ. Saturation Resistance (Ohms)	Switching Characteristics (μsec)
ST4100	60	15	2.5	10	t_r .2
					t_s .2
					t_f .2

APPLICATIONS . . . magnetic core memory . . . high level multivibrators . . . buffer amplifiers . . . clock source

Send for bulletin 1355X

3. 150mc VERY HIGH FREQUENCY TRANSISTOR

New silicon logic transistor with speed surpassing the fastest silicon types, plus unusual power handling ability. Technical breakthrough now provides minimum and typical DC current gains of 20 and 40 respectively.

TYPE 2N1139

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	20	40	—	I_C = 10ma, V_{CE} =10V
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.7V	I_C = 10ma, I_B = 1ma
Collector Cutoff Current	I_{CO}	—	2	5 μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 $\mu\mu$f	V_{CB} =10V, I_E = 0 mA
High Frequency Current Gain	h_{fe}	5	7.5	—	F = 20mc, V_{CE} =10V I_E = 10 mA
Delay Time	t_d	—	6		mμsec.
Rise Time	t_r	—	12		mμsec.
Fall Time	t_f	—	10		mμsec.

Send for bulletin TE1355 B2

4. UNIVERSAL 50mc LOGIC TRANSISTOR

This transistor features universal application (replaces 2N337, 2N338, 2N1005, 2N1006) and high frequency response, with low saturation resistance, low input impedance, low capacitance.

Type	Typ. Alpha Cutoff (Mc)	Beta Typical	C_o (Typical) ($\mu\mu$f)	Max. (Volts)	Typ. Saturation Resistance (ohms)
ST3031	70	50	2	20	40

APPLICATIONS . . . flip-flops . . . IF and video amplifiers . . . transistor logic . . . pulse amplifiers

Send for bulletin 1353X

5. STABISTOR COUPLED LOGIC TRANSISTOR

Designed to provide minimum storage times under severe base overdrive conditions in transistor logic circuitry. Tightly controlled input characteristics provide interchangeability; low R_{cs} assures reliable operation at high temperature.

Type	Beta Typical	V_c max. (Volts)	Typical Saturation Resistance (ohms)	Typ. Alpha Cutoff (Mc)	Switching Characteristics (μsec)
ST3030	12	15	40	50	t_r .05
					t_s .20
					t_f .10

APPLICATIONS . . . designed specifically for SCTL and DCTL circuits (write for descriptive paper on SCTL)

Send for Bulletin 1353Y

DEVELOPMENTS FROM TRANSITRON...*added to* THE INDUSTRY'S MOST COMPLETE LINE

SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (β)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (Mc)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (Mc)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (mw)	FEATURES
	ST3030	50	15	60	50	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	ST3031	70	20	65	50	
	2N1139	150	15	70	500	
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (β)	Typical Rise Time (μsec)	Typical Storage and Fall Time (μsec)	FEATURES
	ST4100	5	60	15	.2	.4	• Fast Switching • High V_c • Rugged Construction
	2N545	5	60	15	.3	.5	
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	1	40	20	.2	.2	

HIGH POWER		Maximum Power Dissipation .. 25°C Case (Watts)	Minimum DC Current Gain (β)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	2N389	85	12 @ 1 Amp.	3.5	60	
	2N424	85	12 @ 1 Amp.	6.0	80	
	2N1208	85	15 @ 2 Amps	1.5	60	
	2N1209	85	20 @ 2 Amps	1.5	45	
	2N1212	85	12 @ 1 Amp.	2.5	60	

Write for Bulletins: TE-1353 and TE-1355

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electronic corporation • wakefield, massachusetts

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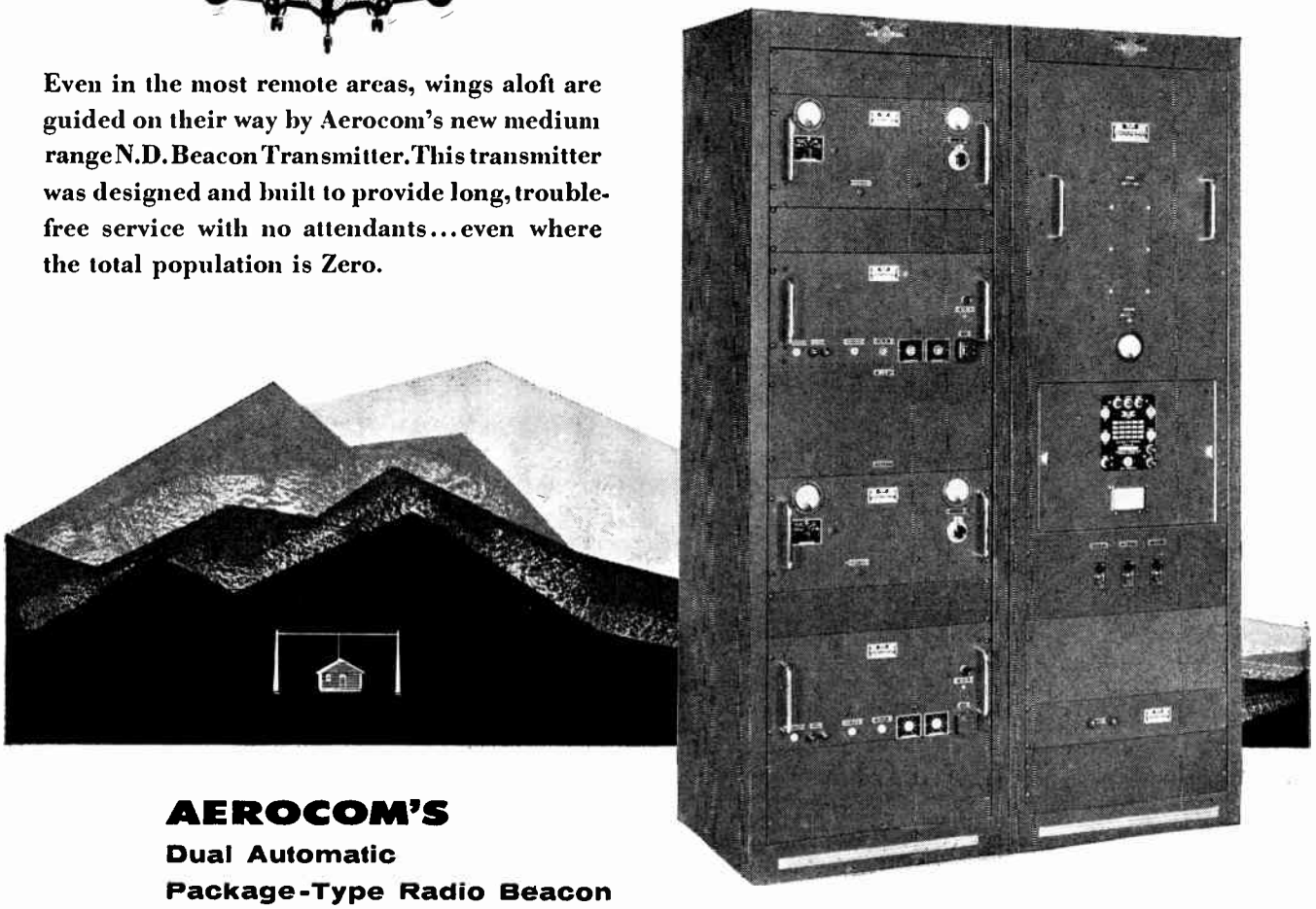
population - 0

Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range N.D. Beacon Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants... even where the total population is Zero.



AEROCOM'S
Dual Automatic
Package-Type Radio Beacon

for completely unattended service. This N.D. Beacon (illustrated) consists of two 100 watt (or 50 watt) transmitters with 2 keyers, automatic transfer and antenna tuner. (Power needed 110 or 220 volts 50/60 cycles, 465 V.A. for 50 watt, 675 V.A. for 100 watt.)

Frequency range 200-500 kcs.: available with either crystal or self excited oscillator coil. High level plate modulation of final amplifier is used, giving 97% tone modulation. Microphone P-T switch interrupts tone, permitting voice operation.

The "stand-by" transmitter is selected when the carrier or modulation level of main transmitter drops 3 db or more, in case of failure to transmit the identification signal or if carrier frequency changes 5 kcs. or more. Audible indication in monitoring receiver tells which transmitter is in operation.

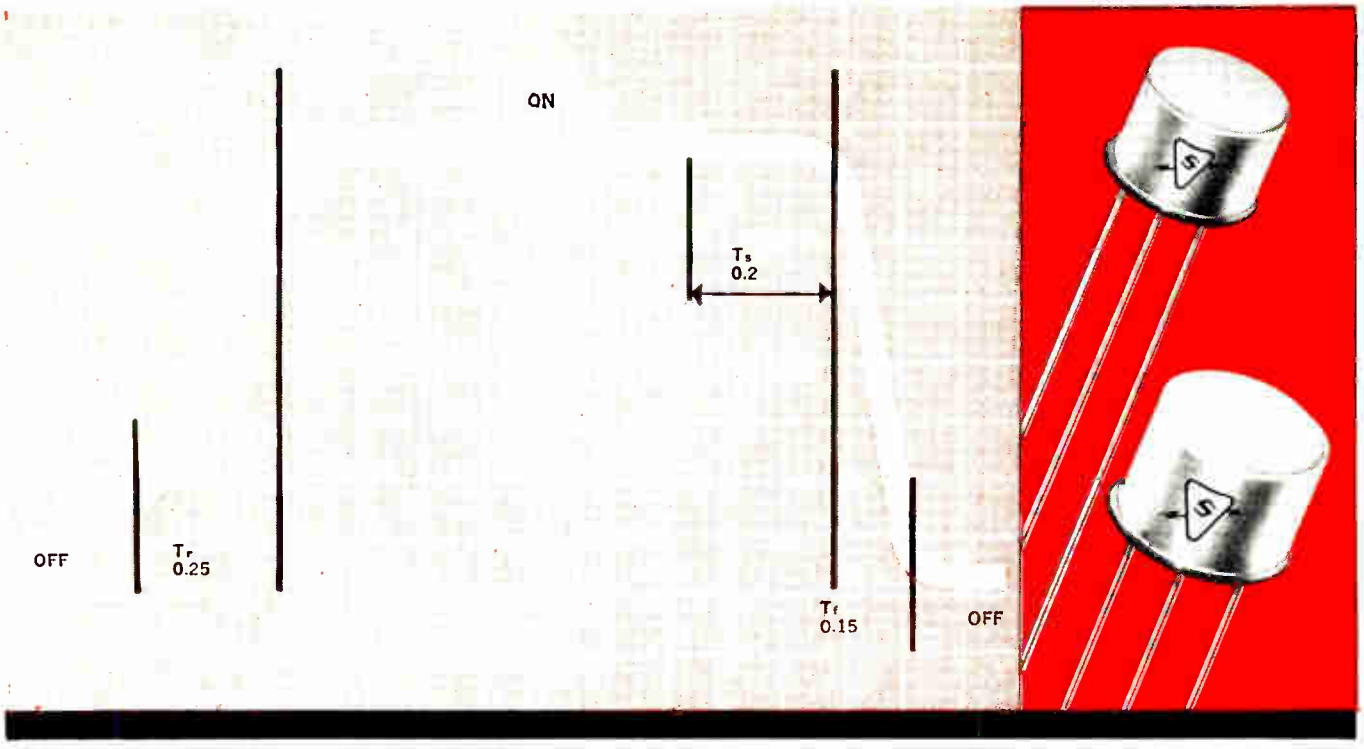
Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.

Also available in 400 watt, 1 K.W. and 4 K.W. Models, 200-415 kcs.

AER-O-COM

3090 S. W. 37th AVENUE • MIAMI 33, FLORIDA

SYLVANIA MEDIUM AND *HIGH SPEED* SWITCHING TRANSISTORS



Both NPN and PNP types that switch in tenths of microseconds

Design engineers can get both NPN and PNP medium and high-speed switching transistors in quantity from Sylvania. Each type in the line is designed especially for computer and switching applications. They feature close control of current gain and frequency cut-off and are especially adaptable to high-temperature use.

These Sylvania medium and high-speed switching transistors are widely used in military equipment because of their outstanding reliability and stability. Each of the types is subjected to 100% leak tests and stabilizing tests that assure top performance under the toughest operating conditions.

Each type is encased in a JEDEC TO-5 package with the Sylvania welded hermetic seal for full protection against humidity and other severe environmental conditions.

Send for your free booklet on Sylvania computer transistors, or call your representative.

SYLVANIA MEDIUM AND HIGH-SPEED SWITCHING TRANSISTORS

Type	Collector to Base V	Emitter to Base V	Power Diss.	Freq. Cutoff, fab V_{CB} = 6 v. I_E = 1 ma min.
		NPN		
2N358	25 v	25 v	100 mw	5 mc
2N377	25 v	15 v	150 mw	2.5 mc
2N385	25 v	15 v	150 mw	4 mc
2N388	25 v	15 v	150 mw	5 mc
2N438	25 v	25 v	100 mw	2.5 mc
2N438A	25 v	25 v	150 mw	2.5 mc
2N439	25 v	25 v	100 mw	5 mc
2N439A	25 v	25 v	150 mw	5 mc
2N440	25 v	25 v	100 mw	10 mc
2N440A	25 v	25 v	150 mw	10 mc
2N679	25 v	15 v	150 mw	2 mc
		PNP		V_{CB} = 5 I_E = 1 ma
2N404	−25 v	−12 v	120 mw	min. 4.0 mc
2N425	−30 v	−20 v	150 mw	2.5 mc
2N426	−30 v	−20 v	150 mw	3.0 mc
2N427	−30 v	−20 v	150 mw	5.0 mc
2N428	−30 v	−20 v	150 mw	10.0 mc

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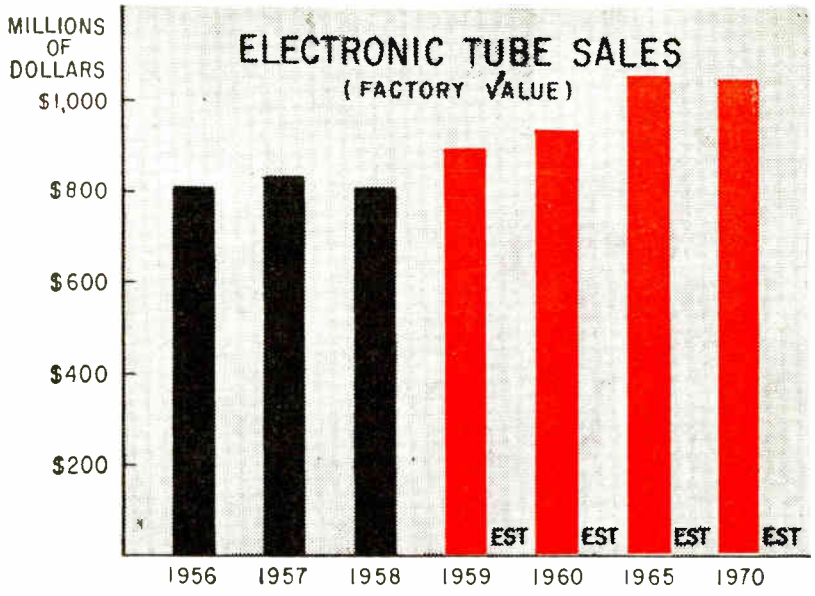

SOURCE: RCA

Tube Sales: $ Billion in '65

ELECTRONIC TUBE SALES will top $1 billion by 1965, claims W. Walter Watts, RCA group executive vice president.

He foresees tube sales of $930 million next year, $1,050 million in 1965 and $1,040 million in 1970. His estimate for 1959 is $885 million, compared with $810 million last year.

Figures include receiving, transmitting and both new and rebuilt picture tubes. Values are based on factory prices.

• **Military spending** will rise from $39 billion in 1958 to $63 billion in 1975, says Murray L. Weidenbaum, product economist for Boeing Airplane Company. Long-run nature of the external threat facing the nation requires us to continue to devote a substantial portion of our total production of goods and services to defense, he explains. Spending projection is based on expectation that gross national product will rise from $438 billion in 1958 to $872 billion in 1975. He figures defense spending will be seven percent of GNP in 1975. It was nine percent in 1958.

• **Market researchers** are vigorously investigating the market for medical electronics. Four manufacturers of electronic equipment have market studies underway.

• **Semiconductor sales** will rise from $208 million in 1958 to about $290 million in 1959. Prediction comes from William J. Pietenpol, vice president in charge of Sylvania's semiconductor division. His estimate for 1959 is close to 170 million semiconductor units. He says the semiconductor industry is roughly doubling its dollar and unit sales volumes every two years. Semiconductor sales, including transistors, diodes and rectifiers, amounted to $75 million in 1956 and $143 million in 1957. Total units amounted to 52 million in 1956, 84 million in 1957 and 119 million in 1958, he says.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	July 10, 1959	June 12, 1959	Change From One Year Ago
Television sets	73,087	128,049	+34.5%
Radio sets, total	198,096	299,599	+91.4%
Auto sets	71,369	134,167	+65.3%

STOCK PRICE AVERAGES

(Standard & Poor's)	July 15, 1959	June 17, 1959	Change From One Year Ago
Electronics mfrs.	100.92	93.44	+89.3%
Radio & tv mfrs.	115.18	109.18	+133.3%
Broadcasters	105.25	96.70	+69.3%

LATEST MONTHLY SALES TOTALS

(Add 000)	May 1959	Apr. 1959	Change From One Year Ago
Rec. tubes, value	$25,904	$26,047	—17.5%
Rec. tubes, units	30,612	29,800	—16.2%
Pic. tubes, value	$12,746	$13,275	+13.4%
Pic. tubes, units	667	696	+19.1%

How to get ultra-uniformity

in a Silicon PNP fused alloy transistor

Through precise manufacturing techniques, Hughes PNP fused-junction silicon transistors give you uniformity of parameters by type. Result: Circuit interchangeability no longer is a problem.

Designed for switching and amplifying applications at low and medium current levels, these Hughes transistors offer you a number of advantages:

- useful Beta over a wide range of collector currents
- high punch-thru voltage (BV_{CEO} in excess of 100 volts in types 2N1244 and 2N1234)
- low collector cutoff current

These devices, now available in production quantities, are housed in TO-5 (single ended) and coaxial packages (double ended). Engineered for reliability, they meet MIL-T-19500A specifications.

Coaxial Package Type:	2N1238	2N1239	2N1240	2N1241	2N1242	2N1243	2N1244
TO-5 Package Type:*	2N1228	2N1229	2N1230	2N1231	2N1232	2N1233	2N1234
Breakdown Voltage @ 100μA: *CEO, CBO, EBO*	15V	15V	35V	35V	65V	65V	110V
h_{fe} (Average)	22	32	14	25	14	25	14
Collector Cutoff Current	.01μAdc	.01μAdc	.01μAdc	.01μAdc	.01μAdc	.01μAdc	.01μAdc
V_{CE} (max.) (I_C = 10mAdc, I_B = 2mAdc)	0.2V		0.2V		0.2V		0.2V
V_{CE} (max.) (I_C = 20mAdc, I_B = 2mAdc)		0.4V		0.4V		0.4V	

Coaxial Package: Power dissipation . . . 1 watt in free air (derate 7.4 mw/°C)
5 watts with heat sink (derate 37 mw/°C)

TO-5 Package: Power dissipation . . . 250 mw (derate 1.8 mw/°C)

Collector current limited by power dissipation. Operating and storage temperature range −65°C to +160°C

*formerly JETEC-30

Your inquiry regarding these transistors will be given prompt attention. Just write or call the Hughes sales office nearest you. They are located in Boston (phone WO 2-4824), Newark (phone MA 3-3520), San Francisco (phone DA 6-7780), Syracuse (phone GR 1-0163), Philadelphia (phone MO 4-8365), Chicago (phone NA 2-0283), and Los Angeles (phone OR 8-6125). Or write Marketing Department, **SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA**

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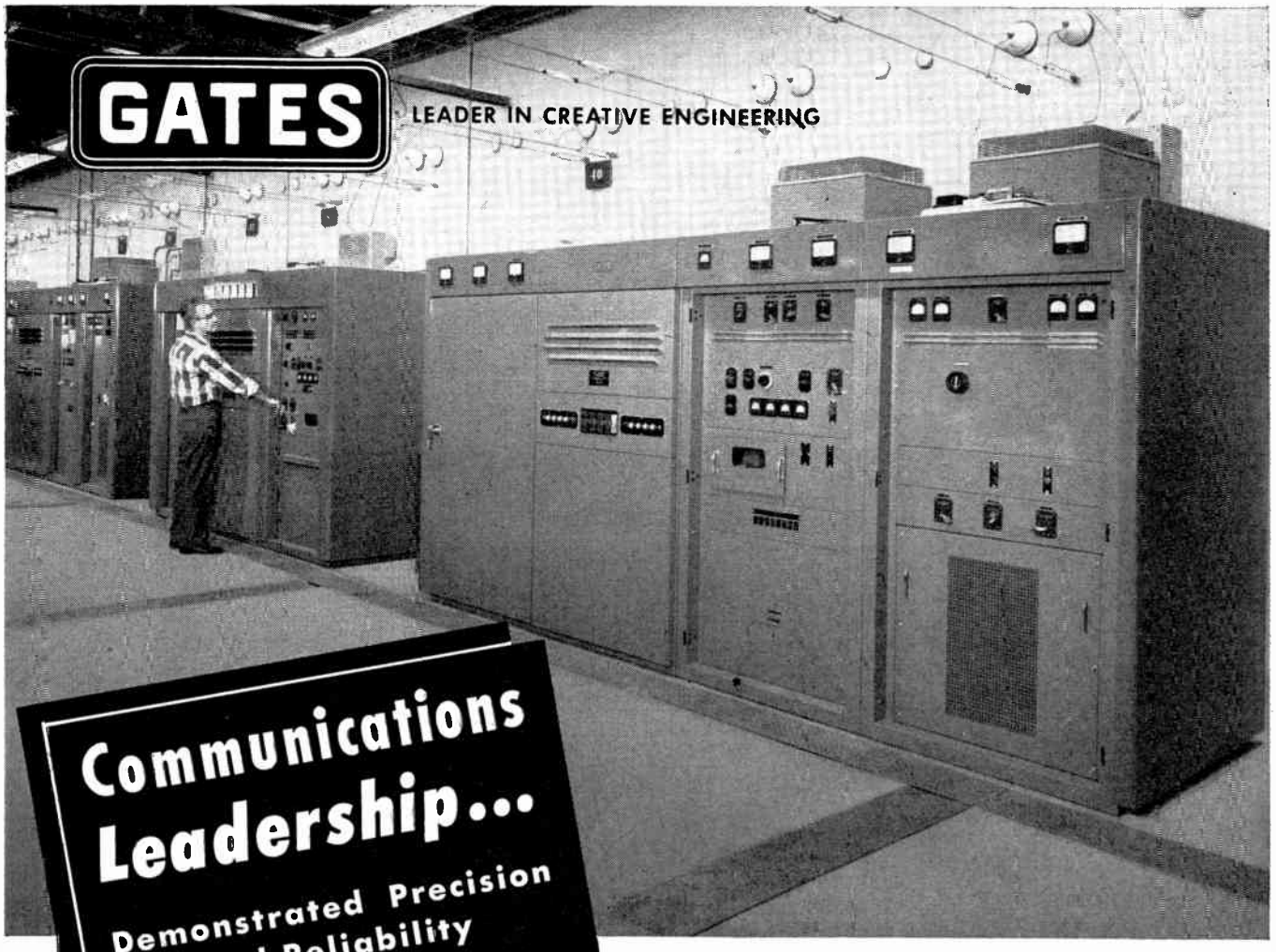
HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS



Gates shortwave high frequency transmitters shown above—one 30 KW and two 10 KW's—are installed at the Press Wireless international transmission plant at Centereach, Long Island. Press Wireless, Inc. operates the world's largest communications service for the press in 62 different countries by means of radioprinter, radiophoto and radiovoice. Its extensive facilities handle over 1,000,000 textual words a day, much of it with Gates transmitting equipment.

This utilization of Gates high frequency transmitters by one of the world's leading radio communications companies is another example of Gates' electronic leadership. With versatility the keynote of its operation, Gates currently manufactures more than 1000 products for broadcast and communications use. Gates 10 kilowatt transmitters are located in Malta—20 KWs in Israel—50 KW in Africa—FM links in the Philippines—5, 10 and 20 kilowatt transmitters in Indonesia. Korea, Nigeria, Indo China, India, England, Central America, South America, Liberia, Formosa and Jamaica are just a few more of the many Gates installations found around the world. Wherever you go, Gates is nearby, serving the world's communications needs.

• • • •

For 37 years, Gates has been a *leader* in electronic communications. During these decades, the Gates creative engineering team and precision manufacturing facilities have been geared to *tomorrow*, searching for and developing new and better products for the broadcast, communications, industrial and military electronics industries.

Whether it be a UDOP transmitter to measure the velocity and position of guided missiles beyond the ionosphere—complex multipile amplifiers used in geophysical studies — modern high frequency transmitters for communications service — or a complete radio-television station installation, the Gates name is synonomous with demonstrated precision and reliability the world over.

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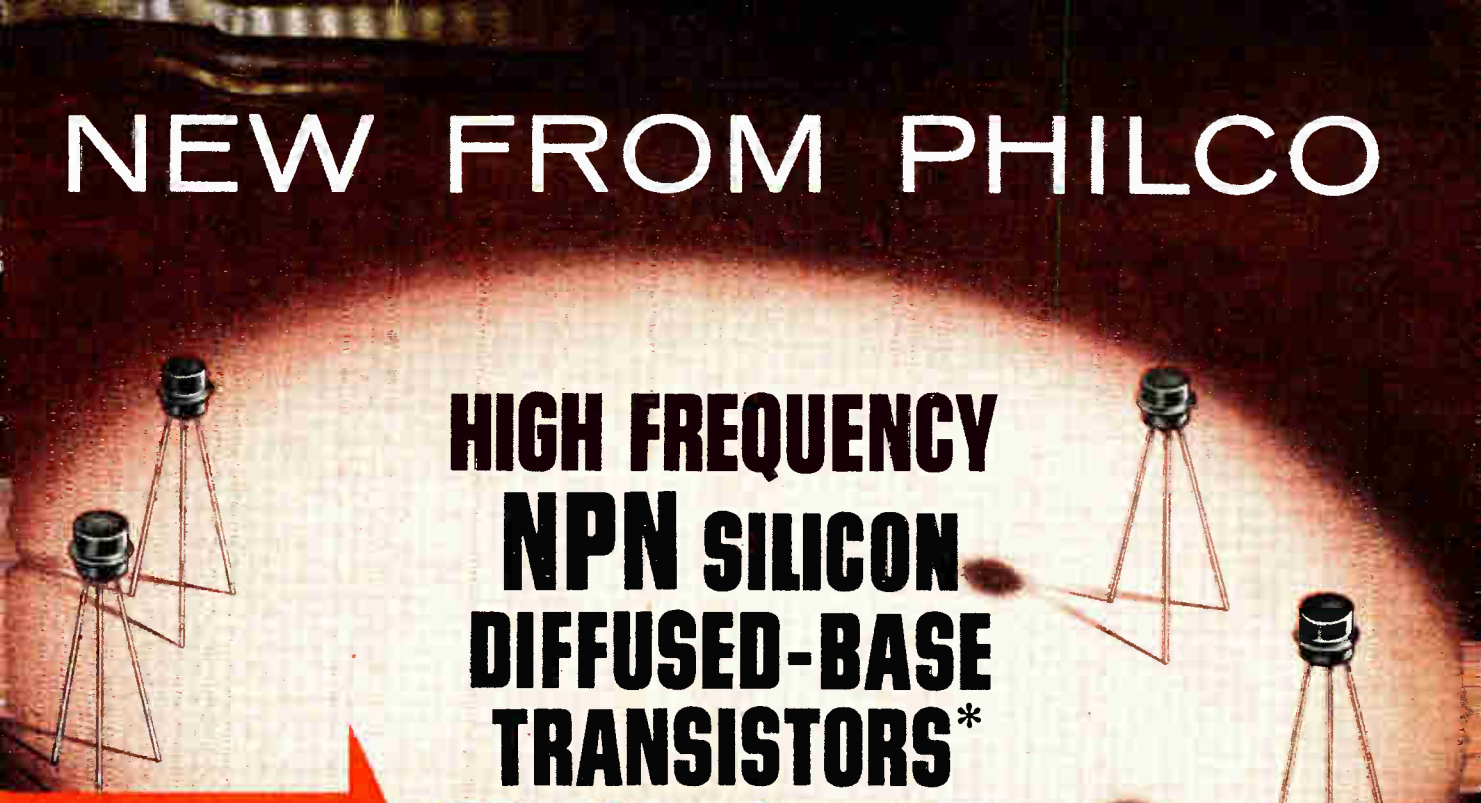
NEW FROM PHILCO



HIGH FREQUENCY NPN SILICON DIFFUSED-BASE TRANSISTORS*

30mc PULSE RATE SWITCHES

Type Number	h_{fe}	Typical Power Gain	Typical Switching Times (Saturated Test Circuits)
2N1199	12-60 (DC)		t_r 35 mμsec t_s 10 mμsec t_f 25 mμsec
2N1267	6-18	25 db at 4.3 mc	
2N1268	11-36		
2N1269	28-90		
2N1270	6-18	25 db at 12.5 mc	
2N1271	11-36		
2N1272	28-90		

Maximum V_{cb}—20 V
Maximum temperature—150° C
Maximum dissipation—100 MW

60mc AMPLIFIERS

2N1199

This high speed switch has exceptionally low saturation voltage (typically 0.125 V), permitting *practical* design of 5 mc pulse circuits, using conventional saturated switching configurations. 30 mc pulse rates are obtainable in *practical* circuits using non-saturating techniques.

2N1267-68-69

The high gain characteristics of these units make possible the design of high efficiency IF amplifier circuits for communications equipment. These devices have unusually low collector capacitance . . . typically 1.5 $\mu\mu f$ . . . and are available with restricted beta ranges to simplify design problems.

2N1270-71-72

The excellent high frequency response of these transistors makes practical the design of high performance communications systems at frequencies up to 60 mc. They have the same low collector capacitance and are available with restricted beta ranges.

Immediately available for prototype design from your Philco Industrial Semiconductor Distributor.

Write Dept. E-759, Lansdale Tube Company, Division of Philco Corporation, Lansdale, Pa.

**SADT . . . Trademark Philco Corp. for Surface Alloy Diffused-base Transistor.*

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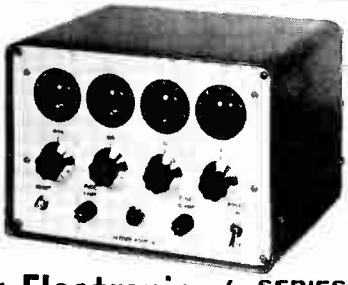
LANSDALE, PENNSYLVANIA

NEW Veeder-Root Counters



New Electronic Predetermining Counters

SERIES 1604

These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slittling, stacking and material handling.

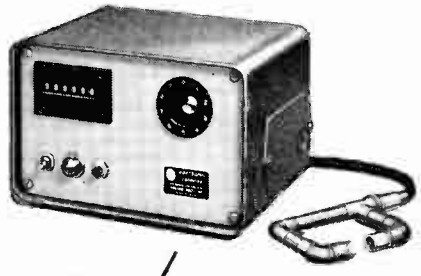
A versatile group of transistorized electronic predetermining counters designed particularly for industrial applications. These units will operate at speeds up to 5,000 counts per second, with automatic recycling at speeds up to 1,000 counts per second. A photohead to actuate the counter can be designed to fit specific applications.

Units can be easily operated by non-technical personnel. The preset quantity can be established quickly at any point within the range of the counter by means of the large selector knobs. Any number of decades can be furnished.

Dual sets of presetting controls for sequential predetermining, or accurate length control in such applications can be furnished on request.

This is your complete package for predetermining counting at high speeds.

For complete details on these units, write today!



Count-PAK

SERIES 1661

Complete electronic counting package for use where high speed, long life and instant reset are required. Highly suitable for high speed direct counting applications such as can and bottle counting or case or piece counting on conveyor lines.

Consists of glow-transfer cold-cathode counting tube and high speed magnetic counter, coupled with transistorized circuits. Photohead designed to your application.

The use of transistors means that heat has been eliminated and no warm up time is required. Unit is completely enclosed in an attractive industrial case to insure long, trouble-free life. Use of an electronic decade increases the life of the electromechanical counter and makes the unit ideal for continuous rugged operation.

Write for complete specifications and prices today!

NEW SERIES 1622

High-Speed Predetermining Counter

Ideal for high-speed counting requirements such as coil winding, textile spinning frames, and other predetermining counter requirements.

Instant quick-lever reset, plus quick and easy setting of the predetermined number are outstanding features of this counter. Measures approximately 2.6″ wide, 5″ long, 2.8″ high. Speeds up to 6,000 RPM or 8,000 CPM are maximums recommended.

Easily preset to the required number of pieces or performance-units, the counter subtracts to zero. Resetting returns wheels to original preset number. This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available without the predetermining feature, as a high speed reset revolution counter.

Also available as a high-speed revolution counter without predetermining feature.

Write for complete information today!

SERIES 1591

Electro-Magnetic Counter

These new compact panel-mounted high speed counters are ideal for D.C. applications requiring accuracy, long life at high speeds and small panel presentation. Counters are suitable for industrial data processing, laboratory and scientific or instrument applications. Available with four or six figures with remote electrical or manual (push button) reset. 3,000 counts per minute recommended speed.

Counters can be connected in series with any device having a contact arrangement. For optimum operation, 60% contact time is required.

Panel Area: 4-figure Counter — 1.7″ x 2.1″
6-figure Counter — 1.7″ x 2.8″

Available for 6, 12, 24, 48 and 115 volts D.C. operation. For A.C. operation suitable electrical components must be added externally. Reset voltages available are 6, 12, 24, 48, 115 and 230.

Write for complete specifications today!

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Employees of defense contractor show security passes as they enter plant

New Security Policy Coming?

Electronics firm engineer who lost security clearance on the testimony of confidential informers is upheld by Supreme Court in his right to confront witnesses. Here's where industrial security stands

By **HOWARD K. JANIS,** Associate Editor

FOR 13 YEARS security clearance denials and revocations under the nation's industrial security program have operated in a dark closet labeled "secret."

This month the Supreme Court opened the door and pulled out a skeleton—the role of average citizens not associated with security work acting as confidential informers.

The decision in Greene v. McElroy affects all companies doing classified work for the government. Such work involves a contractual obligation to participate in the industrial security program. University personnel performing contract work also come under the program.

Here's the story behind the case, which originated in our industry, and how it affects the industrial security program.

William L. Greene was the only engineer employed by a Maryland engineering company when it entered the electronics field in 1948. He designed an electronic aircraft simulator for the Navy and the firm got an important contract.

In 1951 the company received a letter from the Army-Navy-Air Force Personnel Security Board stating that Greene's clearance had been revoked and listing general charges against him. He was said to have associated with suspect persons and groups from 1942 to 1947. The charges originated with confidential informers. After a hearing Greene got his clearance back.

Same Charges Revived

Abruptly, in 1953, the company was ordered in a letter from the Secretary of the Navy to exclude Greene from its plant because his clearance had been dropped again. He was then an $18,000-a-year vice president and general manager. Friends, and his employer, felt the action was unfair, stood by him. But he couldn't get an engineering job, dropped to $4,700 as a draftsman.

A year passed before he was sent a list of the charges against him; they were basically the same charges made in 1951. It took time and money before he got a hearing, then a legal action to get a transcript of the hearing. C. W. Berueffy, Greene's attorney, told ELECTRONICS this week that to this day he has never been able to get the precise findings of the review board.

Travel expenses of witnesses Greene called upon to testify in his behalf amounted to $3,000 for the first hearing alone. Soon the cost of printing the necessary legal documents mounted up to $6,500. Greene refused to give up. Legal action continued through the federal courts without a decision in his favor until this month.

Now the Supreme Court has spoken in an 8-1 decision. Since neither the President nor Congress had ever authorized the proceedings by which Greene had lost his clearance, the Court holds that he should not have been deprived of his clearance without the safeguards of confrontation and cross-examination of witnesses.

Only appeals against a denial of clearance or a revocation of clearance are so far affected. Review boards are holding up decisions in such cases until the Administration's policy is clarified.

Clearances Unaffected

The Court was careful not to knock out other parts of the industrial security program. For example, the form which persons who seek security clearance must fill out is unaffected. Electronics firms are going ahead with routine clearance procedures.

Here's how the matter stood as ELECTRONICS went to press:

In Washington it was rumored that an executive order of the President was being drafted. It authorizes appeal procedures and requires confrontation and cross-examination of witnesses who do not belong to undercover intelligence operations of the government.

Sen. Strom Thurmond (D., S. C.) introduced a bill that would authorize review proceedings and require confrontation of nonprofessional informants. Says the bill: "Confrontation of a regularly established confidential informant engaged in obtaining intelligence or internal security information for the government shall not be allowed if the head of the investigating agency concerned determines that the disclosure of the identity of such informant will prejudice the national security."

Additional Safeguards

The Thurmond bill nevertheless provides additional safeguards for the individual with regard to detailed verification and rebuttal of information obtained by professional undercover agents.

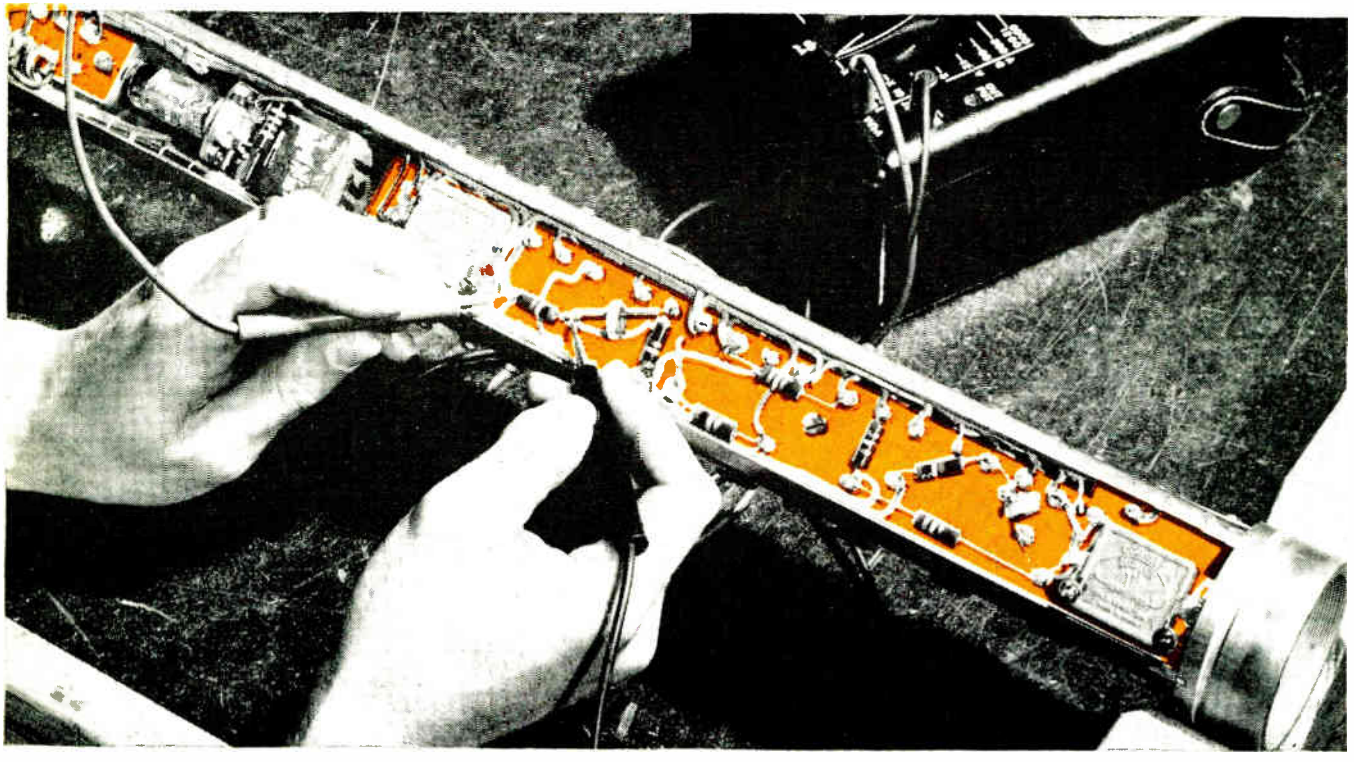
Sen. Kenneth Keating (R., N. Y.) was also reported to be preparing a bill.

Rep. Francis Walter (D., Pa.), chairman of the House Committee on Un-American Activities, has introduced a bill calling upon the Defense Secretary to "prescribe uniform standards and criteria for determining eligibility for access to classified information." In other words, the Walter bill leaves to the Secretary's discretion the decision as to whether to prescribe for confrontation and cross-examination in

(Continued on p 39)

SILICONE NEWS from Dow Corning

Toward Greater Reliability



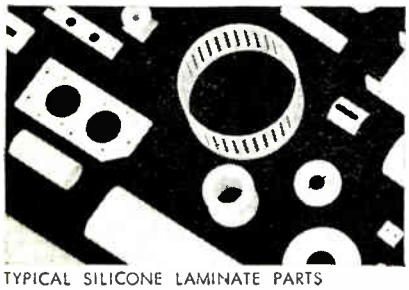
Silicone-Glass Laminate Proves More Dependable in Rough Environments

Schlumberger Well Surveying Corporation, makers and operators of geophysical well-logging instruments, found terminal boards of silicone-glass laminate more reliable in service and easier to fabricate. The instrument shown has a working range up to 191 C amid high humidity environments. In Schlumberger's evaluation tests, here's how a laminate based on Dow Corning silicone resins stacked up against other materials.

Silicone vs. phenolic: Silicone laminate had superior and more uniform dielectric properties at high environmental temperatures. Silicone laminate had lower moisture absorption: approximately 0.02% as compared with 2% for phenolic. Silicone laminate had much better dimensional stability than phenolic laminates.

Silicone vs. bonded mica sheeting: Once again, silicone-glass was chosen for its satisfactory dielectric characteristics. Silicone laminate also proved easier and less expensive to fabricate and install than mica because of mica's fragility.

Other plus properties of silicone-glass laminates include stability at 250 C, low loss factor, good physical strength, ease of fabrication, light weight, resistance to arcing, ozone and corona, and permissibility of adjacent soldering.



TYPICAL SILICONE LAMINATE PARTS

What all these add up to is greater reliability. If you are faced with the problem of engineering an electronic unit that will remain failure-free in difficult environments, investigate silicone-glass laminates. Manufacturers of quadradar sets, rotary switches, test chambers, and radio transmitters, to name but a few, have found these laminates meet or exceed their needs.

Here are some sample data:

Properties of Silicone-Glass Laminates

Property	Range
Flexural Strength, flatwise, psi, ⅛-inch thickness	
Lengthwise	20,000 - 40,000
Crosswise	18,000 - 33,000
Izod impact strength, edgewise, ft-lb per inch notch	
Lengthwise	6.5 - 17.0
Crosswise	5.5 - 14.0
Bonding strength, lbs., ½" thickness	
Condition A	650 - 1100
Condition D-48/50	550 - 950
Dielectric breakdown parallel to laminations, step-by-step test, kv.	
Condition A	32 - 50
Condition D-48/50	15 - 35
Dielectric constant at 1 megacycle, ⅛-inch thickness	
Condition A	3.90 - 4.20
Condition D-24/23	3.95 - 4.20
Dissipation factor at 1 megacycle, ⅛-inch thickness	
Condition A	.0015 - .003
Condition D-24/23	.008 - .022
Arc resistance, seconds	
Condition A	180 - 292
Condition D-48/50	180 - 248
Volume resistivity, meg-cm.	
Condition C-96/35/90	1×10^{1} - 4×10^{7}
Surface resistivity, megohms	
Condition C-96/35/90	10 - 10,000

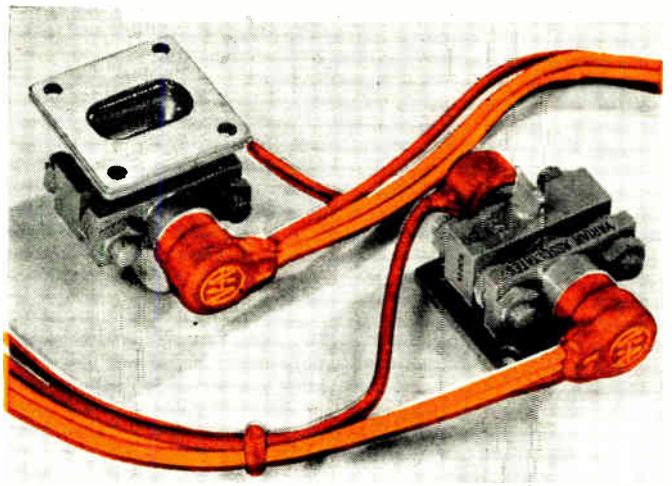
first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

CIRCLE NO. 196 READER SERVICE CARD

...silicones assure dependable components



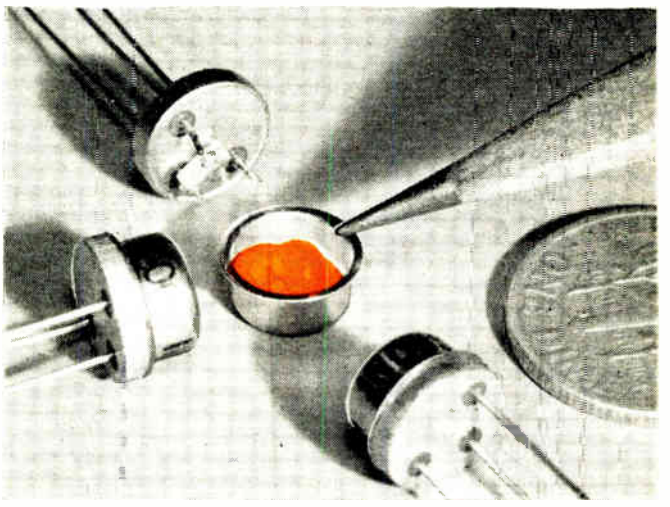
Silastic Protects Against Corona, Humidity

This klystron tube for airborne radar utilizes Silastic®, the Dow Corning silicone rubber, to maintain frequency stability. Silastic moldings cover the tube's connections and lead wires, keeping out moisture and preventing corona. An excellent insulator, Silastic is unaffected by temperature extremes and ozone. Silastic retains its properties . . . can be relied upon to protect electronic gear in widely diverse and adverse environments.

