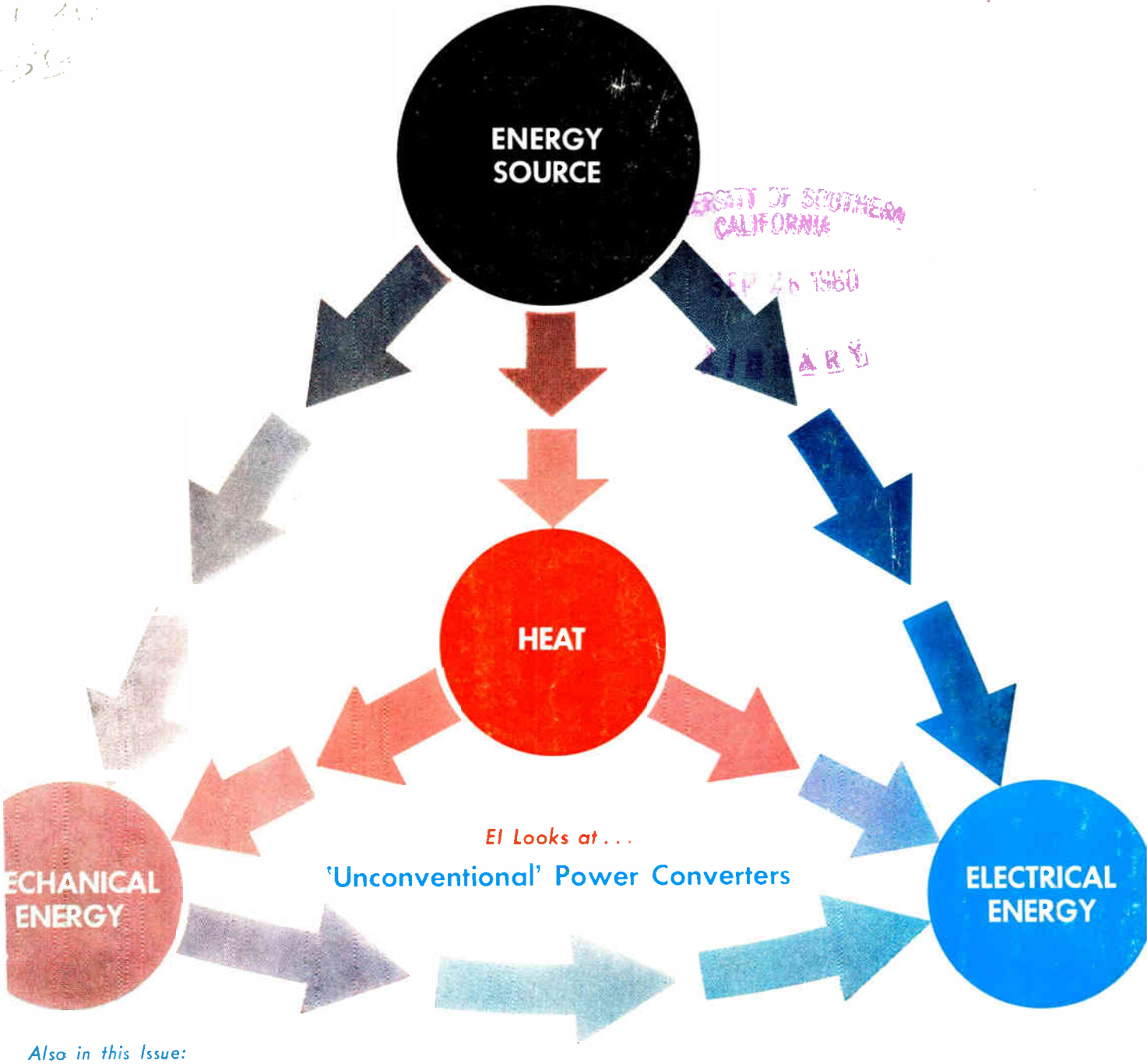
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



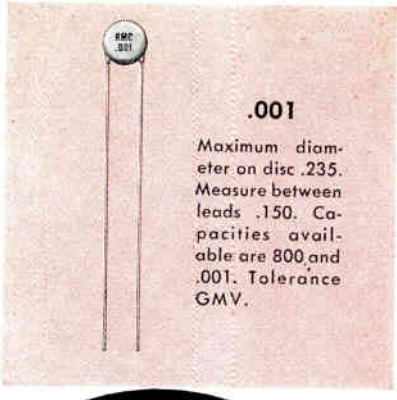
EI Looks at . . .