In addition to its usefulness as a dielectric material, Silastic is often employed for purely physical reasons. Available in sponged or solid form, it protects delicate parts against shock and vibration. Silastic stays resilient from —90 to 260 C (—130 to 500 F), and resists the effects of extended storage, weathering, and corrosive atmospheres.

PHOTO COURTESY VARIAN ASSOCIATES

CIRCLE NO. 197 READER SERVICE CARD



Grease-Like Silicones Boost Transistor Dependability...

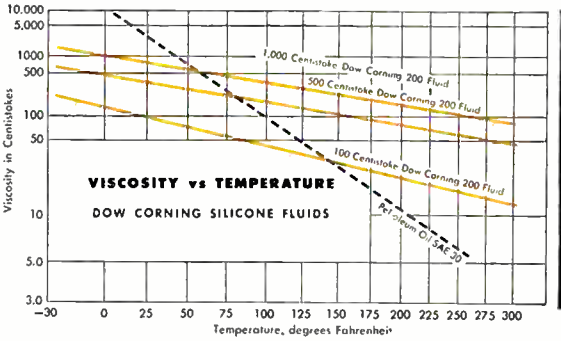
Dow Corning silicone compound is ideal for potting transistors. It seals out moisture and conducts heat away rapidly. In addition, it reduces rejection rates by preventing metal splatter from reaching the transistor wafers when caps are welded in place. These silicone compounds don't melt, don't thicken, and retain their excellent dielectric properties from —40 to 210 C. Industro Transistor Corporation, manufacturer of the units illustrated, finds the grease-like silicone materials help build a new degree of reliability into their product.

Actually, transistor potting is but one of the many jobs performed by Dow Corning silicone compounds. They seal out moisture at joints, on terminals, and in many other applications . . . preventing arcs, shorts, flashovers, corrosion, and contamination . . . assuring the performance of electronic units.

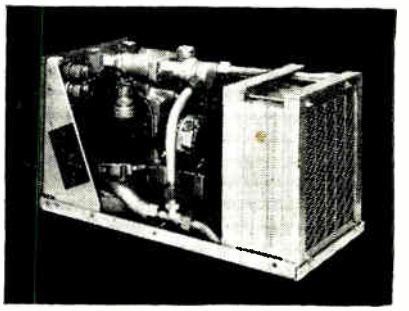
CIRCLE NO. 198 READER SERVICE CARD

Cooling Fluid with Reliable Flow Rate

Because of their thermal stability and relatively flat viscosity-temperature curves, Dow Corning silicone fluids make excellent heat exchange media. Silicone fluids maintain consistency over a range of —65 to 250 C. They can be pumped at high speed without suffering breakdown due to shear, have good lubricity, and will not oxidize or act as corrosives, despite contact with metals at high temperatures. In sum, they allow heat exchange units to operate uniformly and almost indefinitely, as far as the coolant is concerned.



Recognizing these factors, the Hallicrafters Company utilizes Dow Corning silicone fluid as the cooling medium in their new heat exchangers for electronic equipment. Specifically designed to cool airborne, shipboard, and ground support electronic equipment, the Hallicrafters units have ratings up to 7,000 watts dissipation, meet MIL specs.



CIRCLE NO. 199 READER SERVICE CARD

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

main office: MIDLAND, MICHIGAN / branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

Subminiature ... Proven Reliability

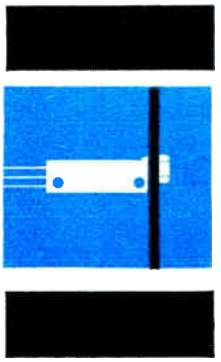
ACTUAL SIZE

TRIMPOT® MODEL 220

As many as 17 of these compact units can be mounted in a space of just one cubic inch. Designed for printed circuits and modular assemblies, Trimpot Model 220 measures less than 3/16" x 5/16" x 1". Power rating is 1 watt and maximum operating temperature is 175°C. This Potentiometer meets or exceeds Mil-Specs for humidity, salt spray, fungus, sand and dust, as well as acceleration, vibration and shock. Self-locking 15-turn shaft insures sharp, stable settings...exclusive Silverweld* fused-bond termination and ceramic mandrel provide extreme temperature stability. The Model 220 is available in a wide variety of resistance ranges and a choice of two terminal types—gold-plated Copperweld wire or insulated stranded leads.

Stocked by leading electronic distributors across the nation, these units are ready for immediate delivery. **Write for complete technical data and list of stocking distributors.** AVAILABLE AS PANEL MOUNT UNIT (illustrated at right) with same specifications.

*Trademark



BOURNS Inc.

P.O. Box 2112G. Riverside, California

Plants: Riverside, California and Ames, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

Exclusive manufacturers of Trimpot®, Trimit®. Pioneers in potentiometer transducers for position, pressure and acceleration.

New Security Policy Coming?

(Continued from p 35)

the proceedings which he would authorize.

Sources close to the industrial security picture indicate that discussions are being held between officials of the Defense and Justice Departments, legislators and industrial security experts.

Final position of the Administration awaits completion of these studies and a set of recommendations from officials.

Protecting Individuals

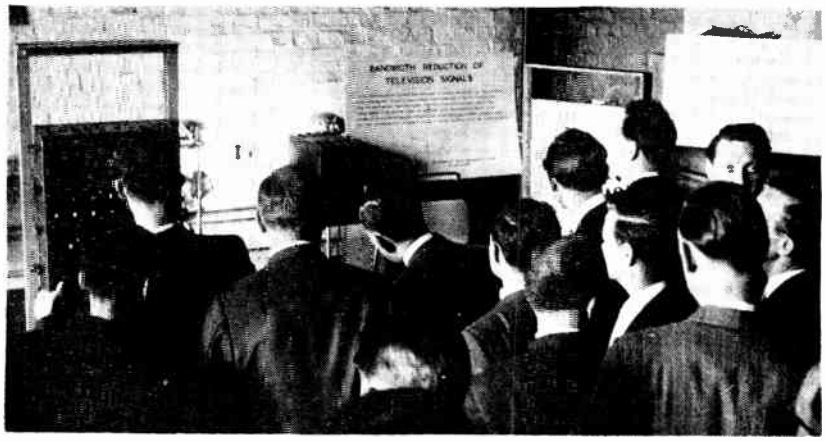
The American Society for Industrial Security, a professional society of industrial executives and specialists concerned with industrial security, is also making its influence felt. A spokesman stressed that the group did not "fully comprehend what all the results (of the Greene decision) will be." But he stated the problem this way:

"How do we protect the rights of the individual while also protecting the identity of informants who are part of our security intelligence system?"

Security officers say the number of cases in which security clearance is canceled is small. The large area of difficulty, they say, concerns persons who have been denied clearance in the first instance. Consensus is that concessions will be made to the individual in appeal cases.

"As a practical matter," lawyer Berueffy says, "the government would be able to prove damn few cases if it had to call (nonprofessional informers as) witnesses. When you can put your finger on these witnesses, and pin them down, you find they really haven't too much to say."

Berueffy also said it was "quite possible" that unethical business practices could be behind some charges brought by confidential informers. He said that he couldn't prove that anyone wanted to create trouble for Greene's firm and knock it out of contract competition by depriving it of its chief engineer, but "it isn't an impossibility or an improbability."



British engineers study demonstration of Howson's and Bell's system for bandwidth reduction, as . . .

Britons Probe New Tv Uses

Punched-tape program switching system holds spotlight at four-day British IRE convention

CAMBRIDGE, ENGLAND — Punched-tape tv program control, closed-circuit tv in the nuclear industry, bandwidth reduction systems and plated circuit techniques high-lighted the British Institution of Radio Engineers' recent four-day tv engineering convention here.

More than 300 delegates attended the meetings in Cavendish Laboratories.

Here's what interested the delegates most. Top of the list was the punched-tape program switching system devised by G. Portington of Marconi's Wireless Telegraph Co. Designed for installation in one of Britain's commercial tv centers, the equipment relies on relays and stepping switches.

A two-character code previews and prelistens to the next program and switches this to the correct network transmitter at the appropriate moment. Built into the system is the ability to advance or retard the master clock by a known deviation to cope with program over or under running.

Using a system analogous to the NTSC color system, E. A. Howson and Dr. Bell of Birmingham University on an experimental setup are obtaining a 2:1 bandwidth reduction on the monochrome video signal. Splitting the video into two bands from 0 to 1.5 mc and 1.5 to 3.0 mc, the upper section amplitude modulates a subcarrier whose frequency is an odd multiple of the half line scanning rate. Interleaving is by recombining the lower sideband with the original 0 to 1.5 mc signal. Reception is by a synchronous demodulator whose lower sideband is recombined with the received signal to reconstitute the full 0 to 3.0 mc video signal.

A new application of closed-circuit television came from the Metallurgy Division of the Atomic Energy Research Establishment where image orthicon tubes coupled to 350-power microscope are enabling microhardness indentations on radio active materials to be measured to better than $\pm\frac{1}{4}$ micron at an overall magnification of 3000 times. Special circuits generate X and Y direction cursor lines on the tube, the position of which is measured by a precision time delay generator.

New Gating Circuit

Although color tv is still a dream in the U.K., conference papers showed that much is happening behind the scenes. Typical was the new gating circuit from Mullard Ltd. for single-gun tv color tubes. It overcomes the output amplitude, efficiency, and gamma defects of the chromagate circuit by a low-

(Continued on p 42)

In high voltage transformers, other heavy duty electrical and electronic equipment...

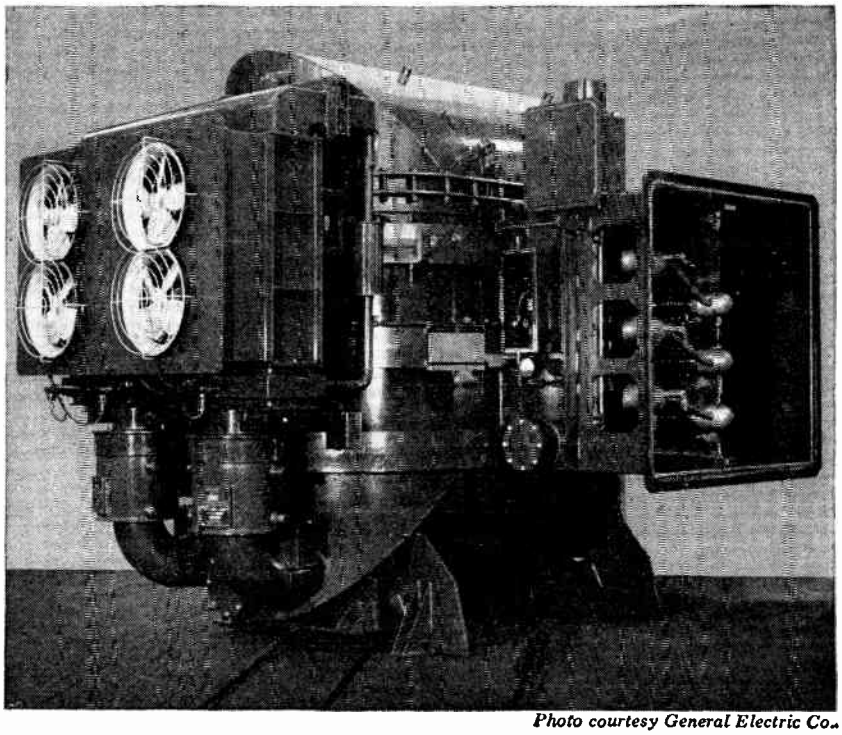


Photo courtesy General Electric Co.

THE TREND IS TO GASEOUS INSULATION WITH B&A® SULFUR HEXAFLUORIDE

The trend in requirements for high voltage equipment is toward higher operating voltages, units of minimum size and weight, greater safety and lower maintenance costs. For these reasons, sulfur hexafluoride is being used to insulate a wide variety of electrical and electronic equipment.

Sulfur hexafluoride is not only the preferred gaseous dielectric—it has also proved superior to liquid insulation in many applications. For example, the use of SF_6 instead of oil to insulate high voltage transformers has the following advantages:

High Dielectric Strength

At atmospheric pressure, SF_6 has a dielectric strength 2 to 3 times that of air, nitrogen or carbon dioxide. This favorable ratio increases with pressure so that in the range of 2 to 3 atmospheres SF_6 has a dielectric value roughly equivalent to transformer oil.

Efficient Over Wide Temperature Range*

SF_6 is stable in the presence of most materials of construction up to temperatures of about 150°C; remains a gas down to −63.8°C.

*Where extreme inertness to other materials is required or when service conditions involve temperatures in the range of 150°C to 250°C (or higher!), Baker & Adamson's Perfluoropropane (C_3F_8) is recommended.

Reduces Noise Level and Weight of Equipment

Both the noise level and weight of transformers can be reduced substantially by insulating with SF_6 rather than with a liquid. The low noise feature is particularly important where residences are nearby. Weight savings pay off for portable equipment and reduce installation costs for stationary equipment.

Safe to Use

SF_6 is non-toxic, chemically and physiologically inert, fire-proof and explosion-proof.

Installation Savings

Installation in fire-proof vaults is eliminated and bus runs can be shortened drastically due to closer proximity of transformer to generator.

Many of these advantages are also applicable to other commercial uses of sulfur hexafluoride, such as in:

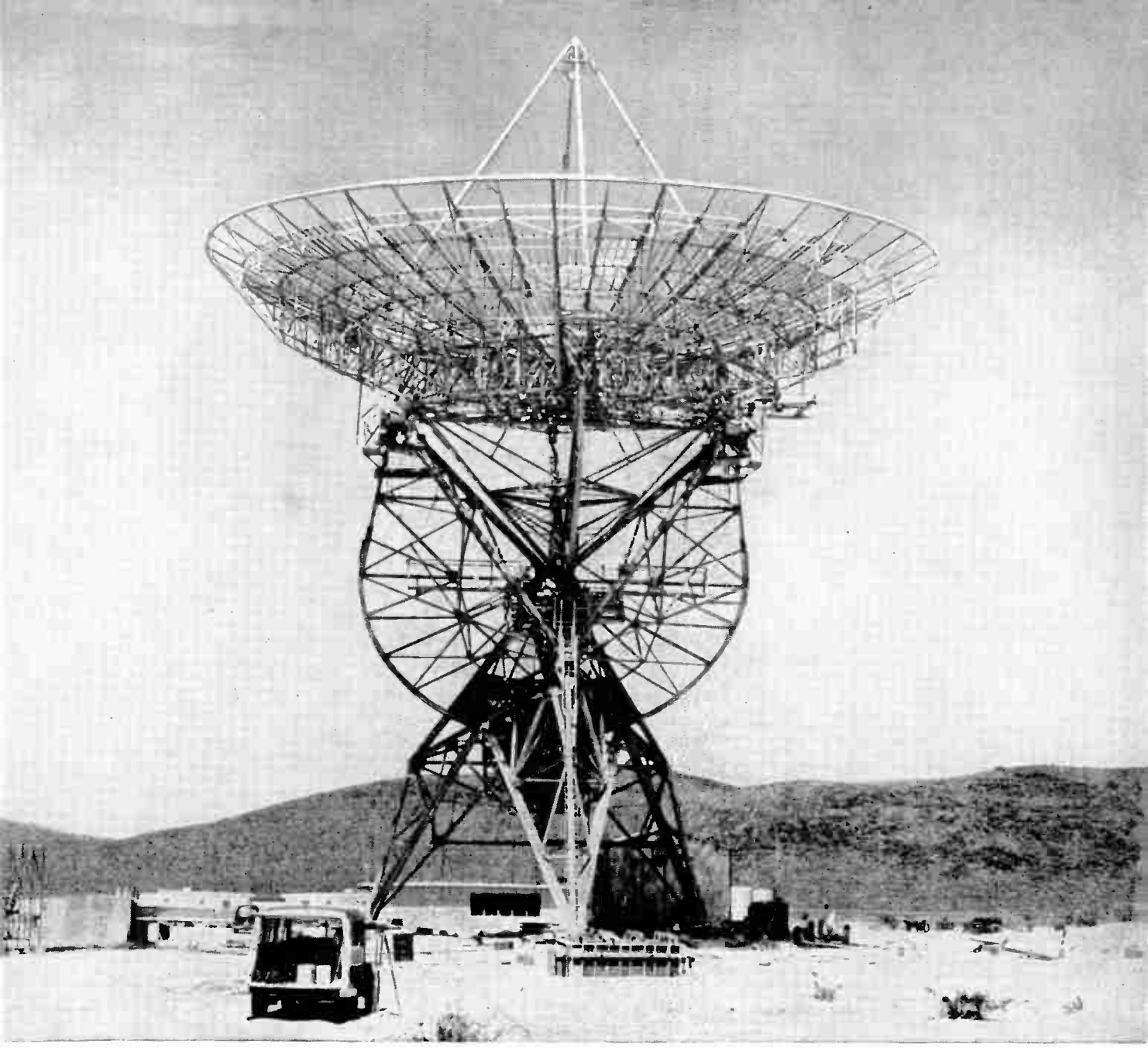
Interrupter Switches
Radio and Microwave Frequency Power Transmission
X-Ray Equipment
Audio Equipment
Cathode Ray Accelerators
Van de Graaff Machines
Television Filterplexers
Radar Duplexers
Gap Tubes
Switch Gear
Wave Guides
Airborne Electronics
Silicon Rectifiers

Investigate all the advantages of B&A Sulfur Hexafluoride gaseous insulation *now*. Write for technical literature.

BAKER & ADAMSON® Electronic Chemicals

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.



85′ diameter tracking antenna, shown under construction. Reflector face surface is fabricated from aluminum. Pedestal, Polar Cage, Declination Cage and back up structure are of galvanized steel.

New BLAW-KNOX 85′ diameter tracking antenna for U.S. Lunar Probe Project

This newest Blaw-Knox 85′ Tracking Antenna is part of the Space Probe Project of the Jet Propulsion Laboratory at Pasadena, Calif. It will be used to maintain communications with space vehicles at ranges up to 250,000 miles.

Its design is fully determinate. All structural members of the assembly are analyzed for stress and deflection before fabrication. Coupled with shop fabrication and field erection to rigidly accurate tolerances, it is capable of the highest gain, with a minimum of distortions or aberrations.

The entire drive system embodies such critical design requirements as infinitely variable movement with negligible creep or overrun for tracking. The slewing drives are capable of the extremely rapid acceleration and deceleration necessary to focus on targets.

Pioneering like this is the latest step in a long series of Blaw-Knox developments. Such milestones as the Guyed Vertical Radiator design in AM radio, the first radar antenna used to bounce signals off the moon, and the Tropospheric Scatter Antenna for over-the-horizon television have marked Blaw-Knox as a world leader in advanced design, fabrication and erection techniques.

Blaw-Knox welcomes the opportunity to translate your most advanced concepts into highly reliable operating equipment. Contact the Antenna Group.

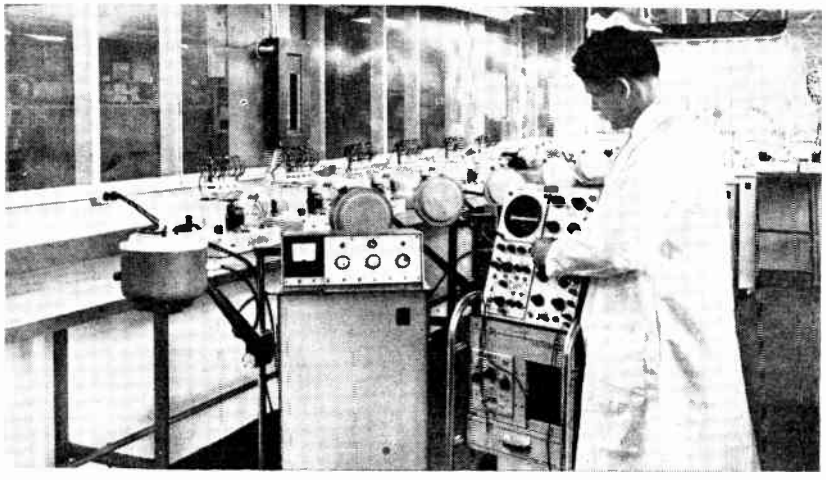
Antennas—Rotating, Radio Telescopes, Radar, Tropospheric Scatter, and Ionospheric Scatter.

BLAW-KNOX

BLAW-KNOX COMPANY
Blaw-Knox Equipment Division
Pittsburgh 30, Pennsylvania

CIRCLE NO. 41 READER SERVICE CARD

Pulsed Energy Goes In



Diapulse unit gets final inspection after installation of power supply chassis and r-f chassis

New 27.12-mc device for broad-spectrum pulse therapy now treating many human ailments

NEW YORK—MEDICAL use of pulsed radio-frequency energy in treatment of a wide assortment of human ills was discussed late last month at a doctors' symposium here.

The symposium was presented by the A. J. Ginsberg Foundation, named for Dr. Abraham J. Ginsberg, the New York doctor who developed the pulse technique in the early 30s and has been quietly testing it ever since.

Dr. Ginsberg's original pulse equipment employed 27.12 mc, one of the several frequencies open to medical use. By happy chance, it is this frequency range which Dr. Ginsberg and some of his colleagues believe "may exert the most beneficial affect on living tissue of any frequency between 60 cps and visible light."

Avoids Heat Effects

The lab equipment used by Dr. Ginsberg for years has now been production-engineered and repackaged for sale to the medical profession by Diapulse Corp., N. Y. Units are being manufactured for Diapulse at Remington Rand's Utica, N. Y., plant. Rem Rand's parent Sperry-Rand Corp. has also made a handful of top physicists available to Diapulse and the A. J. Ginsberg Foundation for further research in the pulse-therapy technique.

Pulse-therapy differs from r-f diathermy in that it does not rely on the production of heat; rather, it avoids heat effects as much as

Britons Probe . . .

(Continued from p 39)

level gating technique using the sequential switching of three linear amplifiers with a common anode load, followed by a 30 mc bandwidth amplifier.

Heart of the technique is the 6BN6 gated beam tube where half-sine pulses are supplied to the limiter grid and clamped video to the quadrature grid respectively. Output pulses thus obtained have a rise time of 15 millimicroseconds and amplitudes up to 100 v.

Typifying the convention theme of no major breakthroughs but steady progress was the discussion of good practice techniques in scanning circuits by K. E. Martin of Mullare Ltd. Circuit improvements of third-harmonic tuning, improved ferrites, and the use of the shorted-turn linearity and width adjuster are enabling British designers to use the same tubes in the line-scanning circuits for this year's introduction of 110-deg picture tubes as used in 1951 for the then-current 70-deg tubes.

Clinics

possible. In order to do this, and still attain high peak values, Dr. Ginsberg quite early in the game settled on pulses of high energy content, separated by enough time to permit vascular dissipation of heat.

Diapulse equipment produces pulses 50-60 microseconds in duration at a rate variable from 80 to 600 a second. Maximum peak power is 1,333 watts, with average wattage in the most common modality around 36 watts.

Energy is radiated from a coil antenna in the "treatment head" of the device. The antenna is embedded in plastic for safety's sake. The patient is placed in the field and the coil is then tuned to resonance; the patient thus becomes part of the radiating system.

Labs Confirm Theory

Besides treating affected members (in cases of infection, for instance), Diapulse technique involves irradiation of the liver-adrenal complex. Dr. Ginsberg's operating theory, being experimentally confirmed in several score clinical laboratories around the country, is that the high-energy pulses stimulate the general defense mechanism of the body, which then works extra hard to overcome whatever danger is present.

The location of general defense controls in the liver-adrenal complex and the lower spine has been postulated by physiologists.

Doctors attending the symposium reported results of Diapulse therapy in infections of the ear, upper respiratory infection, rheumatic ailments, pelvic inflammations, infections of the urinary tract, and calcified bursitis. In the latter case, for example, a long clinical history provided by Dr. Ginsberg showed 91.3 percent efficacy, with complete absorption of deposited calcium in 52.1 percent of the cases.

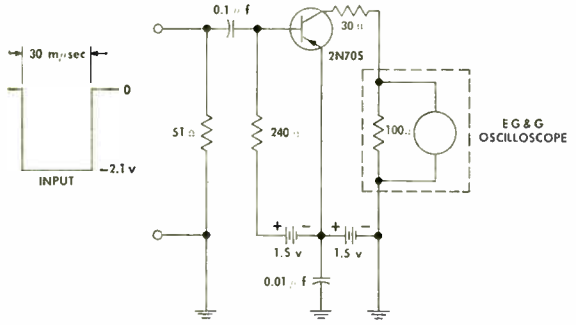
Doctors at various medical research centers also reported on plans for documenting possible effects of pulse therapy on lipid (fats) metabolism, blood circulation, and the birth rate and growth characteristics of several generations of mice.

For high-reliability switching

APPLICATION NOTES

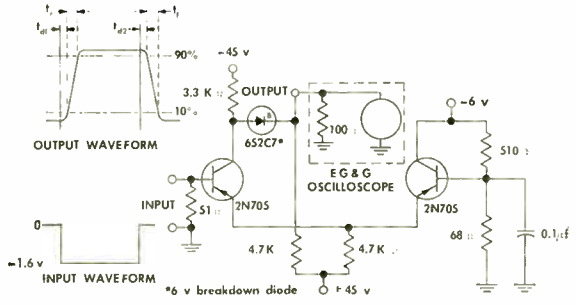
VOLTAGE SWITCHING CIRCUIT

t_d	t_r	t_s	t_f	$V_{BE(0)}$	$V_{BE(1)}$	$V_{BE(2)}$
5 mμsec	7 mμsec	7 mμsec	7.5 mμsec	1.5 v	−0.6 v	1.5 v



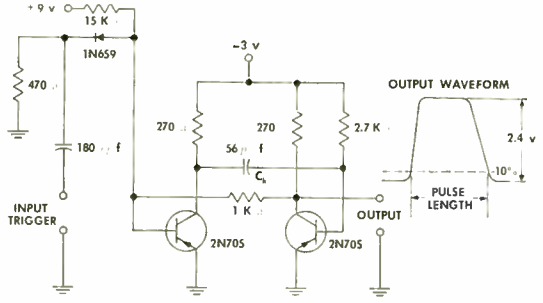
NON-SATURATING CURRENT MODE SWITCH

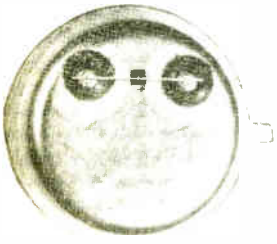
t_{d1}	t_r	t_{d2}	t_f
4 mμsec	3.6 mμsec	5.5 mμsec	10.4 m sec



MONOSTABLE MULTIVIBRATOR

t_r	t_f	Pulse length (depends on C_k)
20 mμsec	40 mμsec	120 mμsec





Exact product uniformity and reproducibility is another benefit to you from TI's diffused-base production process. Maximum mechanical strength and high heat transfer characteristics are a direct result of mounting the wafer directly to the header.

6 times actual size

Highest inherent reliability provided by diffused-base 'mesa' process

- Higher reliability because of lower operating junction temperature from the industry's highest dissipation germanium ultra-high speed switcher.
- Increased protection against surge voltages provided by diffused junction (rugged emitter-base junction) permits greater design freedom.
- Maximum resistance to shock and vibration is designed into all TI diffused-base products by fusing the semiconductor wafer directly to the header.

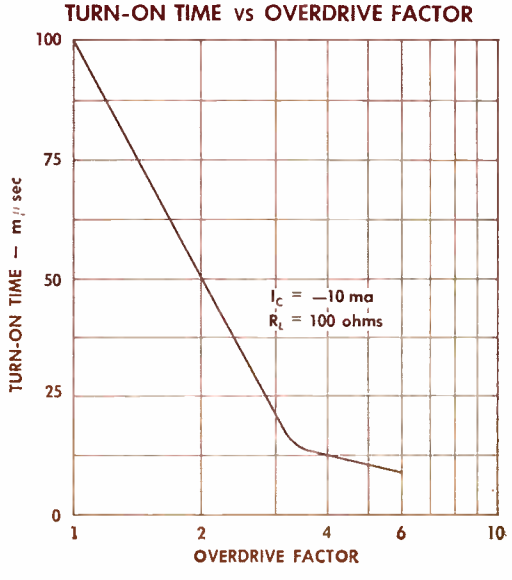
Actual Size

Now utilize the combination of *maximum* reliability and ultra-high speed switching furnished by TI 2N705's. Reliability is determined largely by device operating junction temperature. 2N705 *300-mw dissipation at 25°C case temperature and operation to 100°C junction temperature gives you three times greater power handling capacity* plus typical total switching times of 25 mμsec!

TRUE SWITCHING SPEED

A transistor's true switching speed in any circuit is dependent on the amount of over-drive designed in the circuit: Overdrive $= \frac{I_b h_{FE}}{I_{CS}}$

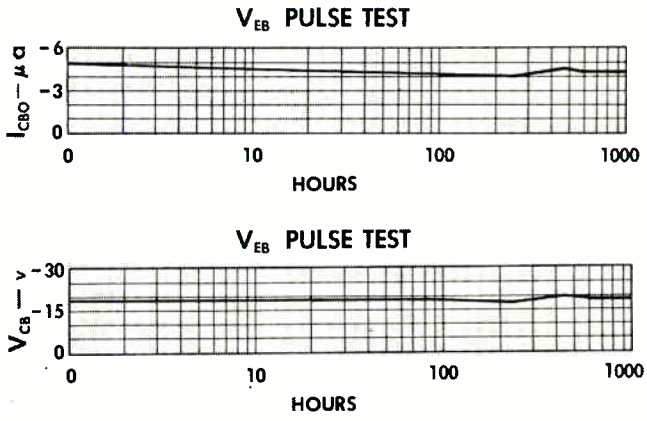
Below is the speed-up of 2N705's as a function of overdrive characteristics.

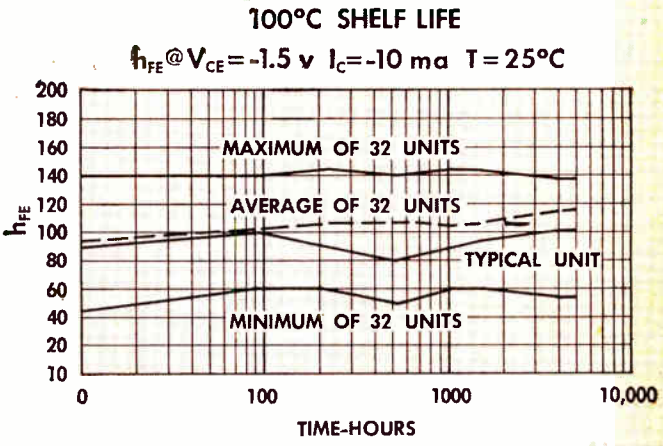


FROM THE WORLD'S LARGEST SEMICONDUCTOR PLANT

TEXAS

...TI 'mesa' transistors!





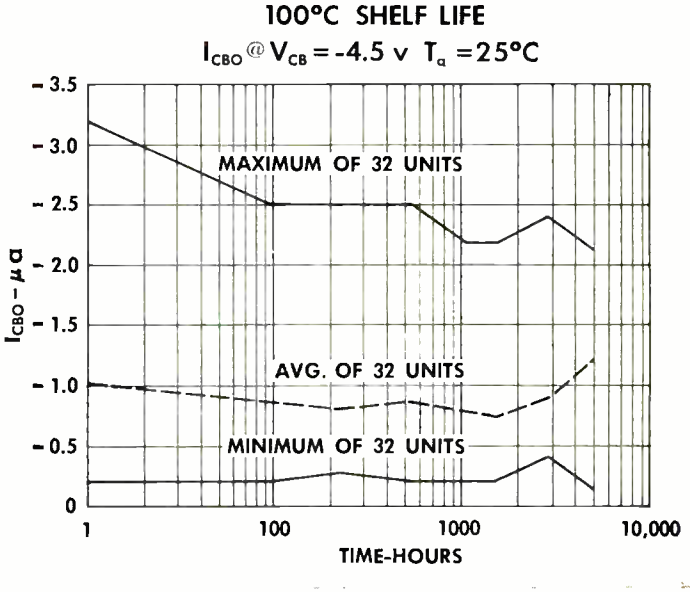
RELIABILITY INSURED BY RUGGED DESIGN, TEST

5000-hours life test data! Check the curves on the right for yourself and see how TI's 2N705 h_{FE} and I_{CBO} proved-performance characteristics apply to your high speed switching requirements. Also, for absolute assurance of conformance to specifications, all units are stabilized at 100°C for 100 hours and then 100% production tested!

Rugged Emitter-Base Junction

For an added design safety factor, consider the voltage surge tests shown above from which the graphic data on this page was obtained. In a circuit utilizing 2N705's a voltage pulse was applied to the emitter base diode in sufficient magnitude that it resulted in breakdown of the emitter base diode, causing flow of a 1, 5 and 10 ma current in each of three separated device groups. This test was continued for 1000 hours and all test data indicated that device characteristics I_{CBO}, h_{FE}, V_{EB}, and V_{CB} were *unaffected by this 1000 hour pulse test.*

Like all other TI semiconductors, the new 2N705 series is guaranteed for one full year.



absolute maximum ratings at 25°C case temperature
(unless otherwise specified)

	2N705	2N710
Collector-Base Voltage	−15 v	−15 v
Emitter-Base Voltage	−3.5 v	−2.0 v
Collector-Emitter Voltage	−15 v	−15 v
Storage Temperature Range	−65 to +100°C	
Emitter Current	−50 ma	−50 ma
Collector Current	−50 ma	−50 ma
Collector Junction Temperature	+100°C	+100°C
Total Device Dissipation	300 mw*	300 mw*

* Derate at 4 mw °C. This is equivalent to a maximum power rating of 300 mw at a case temperature of 25°C. The power rating in free air at 25°C is 150 mw.

Evaluate the data on these pages for your requirements and call your nearby TI sales office for complete price and delivery information . . . or contact your authorized TI distributor for off-the-shelf overnight delivery!

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SEMICONDUCTOR-COMPONENTS DIVISION
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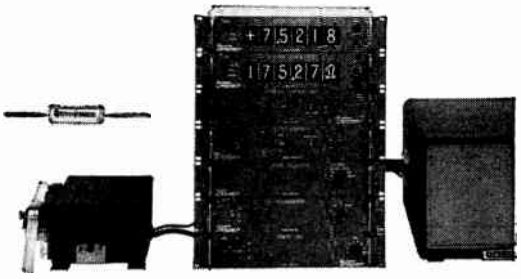
Write on your company letterhead describing your application for specific details on TI products.

Low cost, versatile DIGITAL SYSTEMS

for automatic testing of transistors resistors diodes and capacitors



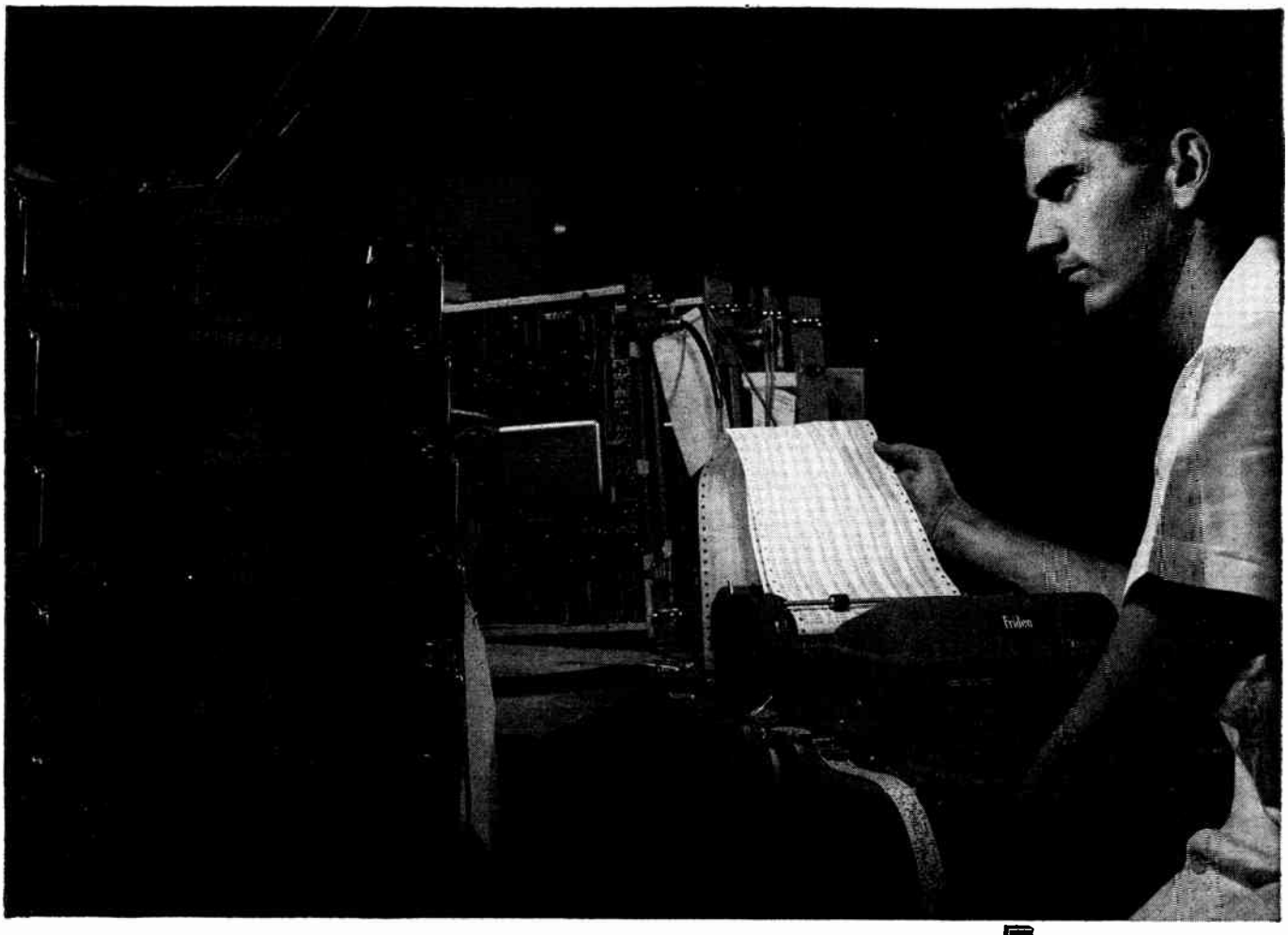
Typical E-I system for evaluating components—includes 100 channel input signal scanner. Can digitize DC voltage, resistance, AC voltage and DC/DC voltage ratio analogs. Digital equivalents are recorded on strip printer for "quick look" data and on punch paper tape for additional data reduction by digital computer.

Small E-I automatic digital systems provide many advantages. First, they cost less. This is primarily the result of large-quantity manufacture of modules which make up the E-I system. Cost is almost a linear function of performance capabilities desired in the system.

Second, they are exceptionally versatile. The E-I system can be expanded simply by adding appropriate modules. Typical systems presently in use measure resistance, capacitance, DC and AC voltages, DC/DC ratios, AC/DC ratios, AC/AC ratios and combinations of these. Measurements to four or five digits can be visually displayed and printed out at rates up to five readings per second. Operation can be semi- or totally automatic with go/no go comparison of values and programmed readout at periodic intervals. Scanners can be provided for scanning thousands of single and multi-wire input channels. In brief, the E-I system has an extensive scope of operating capability.

Third, E-I systems provide unmatched reliability. Where practicable, circuits are totally transistorized. The use of etched, plug-in circuit boards, and modular internal construction make maintenance checks and in-plant repairs easy.

Lower cost, maximum versatility and greater reliability—if you want these advantages in your component test system, contact your nearest E-I representative. He can give you complete information or answer any specific questions you may have.



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Computers Lighten Air Load

They're now handling 20 percent of Idlewild's flight-plan data. Soon it will be 50 percent

NEW YORK—Electronic computers have been processing 20 percent of flight-plan information handled over the last six months at the Federal Aviation Agency's Air Route Traffic Control Center here at New York International Airport (Idlewild).

Operating Costs

It is expected that operating capacity will be upped to 50 percent shortly. Operating and maintenance costs for the computer installation have been about $27,000 per month for 8-hr daily operation.

Eventual goal is to process and display all data automatically. Initial installations will be limited to the northeast area covered by FAA Region 1, with nationwide coverage expected by 1965. Computers are presently in use here, in Washington, D. C., and at Indianapolis.

Flights are being charted in FAA's Flight Control room at Idlewild Airport. Routing cards show information from Remington Rand Univac File-Computer system

Checking New 10-kw Transmitter

Army Signal Corps officers discuss single-sideband, 10-kw transmitter used with Army's new air-transportable radio communications system, AN/TSC-16. Designed and manufactured by Adler Electronics, system gives combat commanders a 1,000 to 2,000 mi communication capability previously possible only with large, fixed radio installations. Entire system, along with required 46 operating personnel, can be assembled, loaded into two C-124's and made airborne within 12 hours. On arrival, system can be made ready for interim operation in about four hours

MEETINGS AHEAD

July 30-31: Computers & Data Processing, Denver Research Inst., Stanley Hotel, Estes Park, Colo.

Aug. 4-5: American Astronautical Society, Western National Meeting, Ambassador Hotel, Los Angeles.

Aug. 17: Ultrasonics, National Symposium, PGUE of IRE, Stanford Univ., Palo Alto, Calif.

Aug. 18-21: Western Electronics Show and Convention, WESCON, Cow Palace, San Francisco.

Aug. 23-26: Electrical Conf. of the Petroleum Industry, AIEE, Wilton Hotel, Long Beach, Calif.

Aug. 24-26: Gas Dynamics Symposium: Plasma Physics, Magnetogasdynamics; American Rocket Society, Northwestern Univ., Evanston, Ill.

Aug. 24-27: Ballistic Missile and Space Technology, USAF, Space Technology Labs, Inc., Los Angeles.

Aug. 31-Sept. 1: Elemental and Compound Semiconductors, Tech. Conf., AIME, Statler Hotel, Boston.

Aug. 31-Sept. 2: Army-Navy Instrumentation Program, Annual Symposium, Douglas Aircraft and Bell Helicopter, Statler-Hilton, Dallas.

Sept. 1-3: Association for Computing Machinery, National Conf., MIT, Cambridge, Mass.

Sept. 3-6: Air Force Association's National Convention, Exhibition Hall, Miami Beach, Fla.

Sept. 17-18: Engineering, Writing and Speech, Dual National Symposium, PGEWS of IRE, Sheraton-Plaza Hotel, Boston; Ambassador Hotel, Los Angeles.

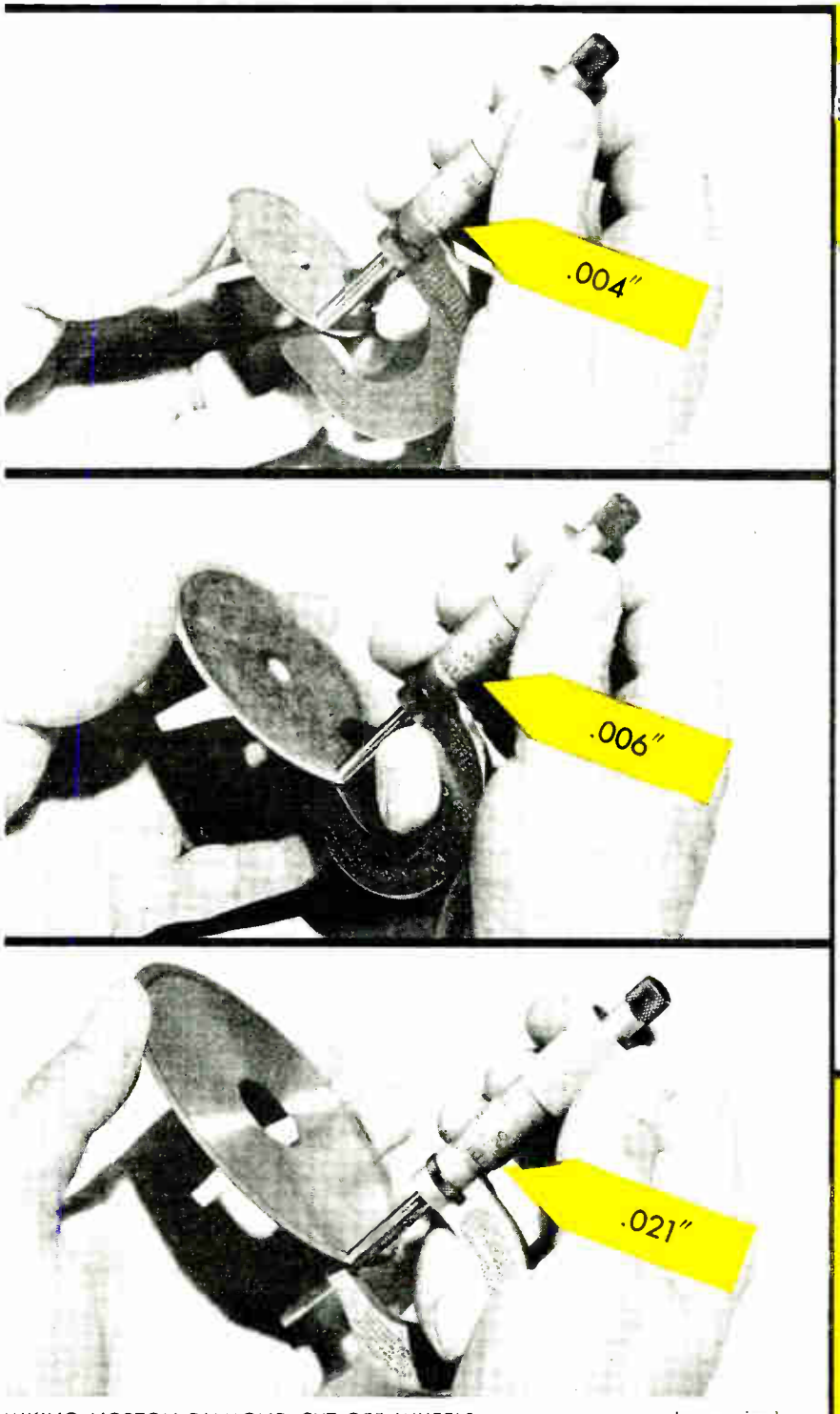
Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Oct. 12-15: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Sherman Hotel, Chicago.

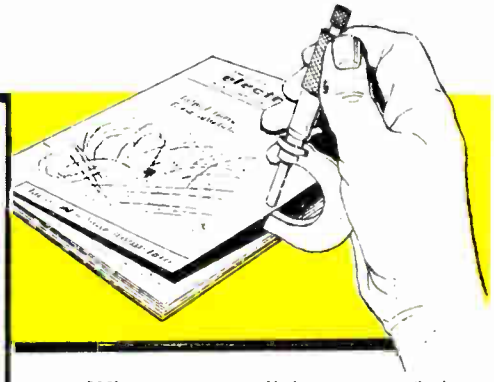
Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

There's more news in ON the MARKET, PLANTS and PEOPLE, and other departments beginning on p 102.

Your "Crown Jewels" for dicing can be thinner than this magazine cover



MIKING NORTON DIAMOND CUT-OFF WHEELS proves you can get the required thinness which is just one of their advantages for better, lower cost electronic parts. The wheels shown measure, in top to bottom photos, 2" x .004", 3" x .006", and 4" x .021" — the first being as thin as the cover of this magazine you're reading. And their uniform thinness enables accurate grouping that saves valuable electronic material.



When you're dicing or wafering germanium for transistors, silicon for high temperature parts, or quartz crystals for radio transmission, your diamond wheels must be uniformly thin to assure dimensional accuracy of the parts you cut — especially important in gang dicing.

Whatever their thinness, Norton diamond wheels cut fast, free and straight. And their non-chipping action avoids wasting material — a particularly cost-saving benefit when you're grinding germanium, silicon, quartz crystals, etc.

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Philco Ground-Space Communications System commands and tracks **DISCOVERER** satellite

DISCOVERER . . . the United States' newest earth satellite . . . is opening new vistas on the frontier of outer space. And Philco is proud to play an important role in this renowned achievement as a part of the Discoverer Team . . . in conjunction with the Lockheed Aircraft Corporation and the Air Force at the direction of the Advanced Research Projects Agency of the Department of Defense.

As the subcontractor for Discoverer's entire communications system, Philco designed and developed the vast complexity of ground-space communications, tracking, commanding and data gathering and processing systems.

The Philco-designed and equipped system observes and commands Discoverer through a series of five tracking and data collection stations in Alaska, California, Hawaii and a specially equipped ship at sea. Philco continues its participation in the Discoverer Program by assisting in the actual operation and maintenance of the communications and data handling network.

Philco's part in the Discoverer Program is typical of the many and diverse advanced research and development activities being conducted in our laboratories on the East and West Coasts where outstanding career opportunities abound for Engineers, Mathematicians, and Physicists.

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Component Density 158 per cu. in. *
Diameter 0.286"; Depth 0.110 ± 5%
Rating 1/10 watt

Here is a graphic illustration of how Centralab has met your needs for greater and greater miniaturization. Pictured (actual size) are three ultra-miniature Centralab Radiohms.® When introduced, each was the smallest variable resistor on the market—and was superseded in that position only by the introduction of the next smaller Centralab unit.

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VARIABLE
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SPECIFICATIONS:

Model 8 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 250° rotation, minimum rotational life 25,000 cycles.

Model 6 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 250° rotation, minimum rotational life 25,000 cycles. Also available with SPST switch.

Model 1 Radiohm®: 500 ohms to 10 megohms at 1/10 watt, wide range of tapers, 260° rotation, minimum rotational life 25,000 cycles. Also available with SPST switch.

Detailed specifications are available in Centralab Technical Bulletins. Write for your free copies.

Model 1 and Model 6 Radiohms® are stocked by your Centralab distributor, available as the B16 and SM control series respectively.

***Cubic inch, rather than cubic foot, is used to provide a more realistic and more readily visualized standard of comparison.**

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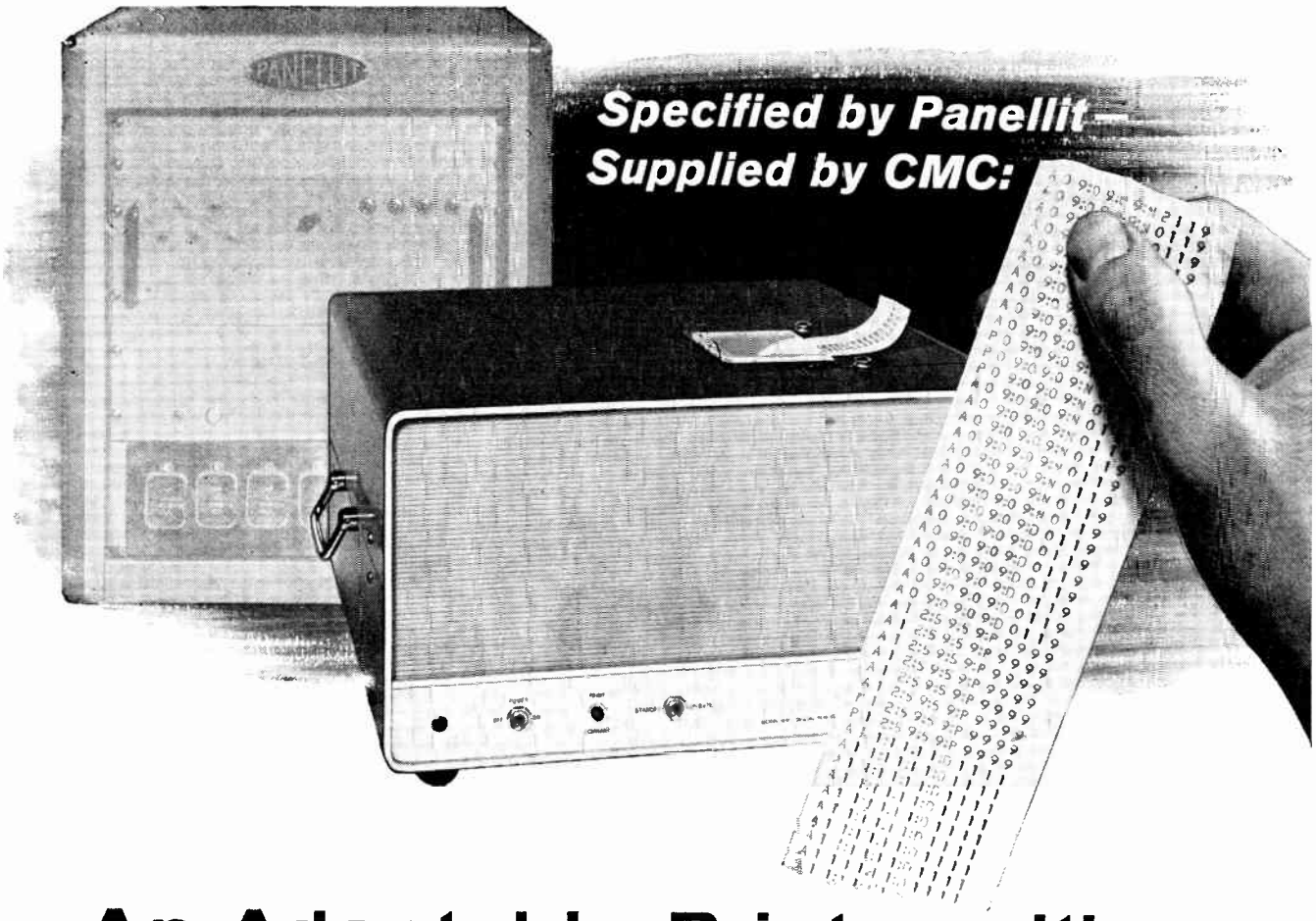
VARIABLE RESISTORS • ELECTRONIC SWITCHES • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS



An Adaptable Printer with Day In-Day Out Reliability

Understandably, Panellit's requirements for a digital printer were strict. The Skokie, Illinois firm's recording annunciator, which monitors trouble in equipment operations, has to have around-the-clock reliability. It has to indicate what went wrong, exactly when it went wrong, and for how long. In many instances, the printer must operate at remote stations, unattended. Panellit chose CMC's new digital printer to provide this high degree of dependability.

READILY ADAPTED

The tape above shows the adaptability of CMC's printer to special applications. The Panellit system scans a number of points and then records, in a single twelve digit printout, the off-normal point, the off-normal code, the hour, minute and hundredth of a minute. The date is printed every twelve hours and on demand.

The system detects the first off-normal to a one cycle accuracy and records sequentially at the rate of four alarms per second. Alarms occurring faster are stored in the memory unit and printed according to a built-in sequence. The entire record is neat, compact and permanent.

PRINTER FEATURES

No stepping switches ★ 4 lines per second printout ★ parallel entry ★ 8 options... 10 line output to drive punches and electric typewriters, analog output to drive strip chart recorder, inline readout, accumulator, code converter, transistorized drive, add-subtract solenoid, print-line identification ★ rugged unitized construction ★ compatible with any line of counting equipment.

KEY SPECIFICATIONS • Model 400C Digital Printer

Print-out capacity 6 digits standard, up to 12 on special order. Accuracy determined by basic counting instrument... display time 0.2 seconds minimum, maximum controlled by counter or system. Weight 64 lbs.

CMC engineering representatives are located in principal cities. For complete information on this all-new instrument, phone your nearby representative or write directly to Dept. 187-A

CMC **Computer-Measurements Company** *A Division of Pacific Industries, Inc.*

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15

Growing of germanium crystal in ribbon form at Westinghouse Research Laboratories

Transistorizing Electronic Equipment

By **RONALD K. JURGEN,** Associate Editor

SEMICONDUCTOR DEVICES • ASSOCIATED COMPONENTS • SOLID CIRCUITS

IN THE ELEVEN YEARS since the announcement of the point-contact transistor, the electronics industry has seen a laboratory curiosity develop into a technological giant. The point-contact transistor has been largely bypassed by other types. Basic design approaches to semiconductor devices have been broadened. Fields of application are now also much wider in scope. And the end is not in sight.

Virtues of the transistor are many. It has a high gain-bandwidth figure of merit. Size, ruggedness and low-power requirements are inherent. It has made possible many high-speed computer developments of the past decade. It is at once an active element and a true switch. Therefore, it has been applied to construction of high-efficiency switching and power-control circuits previously dependent upon low-speed mechanical devices.

It has been said that a technological plateau in transistor manutacturing know-how has been reached. This may be temporarily true. Practical application of new materials could change the picture considerably. Perhaps it will yet be possible to design totally new transistors that can be mass-produced and lessen some of today's high-frequency and power-handling problems.

Whether or not there are advances in the state of the art in the future comparable to those of the past eleven years, one fact is obvious. The transistor circuit designer, as well as the semiconductor device designer, has matured in his thinking. Although the circuit man is not particularly concerned with alloy junctions, diffused bases or mesa constructions, he is vitally interested in whether a transistor is available, how much it costs and how it will perform.

The circuit designer has learned to live with the transistor's limitations just as he first learned its many advantages. He now takes the transistor's inherent impedance characteristics and temperature sensitivity in stride. He is less unhappy with nonuniformity than he used to be and he has learned ways of protecting transistors against even minor changes in supply voltages.

It is not the intent of this report to concentrate on circuit design techniques. Its primary purpose is to present information on the application of transistors and trends for the future.

The Front Cover

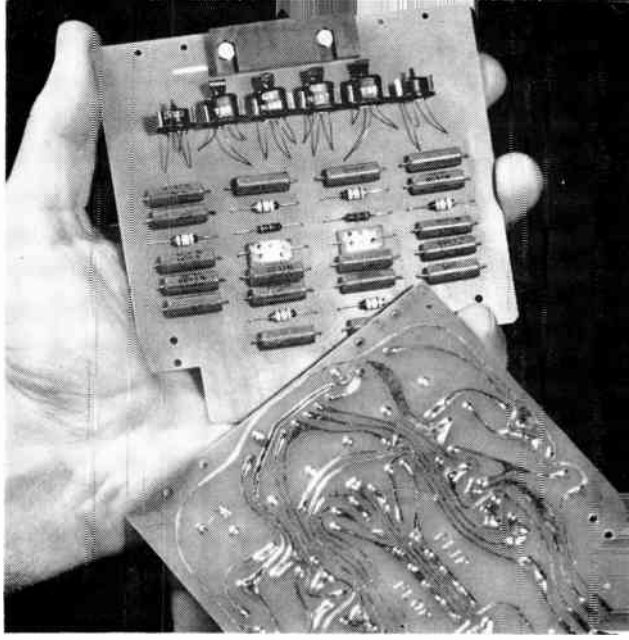
Germanium mesa transistor photographed by Bell Lab's physicist, Dr. H. K. Gummel. Green light is incident light on transistor. Reddish light is being emitted by heavily doped *pn* junction of transistor that has been back-biased. Simplicity of light pattern may be indicative of perfection of alloying process used in forming junction

At top, on left, is a Texas Instruments computing programmer used to calculate the exact time of ejection for the instrument package in the nose of an ICBM. Device is gold-plated for maximum heat-reflecting characteristics

At center is Stromberg-Carlson's breadboard assemblage of EUCLID (Electronic Unitized Components for the Logical Interpretation of Data) modules. Modular concept is designed to shorten the development time in the construction of a special-purpose electronic data handling system

At bottom, comparison of new Gulton Industries' single-package accelerometer system for missile use with older version in three parts

Power for this electronic flash unit is provided by transistorized circuits in lamp head and handle. Device made by Heiland Div. of Minneapolis-Honeywell works off batteries or household current



Flip-flop circuits shown are part of Thompson Ramo Wooldridge RW-300 digital control computer. Note how transistors are mounted in clips

Semiconductor Devices

Availability, selection and state-of-the-art limitations of transistors and other semiconductor devices are discussed, with trends for the future uppermost in mind

IN ANY DISCUSSION of transistorized equipment, a logical starting point is a determination of when to transistorize. This decision is not necessarily an easy one—unless military requirements or other independent factors dictate the answer. But, in general, the transistor should be used when it represents the best element for any particular circuit application.

There are the obvious considerations of economics and availability and such general factors as size, weight and available power. One approach to the problem might be to consider first the factors already mentioned. Assume that these considerations tend to throw the decision in favor of using transistors. Then, determine whether or not the environmental and operating conditions are within the limitations of available transistors. A recent paper[1] summarizes the state-of-the-art limitations of semiconductor devices available commercially at the end of 1958. Tables I, II and III are based on tables given in this paper.

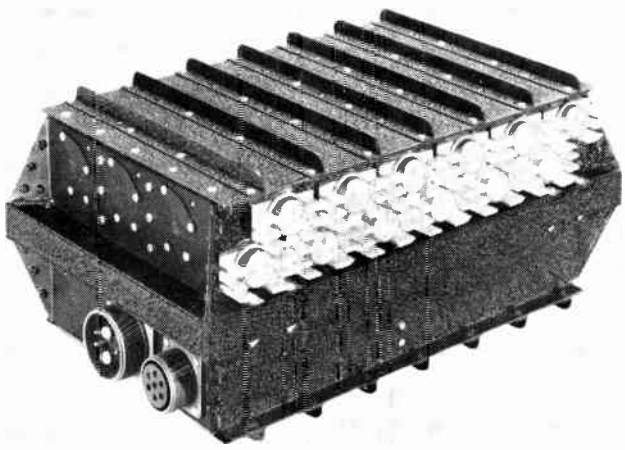
TRANSISTOR SELECTION—Once a decision has been made to use transistors in the design of a particular equipment, there still remains the matter of selection. There are presently about 700 different transistor types on the market, although basic designs number about 30. The large number of different types is due largely to nonuniformity of transistor parameters. Different type numbers get assigned to similar units where only one major parameter is at variance to any great degree. For example, the 2N444, 2N445, 2N446, 2N447, 2N519, 2N520, 2N521, 2N522 and 2N523 are identical except for alpha cutoff frequency[2]. In many cases, the grading process with transistors[3] results in the lowest performance types obtained in great quantities, the next better types in large quantities and the third and possibly fourth types in further decreased quantities.

There are many guides to selection of transistors available from transistor manufacturers and other sources. Many of these include interchangeability guides. There is no short cut to transistor selection. For this reason, there is no attempt here to list all available transistor types and characteristics. However, Tables IV, V, VI and VII give typical characteristics of semiconductor diodes rectifiers and transistors of all types[4].

HIGH-FREQUENCY TRANSISTORS—Current laboratory development work on high-frequency transistors is encouraging. Bell Telephone Laboratories, for example, have a mesa transistor in operation with a coaxial encapsulation designed to match 50-ohm coaxial line. It is operated common emitter and is intended for application as an oscillator or amplifier operating at 3 kmc or in feedback-amplifier applications requiring 500-mc bandwidth. Philco Corp. announced recently a laboratory MADT type, also of coaxial packaging for 50-ohm line, capable of opera-

Table I—Environmental Conditions for Semiconductor Devices

Condition	Semiconductor Devices	
	Germanium	Silicon
Junction or Envelope Temperature	−65 to +85 C	−65 to +175 C
Altitude	No limit	
Relative Humidity	0 to 100 percent	
Maximum Vibration	30 g at 20 to 2,000 cps	
Maximum Mechanical Shock	40 g at 10 millisec 500 g at 1 millisec	
Method of Mounting	Usually soldered Some plug-in	
Thermal Shock	0 to 100 C	
Failure Method	Sudden or gradual	



Power at 28 volts d-c is converted to 400 cps a-c by this 2-kw transistorized inverter. Unit manufactured by Varo is designed to power electrical equipment in an ICBM. Inverter contains about five different transistor types

Table II—Electrical Operating Conditions for Transistors

Condition	Transistors	
	Germanium	Silicon
Input Resistance in ohms	10 to 5×10^5	10 to 5×10^5
Input Signal Power in watts	10^{-8} to 1	10^{-8} to 1
Input Signal Current in amps	10^{-5} to 1	10^{-5} to 1
Input Signal Voltage in volts	10^{-6} to 5	10^{-6} to 5
Output or Load Impedance in ohms	1 to 5×10^5	1 to 5×10^5
Max Out Signal Power in watts		
Class-B Amplification	50	85
Switching	10^3	2×10^3
Max Out Signal Voltage in volts	10^2	2×10^2
Max Power Gain in db	40	40
Max Current Gain in db	10^2	10^2
Collector Voltage in volts	10^{-1} to 2×10^2	10^{-1} to 2×10^2
Collector Current in amps	10^{-6} to 12	10^{-6} to 10
Amplifier Operating Frequency in cps	0 to 5×10^8	0 to 10^8
Max Oscillator Operating Frequency in cps	8×10^8	10^8
Max Variation Between Units of Same Type	400% in current gain	400% in current gain
Ability to Withstand Surges	Poor	Poor
Temperature Coefficients	Current gain may change	Current gain may change

tion as an amplifier in the 1 to 2 kmc range.

These two units certainly do not represent the ultimate in frequency capabilities. Both types may be able to handle 10 kmc or more with further refinements. But not tomorrow! The fact remains that with commercially available transistors, there are less than a dozen that can operate above 300 mc. With many of these, present prices may be a prohibitive factor for large-scale usage. Future approaches to high-frequency operation may well take the path of single *pn* junction diodes operated as negative-resistance elements.[5] The Varactor diode has been operated in oscillator and amplifier circuits in the 10-kmc range with low noise. The Japanese Esaki diode is doped to degeneracy on both sides of the junction and is biased slightly forward. Negative resistance comes about through tunneling of the charge carriers across the junction. Inherent frequency capabilities are extremely high.

POWER TRANSISTORS—High-power units have also received much attention. And the really challenging work is being done in an attempt to combine both high frequency and power in one unit; a feat that is difficult at best. However, there are already developed transistors that will operate at frequencies over 100 mc at power levels over one watt.

Outside the laboratory, the combination of power and frequency response is in a somewhat different status. At the recent IRE Show in New York, Harold J. Paz of Radio Corp. of America stated that most audio power amplifiers, for example, need a power transistor with a beta cut-off frequency of about 30 kc so that low-distortion operation can be obtained at 15 kc. He said further that presently available power transistors for the most part have a beta cut-off frequency of about 6 to 9 kc.

At the recent International Convention of Transistors and Associated Semiconductor Products, W. Shockley hinted at future directions for solving these problems. He stated that in about two to three years, transistor diodes would attain power levels 10 to 100 times higher than related transistors with comparable frequencies and efficiencies.

If high-frequency performance is not a necessity, germanium power transistors are available with collector dissipation up to about 55 watts and silicon units up to about 80 watts.[4]

Table III—Electrical Operating Conditions for Semiconductor Devices as Switches, Regulators or Rectifiers

Condition	Semiconductor Devices	
	Germanium	Silicon
Max PIV in volts	4×10^2	2×10^3
Inverse Current in amps	10^{-5} to 10^{-2}	10^{-5} to 10^{-2}
Max D-C Out Volts	2×10^2	1.5×10^2 (single) 1.5×10^3 (stack)
Max Average Current Out in amps	500	300
Max Power Efficiency	99.9%	99.9%
Max Operating Frequency as a Detector in cps	Point Contact 10^9	Point Contact 10^{10}
	Junction 2×10^6	Junction 60×10^6
Regulated Voltage	———	1 to 6×10^2

SWITCHING DEVICES—The fact that the transistor is a true switch has lead to widespread usage in the computer field. Transistors have been tailored specifically for switch applications. Currently, avalanche transistors and diodes look promising because of the extremely fast switching speeds attainable. The low- and medium-power devices, however, are the ones making great inroads into previously untapped industrial areas.

Three-terminal switching devices such as the Silicon Controlled Rectifier, Thyristor, Trinistor and Unijunction Transistor are all units of switching speeds in the microsecond range plus built-in control of the firing point. More and more semiconductor manufacturers are finding this field attractive and prices of these units most assuredly will drop.

Power capabilities of these so-called solid-state thyratrons are on the increase. Controlled rectifiers of the future should certainly be able to handle 100 amps at much lower costs than today's lower-power units.[6]

Two-terminal *pnpn* or *pnpm* switching diodes with such names as Dynistor, Four-Layer Diode and switching diode are also receiving continued attention. These units are turned on by exceeding their breakover voltage momentarily. They remain on as long as a forward current flows which is greater than the holding current. Turn-on times are generally in the range from 0.01 to 0.1 μsec.

Conventional semiconductor power rectifiers continue to be extremely useful for high-power rectifying applications where there is no need for fast switching. Of high interest at present, and certainly in the future, are rectifiers made from the intermetallic compounds of the III-V groups of the periodic

Table IV—Typical Characteristics of Germanium Diodes and Rectifiers

Type	Maximum peak inverse voltage in volts	Maximum mean current rating	Maximum junction temperature in deg C	Typical reverse current at maximum peak inverse voltage (25 C)	Typical forward voltage drop at maximum current in volts
Point-contact diode	100	30 ma	70	250 μa	1.2
Gold-bonded diode	100	100 ma	75	10 μa	0.8
Low-power junction rectifier	300	0.5 amp	85	100 μa	0.5
Medium-power junction rectifier	300	5 amp	75	500 μa	0.5
High-power junction rectifier	300	50 amp	75	2 ma	0.5
High-current junction rectifier	100	500 amp	75	25 ma	0.5

Table V—Typical Characteristics of Silicon Diodes and Rectifiers

Type	Maximum peak inverse voltage in volts	Maximum mean output current	Maximum junction temperature in deg C	Typical reverse current at maximum peak inverse voltage (25 C)	Typical forward voltage drop at maximum current in volts
Microwave crystal diode	3	30 ma	70	1 ma	0.8
Subminiature diode (switching, etc.)	100	20 ma	150	0.1 μa	1
Miniature junction rectifier	400	200 ma	200	1 μa	1.1
Low-power junction rectifier	400	1 amp	200	1 μa	1.1
High-voltage junction rectifier	1,000	1 amp	200	1 μa	1.1
Zener diodes	3–12	—	200	—	—
Medium-power junction rectifier	300	10 amp	200	20 μa	1.1
High-power junction rectifier	300	100 amp	200	1 ma	1.1

Table VI—Typical Characteristics of Germanium Transistors

Type	Manufacturing process	Structure	Common-base cut-off frequency in mc	Max collector power in mw	Max collector voltage in volts	Current gain
General-purpose low power	Alloy	*pnp*	1	50/200	10–50	20–100
	Alloy	*npn*	1	50/200	10–50	20–100
	Grown	*npn*	1	50	20–50	20–100
Intermediate power	Alloy	*pnp*	0.25	0.5/2 w	30–100	20–50
High power	Alloy	*pnp*	0.1	2/55 w	30–100	20–50
Symmetrical switching	Alloy	*pnp*	2.5–8.5	70/100	5–20	10–60
	Alloy	*npn*	2.5	100	10–20	10–20
High-frequency types	Alloy	*pnp*	10	30/100	10–20	20–150
	Alloy	*npn*	10	30/100	10–20	20–150
	Grown	*npn*	15	50	10–25	20–100
	Alloy drift	*pnp*	30	50	35	30–100
	Grown tetrode	*npn*	50	50	10–25	20–80
	Surface barrier	*pnp*	60	20	5–10	10–30
	Post-alloy diffused	*pnp*	200	50	5–20	10–30
	Diffused	*pnp*	500	50	5–20	10–50

Table VII—Typical Characteristics of Silicon Transistors

Type	Manufacturing process	Structure	Common-base cut-off frequency in mc	Maximum collector power in mw	Maximum collector voltage in volts	Current gain
General-purpose low power	Alloy	*pnp*	1	250	30	10–60
	Alloy	*npn*	1	250	30	10–60
	Grown	*npn*	6	150	20	10–90
Intermediate power	Grown	*npn*	2	1 w	50–120	10–90
	Diffused	*npn*	2	4 w	60–100	10–40
High power	Diffused	*npn*	1	37.5–80 w	60	10–40
High frequency	Alloy	*pnp*	4	250	30–45	20–80
	Alloy	*npn*	4	250	30–45	20–80
	Grown tetrode	*npn*	15	125	30	20–80
	Grown diffused	*npn*	30	125	30	20–90
	Diffused	*npn*	100	150	30	25

table. A recent article in ELECTRONICS[7] summarizes the present state-of-the-art of the nine usually discussed III-V compounds.

OTHER SEMICONDUCTOR DIODES—Zener diodes have become extremely useful in transistorizing equipment. Some of their many possible applications are: replacements for capacitors in some applications; a-c regulating action; prevention of thermal runaway of transistors; surge protection; arc minimizing; protection of indicating lamps and delicate instruments and maintenance of controlled voltage for more reliable relay operation[8]. They are presently available in power levels up to about 50 watts with voltages from about 10 to 200 volts.

Attention here has been given to some of the more glamorous semiconductor diodes. This emphasis is not meant to imply that these are the only important diodes worthy of consideration. To the contrary, the work horses of the semiconductor diode field have been point-contact diodes and junction diodes of several varieties. In this area, once again new materials seem to be the hope for any major advance in the state of the art. Gallium arsenide is one material of high interest. Texas Instruments announced recently a gallium-arsenide diode capable of operating in an ambient temperature range from −65 C to +325 C. This unit has a power dissipation of 800 mw at 25 C ambient. Other semiconductor manufacturers are known to be working on gallium-arsenide units as well.

SOLAR CELLS—Silicon solar cells have been in the limelight recently because of their application in earth satellites. One drawback to wider application is the relatively low conversion efficiency of about 10 to 11 percent. Here again, new materials may be necessary before a definite breakthrough in conversion efficiencies makes the units more widely attractive.

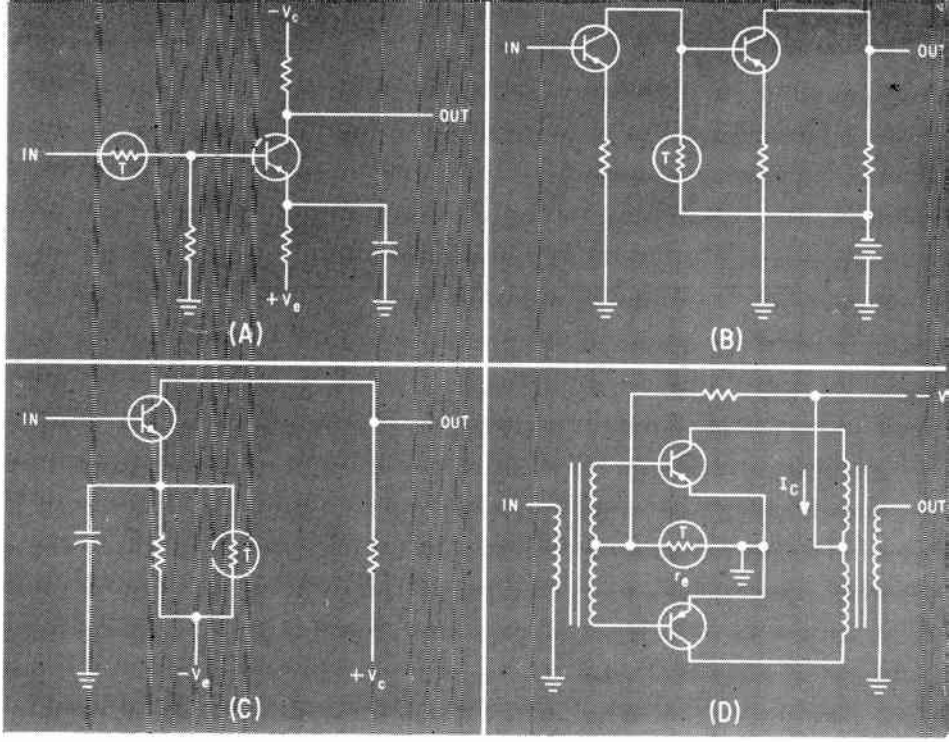


FIG. 1—Thermistor in single-stage amplifier compensates for decrease in gain with increasing temperature (A); simple thermistor-compensated d-c transistor amplifier (B) might otherwise have as much as 100-percent variation in output current for a 15-deg C temperature swing; use of thermistor for impedance compensation is especially useful for silicon transistors (C) and compensation of push-pull output stage to maintain idling current I_c constant with temperature variations (D)

Associated Components

Most transistorized circuits include an appreciable number of nonactive circuit elements. In some cases, such components offset troublesome characteristics of transistors. In others, they perform usual functions but have been highly miniaturized

ALTHOUGH THE ACTIVE semiconductor components already discussed are the backbone of transistorized equipments, design of such equipments has depended to a great degree upon associated components and hardware. In this section, some of these components will be treated. Others are beyond the scope of this report—printed circuits being one case in point.

THERMISTORS— Temperature sensitivity of transistors has been, and will continue to be, a primary problem. Fortunately, there is a solution in temperature compensation through proper circuit design.

There are many possible means of temperature compensation. One that is attractive because of its simplicity and low cost is use of one or more thermistors. Thermistors are available which exhibit not only the required temperature-resistance characteristics but also similar thermal time constants to those of the transistors. Table VIII lists typical thermistors for use in transistor circuits. Figure 1 shows several circuit techniques for temperature compensation of both germanium and silicon transistors with thermistors.[9]

Use of thermistors sometimes means that germanium transistors can be substituted for silicon with a saving in cost. Or a greater gain can be achieved in a circuit for given temperature variations. Or capacitors and resistors that have large temperature coefficients can be used.

SILICON RESISTORS— Another useful technique for temperature-compensating transistors is use of a positive temperature coefficient silicon resistor such as the Sensistor of Texas Instruments or the Silistor of Standard Telephones and Cables Limited.

Figure 2 shows the results obtained with an ordinary resistor and a Silistor in the emitter circuit of a silicon transistor. Use of the silicon resistor results in a substantially constant collector current over a wide temperature range.

CAPACITORS— Transistor circuits demand low-voltage, high-capacitance, miniature capacitors compatible with transistors both electronically and physically.[10] Table IX lists representative styles of recently designed low-voltage capacitors particularly suited for use in transistor circuits. These are forerunners of more efficient designs using advanced thin-film techniques and new materials being explored by both military and industrial research laboratories. Glass trimmer capacitors also have virtues.

Table IX lists only those parameters necessary to categorize and compare the various styles. It is not intended that the chart be all-inclusive with respect

Table VIII—Typical Thermistors for Transistor Circuits

Type	Physical Form	Negative Temperature Coefficient	Resistance Range
Cobalt-manganese-nickel oxide	Disk, rod and washer	3 to 5.2%/deg C	1,000 to 500,000 ohms
Titanium and iron oxides	Rod	1.3 to 2.5%/deg C	10 ohms to 1 megohm
Silicon carbide	Rod	0.25 to 0.55%/deg C	10 to 100,000 ohms

Graetz vhf receiver has transistors mounted on top of chassis. I-f transistors are located between i-f cans; audio transistors are in left foreground

to the increasing variety of commercial items being offered.

Another important area of development is the voltage-variable capacitor—a nonlinear resistance device obtained by reverse-biasing a *pn* junction. As mentioned earlier, such units hold great promise for high-frequency amplification. Aside from these considerations, however, they are important from the point of view of other possible circuit applications such as afc and nonmechanical tuning of radio receivers. These applications all take advantage of the fact that a variable voltage, readily obtainable, can be used to vary capacitance and, in turn, frequency. Application possibilities seem unlimited.

Many manufacturers are already on the market with voltage-variable capacitors. A recently published article in ELECTRONICS[11] tabulates such units known to be commercially available at the present time.

TRANSFORMERS—Because transistors have relatively low input impedances and high output impedances, impedance matching can be a problem.

Transistor stages can be transformer coupled, R-C coupled or direct coupled. Each method has its place, but flexibility of transformer impedance ratios makes it possible to match closely the optimum input and output impedances of transistors in a cascade amplifier. Compared to an equivalent RC-coupled amplifier,[12] the higher gain per stage obtained because of transformer coupling reduces the number of stages required for a given gain by about two-thirds.

Another advantage of transformer coupling is the fact that less power is required. This comes about since a transformer gives a high a-c load impedance without, at the same time, a large d-c drop. For a typical amplifier with a given gain and frequency response, the transformer-coupled version needs about one-sixth the power of the RC-coupled version.

Transformers were rejected in favor of R-C coupling in transistor circuits at first because of size and cost. But now, miniature transformers are available from several manufacturers in production quantities at low prices.

To select a transformer, information is needed about the circuit in which it is to be used. Operating power level; frequency response; distortion at specified levels and frequency; impedance of the source and load between which the transformer is to be connected; unbalanced primary d-c, if any, and permissible phase shift should all be known.

BATTERIES—Because transistors are inherently low power consumers, there has naturally been considerable attention given to batteries as power sources for transistorized portable equipment.

There are several different battery types used. One of the most popular continues to be the carbon-zinc "dry cell". Table X shows typical specifications for carbon-zinc batteries[13].

Two factors influence the choice of a dry battery from a current drain standpoint; operating cost and size or weight. Current can exceed specified values if operating cost is secondary to performance requirements. If size and weight are not important factors, current may be at the low end of the specified range of values.

Battery life is determined by initial current drain,

All receiving circuits of the Voxson Vanguard automobile radio are enclosed behind mirror. Transistorized unit is manufactured by Fabbrica Apparecchi Radio E Televisione of Rome

Table IX—Miniature, Low-Voltage Capacitor for Transistor Circuits

Capacitor Style	Military Specification	Military Designation	Temperature Range	Nominal Voltage Ratings (25 C)	Nominal Capacitance Ratings (25 C)	Insulation Resistance Limit (25 C)	Max Cap. Change over Temp Range	Dissipation Factor Limit (25 C)	Volumetric Efficiency	Vol Efficiency of Conventional Style	Remarks and Application
	——	——	°C	Volts	μf	megohms	%	%	μf/in³	μf/in³	——
Metallized Paper	SCL-6412 [a]	CH02	−55 +85	50	0.1–4	>1500	±5	1	4–9	1–4	By-pass, blocking, coupling
Stripped Lacquer (cellulose acetate)	——	——	−55 +85	50	0.1–5.6	>350	±10	2	5–17	1–4	Under production, development
Deposited Teflon	——	——	−55 +125	50	0.025–15	>20,000	±2	0.2–0.5	4–20	<1–4	Presently under development
Solid Tantalum	MIL-C-55057 (Sig C)	CS12	−55 +85	6–35	0.1–68	<500	±10	3–6	30–6,000	5–450	Polarized, by-pass, filtering, coupling
Tantalum (etched foil)	MIL-C-3965	CL24	−55 +85	15–150	1–380	<40	±50 −40	15–20	55–1,900	5–450	Polarized, filtering, by-pass
Tantalum Slug (wet)	MIL-C-3965	CL44	−55 +85	6–125	2–60	<40	+30 −50	4–25	75–1,300	5–450	Polarized, filtering, by-pass
"Cerafil" (Stable Hi-k)	SCL-6407 [a]	CK1–	−55 +85	100	0.001–0.047	>10,000	+10 −25	2.5	<4	<0.1	Aerovox trade mark; by-pass
"Cerafil" (Temp Comp)	——	——	−55 +85	100	10–7,500 μμf	>10,000	—[b]	Q>1,000 at 1 mc	<0.005 to 0.15	<0.001 to 0.007	Close temp coef tolerance miniature tubulars under development
"Monolythic" (Hi-k)	——	——	−55 +85	25	0.075–0.75	>10,000	+30 −80	4	3.25	——	Sprague trade mark; by-pass
Temp Comp Ceramic	——	——	−55 +100	150	4–470 μμf	>10,000	—[b]	Q>1,000 at 1 mc	<0.005 to 0.04	<0.001 to 0.007	Close tolerance compensation (plate)
Hi-k Ceramic	——	——	−55 +85	50–150	0.001–0.01	>10,000	+30 −80	3	<0.5	<0.2	plate or disk; by-pass
Glass Trimmer	SCL-6408 [a]	——	−55 +125	500	0.8–8.5 μμf	>10,000	—[b]	Q>1,000 at 1 mc	——	——	Body dimensions: 9/16 L × 5/16 in. diam
Glass Trimmer	SCL-6408 [a]	——	−55 +125	500	0.8–4.5 μμf	>10,000	—[b]	Q>1,000 at 1 mc	——	——	Body dimensions: 5/16 L × 5/16 in. diam
Air Trimmer	SCL-6403 [a]	SCT	−55 +85	50	1.5–10 1.8–15 μμf	>10,000	—[b]	Q>250 at 1 mc	——	——	Body dimensions: 0.39 × 0.435 × 5/8 in.

(a) Signal Corps Technical Requirements, (b) Trimmers have ±50 ppm/C; temp comp ceramic available in "O thru N1400" coeff

hours of use per day, end-point voltage, temperature and storage period prior to use. In Table X, service capacity for each cell used in the batteries listed is shown for three different current drains. The value given is for fresh batteries at 70 F. Operating schedule on which the table is based is two hours per day. End-point voltage is 1 volt per 1.5-volt cell for the first three cells listed and 0.8 volt per 1.5-volt cell for the rest.

There are many variations on the basic dry cell available from various manufacturers. Burgess, for example, markets a wafer cell consisting of a sandwich of artificial manganese dioxide mix between small disks of flat zinc and carbon electrodes.

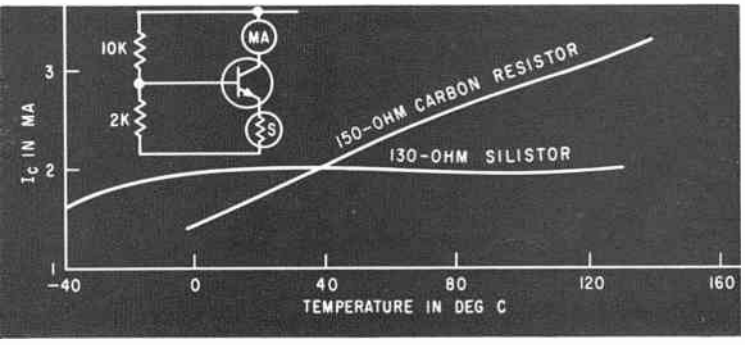


FIG. 2—Comparison of results obtained by using both a resistor and a Silistor in the emitter circuit of a silicon transistor

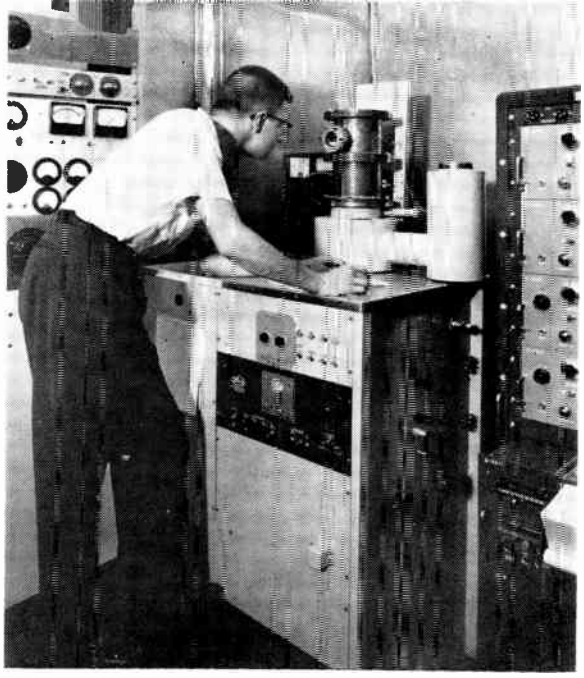
Several other battery types are also used. For example, in a short time a 17-inch portable transistorized tv set will be on the market powered by a silver-cadmium battery manufactured under the trade name Silcad by Yardney Electric. This firm also manufactures silver-zinc batteries. Mercury and nickel-cadmium batteries are produced by several firms.

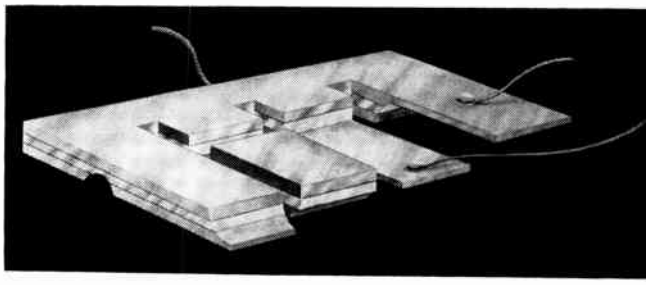
SOCKETS AND CASES—Whether or not a transistor socket should be used has often been a point of argument among design engineers. The non-socket advocates claim that, since the transistor is a low-impedance device, it is subject to trouble when used in a socket in which contact resistance is a problem. Those on the other side of the fence feel that there are more advantages in using sockets than disadvantages. It remains a matter of preference.

There are many varieties of sockets on the market, tailored for specific transistor types. Some accommodate in-line leads, others take pins on a circle and there are now available sockets that handle both lead configurations. Mounting methods are varied. Some sockets use retaining rings, others use compression mounting of plastic materials. Milton Ross Metals manufactures the Transipad, a device used between the transistor and printed-circuit board. It can be used also to convert from pins on a circle to in-line and is available in varied colors to facilitate color-coding of transistors.

Table X—Typical Carbon-Zinc Battery Specifications

Suggested Current Range in ma	Typical Use	Dimensions in in.			Number and Size of cells		Weight of Battery	Current Drain, Starting, in ma	Service Capacity in hours
		Length	Width	Height	Number	Size			
1.5 volts									
0–25	Transistor pocket radio			1–31/32	1	AA	0.6 oz.	3, 15, 30	350, 40, 15
0–80	Portable "A"			1–15/16	1	C	0.4 oz.	5,25, 50	430, 100, 40
0–150	Portable "A", transistor			2–13/32	1	D	3.3 oz	10, 50, 100	500, 105, 45
4.5 volts									
0–200	Transistor table model	2–13/16	1–3/4	8–11/32	6	250	3 lb	5, 25, 50	1,800, 750, 375
6 volts									
0–25	Pocket transistor radio	1–13/32	47/64	4–23/32	4	213	4 oz	3, 15, 30	350, 110, 50
9 volts									
0–8	Transistor portable	1–1/32	11/16	1–29/32	12	113	1–1/3 oz	0.7, 3.5, 7	210, 40, 15
0–9	Transistor portable			1–15/16	6	127	2 oz	1, 5, 10	475, 150, 72
0–15	Transistor portable	1–13/32	1–11/32	2–3/4	12	144	4–1/2 oz	2, 10, 20	500, 85, 30
0–20	Transistor portable	1–13/16	1–13/16	2–7/16	6	165	7 oz	3, 15, 30	770, 200, 90
0–30	Transistor portable	2–9/16	2–1/32	3–5/32	6	175	15 oz	5, 25, 50	1,000, 260, 110
0–30	Transistor portable	2–9/32	1–1/4	7–31/32	6	240	1 lb	5, 25, 50	1,000, 430, 180
0–100	Transistor table model	2–13/16	1–3/4	8–11/32	6	250	3 lb	5, 25, 50	1,800, 750, 375
13.5 volts									
0–10	Transistor portable	1–21/64	1–1/32	2–11/16	9	135	3 oz	1.3, 6.5, 13	450, 108, 52





Air Force's solid multivibrator. Triggering rate is 50 cps to 3,000 kc. Weight is 0.015 oz; size is 0.12 by 0.12 by 0.005 in.