'Unconventional' Power Converters

Also in this Issue:

- The Reliability of Printed Circuit Connectors . . .
- 'Thin Films' In Computers!
- RFI—Its Effect On Receiver Design

September
1960



.001

Maximum diameter on disc .235. Measure between leads .150. Capacities available are 800 and .001. Tolerance GMV.

Shape of the Space Small?

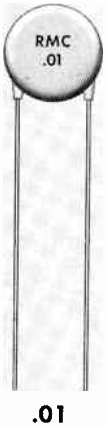
specify RMC Subminiature DISCAPS

.0015

Maximum diameter on disc .285. Measure between leads .250. Tolerance GMV.

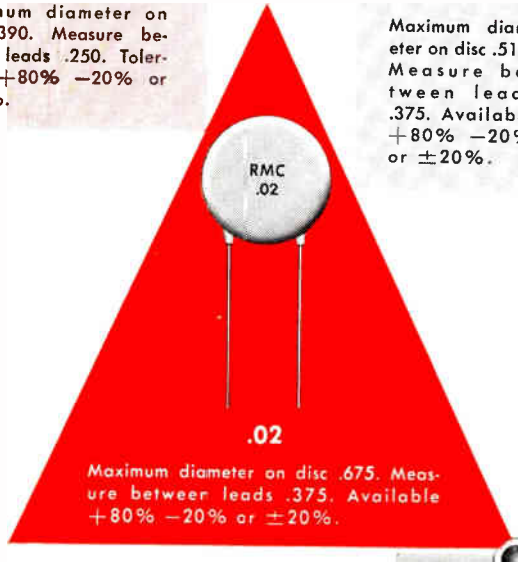
.005

Maximum diameter on disc .390. Measure between leads .250. Tolerance +80% −20% or 20%.



.01

Maximum diameter on disc .510. Measure between leads .375. Available +80% −20% or ±20%.



.02

Maximum diameter on disc .675. Measure between leads .375. Available +80% −20% or ±20%.

RMC Type SM DISCAPS are especially designed for use in applications where ceramic capacitors of the smallest size and highest reliability are required.

Rated at 500 volts, Type SM DISCAPS show a minimum capacity change between +10°C and +85°C and meet the specifications of EIA-RS-198 for Z5U capacitors. Type SM DISCAPS combine miniature size and reliability with lowest cost for greater production savings.

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TEST VOLTAGE (FLASH): 1000 V.D.C.

LEADS: No. 22 tinned copper (.026 dia.)

INSULATION: Durez phenolic (⅛" max. on leads)—vacuum waxed

STAMPING: RMC—Capacity—Z5U

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

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ELECTRONIC INDUSTRIES

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

"Electronics Management's Biggest Challenge"

From a speech delivered by David Packard, President, Hewlett-Packard Co., Aug. 24, 1960, at Western Electronic Manufacturers Association annual corporate luncheon, Los Angeles, Calif., which we believe to be of especial & significant interest to the readers of Electronic Industries

IT is always an inspiration to attend the WESCON Show and Conference. This year's event again gives ample evidence of the dynamic character of the electronic industry and particularly impressive evidence of the important part the West is now playing in the development of the industry. WESCON always has a special significance for me because I remember well the electronic industry on the West Coast before the War when it was difficult to muster even a few hundred people for a regional conference. In those days the industry was small enough so that everyone knew everyone else and the meetings had a very attractive personal character to them. No doubt there will be a few of the old-timers reminiscing this week about the good old days, wishing they could turn back the clock. Electronics people being realistic and accustomed to looking ahead rather than behind understand fully that turning back the clock is something you can only talk about and I am quite sure most of the time here this week will be spent in considering what we are going to do in the future and not what we have done.