Operator leaning on vacuum portion of a deposition system used in fabricating Microcircuits

Solid Circuits

Demands for miniaturization and reliability are higher than they have ever been before. Most assuredly, these demands will become greater and greater. Solid circuits hold great promise as one of the ways of handling the problem

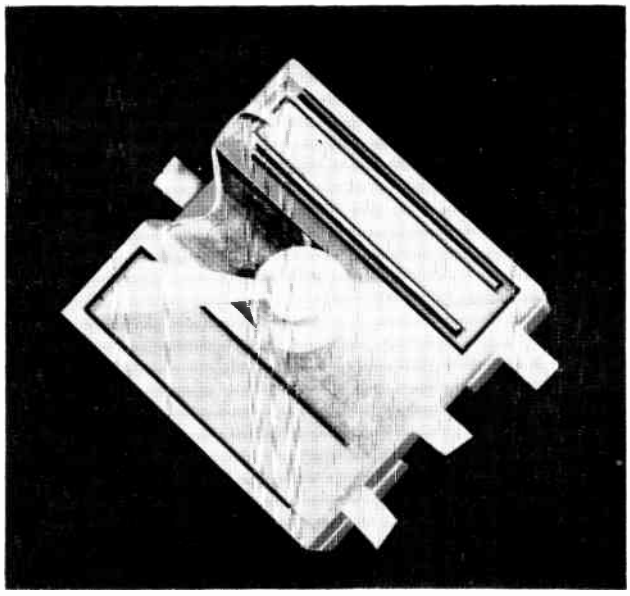
EARLIER IN THIS REPORT, some of the current and possible future laboratory work on semiconductor devices was discussed. However, aside from what may be forthcoming in individual components, one of the most interesting and significant areas of concentrated research at present is on functional circuits. Here, we have a breaking away from the concept of individual components and a taking of definite aim towards producing entire circuits as units.

Transition from lumped circuit elements to solid-state functional circuits is summarized in Table XI based on information in a recently published article.[11] The authors of this paper point out that it is essential to distinguish between general circuits as used in receivers, amplifiers and filters and digital circuitry most often associated with computers. They emphasize that most digital functions can be obtained by using just resistors, capacitors, diodes and transistors with no need for precise frequency-determining elements such as capacitor-inductor combinations. For this reason, computer circuits will obtain most of the initial benefits of solid-state functional circuits.

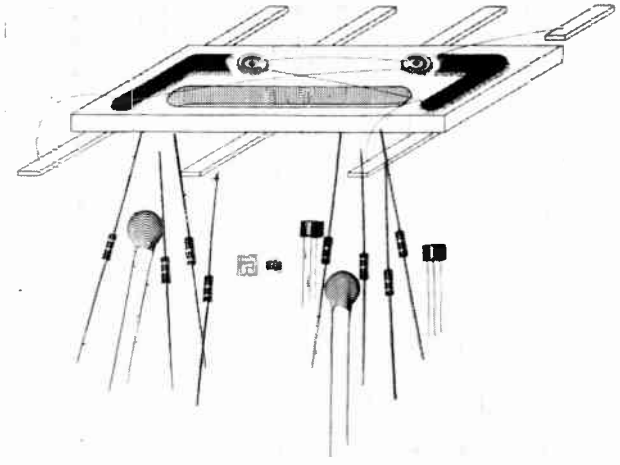
WHAT ABOUT INDUCTANCE? — Inductance at present seems to be the main problem standing in the way of widespread application of functional circuit techniques to other than computer-type circuits. With current know-how, maximum inductance of about 10 mhy can be obtained. Larger values seem to

Table XI—Approaches to Solid-State Circuits

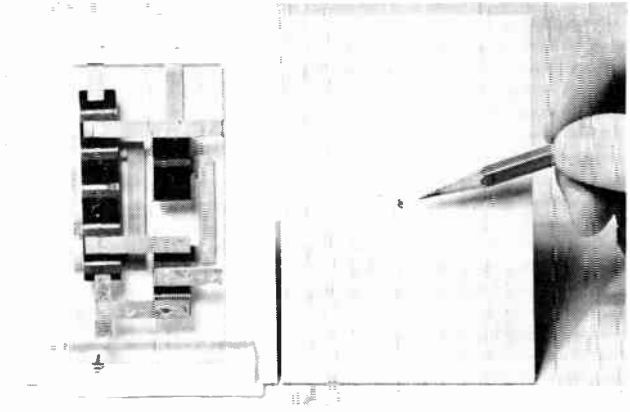
System	Approximate Practical Parts Densities Attainable (parts/cu ft)	Comments
Deposited parts on inorganic substrates	10^6	Essentially limited to R and small C's. Small inductances are possible for vhf. Active parts and others that cannot be deposited can be attached. Research needed for complete system of parts
Deposited parts on single crystal substrates	up to 5×10^6	Limited experimental models make use of deposited techniques for some passive parts using doping, etching, alloying, etc. to form active parts, R's and C's
Solid-state circuits	$>>10 \times 10^6$	Limited experimental models of complex digital circuits have been made. Full range of parts cannot be obtained as yet. Vapor deposition of single crystals could give strong impetus to this approach



Early multivibrator shown was developed by Royal Radar Establishment by shaping and doping a piece of silicon. Size is 6 mm square by 2 mm thick. (British Crown Copyright Reserved)



Texas Instruments' silicon solid multivibrator is detailed above and shown in actual completed form at bottom foreground in among the conventional components it replaces. Unit measures less than 1/4 by 1/8 by 1/32 in.



RCA's integrated circuit concept is illustrated by mock-up of a half-adder at left and in its natural size at the end of the pencil point

be dependent upon new materials capable of maintaining high permeabilities at elevated temperatures. One way of getting around the problem is to have inductive elements external to the rest of the circuit but this approach is a temporary compromise at best.

Another drawback at present seems to be the techniques necessary for producing the active elements in the functional circuits. Most work with the active elements in the functional circuit units to date has taken the approach of sculpturing techniques on a semiconductor block through application of such techniques as diffusion.[15] What is needed is a practical method for depositing the active elements.

Passive elements may be obtained relatively easily, for example, by use of resistive films, conductive films and dielectric films.[16]

WHERE IS THIS CONCEPT TAKING US?—If some of the technical problems are solved and the functional circuit technique becomes more generally attractive, there could well be a decided change in the industry. Equipment manufacturers could conceivably manufacture their own functional circuits and not require individual components. Conversely, component manufacturers (non-semiconductor as well as semiconductor) could get into functional circuit manufacture themselves.

Aside from the obvious advantage of extreme miniaturization, these techniques tend to be inherently more reliable than conventional component assembly approaches. But whether or not the yield of satisfactory circuits on a true production basis can be high enough to be economically feasible remains to be seen.

The author thanks the many individuals who helped make this report possible.

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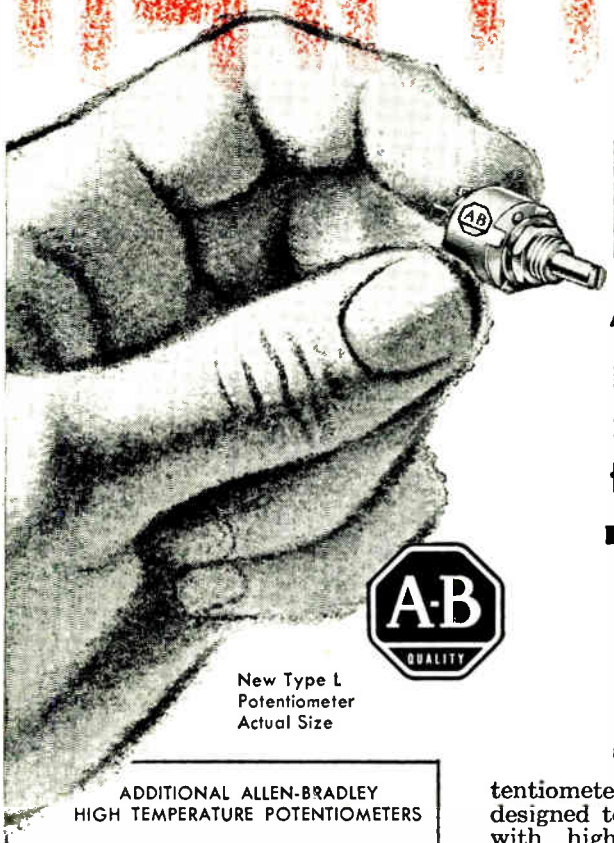
HEAT PROBLEMS?



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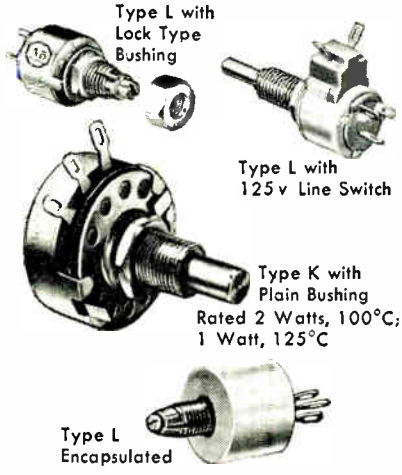

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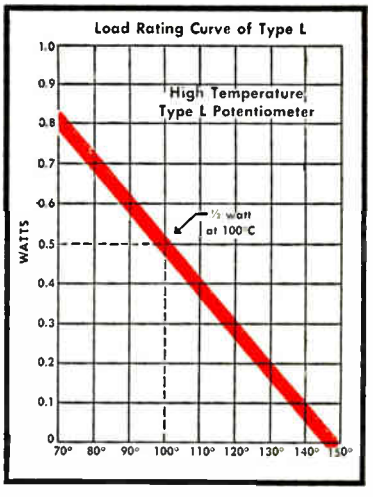

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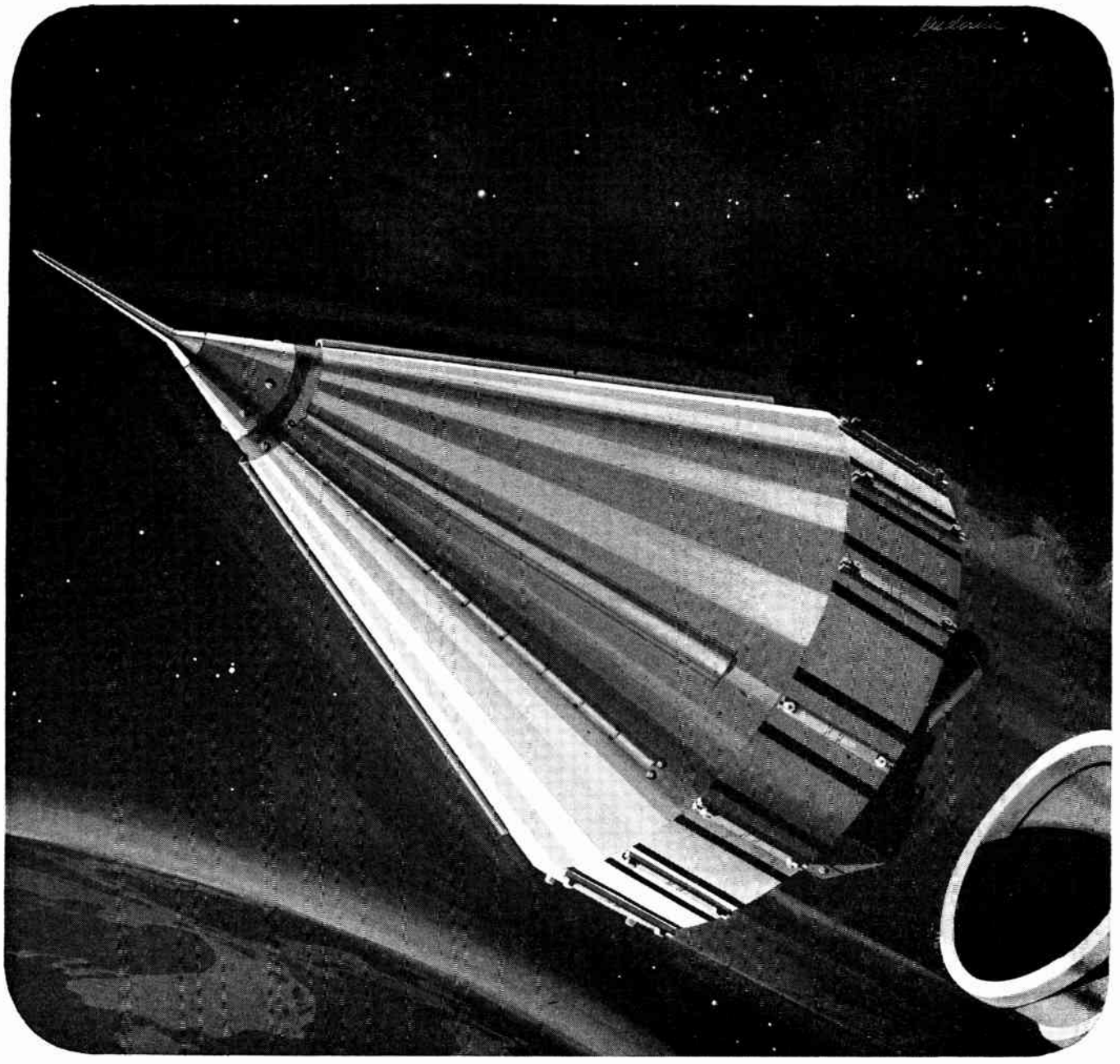

PIONEERING IN SPACE RESEARCH

Another important advance in man's knowledge of outer space was provided by Pioneer III. This, like many others of a continuing series of space probes, was designed and launched by Jet Propulsion Laboratory for the National Aeronautics and Space Administration. JPL is administered by the California Institute of Technology for NASA.

During its flight of 38 hours, Pioneer III was tracked by JPL tracking stations for 25 hours, the maximum time it was above the horizon for these stations.

The primary scientific experiment was the measurement of the radiation environment at distances far from the Earth and telemetering data of fundamental scientific value was recorded for 22 hours. Analysis of this data revealed, at 10,000 miles from the Earth, the existence of a belt of high radiation intensity greater than that observed by the Explorer satellites.

This discovery is of vital importance as it poses new problems affecting the dispatch of future vehicles into space. The study and solution of such problems compose a large part of the research and development programs now in extensive operation at the Laboratory.

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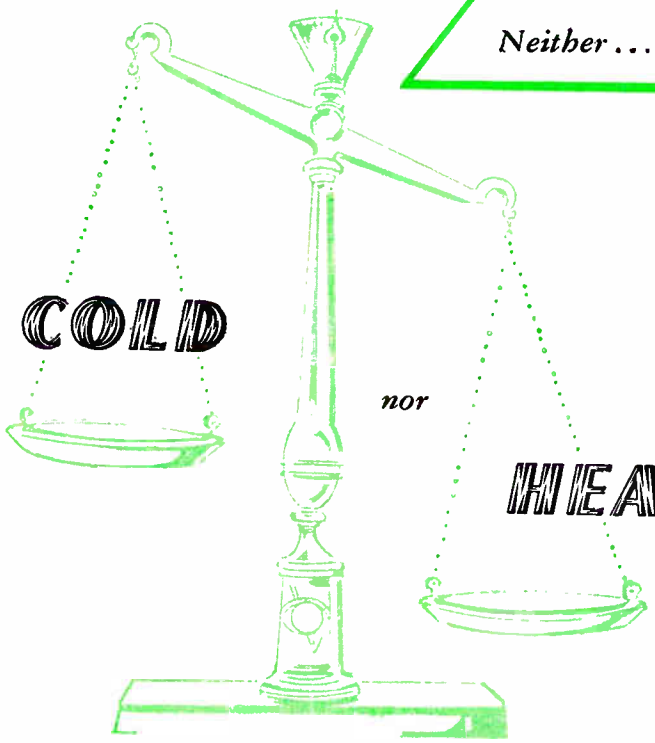
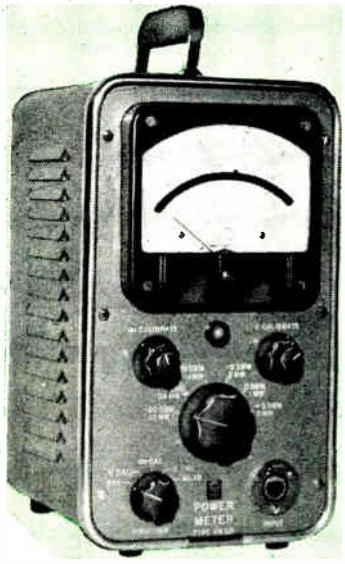


COLD

nor

HEAT

*nor microwatt range stays these instruments from drift-free measurements of RF power.**



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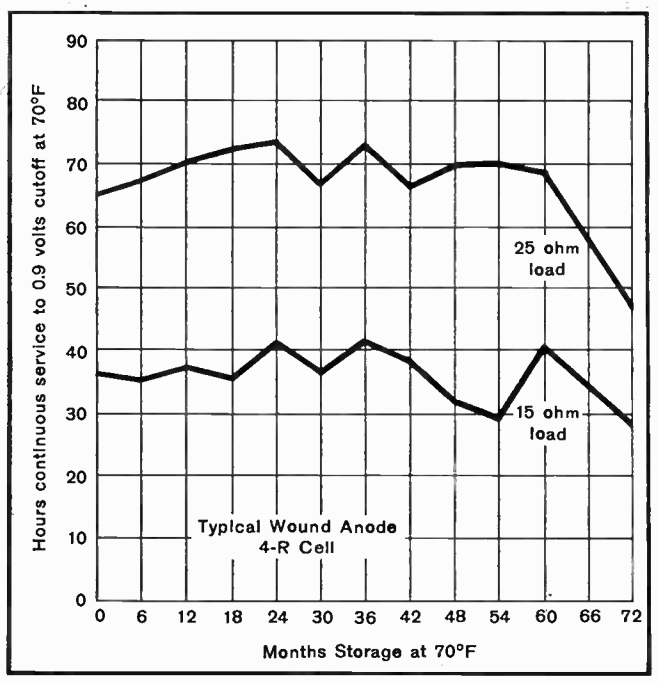
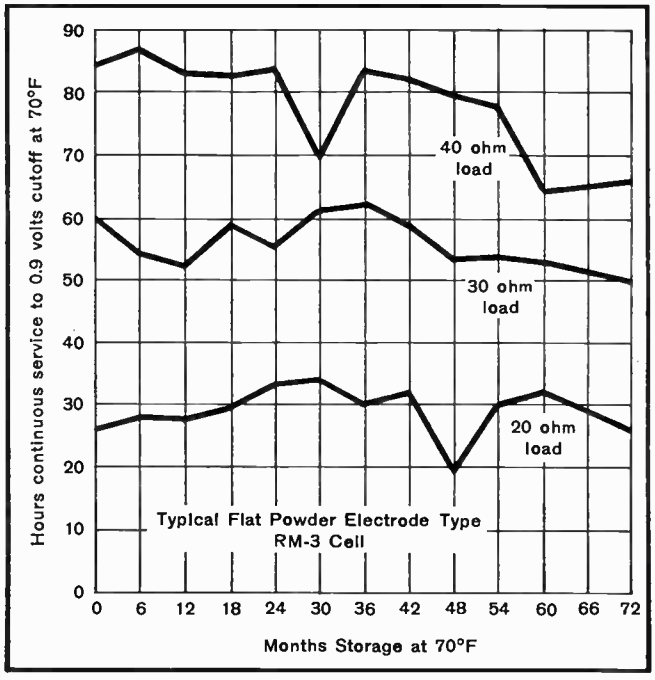
* *With a bow to Herodotus, the 5th century B.C. Greek historian who wrote the much-quoted words appearing on the facade of the New York Post Office and paraphrased here.*

Still "FRESH" After 6 Years Storage – Mallory Mercury Batteries





An extensive series of storage tests, now well past the six-year mark, proves that Mallory Mercury Batteries can take extremely long storage far past the point where ordinary batteries become useless.

Some typical test curves are shown here. Note that even at the end of six years, Mallory Mercury Batteries remain close to their "newly-made" capacity.

This extraordinary stability is one of the unique characteristics of the mercury battery system, pioneered and constantly refined by Mallory. During periods of storage, the system does not deteriorate. And during discharge, output voltage stays practically constant out to the limit of battery life. This is an ideal discharge for providing fade-free performance in transistor circuits.

The long service and storage life you get from Mallory Mercury Batteries mean unmatched convenience and dependability to users of your battery powered products. Their high energy content in compact size makes possible new feats of miniaturization. And their precise, stable output offers opportunities for use in instrument circuits, calibration and voltage reference applications.

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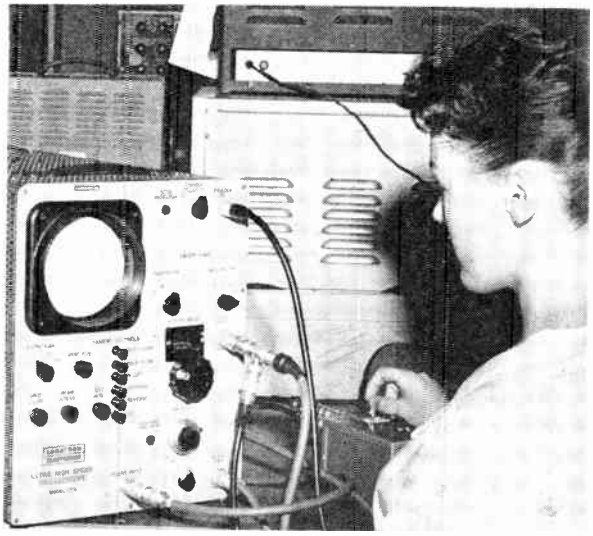
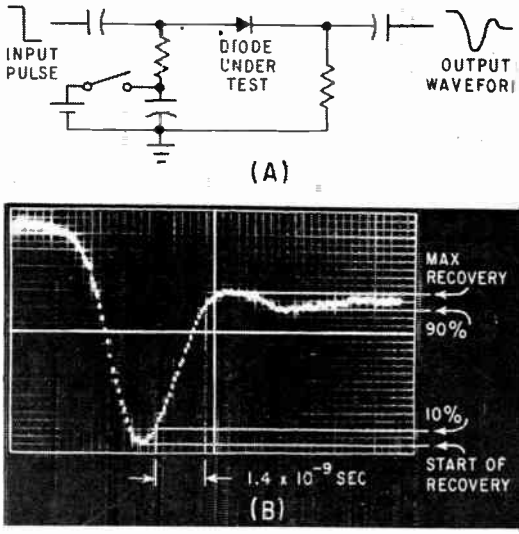




Girl tests fast-switching diode on Microwave Associates' production line using high-speed sampling oscilloscope. Shown at right are test circuit used (A) and oscillogram of the diode recovery characteristic at sweep speed of one millimicrosecond per centimeter (B)

Sample Method Displays Millimicrosecond Pulses

Here's a way to display waveforms detailed enough to permit accurate measurement of ultra-fast semiconductor switching characteristics. Rise times faster than 0.4 millimicrosecond are presented with a sensitivity of better than 3 millivolts per centimeter

By **WILLIAM E. BUSHOR**, Associate Editor

NEW OSCILLOGRAPHIC sampling technique permits measurement and visual analysis of low-level, repetitive pulses having rise times faster than 0.4 millimicrosecond at millivolt levels. The pulses can occur at either fixed or random intervals.

Detailed studies of pulse shape are required in evaluation of semiconductors, multiplier phototubes, transmission and delay lines and various computer, radar and uhf circuits. Experimental sampling oscilloscopes built to test prototypes of fast multiplier phototubes used for nuclear particle detection have displayed rise times as short as 0.56 millimicrosecond.[1] Several sampling oscilloscopes have been developed in England that display rise times down to 2 or 3 millimicroseconds, but sensitivities are in the volt range. The circuits described here are embodied in an instrument manufactured by Lumatron Electronics.

OVERALL OPERATION—A block diagram of the sampling oscilloscope is shown in Fig. 1. When a trigger pulse is applied, the ramp generator starts. The linear sawtooth output is used to fire the strobe generator at some predetermined time. The strobe generator is so named because its operation is analogous to that of stroboscopes used to visualize fast

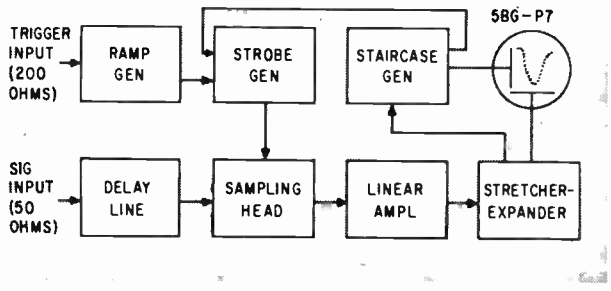


FIG. 1—Trigger pulse input to sampling oscilloscope is derived from input signal or an associated generator

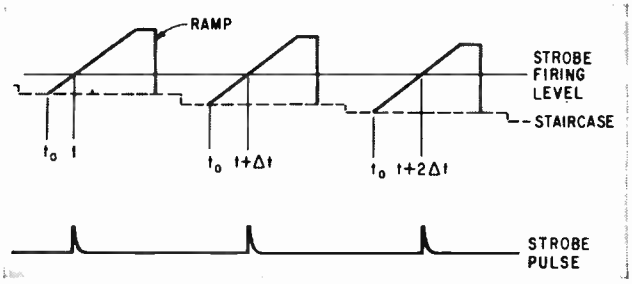


FIG. 2—Technique of generating strobe pulse by superposition of ramp and staircase

moving mechanical devices.

Upon firing, the strobe generator sends a pulse to the sampling head. This pulse is used to obtain instantaneous pulse-height samples of the input signal.

To enable the leading edge of the signal to be observed, an 85-millimicrosecond delay line is used to retard the signal until the sampling pulse has been produced. Resulting height samples are prestretched 50-millimicroseconds, amplified by a linear amplifier, stretched again at their amplified height to approximately 1 millisecond and displayed on the crt screen as a dot. The staircase generator provides automatic step advance of the predetermined strobing time relative to the start of the signal pulse and advances the horizontal sweep in synchronism with the time advance.

SAMPLING TECHNIQUE—Since the ramp rides on a d-c level which is a step of the staircase, each time the level falls one step the sawtooth takes a discrete interval of time longer to reach the firing point of the strobe generator as shown in Fig. 2. Thus, the sample pulse is advanced in equal time intervals relative to the input signal.

The pulse into the staircase generator lowers the staircase level one step after each displayed sample and also advances the X position of the crt beam one increment of horizontal distance. At the end of a full horizontal crt time scan, the staircase generator is automatically reset to start a new scan. The number of dots, or samples. per sweep is adjusted by changing the total number of steps per staircase.

RAMP GENERATOR—The ramp generator, shown in Fig. 3, produces a positive-going ramp with a 100-v amplitude when an input trigger pulse is applied. Time duration of the ramp can be set at either 10^{-7} sec for fast sweep or 10^{-6} sec for slow sweep.

A polarity-reversing switch and transformer assure proper selection of negative-going polarity at the grid of V_1. Output of V_1 is a positive-going pulse that turns on V_2 triggering the sweep switch circuit for the desired sweep duration.

The sweep switch circuit consists of switch tube V_3 and charging tube V_4 arranged as a conventional bootstrap. Sweep velocity is determined by the rate at which the quiescent current charges fast-sweep capacitor C_1 or slow-sweep capacitor C_2.

STROBE GENERATOR—The strobe generator, Fig. 4, produces the sampling, or strobe, pulse. Sweep comparator V_1 mixes the output of the ramp generator with the staircase from the staircase generator. Instantaneous d-c level of the ramp, corresponding to a step, fixes time at which strobe signal is generated.

Isolation blocking oscillator V_2 is driven by the negative pulse from the plate of V_1. The dynode is coupled back to the grid of V_2 through a capacitor to form a blocking oscillator circuit that produces a $\frac{3}{4}$-a pulse with a rise time on the order of 5 millimicroseconds. Fall time of the leading edge of this negative going step is increased slightly by passing it through blocking oscillator V_3. Output of the strobe generator is a 1.3-a, 130-v pulse with a rise time of 5 millimicroseconds. The secondary emission tubes used in the strobe generator are operated at low duty cycles to give satisfactory life.

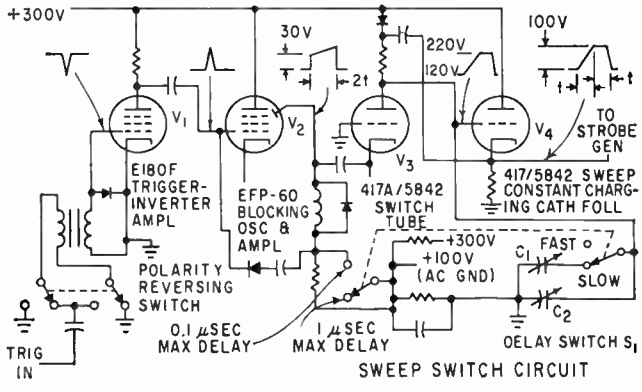


FIG. 3—Velocity of ramp produced by ramp generator must be of utmost precision, stability and reproducibility since time stability of better than 10^{-10} sec for long time intervals is required

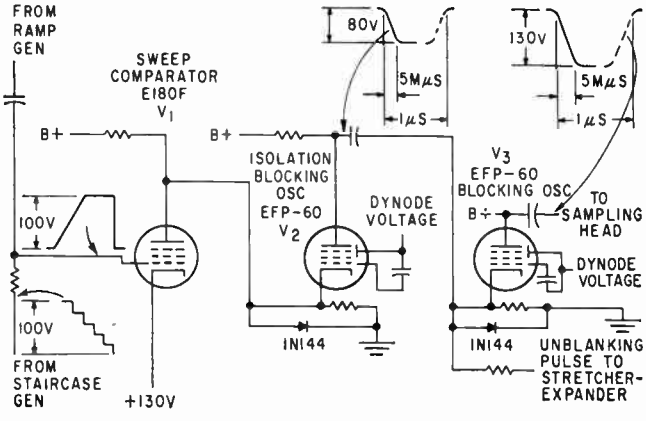


FIG. 4—Total amplitude of staircase input to strobe generator is varied by sweep rate switches in staircase generator

SAMPLING HEAD—The sampling head, shown in Fig. 5, uses the sampling pulse from the strobe generator to obtain pulse height samples of the input signal. To offset the slow initial start of the strobe generator, the sampling pulse is clipped by grounded-grid triode V_1. Plate saturation occurring soon after conduction reduces the gain of V_1. Thus, in effect, a small-amplitude section of the pulse, which is a negative-going step function with a rise time of 1 millimicrosecond, is passed.

The negative-going step function is differentiated by capacitor C_1 to produce a pulse of about 1 millimicrosecond full width at half of maximum amplitude. This pulse is further sharpened by passing the top of it through back-bias discriminator diode D_1 whose output is a pulse about 0.5 millimicroseconds full width at half of maximum amplitude.

After passing through an isolation attenuator, the sampling pulse is mixed with the input signal and the total signal is stretched by capacitor C_2. The stretch time of 0.5 microsecond is a product of the capacitance of C_2 and the back-bias of the sampling diode. A conventional linear amplifier is used to amplify the approximate 10-mv output of the sampling head.

STRETCHER-EXPANDER — The stretcher-expander, shown in Fig. 6, produces the dot pulse that unblanks the crt screen and advances the staircase. The 0.5-microsecond pulse from the linear amplifier is stretched to a rectangular pulse 2-milliseconds wide of approximately the same height, amplified by a variable factor of from 5 to 10 and inverted for push-pull deflection of the crt. This pulse also advances the staircase one step after each sample display.

STAIRCASE GENERATOR—The staircase generator, shown in Fig. 7, provides horizontal deflection voltage to the crt and time advance information to the comparator tube in the strobe generator. Increase of a d-c bias superimposed on the staircase advances the start of the sampling relative to the start of the ramp, decreasing the apparent time delay in the start of the trace on the crt.

The staircase is not of continuous velocity, but is advanced one discrete fixed amplitude step for every displayed sample. Steps of the staircase are produced by pulses from the stretcher-expander. Diode V_4 adds these pulses successively through integrator amplifier V_3 until the end of the staircase when reset tube V_2 returns the integrator to zero. Switches S_2 and S_3 are attenuators for the staircase produced by the integrator. The d-c level of the staircase is set by the horizontal position control.

The attenuated staircase on the d-c level is fed to the comparator tube in the strobe generator. If the end of the staircase lowers the superimposed ramp below the firing point of the comparator tube, the blanking tube blanks the ctr screen since the display becomes meaningless.

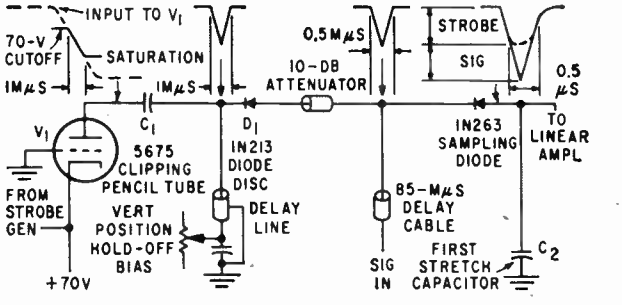


FIG. 5—Output of sampling head is a strobe pedestal modulated by the input signal

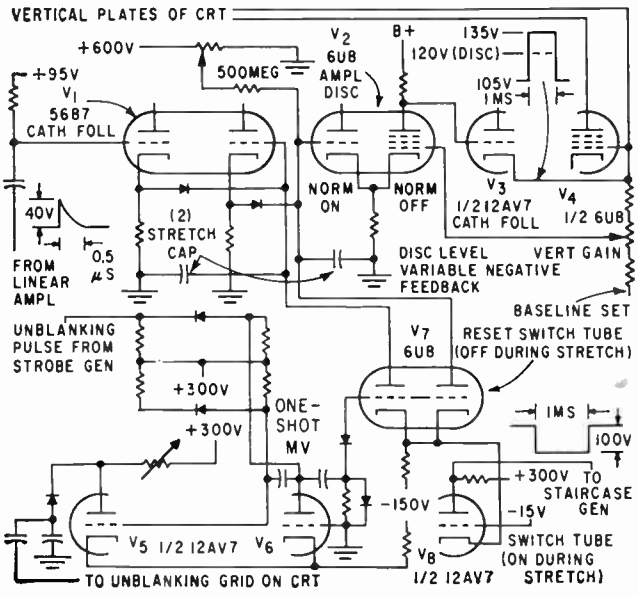


FIG. 6—Each pulse from switch tube in stretcher-expander advances staircase one step

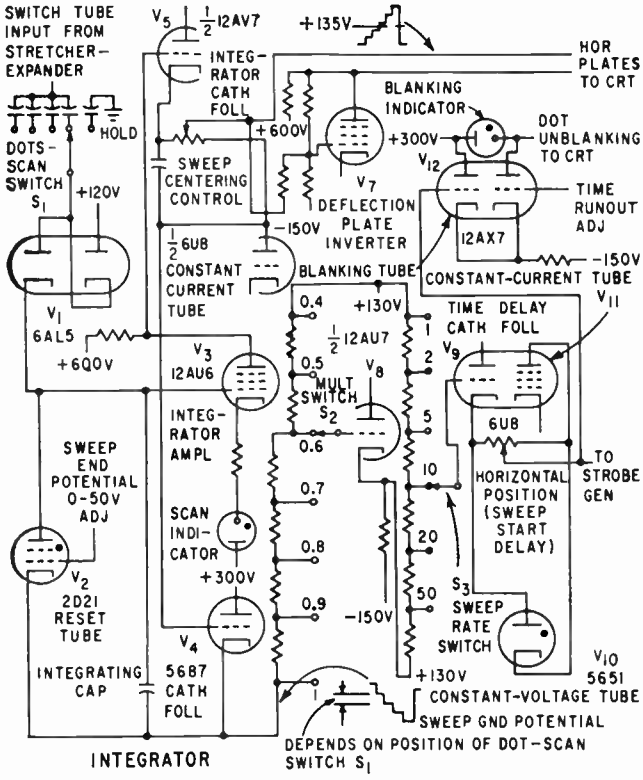


FIG. 7—Blanking indicator in staircase generator is on when screen is blanked; scan indicator flashes when staircase is sweeping

REFERENCE

(1) R. Sugarman, Sampling Oscilloscope for Statistically Varying Pulses, *Rev of Sc Inst*, 28, No. 11, Nov. 1957.

Here's a way to explode wire by switching 30 kv in less than 10 milliμsec. Jitter problem is solved by using one spark gap to trigger another

By H. BRUCE McFARLANE,
Lawrence Radiation Laboratory, University of California, Livermore, California

Spark Gaps for Fast

RESEARCH WORK sometimes requires explosion of a wire for such purposes as generating plasma in a shock tube or generating hypersonic waves in a wind tunnel. The spark-gap switch to be discussed explodes a wire by discharging a bank of capacitors charged to 30 kv.

A basic requirement of this switch is that it must close in less than 10 milliμsec. The greatest problem in using spark gaps for the switch was in reducing the jitter time, which is the maximum statistical variation in firing time. When spark gaps that have a large jitter time are used in parallel, the first to fire may prevent some or all of the rest from firing. This is because the first gap to fire applies 30 kv to the load, and as this load is also connected to all the load terminals of the unfired gaps, the net voltage across them drops to zero and they remain unfired.

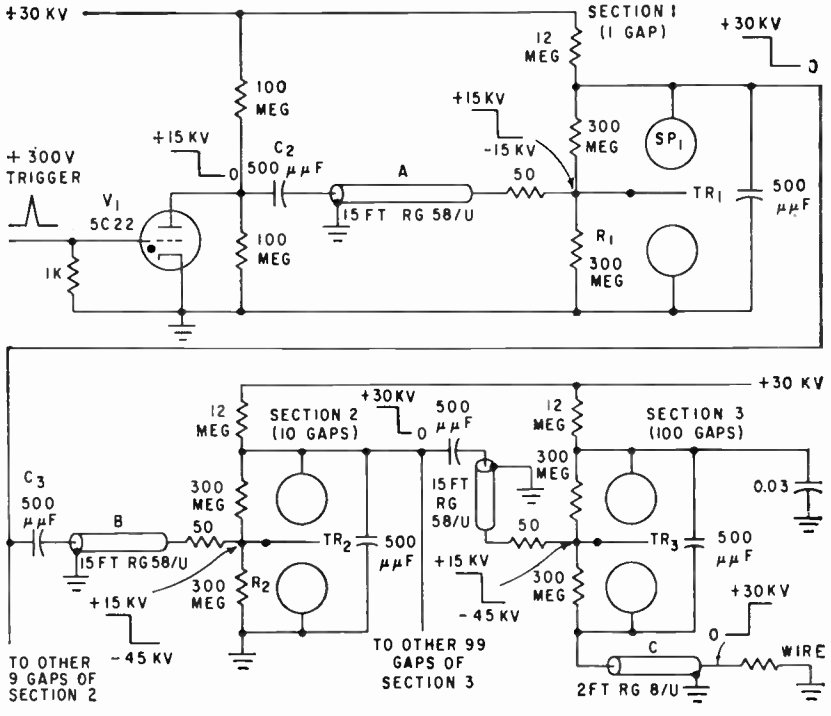


FIG. 1—Spark-gap switch. Only one of the 10 gaps of Section 2 and only one of the 100 gaps of Section 3 are shown

Gap Switching

The spark-gap switching circuit (Fig. 1) uses 111 spark gaps. Thyratron V_1 fires *Section* 1, which contains a single spark gap. This gap triggers ten spark gaps in *Section* 2. Each gap in *Section* 2 triggers ten gaps in the final stage, *Section* 3. The 100 spark gaps of *Section* 3 switch 100 0.03-μf capacitors (one of these capacitors is shown), which are charged to 30 kv, through the wire load.

Coaxial-cable sections A, B and C couple each spark gap to the preceding stage that furnishes the trigger pulse for the gap. The center conductor of each coaxial cable is initially at +15 kv.

When a trigger pulse to thyratron V_1 switches capacitor C_2 to ground, capacitor C_2 discharges through resistor R_1. Simultaneously, cable section A forms a pulse of 15 kv. Discharge of capacitor C_2 and the pulse from cable section A produce a 30-kv pulse across resistor R_1. This pulse drops the potential of the spark-gap trigger electrode, TR_1, to −15 kv. As the gap between the upper sphere SP_1 and trigger electrode TR_1 has a potential of 45 kv it breaks down.

As soon as the upper half of the gap breaks down, trigger electrode TR_1 goes to +30 kv. As the second half of the gap now has double its normal voltage, it breaks down. Breakdown time for 50 kv/cm, which is obtained with 30 kv across

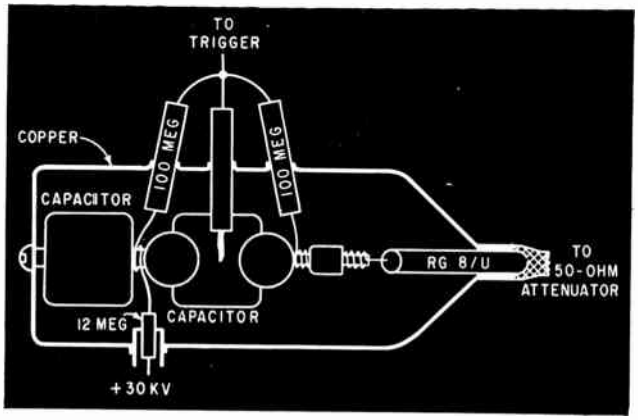


FIG. 2—This experimental spark gap is similar to those used in Sections 1 and 2 of Fig. 1

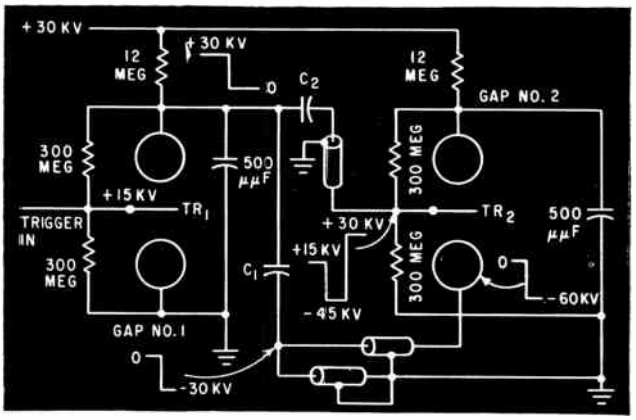


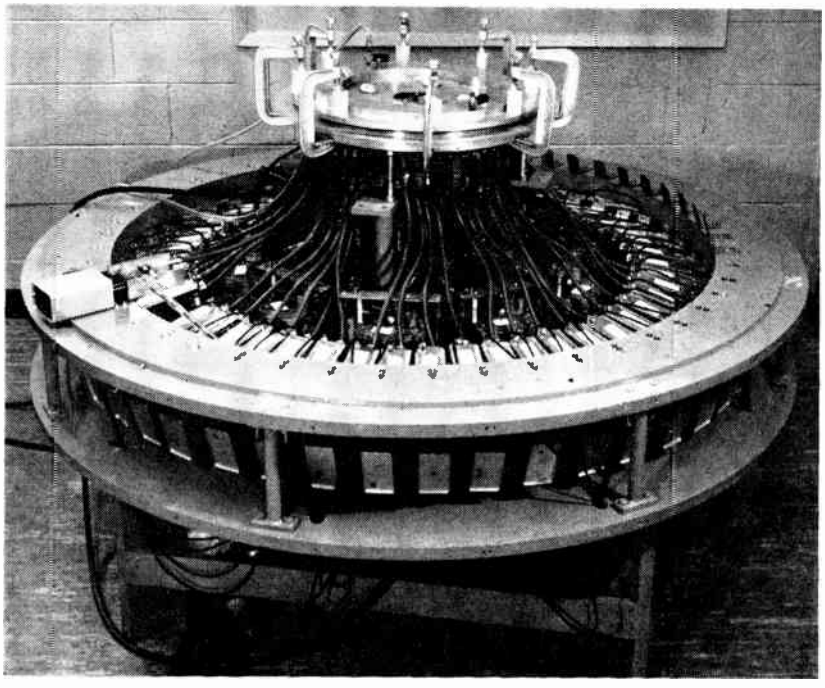
FIG. 3—Improved spark-gap switch which breaks down in less than 1 millimicrosec

High-Voltage Switching

the electrodes, is about 8 millimicrosec.

The ten capacitors that couple the first section to the second section (one such capacitor is represented in Fig. 1 by C_3) now discharge from +30kv to ground potential. The pulse formed by cable B and the discharge of capacitor C_3 impress 60 kv across resistor R_2. Spark-gap trigger electrode TR_2 drops to −45 kv and the first half of the spark gap of *Section* 2 breaks down. With 75 kv across the half gap, which has a spacing of 0.57 cm, a voltage gradient of 130 kv/cm appears and breaks down the gap in about 0.45 millimicrosec. Breakdown in the other nine first-half gaps of *Section* 2 occurs almost simultaneously and in the same way.

Breakdown processes in the second half of the spark gaps of *Section* 2 and in the spark gaps of *Section* 3 are similar to the processes that have been described. The bank of 100 0.03-μf capacitors in *Section* 3 completes its discharge through the wire in 100 millimicrosec.



Photograph of a portion of spark-gap switch shown in Fig. 1. Fifty gaps of Section 3 compose an outer ring of components which encloses the 11 gaps of the first and second sections

As each section takes about 10 millimicrosec to break down, the total time between the breakdown of thyratron V_1 and the start of the discharge through the load wire is about 30 millimicrosec. Jitter time of each section is less than one millimicrosec.

Spark Gaps

The spark gap in *Section* 1 and the ten gaps in *Section* 2 are similar to the spark gap shown in Fig. 2, except that no effort is made to make them coaxial in construction.