The schedule of technical meetings here this week indicates a high concentration of new ideas and this certainly portrays continued exciting growth of electronics in the years ahead; but the events all over the world during the past few years have brought us to a realization that there are troubled times ahead for our nation, in fact for the basic concepts of our entire Western Civilization. Sputnik I and succeeding Russian satellites rudely awakened us to the fact that we have no monopoly on technical competence. The fantastically incredible raving and ranting of Khrushchev in his visits to the United States and finally at the abortive summit conference have shown us the Russian leadership is ruthless and unpredictable. The straining of the peoples in Africa against their traditional bonds and the emergence of the pro-communist Castro Government in Cuba at our very doorstep has brought us to the full realization that we have problems of most serious proportions on our hands. . . .

When we think of the electronic industry in relation to these troubled times, we are immediately reminded of great contributions electronics has made to our military strength. We can recall some of our contributions which were crucial in winning World War II; namely, Radar, Sonar and the proximity fuse. If we look at the present day character of our military strength we must add to those things which were important in World War II and put new emphasis on reliable communication, long range and short range; precise navigation; and on the very complex problem of data handling and data analysis for our defense and command control systems. When we add to these—missile guidance and the space effort, the conclusion is quite obvious: that the electronic industry is the nerve center and heart of our entire defense system. These great contributions we have made—impose on our industry the responsibility to maintain for the United States—leadership in all of these areas in which we are involved. The hope held by many individuals that our industry can and should become less dependent on military work is sheer wishful thinking that borders on irresponsibility. It will be the continuing task of the electronic industry to add to our military strength for many years ahead but I think there is more we can and should do.

Somehow we must develop a more realistic understanding of the problems we face. Wishful thinking seems to have been characteristic of American thinking on international problems during this entire century. We fought in World War I to make the world safe for democracy, then proceeded to come home and dream the dream of isolationism half way through World War II until Pearl Harbor awakened us. We pursued that job with such vigor and realism that we emerged from the war the undisputed leader of the entire world. Again we returned home and concentrated our effort on domestic problems. Some hoped World Federalism was the answer. Others believed a combination of eco-

(*Continued on page* 214)

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ELECTRONIC INDUSTRIES

Vol. 19, No. 9 September, 1960

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

Highlights of this issue

Conversion of Binary to Analog Codes page 70

Binary stored information, used in ECM receivers, is often needed in analog form for processes requiring a dc control voltage. The advantages, circuitry, and packaging of a device for this purpose are presented here.

For Computer Design . . . Storing With Thin Films page 89

The so-called fast, ferrite core storage unit has actually been the limiting factor in computer speed. All other central computer circuits are capable of operating at least ten times as fast. A memory using thin film techniques which offers high potential is presented.

Controlling RFI Susceptibility in Receivers page 92

With good basic design it is usually possible to produce receivers that have low susceptibility to undesired signals. Some of the factors to consider in the receiver's design are sensitivity, selectivity, spurious responses, inter-modulation, and cross-modulation as well as standard shielding considerations.

Unconventional Power Converters page 101

As man contemplates pushing the edge of civilization to the far reaches of the globe and his first move into space, he plans to carry his power supply with him. Conventional methods of getting this power often cannot meet the special conditions imposed and science is developing "unconventional" power supplies to meet his needs. EI outlines the fundamentals of six of the more important proposed systems.

Spectrum Analysis of Time Division Stereo page 228

The stereo trend is prompting development of dual channel transmission techniques by broadcasters. Several proposed systems have been developed around time division. This article presents a theoretical analysis of the system spectrum . . . with experimental verification.

Mapping Small Magnetic Fields page 74

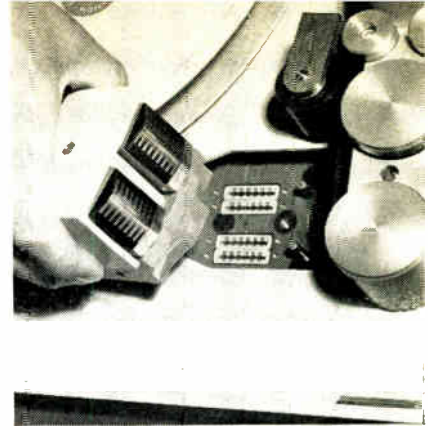
Magnetic tape recording quality is being forced higher and higher. What actually happens at the recording head? To properly study this phenomenon, a new magnetic mapping technique was developed. Here are the details.

Driving the Beam Switching Tube page 78

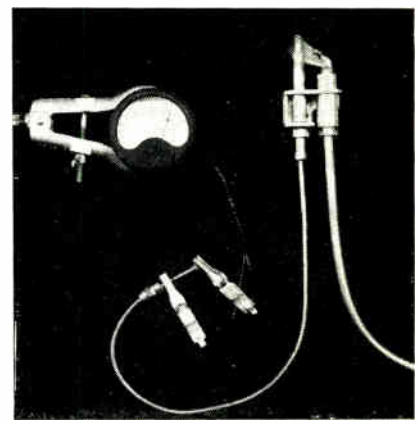
Performing decimal rather than binary functions, this tube can replace up to 20 transistors in switching applications. But, high amplitude drive signals and impedance match are problems encountered when used with transistor logic. Here are some successful solutions.

Reliability and the Printed Circuit page 82

Not long ago, reliability was an auxiliary design objective. Now it is as important as performance itself. Thousands of reports on components are being compiled. The story of one component—the electrical connector—is told here.



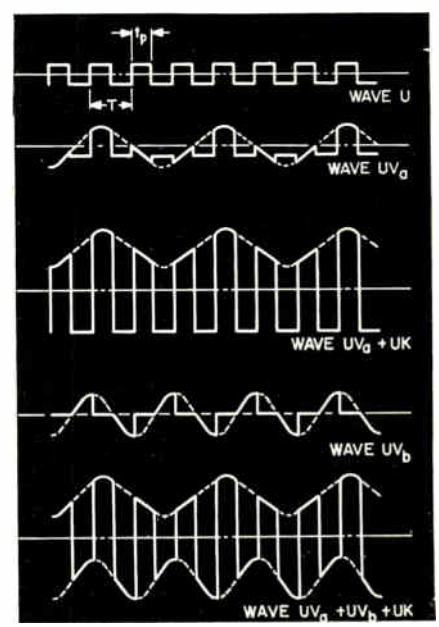
Printed Circuit Connectors



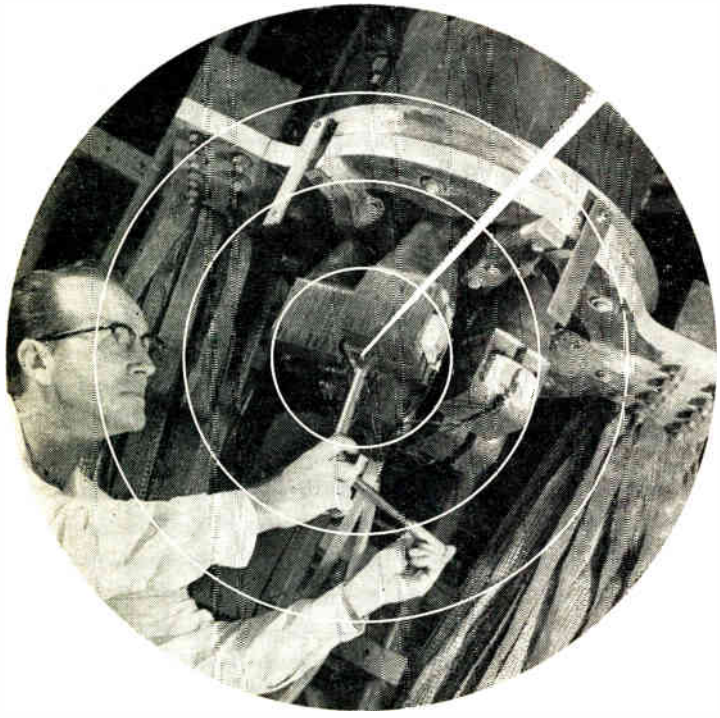
Unconventional Power Converters

Storing with Thin Films

Time Division Stereo



RADARSCOPE



ULTRASONICS IN STEEL MANUFACTURING

Production line vacuum arc-melting furnace at the Westinghouse metals plant, Blairsville, Pa., has been adapted with a transducer assembly for ultrasonic grain refinement in large ingots. Ultrasonic vibration causes a small "equiaxed" structure in the steel ingots, highly desirable for better mechanical properties.