Spark gaps are mounted so that ultraviolet radiation from spark gaps that fire earlier in the operating sequence irradiates succeeding gaps. The intense radiation from the earlier gaps reduces the statistical firing delay, or jitter, of the succeeding gaps.

It may be possible to break down the second half of the spark gap even faster than described above by using the circuit shown in Fig. 3. Here the low-potential end of the gap is connected to trigger source by a short length of cable and a blocking capacitor, which in turn is connected to ground by a similar piece of cable.

The author thanks A. Tilles, A. J. Stripeika, H. M. Graham, D. O. Kippenhan and M. Allen for their assistance in developing this equipment. Work was performed under the auspices of the United States Atomic Energy Commission.

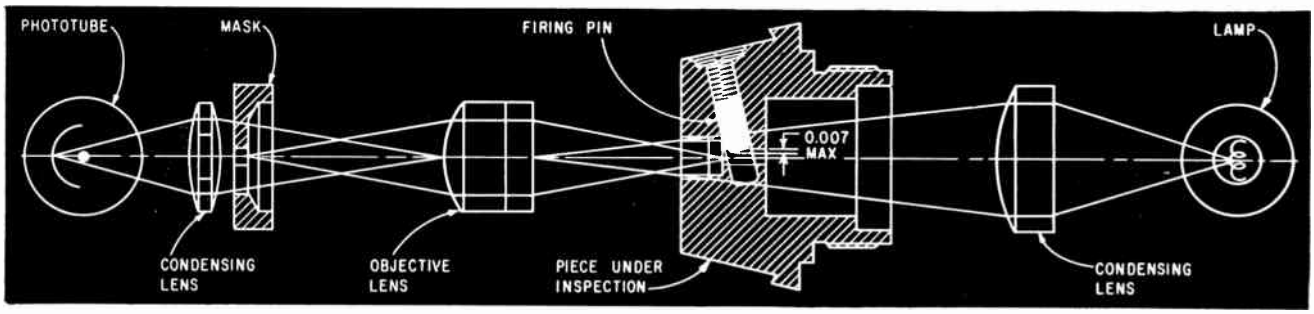


FIG. 1—Optical system shows how light passing mask is concentrated on phototube

Fail-Safe Photoelectric

PHOTOELECTRIC GAGING of machined parts makes it possible to check dimensions without touching critical points. This is important when the surfaces are delicate, when the points to be checked cannot be reached with feelers and when movements of the part under test make it impossible to use feelers.

Photoelectric testing requires a free path for the rays from the light source to the points to be checked, and from there to the photoelectric sensors. Less obvious limitations are: variations in light emission of the lamps, drift in sensitivity of the phototubes, secondary light reflections and vibrations of the part being tested during inspection.

In the fail-safe inspection system there is the further difficulty that resistors and capacitors may fail by short or open circuit and vacuum tubes may lose emission or get gassy. To be fail-safe, the circuit must reject whether the failure increases or decreases the current flow.

Optics

The optical system of a fail-safe photoelectric inspection device is shown in Fig. 1. This device is a sorter used to ascertain complete retraction of the firing pin in a fuse body rotated at specified speed. All pieces in which the pin extends more than 0.007 in. beyond the periphery of the hole are rejected.

When the mask is replaced by a piece of ground glass, the magnified image of the hole appears on the glass. This image is shown in Fig. 2A. The photoelectric inspection system uses the mask in Fig. 2B. Light passing through the three slots decreases each time the image of the pin sweeps across one of the slots as indicated in Fig. 2C. Absence of modulation of the light reaching the phototube indicates retraction of the pin and acceptance of the piece. Three radial slots are used so that an eccentric hole cannot cause modulation.

The amount of alternating photoelectric current caused by a protruding pin is proportional to the light emitted by the lamp and the sensitivity of the phototube. Both these properties vary with time. Fortunately the d-c photosignal, corresponding to the average flux of light reaching the phototube, is also proportional to the light emitted by the lamp and the sensitivity of the phototube.

Therefore, instead of a signal proportional to the a-c photosignal, a signal indicative of the ratio between the a-c and d-c photosignal is produced and amplified. Since the light emission of the lamp and the sensitivity of the phototube appear equally in the numerator and denominator of this ratio, it's value is completely independent of these parameters.

Grid-Current Circuit

The a-c to d-c ratio is obtained by using a grid-current circuit.[1, 2, 3] When current flows in the cathode-to-grid path of a vacuum tube, the a-c impedance across this path is inversely proportional to the magnitude of the grid current. Therefore, if modulated d-c is sent through the grid-to-cathode path, the a-c voltage appearing across the path impedance is proportional to the a-c and inversely proportional to the d-c. In short, it will be proportional to the ratio between the a-c and the d-c (the relative modulation).

The sorter is designed to indicate rejection for all values of relative modulation above an adjustable limiting value. To obtain rejection when the hole is completely obstructed and no modulation is present, a small amount of a-c is introduced into the grid of the grid-current tube. As long as any d-c photo-signal is present, the relative modulation caused by this artificially introduced a-c stays well below the relative modulation of rejection. If the hole is completely covered and no photoelectric current passes the grid, the relative modulation caused by this small a-c jumps far beyond the acceptance limit.

Fail-Safe Principle

Fail-safe operation is assured by testing the sorter each time a piece is inspected. After a piece is inspected, the sorter is exposed to a

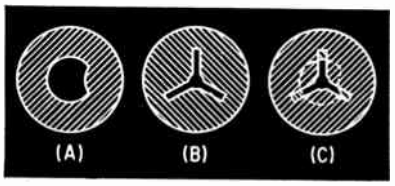


FIG. 2—Image of hole and pin (A) is projected on mask (B) to obtain a-c when the piece rotates (C)

These electro-optical systems permit checking dimensions of machined parts while workpieces are rotating. Measurements are independent of variations in light source and phototube parameters. Fail-safe circuit assures that only satisfactory pieces are accepted

By JOSEPH C. FROMMER, Consultant, Electric Eye Equipment Co., Danville, Illinois

Inspection for Industry

condition which simulates rejection limits. In this artificial no-go position, if the unit indicates that it might accept an unsatisfactory piece, then the sample under inspection is rejected, whether or not the piece actually meets specifications.

If the sorter correctly indicates rejection in the no-go condition, it completes the inspection cycle in normal fashion.[4]

Circuit Description

The circuit diagram of the sorter is given in Fig. 3. Tube V_{1A} is connected as a grid-current tube by connecting phototube V_6 between its grid and cathode without a grid resistor. The contact potential of the grid-to-cathode path provides polarizing potential for the low photocurrents handled. The a-c signal is amplified by V_{1B} and fed to V_2. Tube V_2 obtains degeneration from R_1 and R_2. The plate load of V_2, consisting of L_1 and C_1, is peaked at the modulation frequency. Output of V_2 is then rectified by V_3.

The d-c output of V_3 is connected in series with an adjustable reference voltage derived from R_3. The difference between the rectified output and the reference voltage is applied to the grid of V_4. When the output of V_3 exceeds the limit set by the reference voltage, V_4 cuts off and *output* relay K_1 releases, indicating a non-acceptable piece. If the output of V_3 is below the reference voltage, K_1 operates to indicate acceptance. The small a-c required to provide for the no-modulation case is obtained by grounding one side of the filament supply.

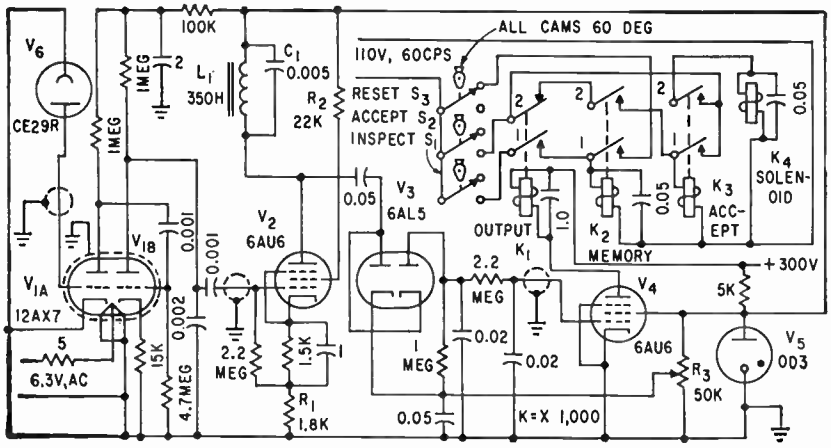


FIG. 3—Sorter unit is adjusted to desired sensitivity by use of go and no-go gages

The fail-safe circuit includes K_1, *memory* relay K_2 and *accept* relay K_3. Contacts of these relays are fed by the line voltage through three cam-operated microswitches. *Inspect* switch S_1 is closed for a 60-deg period that starts after a piece has reached the inspection station and during which the piece is rotated at the specified speed. *Accept* switch S_2 is closed for a subsequent 60-deg period. *Reset* switch S_3 is closed at all times except for a 60-deg period just preceding the closing of S_1.

Before a new piece is inspected, S_3 opens and unlatches K_2 if it is latched. Then, while the piece is spun at the prescribed speed, S_1 is closed. If the piece is acceptable, K_1 operates and K_2 is energized through contact 1 of K_1. Once K_2 is energized, contact 1 of K_2 keeps it latched as long as S_3 is closed. Next, during closure of S_2 the optical system simulates presence of a piece that should be rejected. If the circuit is functioning properly, K_1 releases and K_3 is energized through No. 2 contacts of K_1 and K_2. Relay K_3 latches itself and energizes *accept* solenoid K_4.

When the amplifier senses an unacceptable piece, K_1 does not operate and prevents K_2 from being energized. If the amplifier is faulty and lets K_1 close when an unsatisfactory piece is tested, then No. 2 contact of K_1 stays open when S_2 is closed. Thus, K_3 cannot be energized in either case.

Performance tests show that drift in phototube sensitivity and variations of 10:1 in light emission are made completely ineffective by the grid-current circuit.

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(2) J. C. Frommer, Photoelectric Registration Control Systems *Trans IRE*, PGIE-6, May 1958.
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Switching Circuits for

Production lines and industrial processes as well as missile count-downs, can be stopped if any of a number of variables is out of tolerance. Transistorized level-sensitive switch uses nonlinear negative feedback to provide stable operation over wide temperature ranges

By **DONALD W. BOENSEL,***Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

SYSTEMS for absolute or tolerance measurement often rely on go/no-go indications designed to halt a missile firing count-down, pull a faulty module from a production line or perform some similar function. In such operations, a number of variables, such as power-supply voltage, signal level or bias current, are monitored continuously, sequentially or on command. Each variable is ordinarily compared with a predetermined reference. Both the reference and its tolerance are often programmed to vary with some parameter (such as time).

Usually a process is stopped if one or a combination of variables are out of tolerance. More sophisticated systems may include feedback control techniques to provide automatic correction for out-of-tolerance variables.

An a-c level-sensitive switch has been developed as a reliable comparator. It is stable to ±1.5 percent over a 100-deg C temperature range. The circuit has a switching gain of about 40 db and uses standard components throughout.

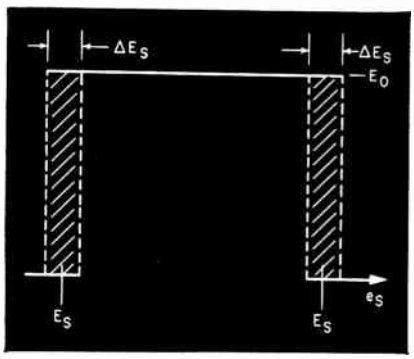

FIG. 1—Level-sensitive switch must operate at E_S despite wide temperature changes and component substitutions

Unlike many switches which are stabilized by compensating temperature-sensitive elements, this design derives its stability from nonlinear negative feedback. This arrangement results in characteristics that are not susceptible to either active component changes or temperature changes.

Requirements

An input-output characteristic similar to that in Fig. 1 must be obtained from the switch. Depending on whether the measurement is absolute or a differential tolerance, drift limits on the switch or on the out-of-tolerance point, E_s, can range from ±0.5 percent to as much as ±10 percent of E_s. In military applications, it may be necessary to maintain these limits not only with component substitutions but over severe ambient temperature ranges. These requirements indicate the desirability of including overall negative feedback to supplement the positive feedback necessary for a regenerative change of state at the switch point. Both types of feedback must be nonlinear to allow the switch to operate in a bistable fashion.

Most high-accuracy systems either process a-c signals or modulate d-c signals and use a-c amplification. An a-c level-sensitive switch is therefore compatible with many critical applications.

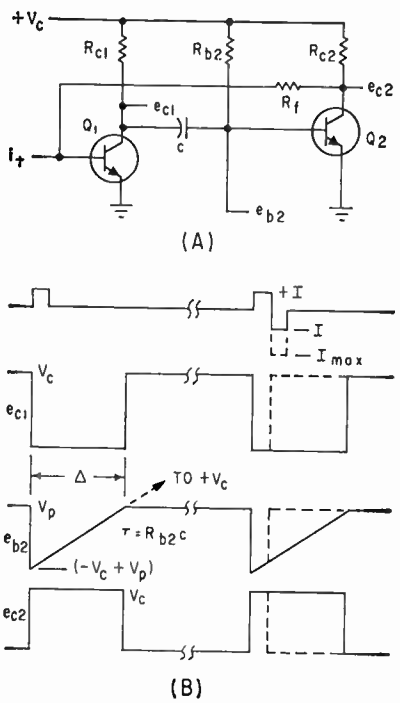

FIG. 2—Conventional multivibrator at (A) provides waveforms at (B). Large negative pulse following positive trigger pulse would affect waveforms as shown in dotted lines

Circuit Operation

The basic comparator consists of a somewhat unconventional monostable multivibrator followed by a rectifying transistor and filter. For signals above the trigger level, the circuit is periodically switched into its transient state.

The more important waveforms

* Now with Space Electronics Corp., Glendale, Calif.

Missile Count-Downs

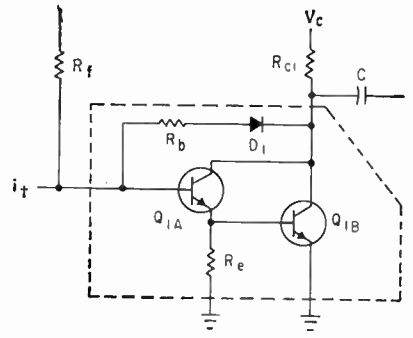

FIG. 3—Portion of circuit in dotted lines replaces Q_1 in Fig. 2A to get required gain and stability

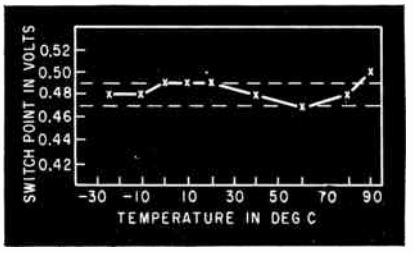

FIG. 4—Switch point stability with temperature indicates a variation between dashed lines of about ±1.5 percent

involved in the operation of the conventional one-shot multivibrator in Fig. 2A are shown in Fig. 2B. The positive feedback loop consists of Q_1, C, Q_2 and R_f. Duration of the transient state[1,2] in which Q_1 is saturated is $\Delta = \tau\ ln\ (2V_c - V_\gamma)/(V_c - V_\gamma)$, where $\tau = R_{b2}C$ and where V_γ is emitter-base contact potential of Q_2. If $V_c \gg V_\gamma$, transient duration is $\Delta \cong \tau\ ln\ 2$.

To use this circuit as a level-sensitive switch requires knowledge of the minimum trigger level. If duration of the input trigger is much greater than time required for switching, minimum triggering level can be calculated as below.

If R_f and R_{b2} are assumed to be much greater than R_{c2} and R_{c1}, respectively, minimum capacitive current necessary to bring Q_2 out of saturation is $i_{c\,min} = V_c[(1/R_{b2}) - (1/\beta_2 R_{c2})]$, where β_2 is common-emitter current gain of Q_2. Consequently, the minimum positive trigger pulse with an input resistance of Q_2 much less than the load impedance of Q_1 is $I_{min} = (V_c/\beta_1)[(1/R_{b2}) - (1/\beta_2 R_{c2})]$, where β_1 is corresponding current gain of Q_1.

The dotted waveforms at the right of Fig. 2B indicate the possibility of improper circuit operation if the positive trigger pulse is followed immediately by a large negative pulse. The maximum permissible value of such a negative pulse is calculated in the same way as that for the minimum positive trigger pulse. Thus, $I_{max} \cong V_c[(1/R_f) - (1/\beta_1 R_{c1})]$.

If $R_{b2} \cong R_f$, $R_{c1} \cong R_{c2}$, and $\beta_1 \cong \beta_2 \cong \beta$, there is no possibility of operational failure with reasonably symmetrical triggering. Under such conditions, $I_{max} \cong \beta I_{min}$. Therefore, triggering the switch with a symmetrical pulse train, rather than a unilateral pulse, is desirable. Although rectangular trigger pulses have been used in the above calculations, in a broad sense, results apply equally to sinusoidal triggering.

Since I_{min} corresponds to the trigger point of the switch, it must be stabilized with respect to temperature and component substitution. With present-day transistors, it is virtually impossible to obtain a trigger point stability better than ±10 percent with the circuit in Fig. 2A because of manufacturers tolerances in current gain and temperature drifts in current gain and emitter-base contact potential. These problems arise primarily in considering the parameters of input transistor Q_1.

If $\beta_2 R_{c2} \gg R_{b2}$, minimum positive current is $I_{min} \cong V_c/\beta_1 R_{b2}$, which is dependent only on current gain of Q_1. Although trigger source impedance must be high for proper regenerative switching it cannot be made infinite so that trigger level is also dependent on input characteristics of Q_1 (in particular, emitter-base contact potential).

If Q_1 is biased and feedback is stabilized in a linear operating range, rather than allowed to remain in its normal cutoff condition, trigger level can be made practically independent of temperature and component change; effects of drift in V_γ can be removed by capacitive input coupling techniques.

In practice, gain-temperature variation of standard small-signal silicon transistors is about 1.5 or 2.5 to 1 over a temperature range of 100 C. It is therefore impossible to adequately stabilize a single transistor performing the function of Q_1 and maintain sufficient gain. Therefore an amplifier configuration that is compatible with requirements for gain and stabilization must replace Q_1.

The transistor combination in Fig. 3 was developed to replace Q_1 in Fig. 2A. Both Q_{1A} and Q_{1B} in Fig. 3 have nominal current gains of 100, so that open loop gain of the cascaded pair is about 10,000. The feedback network consisting of avalanche diode D_1 and resistor R_b not only stabilizes d-c operating point but also a-c gain.

If $\beta_1 R_{c1} \gg R_b$, d-c gain with feedback is $A_{d-c} = R_{b1}/R_{c1}$. Similarly, if $\beta_1(R_{c1}//X_c) \gg R_b$, a-c gain is $|A|_{a-c} = R_b/|R_{c1}//X_c|$, where $X_c =$

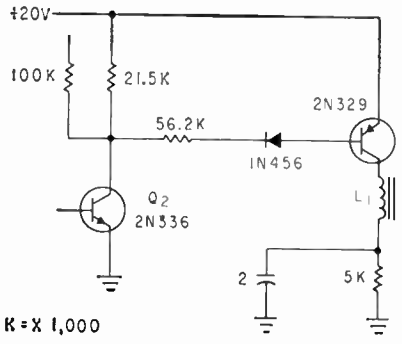

FIG. 5—Output circuit is designed to limit load effects on level-sensitive switch

$1/\omega C$ and ω is sinusoidal triggering frequency.

In this case, effective β_1 of the amplifier is 10,000; furthermore, R_b can be made relatively small because of the voltage drop afforded by D_1, so that the above approximation is applicable.

With values chosen for the experimental comparator (R_b = 147,000 ohms, R_{c1} = 10,000 ohms, R_c = 14,700 ohms, C = 0.03 μf, $\beta_{1A} \cong \beta_{1B} \cong$ 100 and D_1 breakdown voltage = 9 v), d-c gain is about 15

and a-c gain is about 150 at 6 kc.

In this way, operating point was stabilized to about ±0.2 percent and a-c gain to ±2 percent for a temperature range or component changes which produce a 4:1 change in β_1. It is possible to stabilize a-c gain to as little as ±0.5 percent under the same conditions and maintain the same sensitivity that would be obtained if Q_1 had a nominal β_1 of about 40.

Feedback Path

This simply involves reducing a-c gain to 40 by placing an a-c feedback path in parallel with R_b and D_1 or by reducing R_b by a factor of 4. Reduction of R_b produces no significant change in collector operating point of the cascaded pair, since this point is largely controlled by the breakdown voltage of D_1.

The nonlinear negative feedback loop is effective only when the switch is in its stable state. Application of a trigger current sufficient to bring Q_2 out of saturation produces a current that is fed back to the base of Q_1 and that is large enough to open D_1 and drive Q_1 into saturation.

Two other factors that affect trigger point stability are related to variations in the parameters of Q_2. In practice, switching speed places an upper limit on R_{c2} of 20,000 to 50,000 ohms. For β_2 nominally 100, R_{b2} must be below 200,000 ohms for the relationship $\beta_2 R_{c2}$ always $\geqslant 10\ R_{b2}$ to be even partially satisfied. In any event, for typical variations in β_2, it is necessary that $\beta_2 R_{c2}$ be at least 20 R_{b2} to assure that the error in triggering level from this source be less than ±2 percent. Thus, these values should be R_{b2} = 100,000 ohms, R_{c2} = 21,500 ohms and β_2 = 100.

The second factor is associated with the change in input resistance of Q_2 with temperature during saturation. It has been pointed out by Ebers and Moll that incremental input resistance of a common emitter transistor decreases significantly when it saturates. This phenomenon results not only because there is no feedback associated with the resistance of the emitter region, but also because of an order of magnitude decrease in base spreading resistance. The decrease in base spreading resistance has been attributed to a shift in injection coordinates as well as carrier injection into the base region caused by forward bias on the collector-base junction.

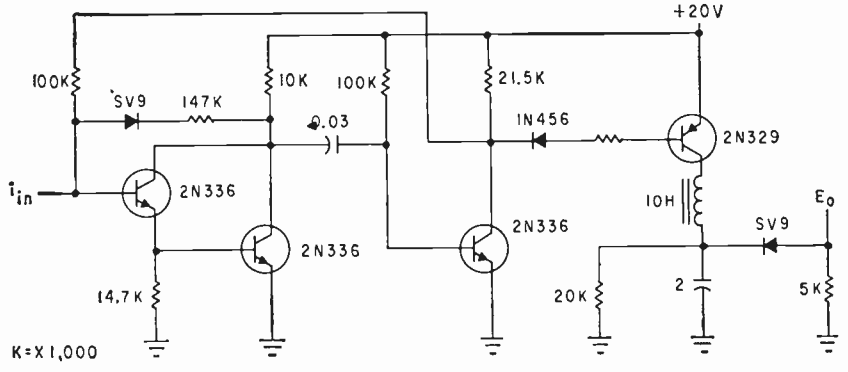

FIG. 6—Final circuit with nonlinear negative feedback is stable within ±1.5 percent over 100-deg C temperature range

Incremental input resistances during saturation of about 10 to 15 ohms can be expected for the 2N336 transistor used as Q_2. If C is chosen to make $\Delta = 20\ (\tau/4)$, such an input impedance represents about 1 percent of total a-c load impedance on Q_1. A simple calculation shows that C= 0.03 μf (X_c = 1,000 ohms at 6 kc). Since the temperature coefficient of silicon is about −0.7 percent/deg C, the change in trigger level contributed by this variation is about ±0.4 percent over a 100-deg C temperature range.

Under the worst possible accumulation of these errors, stability of the switch would be about ±4.4 percent over a 100-deg C temperature range. However, there is direction as well as magnitude associated with these drift errors. The effects of similar drifts in β_1 and β_2 on trigger level tend to cancel each other. A more precise estimate of switch stability would therefore be ±0.5 to ±1.0 percent. Experimental data, a sample of which is shown in Fig. 4, has indicated that this figure is probably closer to ±1.0 to ±1.5 percent.

Output Circuit

The switch output must be converted to d-c. Since filtering at the switch output would interfere with monostable operation, an isolating transistor is introduced between the sensing switch and filter.

This circuit should not cause appreciable loading of the level-sensitive switch. It should furnish a drift-free, low-ripple d-c of prescribed magnitude to the load when the monostable switch is in its stable state. It should also furnish an adequate change in current to the load when the one-shot is triggered.

The circuit in Fig. 5 was developed to satisfy these requirements. The 5,000-ohm load resistor and the 56,200-ohm base resistor were chosen to assure that the output transistor is saturated when Q_2 in Fig. 2A is in its stable saturated state. Inductor L_1 must have sufficient inductance at maximum load current to provide adequate filtering during switching. An inductance of 10 henrys at 4 ma for L_1 and a capacitance of 2 μf reduced ripple to about 20 μamp peak-to-peak low-current state or about 0.5 percent of maximum current.

Although load current does not drop to zero in the unstable state, a characteristic like that shown in Fig. 1 can be obtained by coupling the actual load through an avalanche diode. For example, voltage across the 5,000-ohm resistor in Fig. 5 drops from 19 to 6 v as the monostable switch is triggered into recurrent oscillation. A 9-v coupling diode (similar to D_1) can therefore be used to obtain the desired characteristic. A schematic of the complete switch and output circuit is shown in Fig. 6.

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Sealed Contact Reed Relays

By **R. A. E. FURSEY,** British Telecommunications Research, Ltd., Taplow, England

HIGH PERMEABILITY strips, sealed in gas-filled glass tubes and actuated by external magnetic fields, form the contacts of reed relays. Their simplicity permits high-speed operation. Low contact resistance to small signal voltages is maintained by the gas filling.

Characteristics of dry and wet types are outlined in Table I. Dry reed relays (Fig. 1A) are operated by coils, magnets or both. Bias magnets provide normally closed contacts or magnetically latched pulse action.

Mercury wetting via capillary paths (Fig. 1B) lowers contact resistance and sustains contact during any reed bounce. Mercury relays are usually balanced polar devices. Magnet adjustments give various pairs of operate/release values.

A rapid change in resistance occurs when clean mercury surfaces touch. Pulses with millimicrosecond rise times are generated by mercury relays, preferably coaxially mounted, connecting a charged length of cable to an output transmission line. Pulse repetition rates up to 200 a second are easily obtained.

Both types may be mounted in coaxial mounts with operating coils and magnets oustide the outer conductor. Reed relays were originally developed by Bell Telephone Laboratories.

Table I—Typical Sealed Reed Relay Characteristics

Characteristic[a]	Dry Reed Relay	Mercury Wetted Reed Relay
Contacts.....	single pole single throw normally open snap action	single pole change-over make before break snap action
Gas Filling	nitrogen 1 atmosphere	hydrogen 10 atmospheres
Contact Surface	electroplated rhodium or gold	fixed: Pt balls reed: nickel plate
Open Contact Breakdown	1.3 Kv	about 4 Kv
Maximum Contact Ratings	500 v 500 ma 15 watts[b]	500v 5 amps 25 watts[b]
Operate/Release Ampere Turns	160/120 to 85/30	+60/+30 to +30/−30
Operate Time[c].. Bounce Time[c]... Release Time[d]...	1—1.3 millisec 0.3 millisec 0.15 millisec	1 millisec none 0.8 millisec
Max Operating Frequency	400 cps	350 cps
Dimensions of Insert	2¾ inches long ¼ inch diam.	2½ inches long ⅜ inch diam.
Advantages[e]....	mount in any position, inexpensive, fast, reliable	no contact bounce, high current capacity, changeover contact, fast, reliable
Disadvantages...	single make contact, some contact bounce, large size	Costs more, upright mounting, pressurized inserts need careful mounting

(a) May vary considerably with model and manufacturer (b) For long life (c) With twice the "just operate" ampere turns in a standard 10,000-turn, 1,000-ohm coil (d) When standard test coil is open-circuited (e) Both are fast, reliable, have long life and handle low voltage

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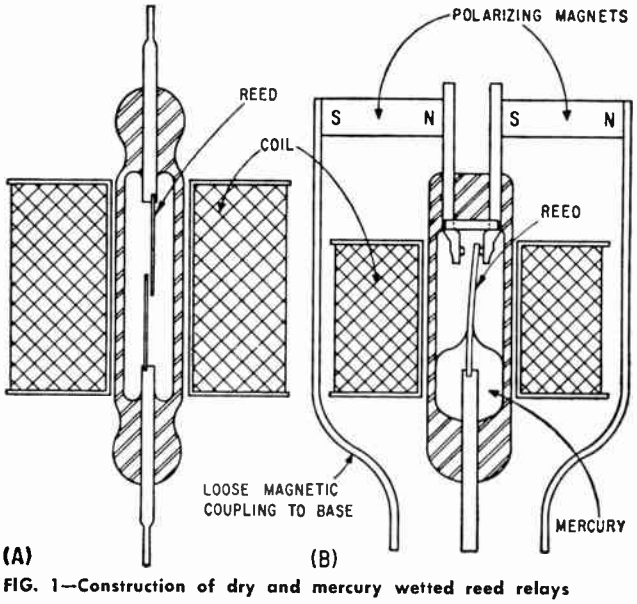

FIG. 1—Construction of dry and mercury wetted reed relays

How to Construct a

Here is a portable transistor transmitter that is easy to build with standard commercial components at a cost of about $25. Range of 200 feet makes it a handy part of public-address system

By **D. E. THOMAS and J. M. KLEIN,** Bell Telephone Laboratories, Inc., Murray Hill, New Jersey

PUBLICATION of the description of an experimental transistor f-m transmitter[1] was followed by numerous requests for information on where the components to build a similar transmitter could be obtained. Unfortunately, the point-contact transistor used in the original transmitter was an experimental device that became obsolete even before it could be coded for manufacture. The experimental f-m transmitter to be described can be built with readily available commercial components at a material cost of approximately $25.

Circuit

The circuit of the new transmitter, which was designed as a cordless hand microphone operating in the commercial f-m band is shown in Figure 1.

The 2N499 transistor performs the three functions of r-f oscillation, frequency modulation, and audio amplification.

Since the frequency of oscillation of this transistor is somewhat closer to its cutoff frequency than the previously used point-contact transistor, less phase shift is required in the feedback coupling circuit to maintain oscillation. Feedback is therefore obtained from a tap on tank coil L_1 through the series combination of R_2 and C_1, rather than through a capacitance only. Coil L_1 consists of 6 turns No. 24 bare tinned copper wire wound on ¼-in. polystyrene form. Feedback tap is at exactly one full turn.

Frequency modulation is accomplished by the feedback-loop phase shift resulting from alpha-cutoff frequency shift under the control of an audio-frequency signal input. The high common-emitter current gain of the 2N499 at audio frequencies amplifies the audio output of the microphone to the level needed to produce adequate frequency deviation.

The audio signal is fed into the base of the transistor as shown in Fig. 2, the equivalent circuit of the transmitter at d-c and audio frequencies. As R_1 appears in series with the emitter of the transistor at audio frequencies, the maximum available common-emitter current gain is reduced.

More audio gain can be obtained by shunting R_1 with the LRC circuit shown dotted in Fig. 1. Inductance L_2, which can be any low-capacitance r-f choke with inductance greater than 1 μh, is needed to avoid

Communication is convenient with this miniature f-m transmitter

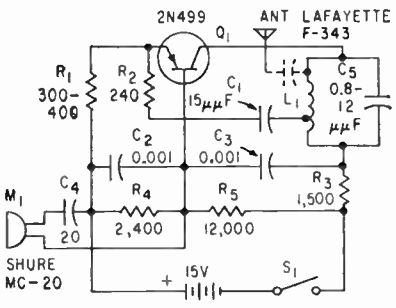

FIG. 1—Miniature transistor f-m transmitter

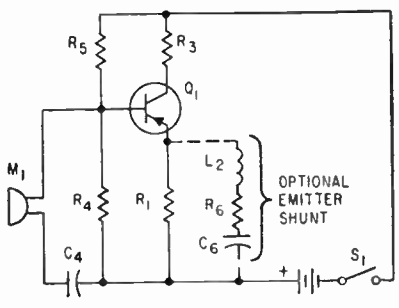

FIG. 2—Equivalent circuit of transmitter for audio and subaudio frequencies

Miniature F-M Transmitter

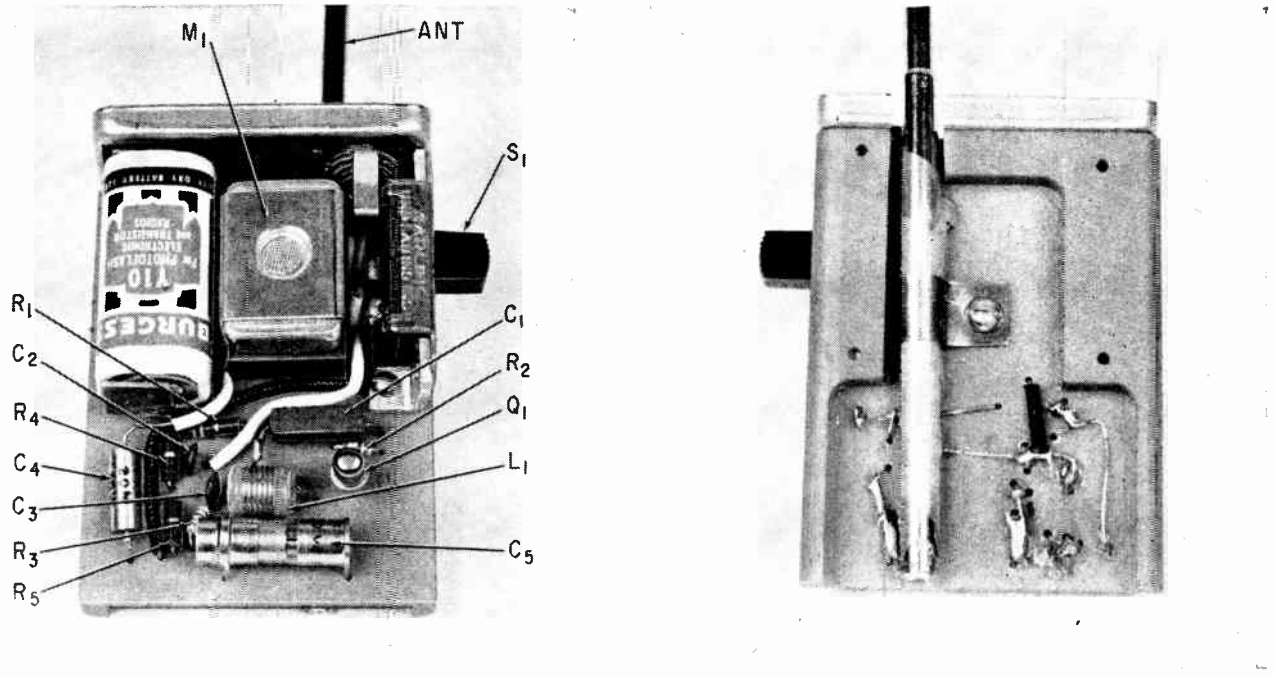

FIG. 3—Component layout, wiring and mounting. Antenna is coupled to tuned circuit by parasitic capacitance

shunting the emitter at r-f and interfering with r-f oscillation. Capacitance C_a, which should be of the same value and type as C_1, is needed to avoid disturbing the d-c biasing of the transistor. Audio gain can be adjusted by varying resistor R_a.

Component Layout

At vhf frequencies, physical position of components may play an important part in performance. Therefore, the physical layout of the components is shown in Fig. 3. All components except the antenna are mounted on one side of a $2\frac{1}{2}$ by $1\frac{7}{8}$ in. panel. Most of the parts are supported by their own leads, which are passed through holes in the panel and wired on the underside.

The bottom section of the antenna is wound in polyethylene sheet and clamped to the underside of the panel directly beneath the L_1 C_5 tank circuit. As the only r-f coupling between the antenna and the tank circuit is the parasitic capacitance between them, radiation is limited to that needed for a portable public address microphone with a range of about 200 ft; also, frequency pulling due to any change in radiation impedance of the antenna is reduced.

Adjustments

The value of resistor R_1 should be adjusted for the particular transistor used so that the d-c voltage drop across resistor R_3 is approximately 6 v when the battery is new. This adjustment, plus the adjustment of capacitor C_5 to give the desired carrier frequency, have been the only adjustments necessary. However, for those 2N499 transistors which happen to be on the edge of the distribution of production acceptability, the circuit may not oscillate. In such cases, a variation of R_2 and/or C_1 should produce oscillation.

Alternate Microphone

An external microphone of different impedance or larger size may be used. The space occupied by the small reluctance microphone could then be utilized for a suitable audio impedance matching transformer.

The alternate microphone selected should be connected to the transmitter by a coaxial microphone cable. In this case, the microphone cable will provide sufficient radiation for limited local transmission and the collapsible dipole antenna may be omitted.

The audio input impedance of the transmitter will vary widely depending upon the transistor used, the value of resistor R_1 and whether an emitter shunt is used to increase the audio gain. If an audio impedance of 1,000 ohms is assumed and an audio transformer is selected to match the microphone selected to 1,000 ohms, the actual audio impedance match will be satisfactory.

Considerably greater range could be obtained by use of an efficient radiator suitably coupled to the transmitter. However, FCC regulations with regard to transmitter frequency, stability of frequency and power must be complied with.

The concept of a frequency-modulated transistor transmitter originated with R. L. Wallace, Jr. The earliest transmitter was built by L. G. Schimpf using an early tetrode transistor modulated by a capacitor microphone across the tank circuit.

Reference

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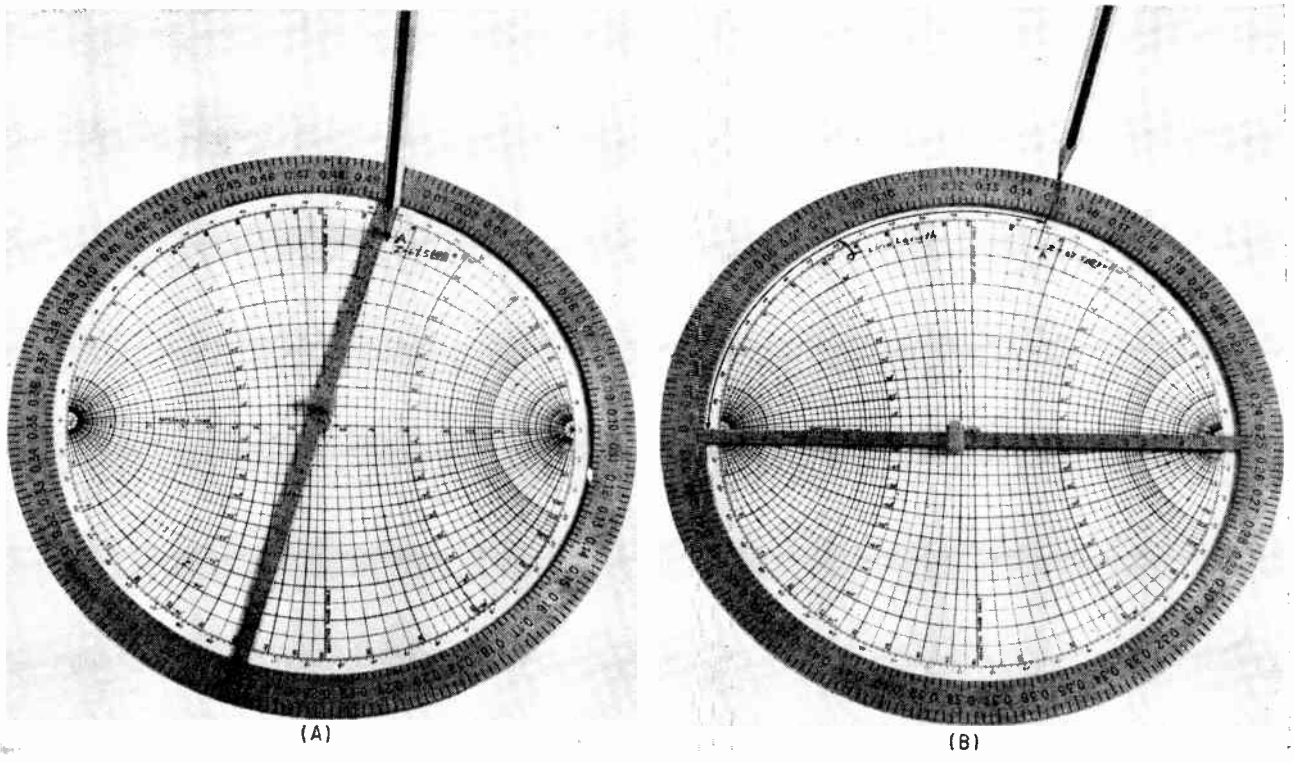


FIG. 1—How to find electrical line length using Z-θ chart and impedance transfer ring. Select a chart of same impedance as line. Assume measured impedance of short-circuited line is 67.5/85° and characteristic impedance is 50 ohms. Plot measured impedance on chart and move scale side of marked half of spoke to pencil (A). Place pencil opposite O mark on outside of ring and turn ring until O mark on inside of ring is opposite O impedance point of chart (B). Reading of 0.149 opposite pencil is electrical length of line in wavelengths

Impedance Transfer Ring

Error-free and less time-consuming technique for finding unknown impedance of antenna is given using Smith or Z-θ charts

By OVE SIMONSEN,
Electronics Scientist, Electromagnetics Division, U. S. Navy Electronics Laboratory, San Diego, California

NUMEROUS DATA RUNS of input impedance represent a considerable part of the work required in developing antennas, particularly those with broadband characteristics. Calculations connected with these data are usually done graphically on Smith or Z-θ impedance charts. Although this technique reduces tedious computations, processing of data on a chart is a chore which can be quite taxing.

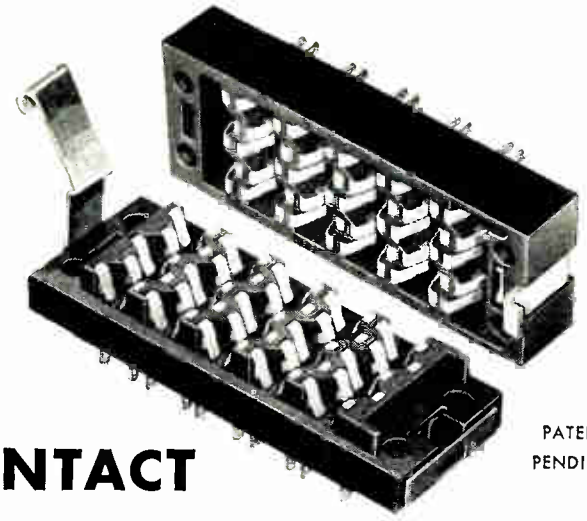
Many devices exist which help make the work on charts easier; however, most of them tend to be unwieldy and are sometimes complex. The impedance transfer ring described here makes work on impedance charts operationally simple and visually clear.

Construction of Ring

Physical construction of the ring can be seen in Fig. 1. The inside diameter is just large enough to include the reflection coefficient scale found on General Radio form 756N Smith charts. This diameter permits the ring to be used when the impedance data are given in terms of the voltage standing wave ratio and the angle of the reflection coefficient.

Numbers on the spoke represent vswr and are arranged similar to the vswr scale on a Smith chart, differing only in that the ring has vswr on both halves of the spoke while on the Smith chart the left side of the scale is marked off in reciprocals of vswr.

The side of the spoke containing the ring center is arranged



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with one end at the 0 and the other at the 0.25 point of the ring wavelength scale. A sliding marker is placed on the half of the spoke attached to the 0 side of the ring. Although the ring can be made from a great many materials, the unit shown is made of anodized aluminum.

Finding Electrical Line Length

When measuring an antenna impedance, it is usually necessary to use a section of coaxial line to connect the impedance to the bridge. Thus, the bridge reading gives the impedance under measurement not as it actually is but as it is after being transformed through the line.

Procedure for finding electrical length using the ring on a Z-θ chart is shown in Fig. 1. When using a Smith chart, it is first necessary to normalize the measured impedance, represented by the expression $R \pm jX$, to the line characteristic impedance Z_o. The normalized value, equal to $R/Z_o \pm jX/Z_o$, is then plotted on the Smith chart and the line length found as for a Z-θ chart.

When an admittance meter is used, the procedure for using a Smith chart is somewhat different. If the bridge gives the admittance in mhos, the admittance expression $a \pm jb$ is normalized by dividing it by the characteristics admittance of the line Y_o which equals $1/Z_o$. Electrical line length can then be found as shown in Fig. 2.

Once the electrical line length is known, the actual impedance of the antenna can be found on a Z-θ chart as shown in Fig. 3. Procedure for a Smith chart is the same once data have been normalized to line characteristic impedance (or admittance).

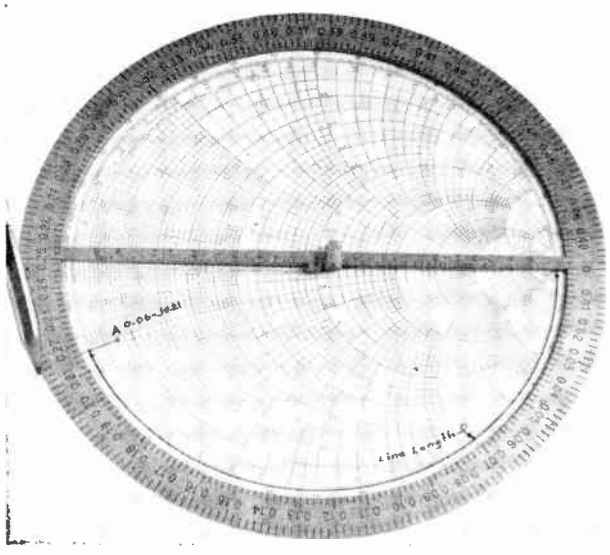
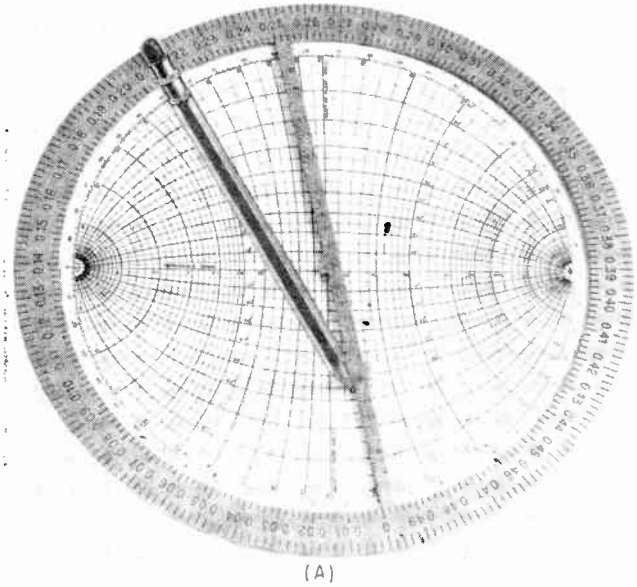
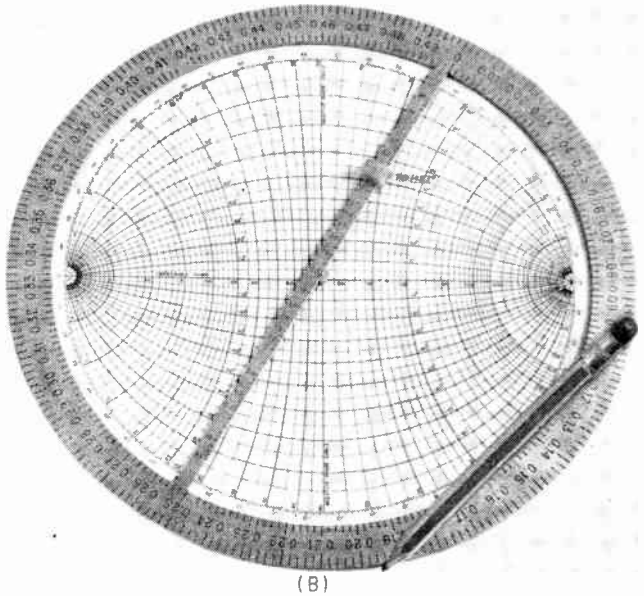


FIG. 2—How to find electrical line length using Smith chart and impedance transfer ring. Assume characteristic admittance of short-circuited line is 0.020 mhos and measured admittance is 0.06 —j0.21 normalized mhos. Plot measured admittance on chart and move marker side of spoke to pencil as shown in Fig. 1A. Place pencil opposite O mark on outside of ring and turn ring until O mark on inside of ring is opposite infinite impedance point of chart. Reading of 0.216 at pencil is electrical length of line in wavelengths

FIG. 3—How to find unknown impedance using Z-θ chart and impedance transfer ring. Assume measured impedance is 57.5$\angle$ —56°, characteristic impedance is 50 ohms and electrical line length is 0.195λ. Place pencil on point of chart corresponding to measured impedance, move scale side of marker half of spoke to pencil and slide marker to pencil (A). Place pencil opposite O mark on outside of ring and turn ring until reading opposite pencil is 0.195 (B). Marker on spoke now indicates actual impedance of unknown which is 78$\angle$ +53°



(A)



(B)

NEW

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FAIRCHILD'S 2N699 OFFERS ANOTHER UNIQUE COMBINATION

120 VOLTS collector to base voltage, permits greater voltage swings in amplifier and oscillator circuits and more protection in inductive switching circuits. Maximum base-emitter turn-on voltage is only 1.3 volts for I_C=150 mA and I_B=15 mA.

120 MEGACYCLES typical gain-bandwidth product means excellent broad-band video performance. In addition the units will provide typically 18 db neutralized gain at 30 mc and 30% efficiency in a 70 mc oscillator circuit.

300° C SURVIVAL has been assured. Every transistor produced at Fairchild has been preaged a minimum of 60 hours at 300° C before test. This provides extra reliability at their recommended maximum operating junction temperature of 175° C.

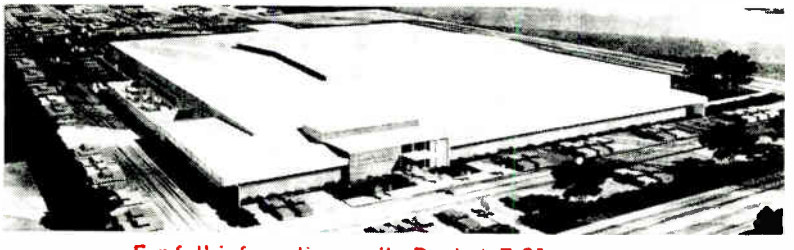
2 WATTS dissipation at 25° C—the combination of power with high frequency that is available only in double diffused silicon transistors.

In Fairchild's recent succession of new transistor announcements, each has offered some exceptional combination of characteristics previously unattainable. The 2N699 combines high collector voltage rating with high-frequency performance, medium power capabilities and low saturation resistance. Its applications range from low-current high-frequency I-F circuits to high-current, low-frequency relay drivers. Other products nearing production at Fairchild promise even greater advances in the state of the art.

2N699 — ELECTRICAL CHARACTERISTICS (25° C)

Symbol	Characteristic	Min.	Typ.	Max.	Test Conditions	
h_{FE}	D.C. pulse current gain	40		120	I_C = 150ma	V_C = 10v
$V_{BE(sat)}$	Base saturation voltage		1.0	1.3	I_C = 150ma	I_B = 15ma
$V_{CE(sat)}$	Collector saturation voltage			5v	I_C = 150ma	I_B = 15ma
h_{fe}	Small signal current gain at f = 20 mc	2.5	5.0		I_C = 50ma	V_C = 10v
C_{ob}	Collector capacitance		14$\mu\mu$f	20$\mu\mu$f	I_E = 10ma	V_C = 10v
I_{CBO}	Collector cutoff current			2μa	V_C = 60v	T = 25°C
				200μa	V_C = 60v	T = 150°C

A new plant of nearly ten-times increased capacity opened in June 1959 to fill demand created by new products introduced in less than a 12-month period.



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Plasma Engine Verifies Theory

EXPERIMENTAL plasma propulsion system has been constructed using the pinch effect to obtain thrust. Plasma propulsion uses the magnetic acceleration of a plasma to eject particles from a space vehicle at low-mass flow rate, high velocity and, therefore, low thrust and high specific impulse. The study program was described at the National Convention on Military Electronics by M. J. Minneman of Republic Aviation Corp.

In the cylinder in Fig. 1, the capacitor bank with a range of 50 to 1,000 μf may be charged from 1,000 to 20,000 volts. The capacitor is connected to the electrodes that form the ends of the cylinder through a switch and low-inductance, low-resistance conductors. When the switch is closed, a discharge is initiated in the gas in the form of a Townsend shower. As a result of skin effect, current flows initially in a thin hollow cylinder of plasma confined to the outer edge of the confining cylinder. The magnetic forces that result from the current cause the hollow cylinder to constrict toward the center line of the cylinder.

Pinch Effect

The exact mechanism of this transition from Townsend shower to skin current is now under theoretical and experimental study. The force on a moving charged particle is proportional to the charge, velocity and magnetic field, and is at right angles to both the velocity and the field. In this case, the field is self-induced by the current and the direction of force on both the positively charged ions and negatively charged electrons is radially inward. The gas is highly ionized by the high currents that flow and the consequent heating; currents as high as 500,000 amperes are used in the experiments.

The action is assumed to be like a magnetic piston in cylindrical form which is constricting radially inward. Thus the gas too is being driven radially inward. This magnetic piston causes a shock wave to run ahead, thereby raising the pressure and temperature of the

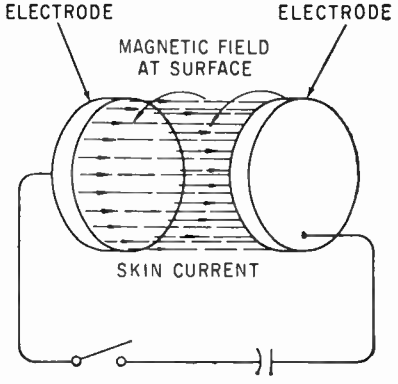


FIG. 1—Basic pinch-effect cylinder has electrodes at each end

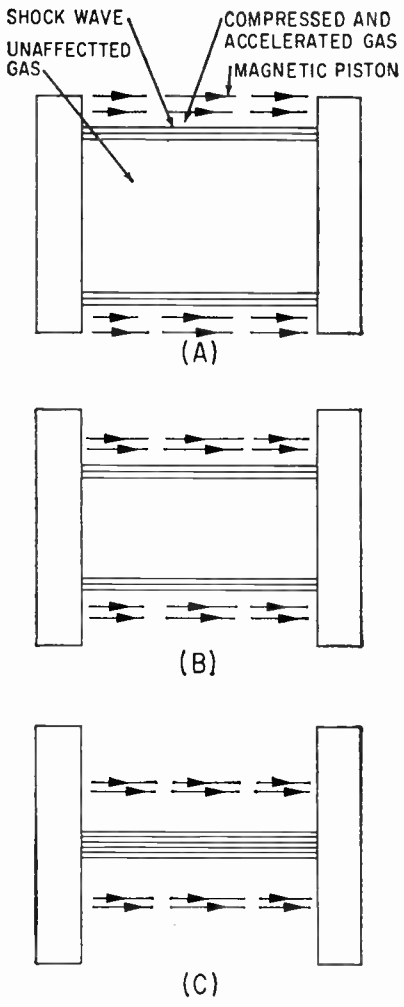
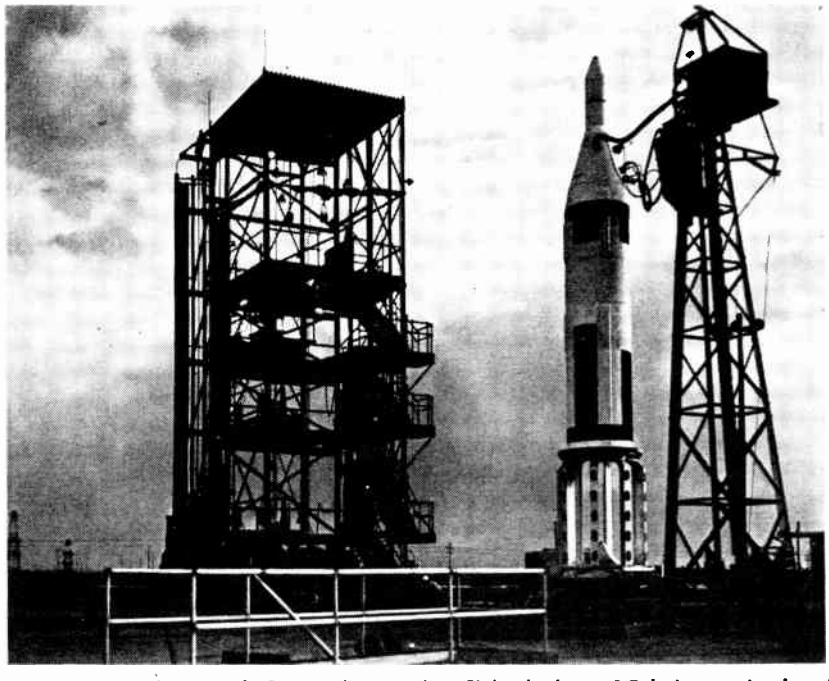


FIG. 2—After capacitor discharge, magnetic piston is at outer edge (A) and moves toward center a short time later at (B). Finally at (C) shock wave reaches axis

Checkout Sequencer for Polaris



Static sequencer for control of count-down and preflight checkout of Polaris was developed by Magnetic Amplifiers, Inc. It can trigger 60 checkout operations/minute, has no moving parts and can compare information received and verify accuracy of test results

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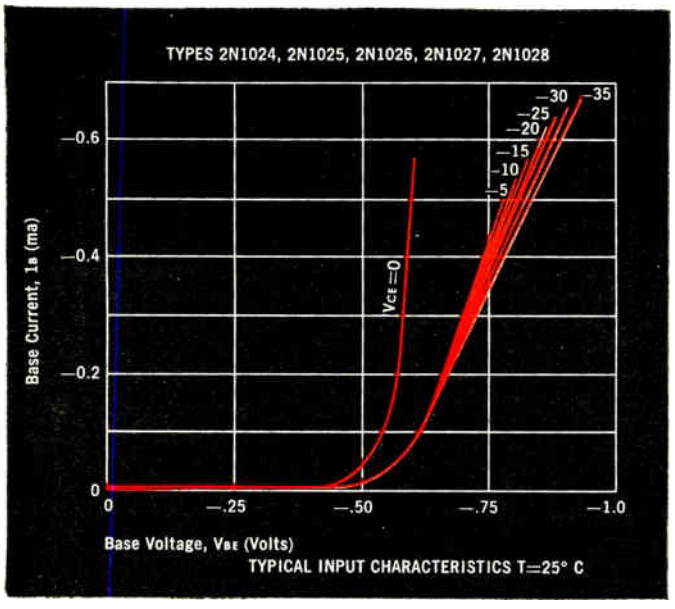
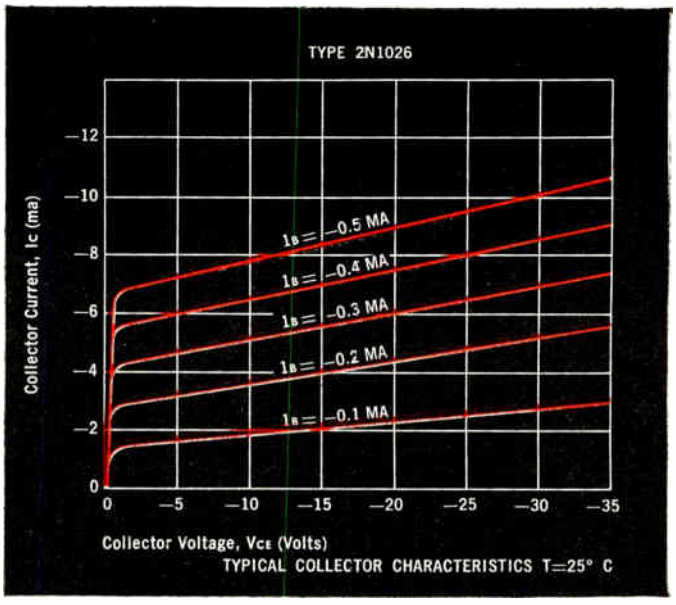
SILICON PNP TRANSISTORS FOR AIRBORNE AND MILITARY APPLICATIONS





SPECIFICATIONS

TYPE	COLLECTOR VOLTAGE	BETA (h_{fe})	f_{ab}	APPLICATIONS
2N1024 2N1025 2N1026 2N1026A	15v 35v 35v 35v	9 min. 9-18 18-36 36-72	1mc min. 1mc min. 2mc min. 2mc min.	D.C. and audio amplifiers, voltage regulation. Modulator and demodulator and switching circuits.
2N1027	15v	18 min.	4mc min.	Medium frequency—amplifier, oscillator and switching circuits.
2N1028	10v	9 min.	4mc Beta 1.8 min.	High speed computer switching.

These Sperry silicon transistors, made by the alloy junction process, offer important advantages for general-purpose and switching circuits in missile and airborne applications.

- **Low saturation resistance**
- **High-temperature operation**
- **Uniform input impedance**
- **High conduction**
- **150 Milliwatts power dissipation**
- **Light, ruggedized design**
- **JETEC 30 (TO-5) package for automatic assembly**

For complete electrical characteristics of these Sperry PNP transistors, write for data sheets.

SPERRY SEMICONDUCTOR DIVISION
SPERRY RAND CORPORATION
South Norwalk, Connecticut

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gas to very high values.

The pressure in this region opposes the constriction of the magnetic piston. In Fig. 2A, these conditions are shown at the initiation of discharge. The magnetic piston is near the outer radius. A shock wave is running radially inward ahead of it. Between the piston and the shock wave is a region of compressed and accelerated gas. Ahead of the shock wave is unaffected gas.

This process is shown a short time later in Fig. 2B, and finally in Fig. 2C the shock wave is reaching the center of the cylinder and the piston is lagging behind.

Curved Electrodes

A cross section of the electrodes used is shown in Fig. 3. The electrodes have been curved, and one electrode has been opened and a nozzle formed on it. Upon gas breakdown, a skin current flows, the pinch effect drives the gas toward the center, and a shock wave is generated ahead of the piston.

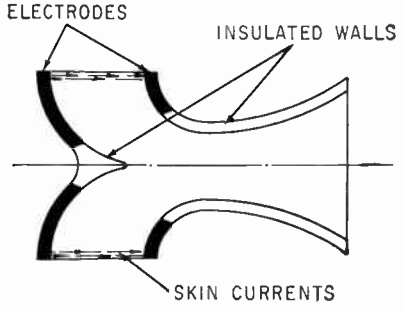


FIG. 3—Curving electrodes of pinch cylinder forms nozzle

In Fig. 4A, conditions are similar to that for the simple cylindrical electrode. However in Fig. 4B, showing conditions a short time later, because of the electrode curvature, the piston and the shock wave are being forced into an axial direction, rather than continuing radially inward. Finally in Fig. 4C, the magnetic piston reaches its farthest travel and compressed and accelerated gases having high velocity continue to flow axially and finally leave the nozzle.

Experimental equipment has been constructed, and results have verified the theoretical predictions. A preliminary measurement of thrust developed by this nozzle electrode assembly has been made. Peak thrust of more than 4,000 pounds was obtained with a specific impulse of over 1,700 seconds.

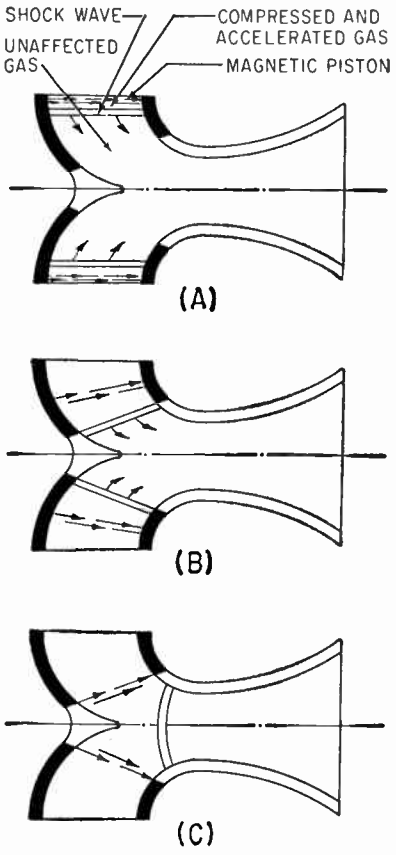


FIG. 4—Discharge is initiated at (A) and shock wave moves axially as well as inwardly a short time later at (B). At (C), magnetic piston reaches inner radius of electrodes

To determine thrust, a disk was placed over the nozzle so that accelerating gas would exert pressure on the disk and cause it to be thrust vertically upward against the force of gravity. The impulse that the gas exerts is thereby determined since it is equal to the measured initial momentum of the disk.

Plasma Engine

A plasma engine may be applied to a mission starting in a geocentric orbit around the Earth and terminating in an orbit around Mars. A space vehicle has been studied with a payload of 5,000 pounds for such a mission. Peak thrust developed by the engine is 9,000 lb/pulse; with a pulse length of 0.39 μsec and a repetition rate of 500 pps, an average thrust of 1.8 lb is developed.

Weight of the engine system, including a primary nuclear power reactor, is estimated at 12,000 lb, the space vehicle structure at 2,000 lb, payload of guidance, telemetering, etc. at 5,000 lb, propellant at 8,300 lb—an overall weight of 27,300 lb. The mission takes just over eight months to accomplish.

Transducer Offers Improved Design

By STANLEY R. RICH*, Vice-President, Acoustica Associates, Inc., Plainview L. I., N. Y.

DEVELOPMENT PROGRAM at Acoustica has led to the full scale production of a transducer that overcomes the inherent disadvantages of the two basic types of transducers: piezoelectric and magnetostrictive. The points of superiority, coupled with lower cost, represent a major breakthrough in ultrasonic technology.

Called a Multipower transducer, the device has a higher efficiency than the common ceramic piezoelectric type and operates even if heavy metal parts are dropped directly on the vibrating surfaces. Thermal characteristics of the unit permit continuous operation at higher power levels without external cooling and without overheating. A new studwelding technique for mounting has eliminated the need for adhesive cements. And the device has the advantage of low Q (broad tuning) so that it can be operated by fixed-frequency sources such as motor alternators and simplified electronic generators. The transducer overcomes extreme sharpness of tuning that usually requires continual readjustment of driving frequency during operation.

* Also Pres., Tech. Director, General Ultrasonics, Bloomfield, Conn.

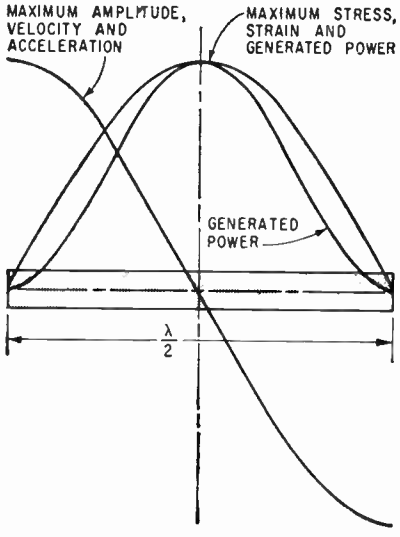


FIG. 1—Distribution of amplitude, velocity, acceleration, stress, strain, and generated power along a half-wave transducer

Construction

In a transducer measuring one-half wavelength, the maximum generated power with minimum amplitude of vibration is at the center, while the maximum vibration amplitude with minimum generated power points are at the ends.

The curve in Fig. 1, taken from the International Nickel Co. handbook on transducer design, shows the effectiveness of transducer material versus position along what is known as a half-wave vibrator. It is immediately seen that only the center section of the curve permits transducer material, of whatever variety, to contribute its full output to a half-wave vibrating transducer.

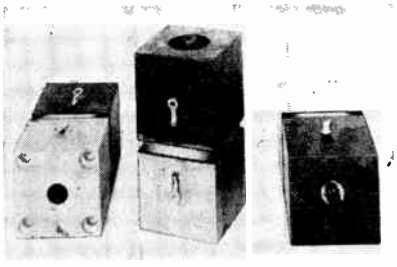
The transducer uses this construction principle. The transducer material is positioned near the center of the unit.

The remainder of the vibrator is made up, not of transducer material but of special alloys which are positioned, machined and dimensioned so the overall vibrator possesses significant advantages.

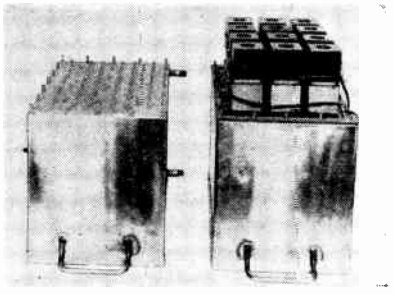
The solid metal sections of the new transducer, shown in top photograph, can be hammered hard enough to leave a dent in them without at all affecting the effectiveness of the element.

By restricting the use of the transducer material to the center zone, where it is most effective, the balance of the transducer can be made of solid metals that are nearly lossless at commonly used vibration frequencies, 300 cps to 50 kc, resulting in greater transducer efficiency.

Efficiencies of well over 90 percent at high power levels are readily achieved and measured by use of motional impedance circle diagrams. Further, the solid metal sections are



New transducer is constructed of solid metal sections



Cleaning tank with studs (left) on which transducers are mounted as shown (right)

excellent heat conductors and permit almost any transducer element to be used continuously and at high power level. The metal readily conducts whatever internal heat is generated in the transducer to the air and into the liquid being treated.

The transducer material in the center can be almost any suitable piezoelectric or magnetostrictive substance, and higher overall efficiency will be obtained than if ceramic piezoelectric or magnetostrictive material were used for the entire vibrator.

Mounting

A studwelding technique has been devised for mounting the elements. Each unit is mounted on stainless steel welded studs which provide extremely rugged support as well as indefinite life without any sign of fatigue. The studwelding technique has eliminated the need for adhesive cements or other non-engineering binders, thereby removing the possibility of separa-

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 59-5 REFERENCE DATA FILE SANGAMO

Important factors in specifying toroidal inductors

The powdered molybdenum permalloy toroidal inductor is finding increasing use in today's complex electronic equipment. Excellent magnetic stability, superior temperature stability, high Q values, and small physical size are but a few of the outstanding features which explain the popularity of molybdenum permalloy toroids. To fully realize the advantages of these inductors, the components application engineer must accurately specify those parameters which are of critical importance in a given application. "Under-specification" may result in a component which fails to give adequate performance in the circuit. "Over-specification", on the other hand, may result in a component of extremely high cost. An understanding of the factors involved in the design and manufacture of toroidal inductors at Sangamo will enable the components application engineer to effectively judge the consequences of his specification in relation to the cost and performance of the final product.

THE EQUIVALENT CIRCUIT of a toroidal inductor is illustrated in figure 1.

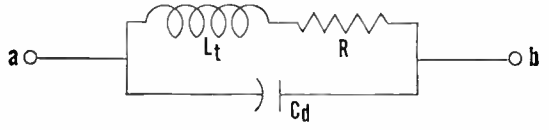


FIGURE 1

L_t is the so-called "true inductance" of the toroid and is assumed to be constant at all frequencies. R represents the sum of copper losses and core losses which increase with frequency. C_d, the distributed capacitance, approximates the capacitance between turns of the winding and between the winding and core. Due to the fact that the dielectric constant of the insulation on the windings and on the core itself is not constant with frequency, the distributed capacity will also vary with frequency. This variation, however, is usually small and may be neglected in the following discussion.

THE APPARENT INDUCTANCE (L_a) is the equivalent inductance between terminals (a) and (b). As might be expected, the apparent inductance varies with frequency. If R is neglected the expression for L_a becomes:

$$L_a = \frac{L_t}{1 - \omega^2 C_d L_t}$$

Inductors for single frequency or resonant circuit applications are usually specified in terms of apparent inductance. The standard tolerance on L_a is 1% or one turn whichever is greater.

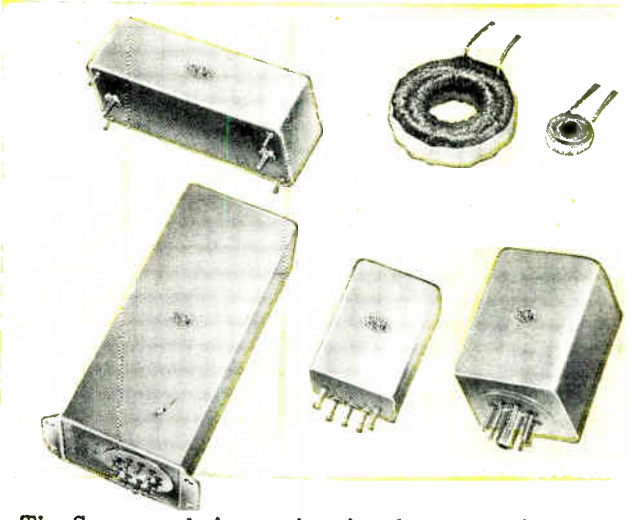
THE Q FACTOR is usually specified in lieu of R since most applications are concerned with the ratio of inductive reactance to equivalent resistance. The accepted method of specifying Q is to set a limit on minimum Q at the operating frequency or over a range of frequencies. Normally, the Q of a given design at a given frequency will vary some 20% between units. Where direct current flows through the inductor it may sometimes be desirable to set a limit on the d-c resistance as well as on Q. Analysis of the equivalent circuit, assuming constant R, shows that:

$$Q_{equiv} = \frac{\omega L_t}{R} - \omega R C_d - \frac{\omega^3 L_t^2 C_d}{R}$$

From the above equation one may deduce that anything which increases the distributed capacitance must necessarily reduce the Q.

DISTRIBUTED CAPACITY becomes most important in wide band or multiple frequency applications, since C_d will determine the variation of L_a with frequency. The majority of users do not find it necessary to specify C_d. Where C_d must be specified, the accepted method is to set a limit on the maximum allowable distributed capacitance. An alternative method of specifying C_d is to set a tolerance on the apparent inductance to be measured at two different frequencies (usually corresponding to the upper and lower frequencies encountered in a given application). The design engineer controls the C_d by varying the method of winding the inductor. In decreasing order of capacity he may choose 1) random continuous windings; 2) progressive winding, or segmented winding. Unfortunately, winding costs increase as distributed capacity decreases. Wax or varnish impregnation will increase the distributed capacity. In applications where it is necessary to insure that L_a be reasonably constant over a wide frequency range, it is also usually desirable that L_a be reasonably constant with temperature and with time. These features are best achieved using a stabilized core, a low capacity winding, and an unfilled hermetically sealed enclosure. In this way, the undesirable effects of impregnation may be avoided.

REQUIREMENTS FOR STABILITY OF INDUCTANCE with temperature, with a-c voltage level, and with direct current are additional factors which will influence the cost and the size of a given inductor. Temperature stabilized cores are available only in certain core sizes and are, of course, more expensive than the standard unstabilized cores. High values of a-c voltage and direct current will lead to larger cores and increased cost.



The Sangamo design engineering department is ready to discuss your inductive components problems. Typical examples of specialty components designed and produced by Sangamo are described in engineering bulletin series IC-260. Address: Sangamo Electric Company, Inductive Components Section, Springfield, Illinois.

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tion. Cement may be used, not for bonding but simply to assure an air-free boundary between transducer and tank.

Lower Q

The solid metal sections in the transducer are designed to constitute a mechanical impedance transformer. The choice of materials and shapes for these sections cause the transducer element to be properly matched to the liquid into which energy is radiated so that a proportionally greater amount of power is radiated per unit of stored energy in the vibrating transducer. This produces a lower Q, a great advantage in the frequency range of several hundred cycles per second up to 60 kc. Less critical tuning is required for many applications and this is a necessity when rotating electrical generators are used.

Furthermore, the use of prestressing places each complete transducer element under a compressive stress greater than any negative or tensile stress that may be created by the vibrational energy. Since ceramic materials are strong in compression and weak in tension, the new transducer element can be driven, even by ceramic elements, at levels heretofore unobtainable.

The transducer may be fabricated from a variety of basic driving elements. These include certain special titanate drivers, high temperature zirconates, and magnetostrictive ceramic drivers. The selection of driving materials is made on the basis of application, since the element has separated the functions of power generation and the radiation of energy into liquid loads.

The transducer and the methods for mounting it are the subjects of several pending patents, as well as a number that are already issued.

Application

A typical example of the successful operation of the new device is at Keeney Manufacturing Co., Newington, Conn., manufacturers of brass plumbing fixtures. At this plant, an array of 96 elements housed in 12 stainless immersion containers floods a 600 gal. tank

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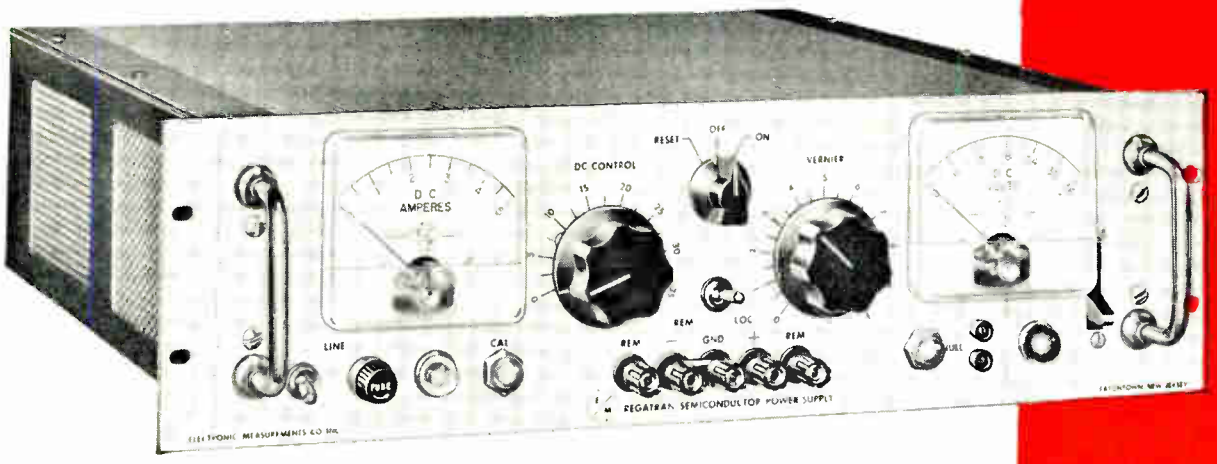

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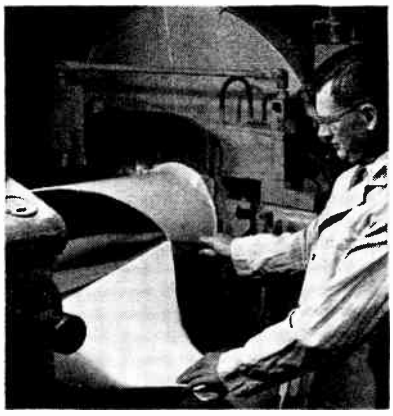
New Silicones Easy to Process



New silicone rubber stock is easily stripped

SEVERAL new silicone rubber compounds, characterized by their ease of processing, were announced recently by Dow Corning. Silastic 1601, developed especially for cable and wire insulation, needs no milling before use in most extruders, is easily handled, and meets standards SF and SFF for flexible cord and fixture wire.

Two other general purpose compounds are Silastic 52 and 82. They are 50 and 80 durometer (Shore A hardness) stocks that can be blended to obtain any intermediate hardness. These stocks release from mill rolls without the use of scraper blades, and feed into extruders easily. Both 52 and 82 meet requirements of MIL-R-5847C Class II (high temperature). Silastic 52 meets AMS 3302B and ASTM, SAE TA 507. Silastic 82 meets AMS 3305C and ASTM SAE TA 806 specifications.

Silastic 433 is a masterbatch from which the stocks can be made by secondary processes. It contains 80 percent silicone polymer and 20 percent reinforcing silica.

The new silicones allow thinner-walled wire and cable insulation. Walls can now be made under 15 mils thick.

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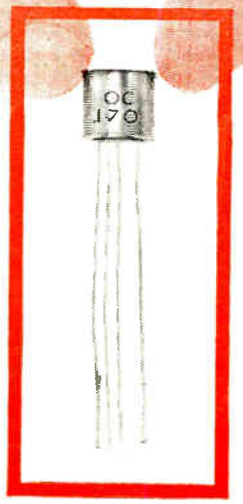
d yet they cost no more, in many cases, in equivalent vacuum tubes and are ailable now in production quantities.



last, you can realistically employ high frequency nsistors for RF and IF amplifiers in production FM ivers; as mixers, oscillators and RF and IF amplis in mobile radio equipment, car radios and short e receivers; and as broadband amplifiers in instrutation and industrial applications.

lemented and fully proven by Amperex, a unique ufacturing technique originating with Philips of the herlands now enables Amperex to provide you with production VHF tranors of unparalleled laboratory quality at truly reasonable prices.

new Amperex "alloy-diffusion" P-N-P transistors combine the best qualities oth the alloy and the diffusion approaches to transistor construction. As a lt of the special "self-jigging" techniques, a maximum degree of uniformity chieved. Thus the necessity for "selection" is completely eliminated.

Type OC170 is designed for use as a mixer oscillator in short wave receivers, n IF amplifier in FM receivers, and as a broadband linear amplifier for umentation and industrial applications. The OC170 features a high cut-off uency of 70 Mc and a low collector-to-base capacitance of 1.8 $\mu\mu$f.

Type OC169 is designed for lower frequencies and gain.

Type OC171 is designed for use as a local oscillator and preamplifier in FM vers and has a cut-off frequency of 100 Mc.

AXIMUM RATINGS		OC169	OC170	OC171
CE		20 V	20 V	20 V
		10 mA	10 mA	5 mA
at $T_{amb.}$ = 45°C		50 mW	60 mW	60 mW
'PICAL CHARACTERISTICS				
ut-off frequency	$f_{\alpha b}$	70 Mc	70 Mc	100 Mc
ower gain	P_g at 0.45 Mc	35 db	57 db	—
	P_g at 10.7 Mc	20 db	31 db	—
	P_g at 100 Mc	—	—	23 db
oise figure	NF at 0.45 Mc	4 db	4 db	—
	NF at 10.7 Mc	5 db	5 db	—
	NF at 100 Mc	—	—	11 db

The Breakthrough... How It Was Accomplished!

This VHF transistor breakthrough was made possible by a new alloy-diffusion process, a manufacturing method that combines the best features of the currently used alloy and diffusion processes, without their drawbacks.

The limitation of the alloy process is encountered when attempting to manufacture transistors with an average cut-off above 20 Mc. In this process the collector and emitter elements are fused (or alloyed) to the base. For this to be successfully accomplished the base must be relatively thick and the thickness very accurately controlled in order that during the fusion process the collector and emitter elements do not flow through the base and short the transistor. This relatively thick base increases the transit time, precluding any usable response above 20 Mc.

In the diffusion process the base is formed on the collector by gaseous diffusion in a high temperature oven. Very thin bases can be manufactured by this method with low transit time and very high cut-off frequencies. In this process the problem lies in attaching the emitter junction and base lead.

In the AMPEREX "alloy-diffusion" process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of P-type germanium. Two small pellets are placed on the germanium. Pellet B, the base pellet, contains only an N-type impurity. Pellet E, the emitter pellet, contains a P-type and an N-type impurity.

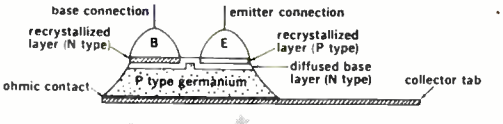
When this assembly is heated at a certain temperature, the germanium dissolves into the metal pellets until saturation is reached, and the pellet impurities diffuse into the solid germanium.

However, the P-type impurity in pellet E has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The N-type impurity in pellets E and B has a much greater diffusion constant and readily penetrates into the solid germanium to form a diffused N-type layer underneather the pellets.

When the assembly is cooled down, a layer of germanium recrystallizes from the pellets as in the normal alloy technique. The recrystallized layer of pellet E contains many atoms of the P-type impurity and is, therefore, a P-type germanium layer. The germanium layer recrystallized from pellet B is, of course, the N-type because there are no other impurities in the pellet.

Connections are made to the germanium and the metal pellets and a P-N-P transistor is obtained. The original P-type germanium is the collector, pellet B the base, and pellet E the emitter.

This process makes it possible to mass produce transistors with a base layer of a few microns for very short transit time and high cut-off frequencies. The yield is also very high which enables AMPEREX to supply these transistors at low prices.



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CIRCLE NO. 95 READER SERVICE CARD

Rod and Strip Make P-C Frames

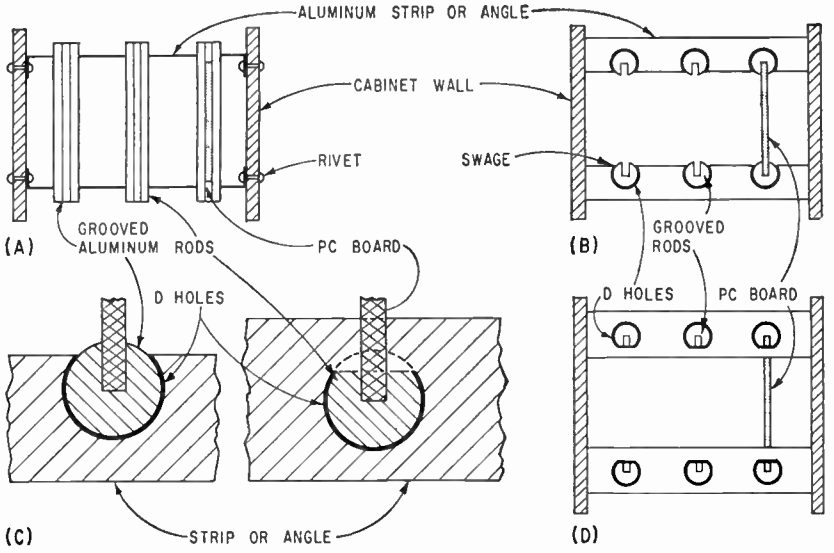


FIG. 1—Details of how frames made of aluminum rod and punched and drilled strip are assembled in cabinet

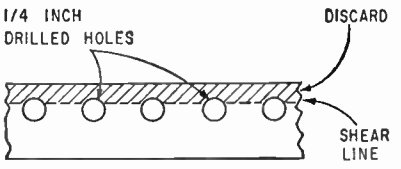


FIG. 2—Method of preparing strip for board insertion end of frame

CIRCUIT BOARD frames that are lightweight, economical, easily constructed and versatile can be made with grooved aluminum rods and punched and drilled aluminum strip. Dimensions and arrangement can be varied to suit.

The frames shown are used by Fischer & Porter Co., Hatboro, Pa. They were developed by H. J. Hampel, design engineer, and H. C. Sauer, manufacturing engineer.

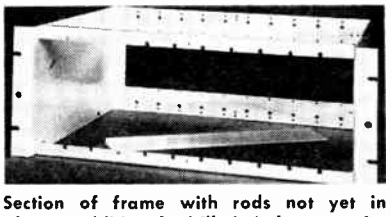
Frame Design

General design of the frames is detailed in the cross-sectional sketches of Fig. 1. Fig. 1A is a top view of the lower level of a frame; Fig. 1C, details of the D holes used in the strips to hold the rod ends; Fig. 1B, side view of the board insertion end of the frame, and Fig. 1D, side view of the other end of the frame.

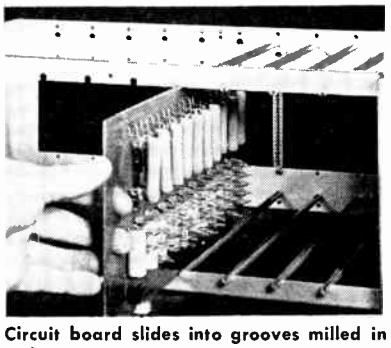
In actual practice, the frame can hold as many circuit boards as desired. Adding boards merely requires that the end strips be longer. Normally, boards are stacked vertically and parallel to the cabinet walls. However, the rods and strips can be assembled in any desired configuration.

Frames which hold a large number of boards, or heavy boards, can be beefed up by using heavier stock, providing larger areas for riveting or fastening to cabinet wall or framework, angle iron types of end pieces, bracing and so on. Normally, rivets placed as shown (Fig. 1A) are satisfactory.

Rods are normally made of ¼-inch diameter aluminum bar stock. They are prepared from stock in 4 to 10-foot lengths and then cut in lengths slightly longer than the distance between the outside edges of the opposite end of the frame. The groove is cut by pushing the rod stock through a milling machine with a fixed position center.



Section of frame with rods not yet in place. Additional drilled holes are for mounting strip connectors



Circuit board slides into grooves milled in rods

The strips seen in Fig. 1B are prepared by drilling holes in a line near the top edge of the strip or angle stock. The edge of the strip is then sheared off, leaving smooth-sided D holes (Fig. 2).

The D holes in the strips seen in Fig. 1D are punched. The additional material above or below the holes serves as mounting plates for printed circuit board connectors.

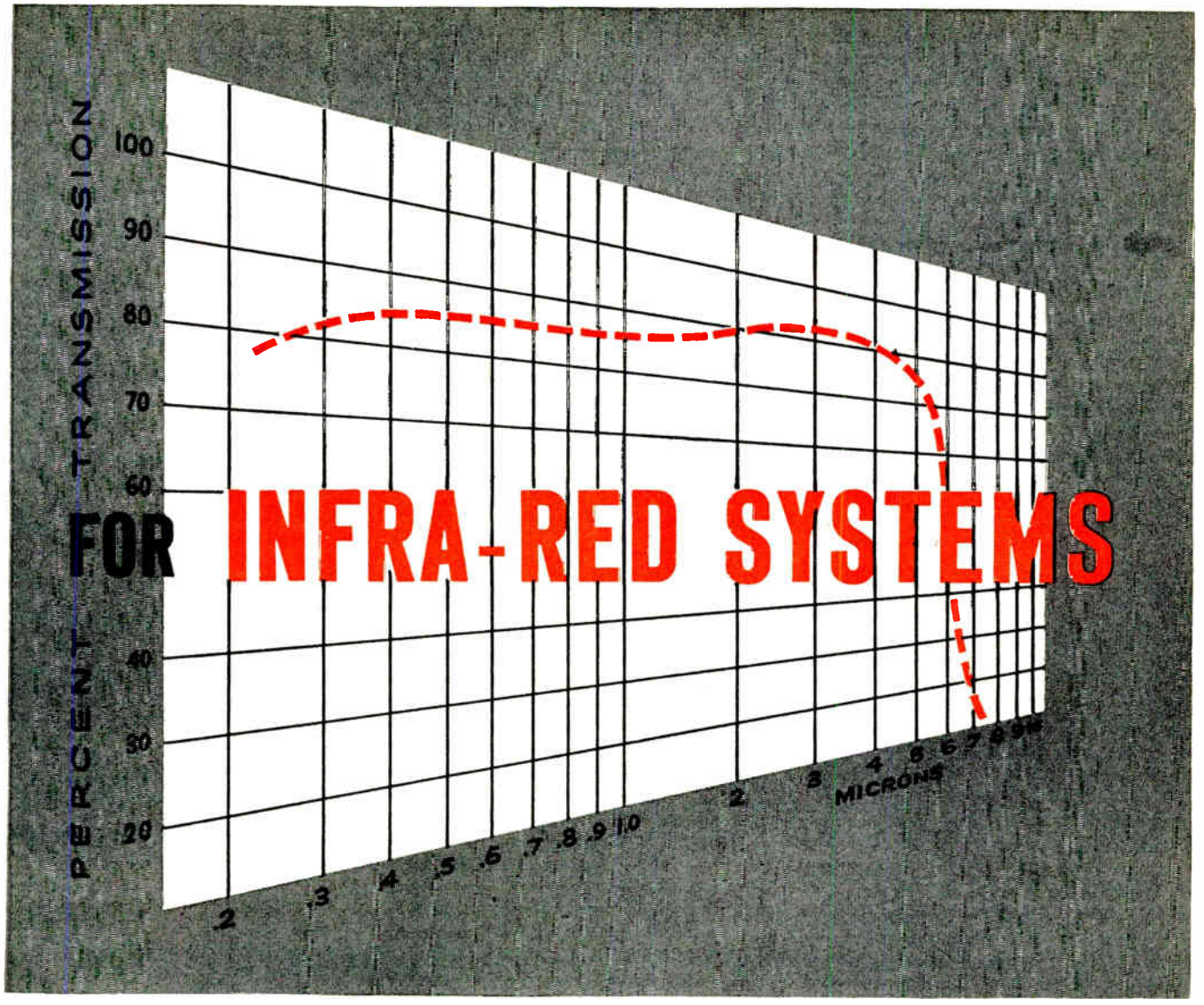
Rods Can't Move

Shape of the D holes prevents vertical movement of the rods. The rods slide easily through the drilled holes (Fig. 1C). But they are driven through the punched holes (Fig. 1D). This force fit swages the rods in place, since the thin edges of the rod groove are slightly deformed by the flat top of the hole. For additional strength and rigidity, the rods can be swaged to the front brackets as indicated in Fig. 1C.