MINIMUM WAGE proposed by the Dept. of Labor, and applicable to all electron tube manufacturers supplying the defense industry, would be $1.42 an hour for electron tubes (except television picture tubes,) and $1.35 for solid-state semi-conductor devices. Roughly 55,000 production workers are affected in 100 establishments.

BASIC RESEARCH in the U. S. reached a level of $1 billion in the year 1959-60, according to the National Science Foundation. The Federal Government remains the prime source of funds for basic research. The physical sciences received a total of over $550 million or approximately ⅔ of all the National Science Funds.

CANADIAN ELECTRONIC INDUSTRY faces severe trouble, unless competition from abroad can be cut back. The Electronic Industries Association of Canada is warning that if Japanese imports of transistor radios continue "it will put the Canadian radio industry out of business." Canadian radio receiver manufacturers last year lost over 45% of their domestic market to foreign imports. Canadian production of electron tubes will cease within 18 months, EIA warns, if Japanese imports are not controlled. The employment in Canadian vacuum tube plants dropped 24% last year.

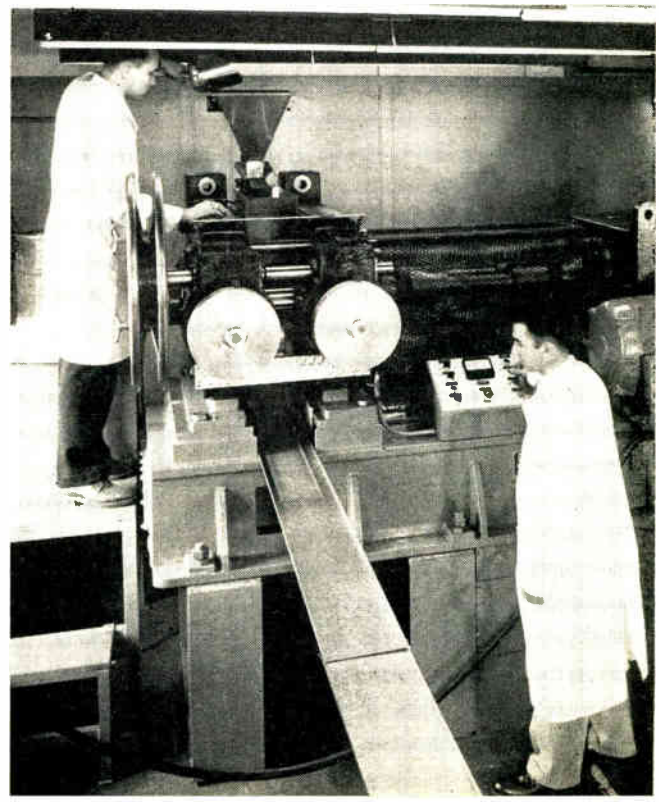
GERMANIUM RESEARCH being pushed by the Bureau of Mines will include investigations on the economic recovery of germanium from coal fly-ash, and the development of simpler methods for detecting germanium. At the moment germanium is obtained solely as a by-product of base metal processing.

TV BOOSTER STATIONS have won their fight for legal status with FCC. The President OK'd a bill ending the two-year struggle between Congress and FCC over rights of locally owned and operated TV signal boosters. The FCC ordered the boosters "off the air" on numerous occasions but each time Congress, in response to demands from fringe area, TV viewers and station operators pressured FCC to postpone the order. The new law authorizes the FCC to license all boosters now in operation and any future booster stations operating in the public's interest.