The deformation is confined to the rod portion in the hole and beyond. The remainder of the groove remains smooth, permitting easy insertion and removal of the board. The board becomes locked in place when the cabinet is closed.

Poly-Glycol Fluxes Avoid Fire Risk

SOLDERING FLUX solvent of polyethylene glycol may provide a useful alternative to alcohol solvents, according to a report in the *Journal*,



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Spring, 1959, of the Tin Research Institute, Greenford, England. Fluxes made with the glycol are said to have no fire risk.

Polyethylene glycol was found to resist evaporation, have little effect on the activity of resin or activated resin flux, give off no unpleasant odor or intoxicating fumes and leave no charred residues on copper. The low evaporation prevents excessive pickup of resin by printed circuit boards which are to be dip soldered, it was reported.

Test Results

Polymers of molecular weights 200, 550 and 4,000 were obtained from Shell Chemical Co., Ltd. All took up 20 percent by weight of resin (Hercules Powder Co. Polypale). The 200 is liquid when cold, 550 is a soft paste and 4,000 is a waxy solid, but melts on hot water.

After 4 hours on hot water, the 200 resin flux mixture lost 2 percent by weight; the 550, 1 percent, and the 4,000 loss was negligible. Flash points are 200, 171 C; 550, 238 C, and 4,000, 271 C. None caught fire when placed on molten solder at 300 C.

Hand Tool Quickly Strips Wire Shield

End of braid on stripped wire is slightly frayed. The plunger is retracted

REMOVING braided wire shield is simplified with a hand tool used at Missile System Division, Lockheed Aircraft Corp., Van Nuys, Calif. The tool consists of a hollow tube with a rounded nose and a wire plunger.

Use of the tool is illustrated in the photos. This method takes about 15 seconds and does not damage the

MAIN PLANT — ELKHART, INDIANA • Manufacturers of variable resistors, precision wire fixed resistors, tube savers, switches and other special components for radio, television, commercial and military electronic equipment.

CANADIAN SUBSIDIARY — C. C. Meredith & Company, Ltd., Streetsville, Ontario, Canada • Manufacturers of variable resistors and associated switches, industrial rectifiers (selenium, silicon, tube, regulated—mechanical and static control, non-regulated), emergency/normal motor generator sets, diesel driven generators, 400 cycle motor generators, control panels, switchboards, and photo-electric street lighting controls.

EXPANDS

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MIDWEST SUBSIDIARY — CTS, Inc., Berne, Indiana • Manufacturers of wirewound variable resistors, buzz and balance rheostats and special electronic components.

SOUTHEASTERN SUBSIDIARY — CTS of Asheville, Inc., Mill Gap Road, Skyland, North Carolina • Manufacturers of variable resistors and associated switches.

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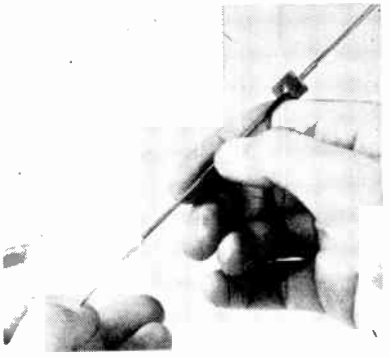
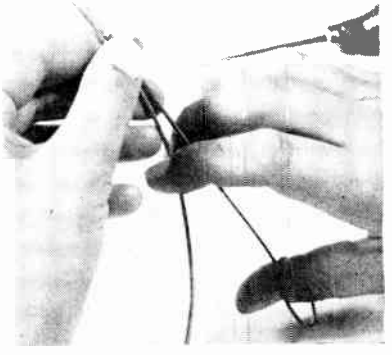
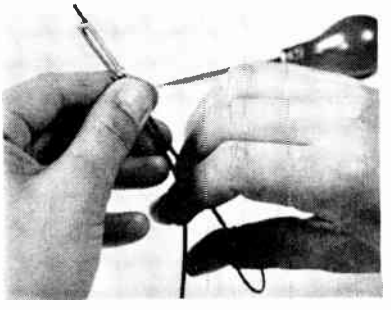


The tool's tube is slid between shielding and wire for about 1 inch

Shield is bent at end of tube and rounded point of tube is pushed through braid



Plunger is pushed through tube. Thumb in loop, fingers on cross bar squeeze as for hypodermic



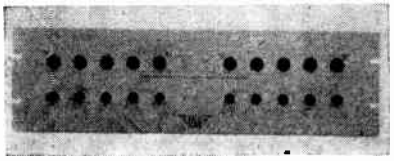
As plunger is fully depressed, the wire is ejected from the shield. Tool is then removed from braid and braid is smoothed by hand

braid. Formerly, the braid was teased off the wire with a dull awl, which took about 4 minutes and resulted in about 10 percent of the braids being damaged.

On The Market

Attenuator with dial lights

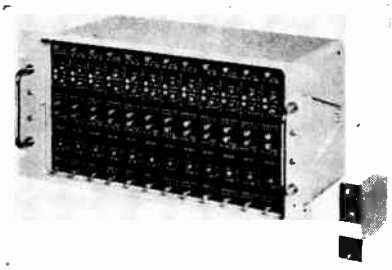
THE DAVEN CO., Livingston, N. J., has developed a new variation of its RF540 and 550 push button attenuator. As a Spec 7130 network, dial lights are installed which indicate the total attenuation in decibels when one or more of the dial buttons are depressed. The dial lights will operate from an external 6 v source. All units have a flat frequency response from d-c to 225 mc. They are available for a total of either 120 db in steps of 2 db or 100 db in steps of 1 db.



CIRCLE NO. 200 READER SERVICE CARD

Normalizing Network in modular form

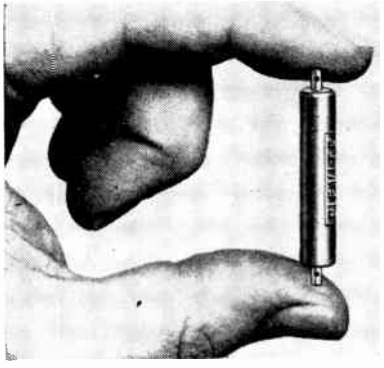
KAUKE AND CO., 1632 Euclid St., Santa Monica, Calif. A system of normalizing networks capable of accepting a wide variety of transducer signals and featuring modular form has been developed. Each of the eight different types of plug-in networks contains circuitry applicable to a particular type of transducer such as strain gages or thermocouples and provides means for a normalized output acceptable by a wide variety of multiplexing and encoding systems.



CIRCLE NO. 201 READER SERVICE CARD

Ceramic Filters miniaturized

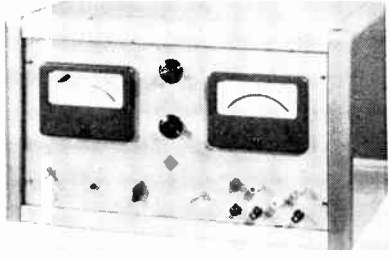
CLEVITE ELECTRONIC COMPONENTS, Division of Clevite Corp., 3311 Perkins Ave., Cleveland 14, Ohio, announces a line of ceramic ladder filters with increased selectivity and greater frequency stability for use in i-f sections of modern superheterodyne communications systems. Units with a center frequency of 455 kc and 6 db bandwidth ranging from 4 to 50 kc have very little insertion loss. Up to 90 db rejection to frequencies outside the pass band is provided. The low impedance input of the filters make them ideal for transistor circuit applications. Units occupy less than 1 cu in. as compared to the 64 cu in. volume required by some conventional filters.



CIRCLE NO. 202 READER SERVICE CARD

Relay Tester automatic unit

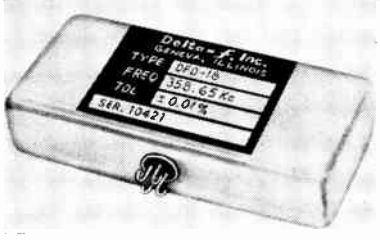
MID-EASTERN ELECTRONICS, INC., 32 Commerce St., Springfield, N. J. This new instrument provides an accurate means of inspecting the pull-in and drop-out characteristics of relays on a production line basis. A motor-driven variable voltage transformer furnishes automatic constant-rate increases and decreases in voltage and an automatic voltage increase is impressed on the relay coil before the drop-out cycle, which causes the relay to pull in harder before the decrease cycle.

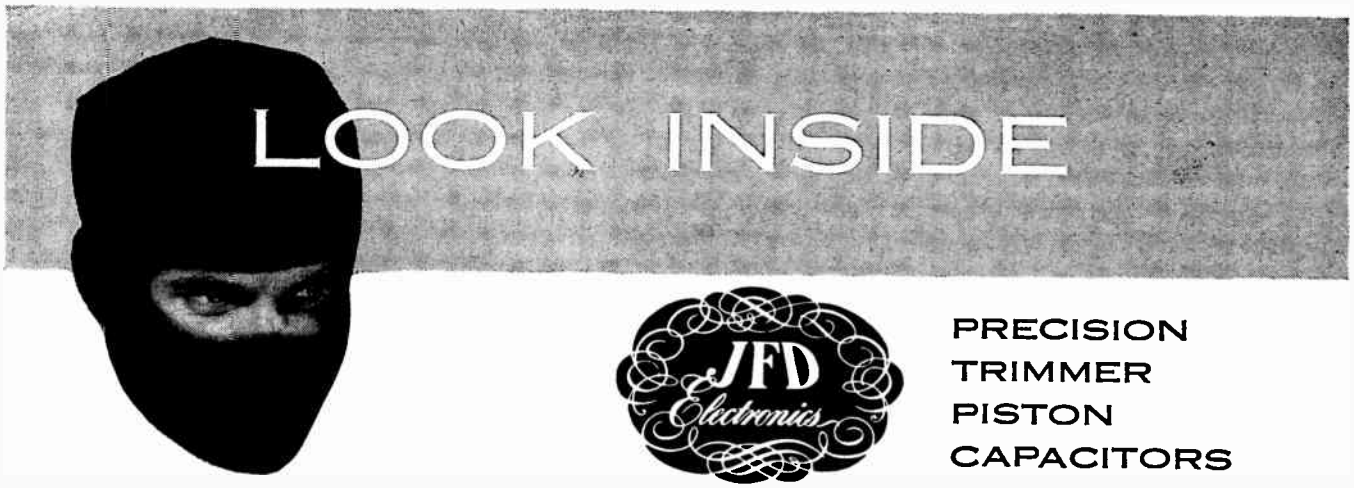


CIRCLE NO. 203 READER SERVICE CARD

Crystal Oscillator transistorized

DELTA-F, INC., 113 E. State St., Geneva, Ill. The DFO-18 transistorized crystal oscillator is now available for commercial use at any specified frequency in the 10 kc to 100 mc range. A completely encapsulated circuit, the package size is only ½ in. high, 1⅛ in. wide and 3⅛ in. long. The DFO-18 is available in the 4-pin solder type connector positioned as illustrated or any other type or position compatible with the unit size. Operating





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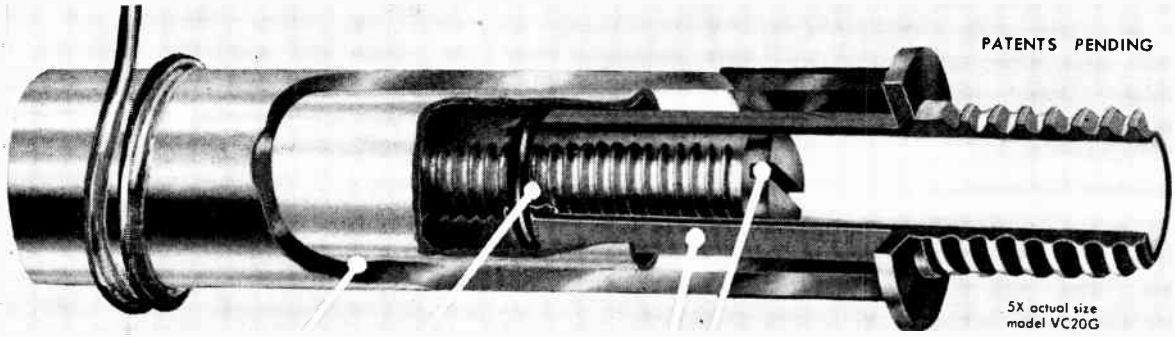

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(No compromises here that must be compensated for by substitution of expanding core type piston.)

Painstaking assembly of precision-machined bushing and full-threaded anti-backlash adjusting mechanism insures perfect coaxial alignment of piston inside cylinder for all adjustments. Result: No tuning reversals. Absolute repeatability.

(No compromise here with direct traveling mechanism that requires additional encumbering parts leaving no room for vital anti-backlash spring . . . or square adjusting shaft threaded only at corners and having short rotational life.)

Gold plating over special JFD alloy plating enables all metal parts to withstand 50 hour salt spray test and provides superior R.F. conductivity.

(No compromise here with porous silver-plating which permits corrosion of base metal.

Screwdriver adjust slot (or hex socket) recessed within well for ease of location and blind hole tuning.

(No compromise here with protruding adjusting shaft which adds to overall length of capacitor and lacks ease of tuning.)

actual size
model VC20G
0.8 mmf. min.—8.5 mmf. max.

actual size
SEALCAP
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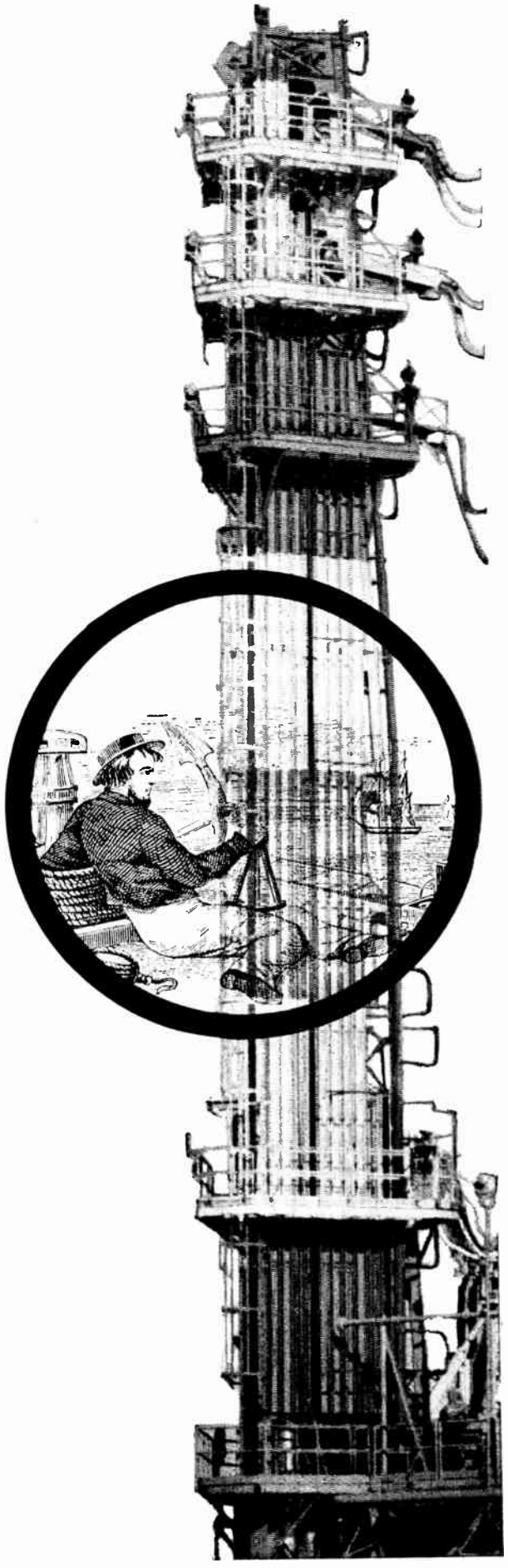


PORT OF EMBARKATION

In the decade of missilery ahead, prime contractor capability must go far beyond the requirements of hardware design and manufacture. New experience and facilities are now required in the increasingly critical launching phase—from ground handling and testing to countdown and data control.

Martin's Cocoa Division is the first organization of its kind devoted exclusively to this specialized area. Accomplishments have already established new operational standards at Cape Canaveral, one of the two U.S. ports of embarkation for the major space events of the decade ahead.

An example of the latest development in electronic fail-safe launching equipment is the new Martin Master Operations Control [MOC] system, which automatically monitors count-down procedures in the test firing of research and development-type TITAN missiles. With equipment such as this, TITAN launchings have achieved unheard-of performance reliability.

temperature range is −55 C to +90 C with a frequency stability of 0.005 percent to 0.015 percent, depending on the specified frequency.

CIRCLE NO. 204 READER SERVICE CARD

Synchronous Motors 26, 55, 120 v/a-c

WESTERN GEAR CORP., Electro Products Division, 132 W. Colorado St., Pasadena, Calif., announces new size 10 and 11 gearhead hysteresis synchronous motors. Units are available for 26, 55 or 120 v a-c 400 cycle operation. They may be supplied in any gear reduction required up to 8,000:1. They are designed for operation in ambient temperatures from −65 C to +125 C.

CIRCLE NO. 205 READER SERVICE CARD

Frequency Recorder narrow-range

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Designed to measure the critical 58 to 62 cycle band with an accuracy of ±0.05 cycle, the new narrow-range CH frequency recorder is self contained for economical mounting and wiring. Calibrating the 6-in. record roll for only four cycles achieves higher recording accuracy and greater chart readability.

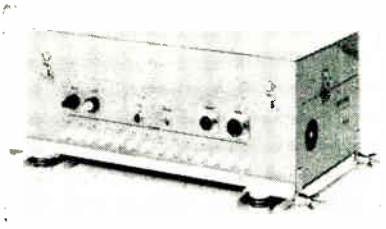
CIRCLE NO. 206 READER SERVICE CARD

Silicon Switch three terminal

WESTINGHOUSE ELECTRIC CORP., Semiconductor Div., Youngwood, Pa. The Trinistor is a three terminal multijunction silicon *npnp* switch, whose breakover voltage can be controlled by the base current. In the forward or conducting direc-

tion, with no input signal to the base terminal, the device will block up to the full rated voltage. When a base signal is applied the Trinistor will switch from a blocking to a conducting condition, characterized by a low forward drop similar to that of a conventional silicon diode. Unit is designed for applications in circuits with voltage up to 400 v and currents up to 50 amperes.

CIRCLE NO. 207 READER SERVICE CARD



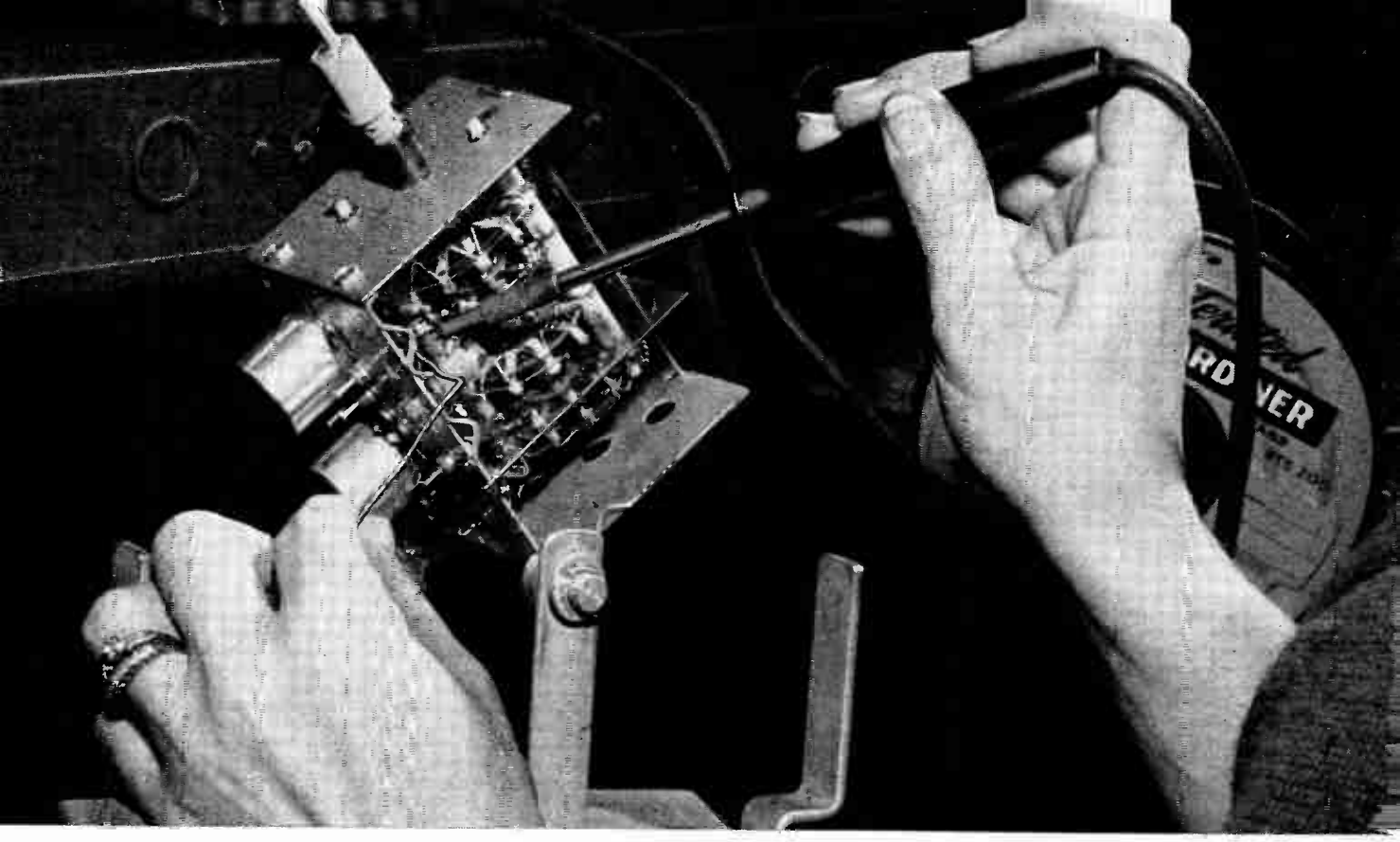
Data Handler miniaturized

EPSCO-WEST, 125 E. Orangethorpe Ave., Anaheim, Calif., announces an airborne miniaturized data handling system. It will be used to make compatibility studies of air to surface missiles. Unit takes the parallel output from a series of shaft position-to-digital encoders, serially selects specified output bits, resolves all binary ambiguity and records these specified bits on a 14 channel magnetic tape recorder. Data input is obtained by paralleling the output of a diode switching matrix and serially sampling a number of shaft position-to-digital encoders.

CIRCLE NO. 208 READER SERVICE CARD

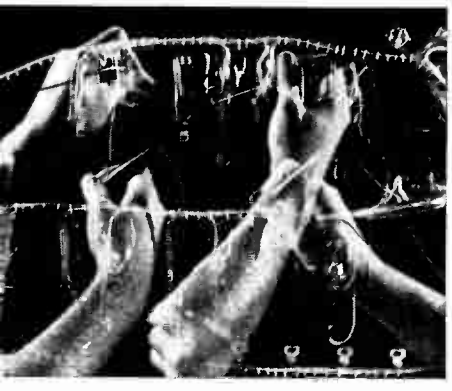
Voltage Converter light-weight

CENTRAL SCIENTIFIC CO., 1700 Irving Park Road, Chicago, Ill., has developed an instrument for converting low voltage d-c to high voltage d-c. It weighs only 3½ lb, and contains no moving parts, tubes or vibrators. The converter is instant starting, practically silent in operation, and creates no electrical interference. Unit utilizes two power transistors in an oscillator circuit similar to the multivibrator in v-t circuits. The transistors act as switches in the primary side of a special toroid transformer. The



"IT'S SIMPLE ECONOMICS," says Mr. Robert R. Keller, Process Engineer at Sarkes Tarzian Inc., well known electronics components manufacturer in Bloomington, Indiana. "We have an average of 185 General Electric Midget soldering irons in operation on our television tuner assembly lines. We find the G-E Midget iron more efficient than our heavier irons on many operations. Each iron solders an average of 85,000 joints every year. Some irons solder as many as 150,000 joints per year. Compared to maintenance and replacement costs on other soldering irons we have tested and used, we save approximately $57.50 per year on each iron. Our present annual saving with all the G-E Midget irons is about $10,600." Sarkes Tarzian Inc., found that the rugged ironclad copper tips on the Midget last from six to nine months, provide fast, concentrated heat with reduced risk of loosening nearby joints.

Every Year, 185 General Electric Midget Irons Save Over $57 Each At Sarkes Tarzian Company



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-5, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE NO. 107 READER SERVICE CARD

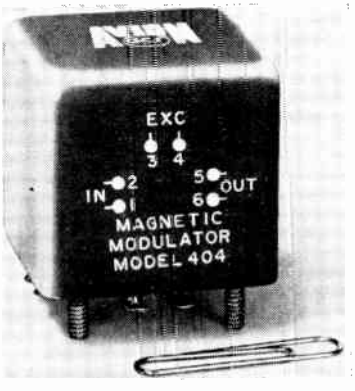
square wave produced is stepped up by the toroid and rectified by a bridge circuit consisting of eight silicon rectifiers. The output is then filtered so as to reduce the ripple content to a negligible value.

CIRCLE NO. 209 READER SERVICE CARD

Autotransformers ruggedized

GENERAL RADIO CO., West Concord, Mass. Two types of metered Variacs (using 5-ampere-rated Variacs) have meters in the output or load circuit so that voltage, current or power measurements can be made directly. One provides direct volt and ampere readings (W5MT3A); the other affords direct voltage and wattage information (W5MT3W). Meter shielding reduces the Variac stray field so that an overall accuracy of 3 percent (full scale) can be obtained with 2 percent meters.

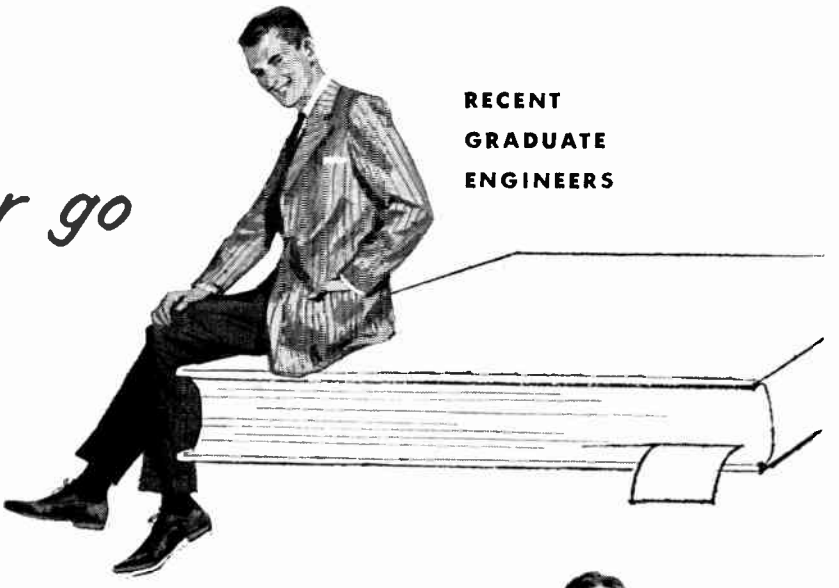
CIRCLE NO. 210 READER SERVICE CARD



Magnetic Modulator wide band

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. Model 404 series of magnetic modulators exhibits unusual wideband characteristics by operating with an excitation frequency of 100 kc. It is especially useful as the key component of low-level, stable,

How far can an engineer go at AC?



RECENT GRADUATE ENGINEERS

Free education for the space age

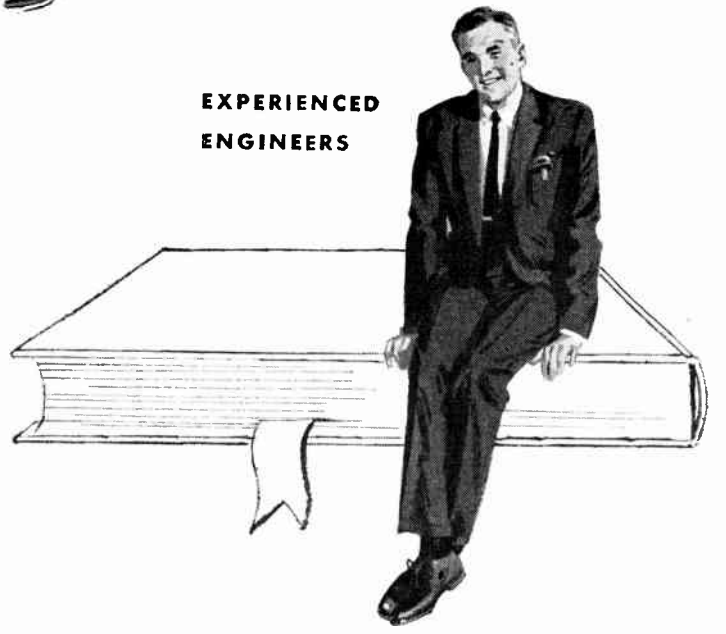
Three levels of special advanced training that can help you prepare for promotion and enhance your professional status. That's what you'll find when you go to work in AC's instrumentation business.

Program A—for recent graduate engineers—gives you a solid foundation in the theory and application of inertial guidance systems and servomechanisms.

Program B—for experienced engineers—consists of upgrading studies in inertial guidance, servomechanisms, environmental problems, engineering math and physics, plus advanced state-of-the-art courses.

Program C—for all engineering supervisors—involves management training developed by a team of AC executives and University of Chicago industrial relations experts.

Comparison will prove these are the finest "in house" programs available anywhere. And they are educational "extras," for AC offers them in addition to their educational assistance programs for men who wish to study for advanced degrees in nearby universities.

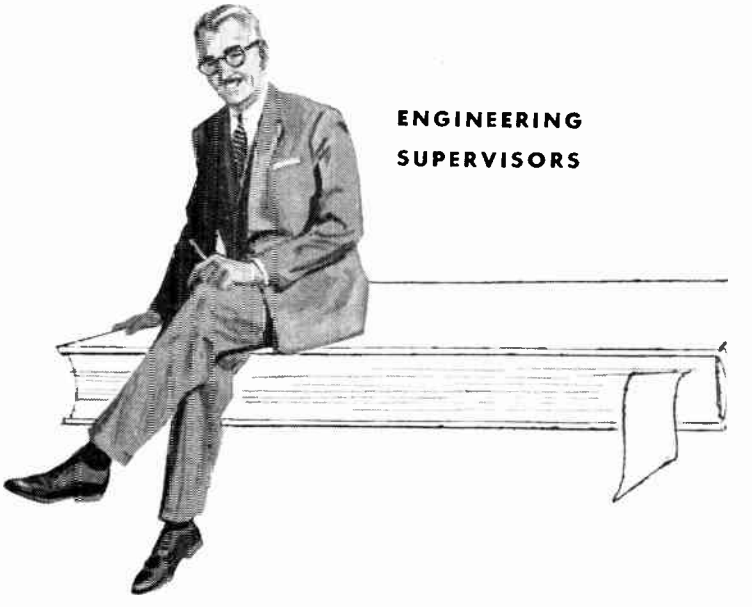


EXPERIENCED ENGINEERS

You may be eligible for training . . .

if you are a graduate engineer in the electronics, electrical or mechanical fields, or if you have an advanced degree in mathematics or physics. You'll study while you work on the renowned AChiever inertial guidance system or a wide variety of other electromechanical, optical and infra-red devices.

For more information, write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. A, Box 746, South Milwaukee, Wisconsin.



ENGINEERING SUPERVISORS

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

INERTIAL GUIDANCE SYSTEMS • AFTERBURNER FUEL CONTROLS • BOMBING NAVIGATIONAL COMPUTERS • GUN-BOMB-ROCKET SIGHTS • GYRO-ACCELEROMETERS • GYROSCOPES SPEED SENSITIVE SWITCHES • SPEED SENSORS • TORQUEMETERS • VIBACALL • SKYPHONE

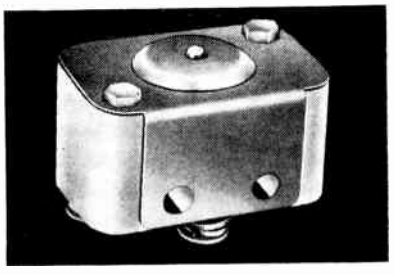
wideband d-c amplifiers. Output is a second-harmonic signal of the exciting frequency, whose amplitude and phase are functions of the amplitude and polarity of the input signal. Modulator can be used at low signal levels because of the inherently excellent zero stability of the magnetic second-harmonic principle.

CIRCLE NO. 211 READER SERVICE CARD

Magnetic Amplifiers two new models

WESTBURY ELECTRONICS, INC., Westbury, N. Y., announces two new models of magnetic amplifiers. Model SR-4 comprises eight different types covering output powers up to 18 w. Model SS-4 is an exceedingly high-gain device (power gain 300,000) with weight of 2 lb, 5 oz. Both units operate from a 400 cps source and are hermetically sealed.

CIRCLE NO. 212 READER SERVICE CARD



Precision Switch spdt device

METALS & CONTROLS DIVISION, Texas Instruments Inc., Attleboro, Mass. A new spdt limit or sensitive switch, the Klixon 21135-1, will maintain its operating characteristics during long exposure to temperatures as high as +800 F. It is designed for precision applications on aircraft and guided missiles, and for use in furnaces, ovens and other high-temperature environments. All components are completely inorganic.

CIRCLE NO. 213 READER SERVICE CARD

Ultrasonic Cleaner for small parts

DETREX CHEMICAL INDUSTRIES, INC., Box 501, Detroit 32, Mich., has introduced a new model Econo-Sonic unit that is a complete cleaning,

are you silicon wait-bait?

avoid unnecessary delays

GT DELIVERS SILICON TRANSISTORS IN 24 TO 48 HOURS!

No need to get hung up with delays or hooked by unkept promises! GENERAL TRANSISTOR delivers sample quantities of GT Silicon Transistors in 24 to 48 hours... production quantities in 2 to 4 weeks!

These are not mere claims, but firm promises on which you can base your design and production schedules.

Quality? Yes—plenty of weight here without waiting. General Transistor is today one of the largest suppliers of highly dependable devices, delivering **quality** in **quantity.**

For full information—**and fast delivery**—call your local General Transistor representative, or contact us directly. Write for Silicon Brochure S-100.

GENERAL TRANSISTOR CORPORATION

91-27 138th Place, Jamaica 35, New York
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A Few of the GT Alloyed Junction Silicon Transistors Now Available

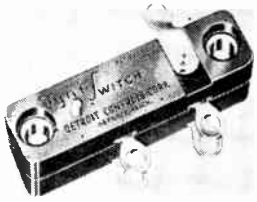
- **HIGH SPEED SWITCHING**
- **MEDIUM SPEED SWITCHING**
- **HIGH VOLTAGE**
- **HIGH SPEED LINEAR AMPLIFIER**
- **MEDIUM SPEED LINEAR AMPLIFIER**

	2N1219	2N1220	2N1221	2N1222	2N1223
V_{CBO}	30 v	30 v	30 v	30 v	40 v
V_{CEO}	25 v	25 v	25 v	25 v	40 v
V_{EBO}	20 v	20 v	10 v	10 v	10 v
I_{CO}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h_{FE}	18 min.	9 min.	—	—	—
f_{ab}(mc)	5 min.	2 min.	5 min.	2 min.	2 typ.
h_{fe}	—	—	18 min.	9 min.	6 min.

FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK. PRECISION MAGNETIC RECORDING HEADS AVAILABLE FROM GENERAL TRANSISTOR WESTERN CORP., 6110 VENICE BLVD., LOS ANGELES, CALIF.

distillation and filtration system in itself. Priced at only $1,750, the unit pre-cleans, ultrasonic cleans and pressure-spray rinses. It is ideally suited for the use of manufacturers of small precision parts. Unit measures 38½ in. wide, 17½ in. deep and 28¼ in. high.

CIRCLE NO. 214 READER SERVICE CARD



Snap Acting Switch
high precision

DETROIT CONTROLS DIVISION, 5900 Trumbull Ave., Detroit 8, Mich. Ratings for the Class 1 and Class 4 TyniSwitches are 15 amperes and ½ h-p, 125 and 250 v, a-c; and 10 amperes and ⅓ h-p, 125 and 250 v, a-c. Switch features sharp contact break and virtually bounceless contact make.

CIRCLE NO. 215 READER SERVICE CARD

Moisture Gage
transistorized

HENRY FRANCIS PARKS LABORATORY, P. O. Box 1665, Lake City Station, Seattle 55, Wash. Model 101 moisture gage features printed circuitry wiring and long battery life. Accuracy is ±2 percent at 70 F ambient for materials whose d-c resistance ranges between 0 and 85,000 ohms and for which it has been calibrated. It measures 6¼ in. long by 3¾ in. wide, by 2¾ in. deep; weighs less than 1½ lb.

CIRCLE NO. 216 READER SERVICE CARD

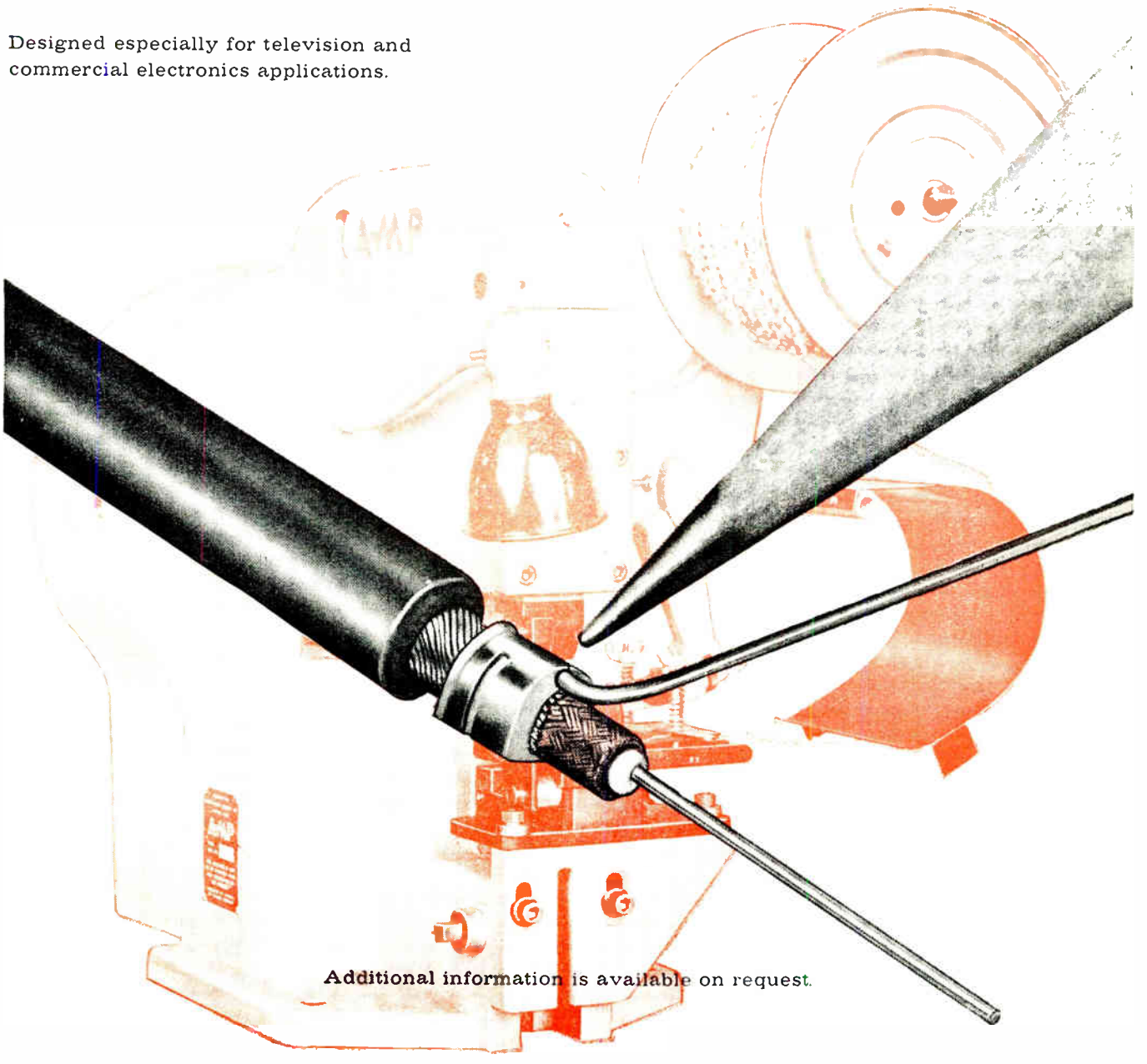
Crystal Oven
change-of-state

ROBERTSHAW-FULTON CONTROLS CO., 911 E. Broad St., Richmond 19, Va. Model 35 Thermal-Set, a change-

NOW... AUTOMATED PIGTAILING ...AT 75% LESS COST - with the NEW AMP Automachine Shielded Wire Ferrule

● machine-fed ferrules and pigtail wire ● controlled compression termination, with AMP automachine technique ● dual applicator permits termination of two leads or double-ended jumper, simultaneously ● pigtails cut to desired length, automatically!

Designed especially for television and commercial electronics applications.



Additional information is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

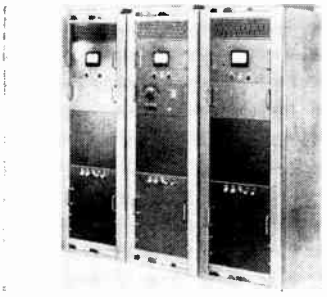
of-state crystal oven, was developed to meet the requirements for an oven combining small size with precise temperature control, no thermal oscillation or contact noise, low power consumption, and long-term cavity temperature stability. Cavity temperature variation is less than 0.01 C per deg ambient temperature change.

CIRCLE NO. 217 READER SERVICE CARD

I-F Filter
highly selective

HERMETIC SEAL TRANSFORMER CO., 555 N. Fifth St., Garland, Texas. A highly selective i-f filter weighs less than 12 oz. Center frequency, 460 kc;—6 db 440 kc—480 kc;—90 db 415 kc—505 kc; input/output impedance, 17,500 ohms; insertion loss, approximately 14 db; temperature stability: CF shift 500 cycles, —40 C to +65 C. Surpasses MIL-T-27A vibrational, shock and humidity specifications.

CIRCLE NO. 218 READER SERVICE CARD



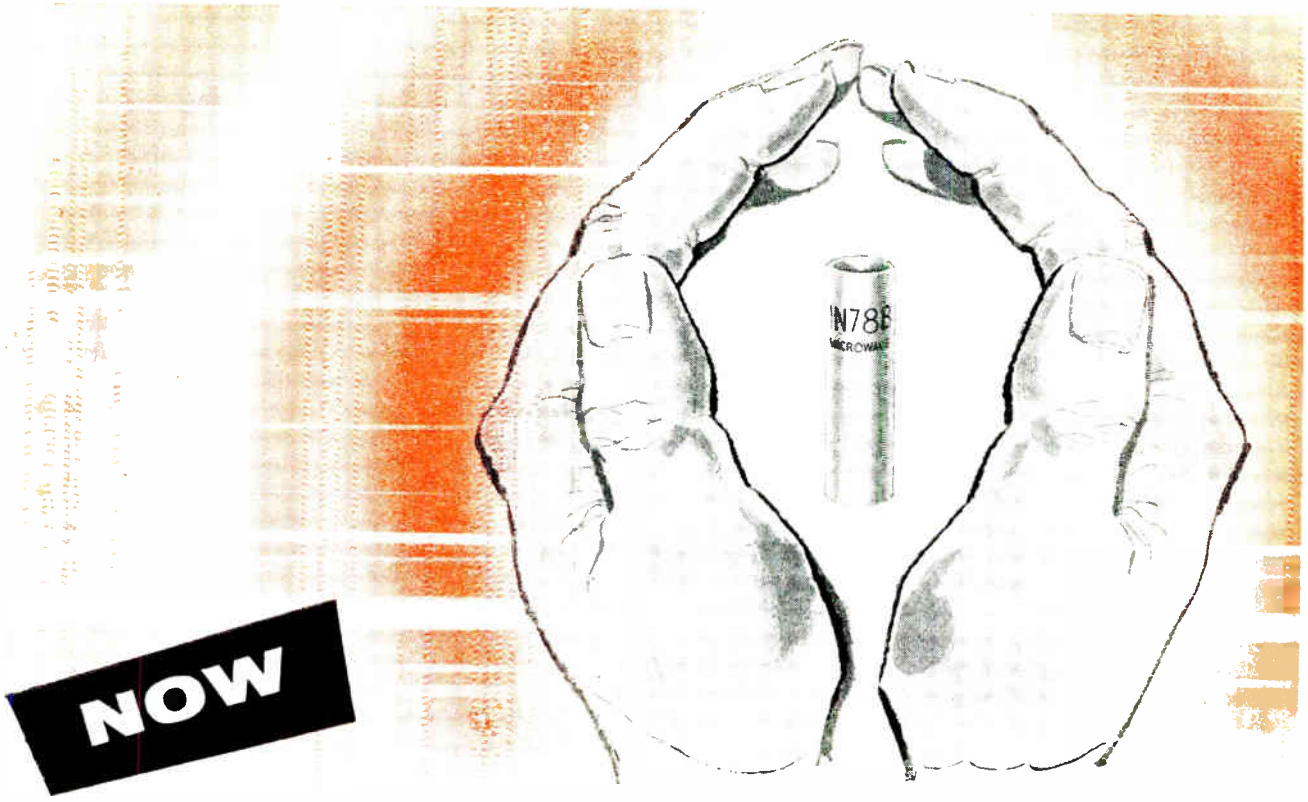
A-C Power Source
15 kva output

BEHLMAN ENGINEERING CO., 2911 Winona Ave., Burbank, Calif. Model 15003-D-1 Invertron a-c power source has an output of 15 kva, three phase, and a frequency variable over the range of 300 cps to 450 cps. Input power for this model is 460 v, 60 cps, three phase.

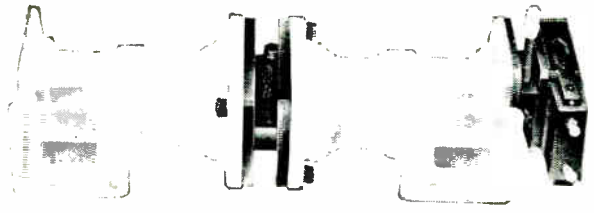
CIRCLE NO. 219 READER SERVICE CARD

Tachometer
electro-optical

GEBR. MAYER G.m.b.H. Neheim-Husten 2, Germany. The Touro-Strob is an electro-optical tachometer with all the advantages of speed measurement without loss of power and mechanical coupling. It is designed for speed measurements

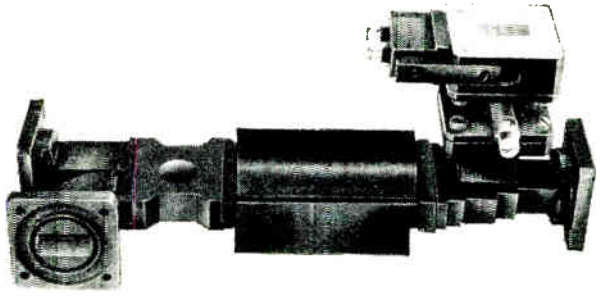


Guaranteed protection in Ku band!



BALANCED DUPLEXER: DUAL PRE-TR, DIODE PROTECTOR, SHUTTER

BALANCED DUPLEXER: DUAL TR, SHUTTER



FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER

New Microwave Associates Ku Band duplexers give you guaranteed crystal protection - for life - at full rated power and elevated temperatures.

For the first time, Ku Band users are enjoying crystal protection never before attained in this band!

New, highly successful gas tube and ferrite devices of proven design but previously produced for L, S & X bands, are now in actual production for Ku Band . . . and available for immediate delivery.

These new duplexers developed by Microwave's Switching Devices Laboratory under the direction of Dr. Lawrence Gould are guaranteed to solve premature crystal burnout problems. One of these systems will bring you optimum duplexer performance and reliability. All three use the MA-760 shutter for standby receiver protection.

If you work with the Ku Band, you owe it to yourself to see how these latest developments from Microwave will bring you new concepts in receiver performance and crystal protection. Write or call our application engineering department.

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASS. TEL. BRowning 2-3000

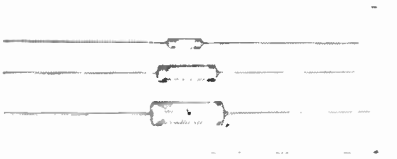
between 200 and 15,000 rpm, in three ranges: 200-900 rpm, 900-3,600 rpm and 3,600-15,000 rpm. The neon discharge tube produces a sharply focused red light which can easily be observed in daylight. All measurements are done on electrical and optical principles using the stroboscopic effect and require no mechanical coupling to the part under examination.

CIRCLE NO. 220 READER SERVICE CARD

Tracking Antenna transportable

D. S. KENNEDY & Co., Cohasset, Mass. Transportable tracker features folding 28-ft reflector, hand-operated el-az drive system and self-contained trailer mount and tower. Reflecting surface is a special cloth which folds compactly, and ribs of reflector are hinged around center section. Antenna can be towed by light truck or station wagon.

CIRCLE NO. 221 READER SERVICE CARD



Resistors high precision

PYROFILM RESISTOR CO., INC., U. S. Highway No. 46, Parsippany, N. J. The new Pyro-Seal MIL series resistors provide the military equipment designer with resistors capable of withstanding shock at 500 g, temperature at 200 g, acceleration at 100 g and vibration over 15 g which far exceeds military specifications. The miniaturized units will maintain characteristics even under long storage at high humidity and temperature. They are power rated at $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{1}{2}$ w.

CIRCLE NO. 222 READER SERVICE CARD

Discriminator phase-lock

VECTOR MFG. CO., INC., 3040 Overland Ave., Los Angeles 34, Calif. A new f-m subcarrier discriminator is completely transistorized and utilizes phase-lock detection tech-

Exceptional openings
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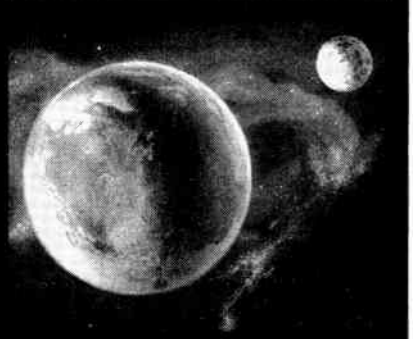
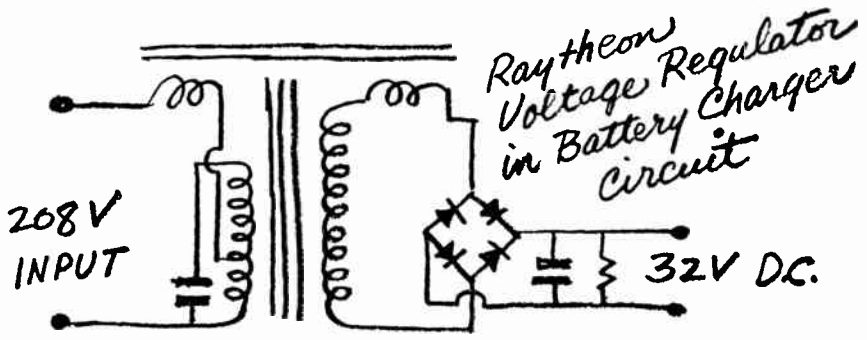


BOEING
...environment for dynamic career growth

IS CONSTANT VOLTAGE POSSIBLE IN THESE CHANGING TIMES?



...Basically, the problem is a classical one of semantics. Higher minds than ours have pondered this question for centuries.

As a practical exercise, let us examine the case of voltage regulation reference source in the power supply circuit shown above. This passive network corrects input voltage changes of more than ±15% of rated outputs and controls them to within ±½%...a feature that is highly important in keeping storage batteries alive longer.

The point is that constancy is a relative term understood only against a background of change. The answer then to the initial question is "yes"...constant voltage is possible.

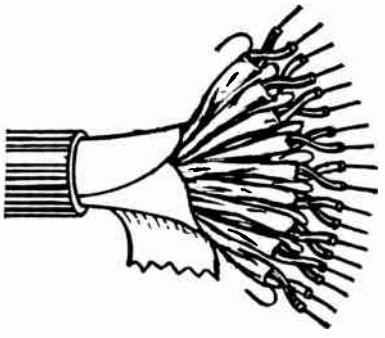
You can get the Complete Story about voltage regulators from the higher minds at Raytheon by writing to:

VOLTAGE REGULATOR MAN
Raytheon Company
Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

RAYTHEON
Excellence in Electronics

niques. These techniques provide maximum quality of information signals with high noise content and appreciably improved threshold characteristics over conventional detection methods. Unit is only 2½ in. wide, and six channels can be mounted across a 19 in. panel required for just one channel of a conventional vacuum tube f-m telemeter discriminator. Circle 000 telemeter discriminator.

CIRCLE NO. 223 READER SERVICE CARD



Intercom Cables multiconductor

BELDEN MFG. CO., Chicago 80, Ill., introduces two new multiconductor, individually paired and shielded, intercom cables. Available with either 9 or 15 pairs of No. 22 Awg wires, these cables have individually shielded and completely isolated pairs. The extremely lightweight and efficient Beldfoil aluminum-Mylar shield is used. Each pair in the cable is shielded, and each shield is isolated from all others in the cable, providing noise free and more dependable communications at all times.

CIRCLE NO. 224 READER SERVICE CARD

Power Supply dual-range output

TECHNICAL MEASUREMENT CORP., 441 Washington Ave., North Haven, Conn., announces a compact, accurate 5,000 v power supply for gas proportional counters which use methane and other high voltage

0-15mc with ONE BASIC MULTI-PURPOSE SPECTRUM ANALYZER

PANORAMIC'S SPA-3

for maximum economy ...maximum application

Combines the most desirable features of a whole series of equipments and MORE . . . in one compact functional unit:

- 3 mc wide sweepwidth continuously adjustable down to 0
- Variable tuning control calibrated from 0 to 13.5 mc
- Variable resolution 200 cps to 30 kc
- Variable scan rate 1 cps to 60 cps
- Lin. log and square law amplitude scales
- High sensitivity — 20 μ full scale
- Calibrated 100 db attenuator

SPA-3/25 EXTENDS RANGE —200 cps to 25 mc

Same basic circuitry as SPA-3, but with greatly extended frequency range. Controls and parameters similar, except variable tuning control is calibrated 0 to 23.5 mc.

Ask for Catalog Digest and the PANORAMIC ANALYZER

the pioneer is the leader

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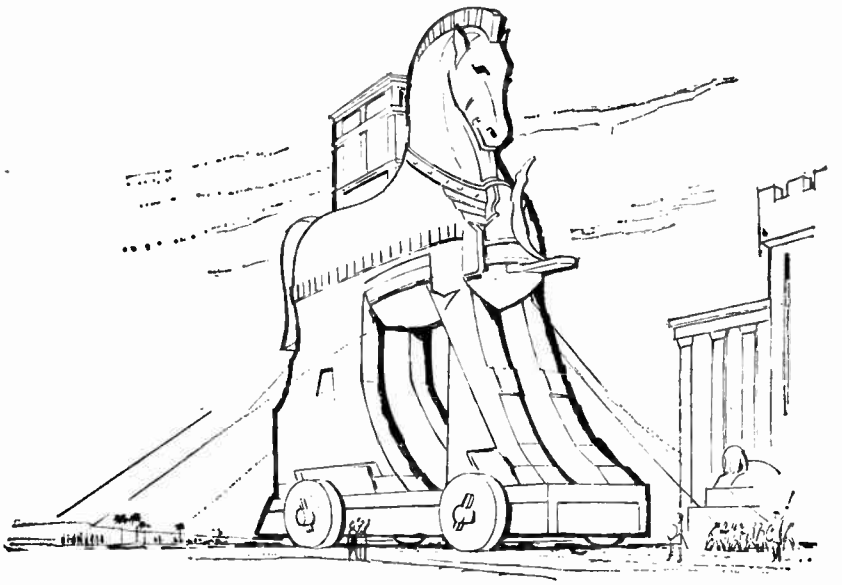
RADIO PRODUCTS, INC.

530 So. Fulton Ave., Mt. Vernon, N. Y.
OWens 9-4600
Cables: Panoramic, Mt. Vernon, N. Y. State



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The mature engineer's capacity to reach deeply into provocative lines of inquiry is particularly valued and encouraged at Melpar. Your own intellectual dimensions govern remuneration and assignments.

Opportunities are now available at Melpar in the following areas:

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10 miles from Washington, D.C.

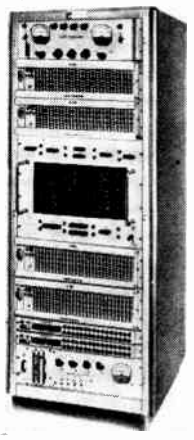
sec, and 50 v indefinitely at reduced power. Voltage drift is ±3 percent across a temperature range of from −55 C to +71 C.

CIRCLE NO. 227 READER SERVICE CARD

Impedance Plotter portable unit

CHESAPEAKE INSTRUMENT CORP., Shadyside, Md., has available the VILP (vector impedance locus plotter), a portable laboratory instrument designed to measure continuously, and plot automatically and simultaneously the rectangular components, resistance and reactance, of the equivalent series complex impedance of any passive electrical element.

CIRCLE NO. 228 READER SERVICE CARD



Memory all-transistor

COMPUTER CONTROL CO., INC., 92 Broad St., Wellesley, Mass. Model TCM is a new all-transistor, coincident current, ferrite core, high speed random access magnetic core memory with an 8 μsec cycle time. Word capacities up to 4,096 and word lengths up to 40 bits/word are readily assembled due to the flexibility of the modular construction employed.

CIRCLE NO. 229 READER SERVICE CARD

Pressure Pickup hermetically sealed

CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pasadena, Calif. Type 4-313A small light-weight transducer is available in absolute or gage models in pres-

LUCITE
PLEXIGLAS
ACRYLIC
ACETATE
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CAST PHENOLIC
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NAME PLATES
PINS
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SIZES: ⅛" to 2¼" LENGTHS: 1/16" to 9"

Write, wire, phone for samples, prices and Bulletin F listing stock items. Send specifications or blueprints for prompt quotations on specials.

New e-x-p-a-n-d-e-d production facilities now give you ACE PRECISION on all types of screw machine centerless ground parts and special shapes... all colors... all materials.

ACE PLASTIC COMPANY
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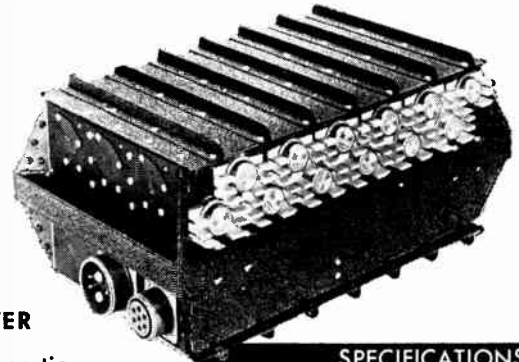

MODEL
4311

PRECISION POWER

★ Generation
★ Control
★ Measurement
★ Conversion

SPECIFICATIONS		
POWER OUTPUT	FREQUENCY	VOLTAGE
2 KVA	400 cps ± 0.1%	115-v, 3-phase, Y
SHORT CIRCUIT PROTECTION		

Microwave Power & Microcircuitry
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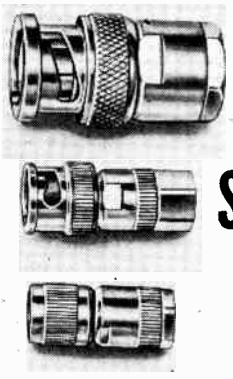
CHALLENGING ENGINEERING OPPORTUNITIES AVAILABLE

CIRCLE NO. 155 READER SERVICE CARD

Today's requirements call for miniaturization,

but...



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Automatic
MAKES THEM ALL!

Unit engineered to fit all available sub-miniature cables, AUTOMATIC'S Sub-Miniature Connectors are available in three types; BAYONET, PUSH-ON AND THREADED COUPLING.

Special receptacles available for printed circuit applications.

CHECK THESE FEATURES:
No special tools required for assembly. Foolproof clamping insures accurate alignment . . . positive contact . . . extra strong grip. Exclusive internal-parts design allows outside dimensions of connectors to remain constant regardless of cable dimensions.

For BAYONET, PUSH-ON and THREADED SUB-MINIATURE and MICRO-MINIATURE COAXIAL CABLE CONNECTORS, always specify AUTOMATIC. Our engineers are always ready to discuss your special requirements.

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METAL PRODUCTS CORP.

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sure ranges from 100 to 5,000 psi. It is especially adaptable to pressure measuring in corrosive, explosive or radioactive atmospheres, such as those encountered in water depth-determination, pressures in oil wells, liquid oxygen systems and gas or pipe lines.

CIRCLE NO. 230 READER SERVICE CARD

Capacitors for miniaturization

ELECTRON PRODUCTS CO., 430 N. Halstead Ave., Pasadena, Calif. Series M-150 and W-150 metallized paper capacitors feature small size and standard values and are now available from stock in round, rectangular and wafer configurations to suit the requirements for miniaturized packaging. These series are also available in hermetically sealed rectangular or round tubes for extreme environmental conditions. They have self-healing characteristics for utmost in reliability. Operating temperatures are − 55 C to + 125 C. Voltages available are 100, 200, 300, 400 and 600 v; values, from 0.001 μf to any value specified.

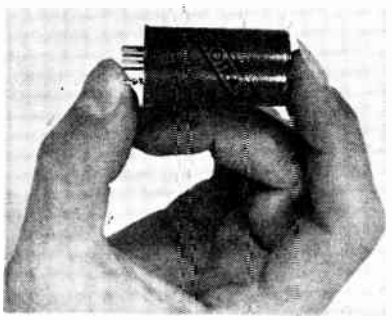
CIRCLE NO. 231 READER SERVICE CARD

Silicon Switch compact and rugged

SHOCKLEY TRANSISTOR CORP., Stanford Industrial Park, Palo Alto, Calif. Type AD is a higher power 4-layer diode. This self-actuated silicon switch is similar in function to a relay or gas tube. It is turned

on by a voltage pulse, turned off by dropping the current or reversing the voltage. To match circuit requirements, it is available with switching voltages of 30, 40, 50 and 200 v and holding currents of 5 to 45 ma. It is capable of handling 300 ma steady d-c or a 20-ampere pulse current.

CIRCLE NO. 232 READER SERVICE CARD



I-F Amplifier transistorized

FERROTRAN ELECTRONICS CO., INC., 693 Broadway, New York 12, N. Y. The Amplitran, a new semiconductor device, is a complete i-f amplifier stage encased in a tiny can 13/16 in. in diameter and 1½ in. high. It is completely transistorized and designed to plug into a 7-pin tube socket. The company's unique circuitry permits encasing the entire i-f stage without danger of oscillation or instability. The nature of the circuit also permits the cascading of these units to produce a complete i-f strip.

CIRCLE NO. 233 READER SERVICE CARD

Precision Pot 10-turn unit

SPECTROL ELECTRONICS CORP., 1704 S. Del Mar Ave., San Gabriel, Calif., announces a new ⅜ in. low cost ten-turn precision wire wound pot. Model 150 is available in ranges from 25 to 120 K ohms. Standard linearity tolerance is ±0.25 percent with tolerances of ±0.1 percent on special order. Unit will operate over a temperature range of −55 C to +105 C. Up to 46 additional terminals can be added to the standard unit for special applications. Sleeve bearings at both shaft ends are standard. Shaft diameter is ¼ in.

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CIRCLE NO. 158 READER SERVICE CARD

CIRCLE NO. 159 READER SERVICE CARD

CIRCLE NO. 160 READER SERVICE CARD

CIRCLE NO. 127 READER SERVICE CARD

Literature of

MATERIALS

Silicon Rubber. General Electric Co., Waterford, N. Y. Silicone rubber selector chart CDS-145 contains data on applications, typical properties, primary classes and standard industry and military specifications.

CIRCLE NO. 235 READER SERVICE CARD

High-Strength Adhesive. Adhesive Division, Houghton Laboratories, Inc., Olean, N. Y. A new one component adhesive, providing exceptional strength at 300 F and above, is described in a recent technical data bulletin.

CIRCLE NO. 236 READER SERVICE CARD

Microwave Ferrites. General Ceramics Corp., Keasbey, N. J. Bulletin 259, illustrated with graphs, describes and lists applications for a line of microwave ferrites.

CIRCLE NO. 237 READER SERVICE CARD

COMPONENTS

Magnetic Heads. J. B. Rea Co., 2202 Broadway, Santa Monica, Calif. An 8-page brochure discusses precision tape and drum heads, ranging from one to 64 channels.

CIRCLE NO. 238 READER SERVICE CARD

Power Transmission Components. Fourdee, Inc., Orlando, Fla. A 4-page folder illustrates and describes miniature Posiflex flexible couplings and shaft joints.

CIRCLE NO. 239 READER SERVICE CARD

Diode Catalog. Silicon Transistor Corp., Carle Place, L. I., N. Y. Form 1895 is a new 4-page catalog on silicon glass diodes.

CIRCLE NO. 240 READER SERVICE CARD

Power Packs. Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. Catalog sheet 117 describes a line of short-circuit-proof miniaturized power packs.

CIRCLE NO. 241 READER SERVICE CARD

the Week

Precision Switches. Unimax Switch Division, The W. L. Maxson Corp., Ives Road, Wallingford, Conn. The new 28-page catalog No. 359 contains detailed information on the expanded line of Unimax snap-acting precision switches.

CIRCLE NO. 242 READER SERVICE CARD

Inductive Potentiometers. Daystrom Transicoil Div., Daystrom, Inc., Worcester, Montgomery County, Pa. A size 8 inductive potentiometer line for air and missile borne electronics is described in data sheet 801-LP4.

CIRCLE NO. 243 READER SERVICE CARD

EQUIPMENT

Instrumentation. North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y. Bulletins 301 and 401 describe new a-c signal measuring and analyzing instrumentation.

CIRCLE NO. 244 READER SERVICE CARD

Airborne Tape Recorder. Ampex Corp., 934 Charter St., Redwood City, Calif., has published a 3-color, 12-page brochure on the new AR-200 airborne magnetic tape recorder.

CIRCLE NO. 245 READER SERVICE CARD

Induction Soldering Unit. Weldotron Division, Mils Engineering Co., 780 Frelinghuysen Ave., Newark 5, N. J., has published a flyer giving a description and specifications for the model 5L induction soldering unit.

CIRCLE NO. 246 READER SERVICE CARD

FACILITIES

Sonar. Stromberg-Carlson, a division of General Dynamics Corp., 1400 N. Goodman St., Rochester 3, N. Y. A new sonar brochure on current research, development and engineering projects and facilities in the field of underwater acoustics and communications is now available.

CIRCLE NO. 247 READER SERVICE CARD

CIC Opens Third Facility

COMPUTER INSTRUMENT CORP. recently expanded its engineering division into newly-leased quarters in Hempstead, N. Y. Company will now occupy three plants in Hempstead. The new facility contains approximately 10,000 sq ft.

The new plant is intended to consolidate under one roof all the research and development activities which previously occupied various remotely-located quarters. The company thereby hopes to gain greater efficiency in its R&D activities in the field of precision film potentiometer products, in which it is currently a leading manufacturer. Present plans include building the engineering staff up to a total of 50 by the end of this year.

Company points out that its film potentiometers figure prominently in many of the space-age vehicles currently on the drawing board and in production, including practically all U. S. military manned aircraft and more than 15 missiles of all types.

Elect Stevenson V-P at Raytheon

WILBERT E. STEVENSON, president and director of Machlett Laboratories, Inc., a subsidiary of Raytheon Co., has been elected a vice-president of Raytheon.

Merger of Machlett into Raytheon became effective May 25. Assets and business acquired by Raytheon in the merger were immediately transferred into a subsidiary named Machlett Laboratories, Inc. Machlett manufactures high-voltage, high-power electron tubes.

Stevenson, president of Machlett since 1955, had been vice-president in charge of sales of the Connecticut firm since 1935.

Filtors Expands

LLOYD ASPINWALL, JR., president of Filtors, Inc., Port Washington, N. Y., manufacturer of sub- and microminiature relays for the military, aircraft and missile markets, recently announced the completion and opening of the firm's new production reliability center. This 3,000 sq ft area is adjacent to Filtors' main building.

The new test center gives Filtors approximately twice the area previously employed and has enabled the growing firm to add more modern equipment for relay testing. Included, among others, are devices for electrical testing, heat and cold testing, vibration, shock and mass spectrometer leak detection.

Ramo-Wooldridge Hires Yoshida

MAKOTO YOSHIDA has joined the technical staff of the Ramo-Wooldridge Division of Thompson Ramo Wooldridge, Inc., Los Angeles, Calif.

Prior to joining R-W, he worked as an engineer for Amelco, Inc. He also held engineering positions with the Westinghouse Electric Division and Bendix Aviation.

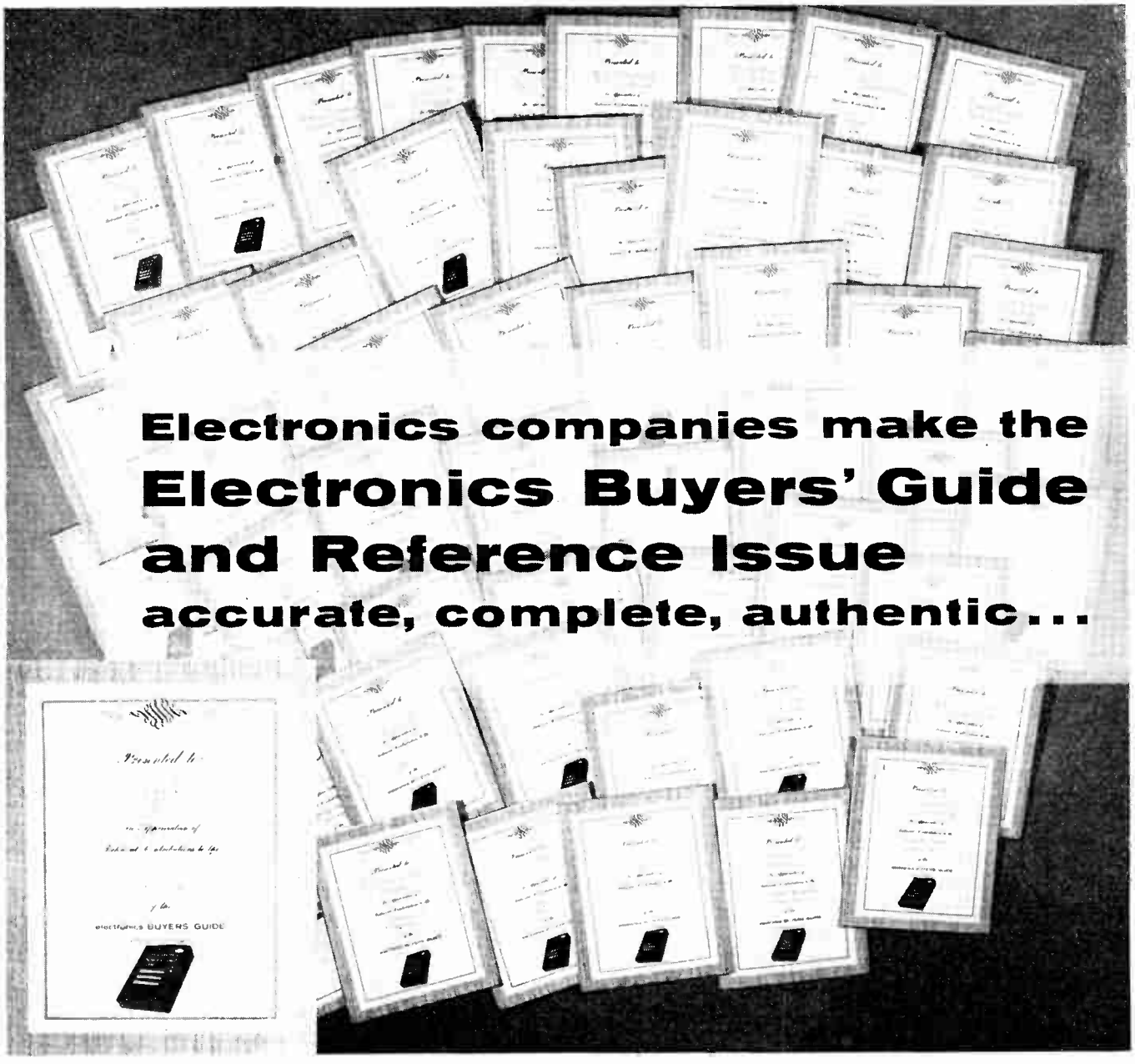
Inertia Switch Elects V-P

WARREN D. PALEY was recently elected vice president of Inertia Switch, Inc., New York City. He will continue as general manager of the company.

Before joining Inertia Switch, Paley was vice president in charge of marketing and sales at Charles Denning, Ltd. Earlier, he had served as director of programs and planning for Bulova Research and Development, and has also engaged in independent engineering consultant work.

Wood Joins TI

TEXAS INSTRUMENTS INC. has hired Richard C. Wood as marketing manager, advanced technologies, in the



Electronics companies make the Electronics Buyers' Guide and Reference Issue

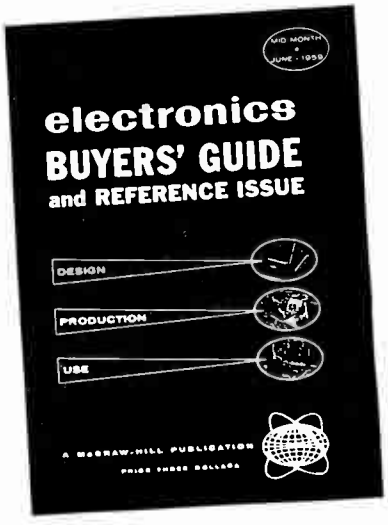
accurate, complete, authentic...

For nineteen years, firms in the electronics industry have made direct contributions to the accuracy, completeness and authenticity of the BUYERS' GUIDE.

Recently, the staff of the BUYERS' GUIDE decided to award plaques to express appreciation to those in the industry who had made direct contributions to improve the product listings. The photograph above represents a few of the awards that have been made.

The awarding of the plaques is but one indication of how the BUYERS' GUIDE evolved over the years . . . a *cooperative effort between the publication and the industry it serves.*

Only through years of experience can a buyers' guide reflect the needs of an industry as complex and dynamic as electronics . . . one more reason why the BUYERS' GUIDE is the ONE accepted product and data book in the field.



Published mid-year as the 53rd issue of **electronics**

A McGRAW-HILL PUBLICATION

330 WEST 42ND STREET, NEW YORK 36, N.Y.

central staff marketing division.

In the newly-created position, Wood will be responsible for marketing of the research and development activities undertaken by TI's central research laboratory and he also will coordinate the company's relations with agencies of the U. S. Government.

News of Reps

Acton Laboratories Inc., Acton, Mass., appoints **S.S. Lee Associates Inc.** of Falls Church, Va., to represent its line of electronic laboratory test instruments in Virginia, Maryland, North and South Carolina, Georgia, Florida, Alabama, Tennessee and Mississippi.

Also appointed to represent ALI in the northern New York state area is **D. B. Associates, Inc.** of Syracuse, N. Y.

The Milwaukee Resistor Co., Milwaukee, Wisc., appoints **Unger Sales Associates** of Los Angeles, Calif., as its rep for southern California.

Dynacor Inc., Kensington, Md., appoints **John A. Upson** of the **Upson Sales Co.**, West Cheshire, Conn., as sales rep in the New England states and upper New York state.

Lynch-Gentry Associates, Inc., Ft. Myers, Fla., now represents The Helipot Division of Beckman Instruments, Inc., Fullerton, Calif., in the state of Florida. Rep firm handles all of Helipot's product lines, which include precision pots, monitoring and control components, rotating components, and standard electromechanical breadboard parts.

Kenneth E. Hughes Co., Inc., of Union City, N. J., and Philadelphia, Pa., is named sales rep for Shockley Transistor Corp., Palo Alto, Calif., in the metropolitan New York, New Jersey, and eastern Pennsylvania areas.

Sheridan Associates, Inc., of Cincinnati, Ohio, has been appointed Ohio, Kentucky and western Pennsylvania sales rep for Shockley Transistor Corp.

(Continued on p 136)

Jack Carroll

Managing Editor, **electronics**
Holds Partial Staff Meeting

Resumé:

Carroll, John M., (seated in photo) Lehigh University, BS, Hofstra College, MA in Physics, member several I.R.E. committees. Naval electronics, World War II. Electronics engineering officer during Korean war. Background in engineering derives from experience with the National Bureau of Standards, Naval Research Laboratories, Liberty Aircraft, American Instrument Co. Author of technical books for McGraw-Hill Book Company.

Present Occupation:

Jack Carroll is responsible for "getting-out-the-book" each week within the framework of editorial policy formed by W. W. MacDonald, Editor of **electronics**. Jack is occupied with editorial makeup, with the accuracy of editorial content, with scheduling the workload of a 26-editor staff to provide maximum coverage of technical developments and business information.

References:

Jack is a dedicated man—dedicated to the interests of the readers of **electronics** magazine. His prime goal is to help edit a publication which will be required reading for the important people in the electronics industry — a publication that will fill the needs of design-research, production, management. If you are not receiving the publication that is edited to keep you best informed, if you are not a subscriber, or if your subscription is expiring, fill in the box on the Reader Service Card. Easy to use. Postage is free.

electronics
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Appointment of **Stone Laboratories**, Boston, as direct sales and engineering rep in the New England area for the Electronics Division of Clary Corp. has been announced.

Electron Products Co., Pasadena, Calif., manufacturer of capacitors and interference filters, announces appointment of the following reps:

G. E. Arneson & Co., of Wayzata, Minn.; **Maury E. Bettis Co.** of Kansas City, Mo.; **Bruce Cumming & Associates, Inc.** of Chicago, Ill.; **Electronic Component Engineers** of North Abington, Mass.; **Engstrom Associates, Inc.**, of Winter Park, Fla.; **Robert Finlay** of Ridgewood, N. J.; **Leo Jacobson Co., Inc.** of Buffalo, N. Y.; **Art Malear & Co.** of Palo Alto, Calif.; **N. R. Schultz Co.** of Seattle, Wash.; **George Weinreich Associates** of Dallas, Tex.; **Weller-Rahe Co.** of Worthington, Ohio; and **Electromechanical Products** of Agincourt, Ontario, Canada.

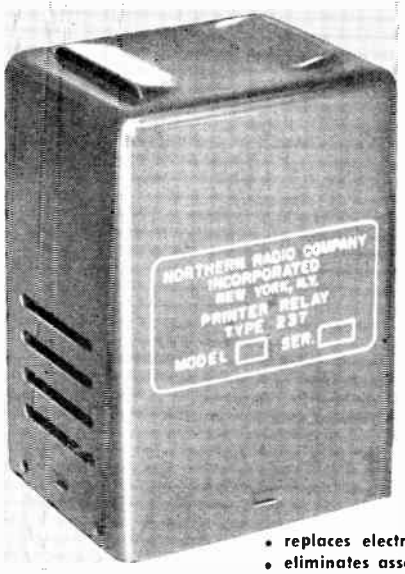
Logan & Stone Co. of San Francisco, Calif., has been appointed by Chicago Telephone Supply Corp., Elkhart, Ind., as its rep in northern California and northern Nevada.

E. V. Roberts and Associates, electronic manufacturers' rep, has added **Jerry Porter** to its staff as electronics sales engineer specializing in the servicing of distributors in the Los Angeles area.

Babcock Relays, Inc., Costa Mesa, Calif., names the **Ed Landa Co.** of Los Angeles as its rep for California, Nevada and Arizona.

Silicon Transistor Corp., Carle Place, N. Y., adds two west coast rep organizations: **Northwestern Agencies, Inc.**, of Seattle, Wash, for the Pacific Northwest; and **F. W. Moulthrop Co.**, of San Francisco, Calif., for northern California.

The Amerelay Corp., New Hyde Park, N. Y., appoints two more rep firms: **Harry P. Woodit Associates** of East Orange, N. J., for metropolitan New York, Westchester County, Long Island and northern New Jersey; and **Harry G. Lake Co.** of Dayton, Ohio, for the state of Ohio.



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Model 1

- replaces electro-mechanical signal relays
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- eliminates electro-mechanical maintenance problems
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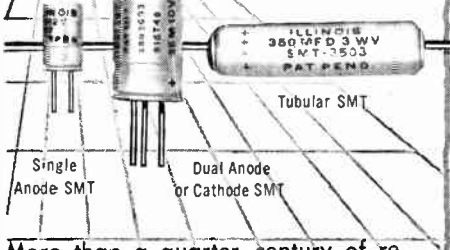
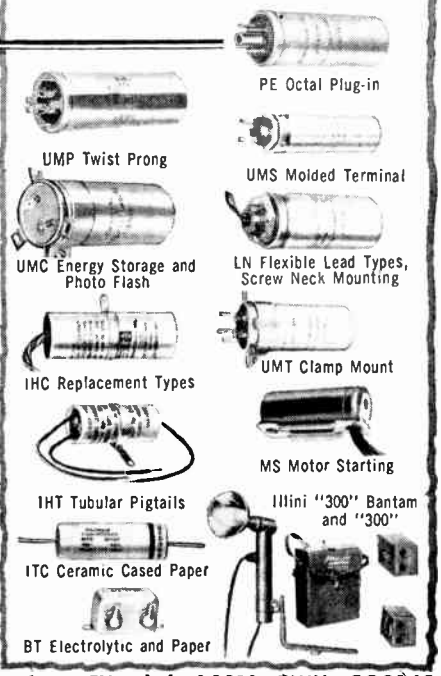
there is an Illinois Electrolytic Capacitor for every Electronic Requirement!





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COMMENT

Microwave Radiation Monitor

While I was at a test site working on the development of instruments to be used in an r-f hazard alarm system, I received a copy of an article called "The Neon Warning" from *Time's* May 25 edition. I had mixed emotions as I read it, because I approve of giving the problem of protection from r-f hazards the notice it deserves, and I deplore the exaggerations and misleading statements and implications which usually appear in news on this subject . . .

Your paragraph "Microwave Radiation Monitor" (Newsletter, p 11, June 12) carries much more weight with electronics men, and may result in some placing too much confidence in a neon lamp.

I have used General Electric NE-2 neon lamps as r-f field strength monitors for five years, but cannot give any general statement of sensitivity because I have observed wide differences between individual lamps. I have also found that their sensitivity varies with r-f frequency and with orientation in polarized fields. Consequently, when they are used, they should be tested first for sensitivity and whirled about on the end of a string in the area being monitored.

It should be emphasized that the monitoring of r-f field strength to determine whether or not the ceiling tolerance level is being exceeded requires careful and ingenious use of several types of detectors used in combination with several types of antennas.

The term "danger level" for 0.01 watt/cm^2 has misleading implications. Our knowledge of the specific effects of over-exposure to r-f radiation is not sufficient yet to establish danger levels, even at fixed frequencies. It has been suggested that the term "tolerance level" be used.

HARRY R. MEAHL
GENERAL ELECTRIC CO.
SCHENECTADY, N. Y.

We did not mean to give the impression that all one needs to monitor microwave radiation is a neon lamp. We did feel that the fact that the NE-2 lights up at half the tolerance level under some condi-

tions was worth reporting, since an NE-2 is easier to carry than a power-density meter, which itself makes certain limiting assumptions about propagation characteristics.

We agree that careful use of sophisticated detectors is a must, but perhaps it would still be wise to make assurance double sure and have people plug NE-2's into their lapels even after all tests have established work areas as tolerable.

More On Random Noise

It is my desire to add to Mr. Bendat's remarks (Comment, p 154, May 29) on the review of his book *Principles and Applications of Random Noise Theory* (New Books, p 126, Apr. 10).

In agreement with Mr. Bendat, I think that some of the harsh criticism of the reviewer has missed the mark, for the reason that the purpose of the book was not properly considered in the review. Besides the points mentioned by Mr. Bendat, his approach has the great merit that it can be understood without specialized knowledge of control engineering, and that it is mathematically self-contained. Being an experimental biophysicist, I have found the latter feature extremely helpful.

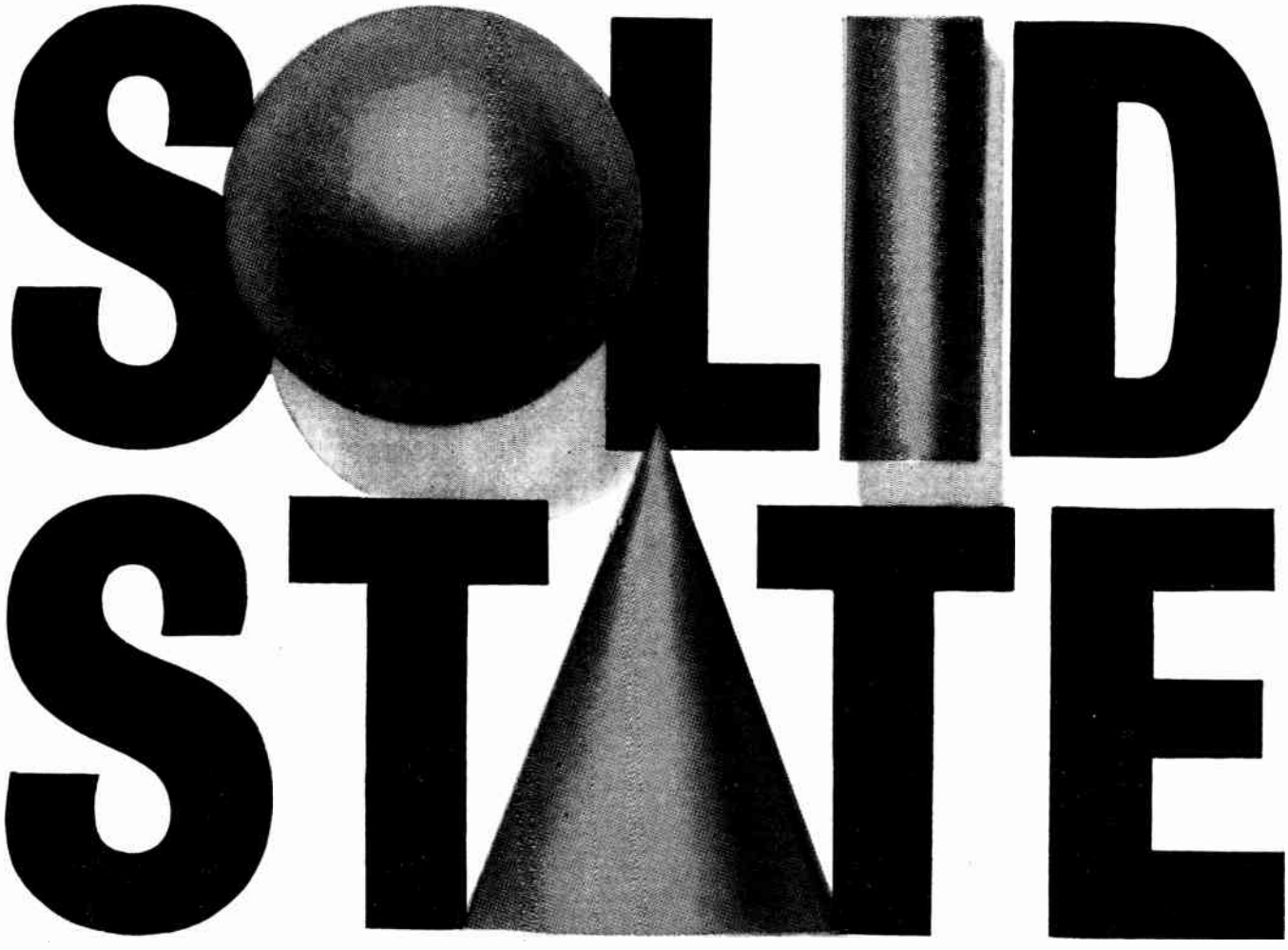
In trying to assimilate a method which appears to be relevant to ones' own research problems, one simply does not have time enough to work through a stack of texts preparing to read a book on the topic one really wants.

The mathematical literature is replete with books written only for a small group of specialists. In this way, methods which otherwise might become useful tools in applied science simply do not reach the proper audience. Mr. Bendat has done very well in presenting a difficult topic to the non-specialist.

That a book of this nature may also have some flaws in its details is probably unavoidable and does not seriously detract from its overall value.

ERNEST K. FRANKE
UNIVERSITY OF CINCINNATI
CINCINNATI, O.

Explore new areas at IBM in



Solid state studies are now yielding important discoveries at IBM. Ranging from basic research to product development, solid state projects include a study of the behavior of molecules adhering to a surface in an ordered array. Another project involves the development of high-speed semiconductor switching devices. In magnetics, engineers and scientists are developing a ferrite core which will function normally at 500°C., and a one-million bit memory drum weighing only five pounds. Advanced work such as this requires creative engineers and scientists with inquiring minds and an enthusiasm for investigating the unknown.

You will enjoy unusual professional freedom and the support of a wealth of systems knowledge. Comprehensive education programs are available, as well as the assistance of specialists of many disciplines. Working independently or as a member of a small team, your individual contributions are quickly recognized and rewarded. This is a unique opportunity for a career with a company that has an outstanding growth record.

CAREERS AVAILABLE IN THESE AND RELATED AREAS . . .

Circuit design	Logic	Nuclear physics	Radar circuits
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■ DESIGN ENGINEERS — PULSE MODULATORS & TRANSMITTERS

Design and development background in very high power UHF RF amplifiers (100 kilowatt region) including design of associated grid and plate distributed parameter circuits. Design of high power line-type pulse modulator circuits for driving high power transmitter tubes.

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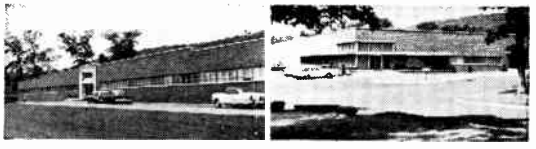

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