A GOVERNMENT STUDY of broadcast frequency allocations, by a 5-man group, is urged by Senator Vance Hartke (Democrat of Indiana). He points out that broadcasts to and from outer space are overcrowding an already crowded field. He said the FCC is hampered by split decisions and by lack of power to function in some fields of communication, sharing authority with a variety of agencies.

NEW CATHODE PROCESS

In this new application of powder metallurgy developed by Sylvania high purity nickel powder is rolled into strips from which electron tube cathodes are formed. The improved cathodes improve the reliability and uniformity and lengthen the life span of a wide variety of of receiving tubes used in electronic equipment.



COMBINATION OF TV AND SHORT WAVE RADIO is being experimented with by the Japanese Broadcasting Corp. for the long distance transmission of TV signals. TV images were recorded in a form of frame-by-frame video signals. These are transmitted over short wave channels. Signals received are reproduced and broadcasted over the JBC-TV channel for black and white reception. A number of technical problems remain to be solved but JBC officials are very enthusiastic about its possible applications.

HIGHER SHAFT TO DIGITAL ENCODER SPEEDS are possible with the new non-contact technique developed by Librascope Div., General Precision, Inc. Digital signals representing input shaft position are generated by altering the magnetic state of ferrite readout cores in accordance with the coded pattern cut into the surface of a ferrite disk driven by input shaft. The technique was developed to meet the rigid speed and endurance requirements of Naval Shipboard Fire Control Systems.

MINIATURE RF CONNECTORS devised for the Signal Corps by Armour Research Foundation offer unusual ease of assembly and excellent gripping properties. The clamping technique includes a discontinuity free path from cable to connector body, static axial load support over 60 lbs., and natural water seal form without gasket. VSWR is less than 1.32 for frequencies under 5000 MC.

RESIDUAL FLUX ON PRINTED CIRCUITS can be measured with a new technique developed by Nuclear Corp. of America. The problem is solved with radio active tracer technique in which one flux element is tagged and the amount remaining on the board is measured. Flux residues as low as 0.01% can be measured by counting devices.

RADAR MAPS can be transmitted directly to ground equipment from airborne radar stations with a new type of data transfer system delivered to the Signal Corps by Western Military Electronics Center, Motorola Inc. An encoder and transmitter in the airplane takes information from the radar and transmits it directly to a receiver, and decoder and indicator on the ground. The map of the area is displayed on a special viewer on the ground while a permanent is recorded photographically.

EXPERIMENTAL FM STATION is being operated in Japan on the 400 MC band. The Japanese Broadcasting Corp. has a transmitter on 476 MC. The frequency was chosen because of the comparative ease of developing FM receivers for the frequency band. The feeling is that FM broadcasting in the 400 MC band would have the best chances of developing in Japan.

NEW TUBE CONSTRUCTION—the "10-pin"—has been developed by Sylvania. The configuration makes possible additional tube functions within a single envelope. It is similar to the regular 9-pin arrangement of the conventional miniature tube, with an additional pin in the circle.

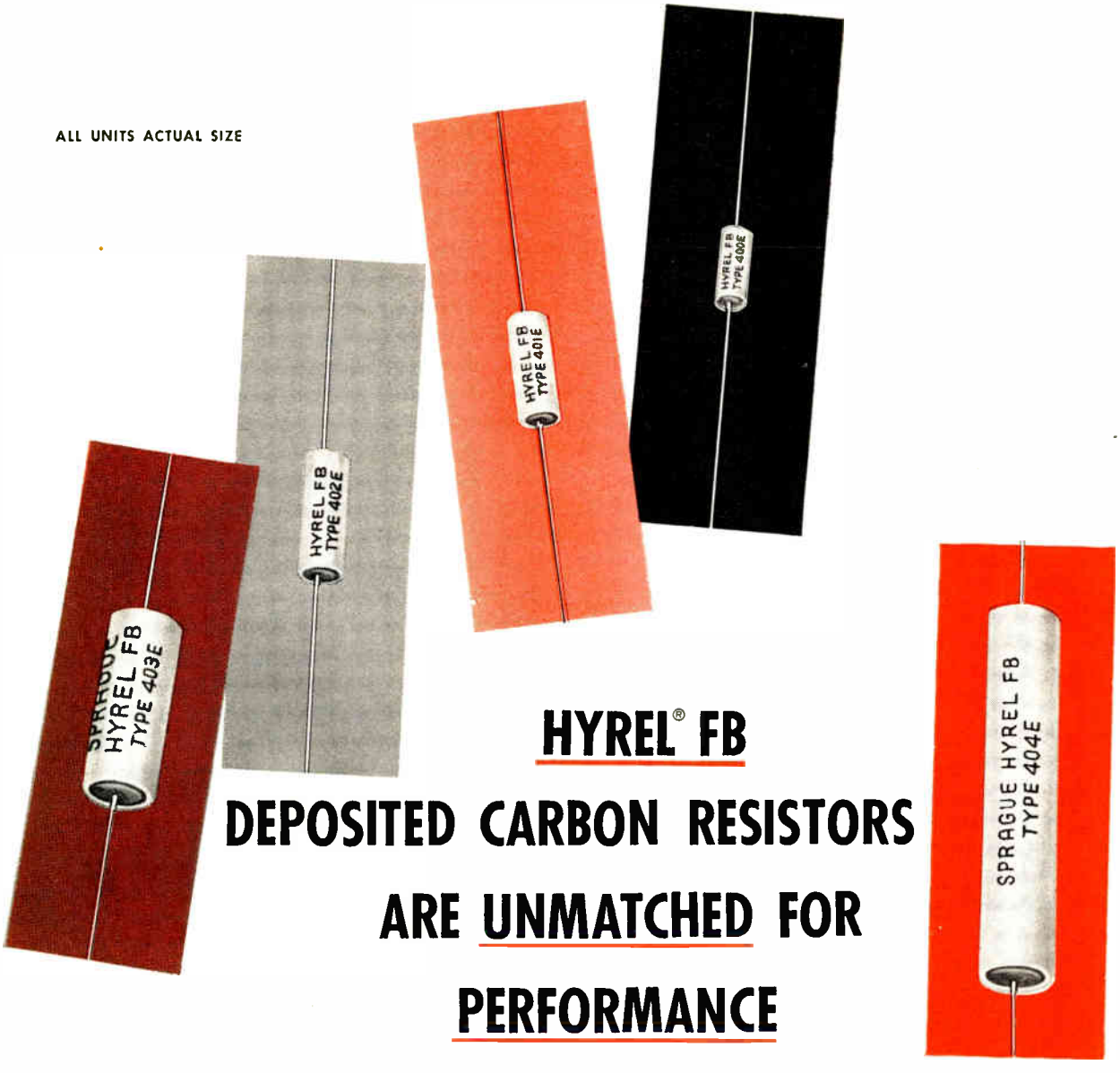
PURE LIQUID HYDROGEN—the lightest of all the elements—may soon emerge as a major low-cost rocket fuel. It's about 25% more powerful than any other chemical fuel, pound-for-pound.

COMPUTER FIELD is showing more feverish competition than at any time in its 10-year history. IBM is still doing more than 80% of computer business. but the rest of the industry is openly intent on cutting this down. Industry spokesmen are prophesying that within a few years the IBM slice of the market will be cut to 50%, with the balance being carved up by some dozen manufacturers. During the past year RCA's Electronic Data Processing Div. and Rem-Rand's Univac Div. have spent millions of dollars building up sales staffs and marketing operations. Among the other firms beefing up their competitive position are General Electric, introducing its first general-purpose computer for the business market. National Cash Register Co., Burroughs, and Minneapolis-Honeywell. Additional competition is coming from foreign firms, England's Electrical and Musical Industries, Inc. (EMI) and La Compagnie des Machines Bull of France, one of the largest manufacturers of computers in Europe.

ANTENNA BALANCING

At ITT Corp.'s Federal Division J. M. Mancuso is using a Model SU-7 Dynamic Balancer manufactured by Micro Balancing Inc. to dynamically balance the rotating portion of VORTAC antenna.

ALL UNITS ACTUAL SIZE



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As We Go To Press...

Electronic Eye Detects-Multiplies Single Photon

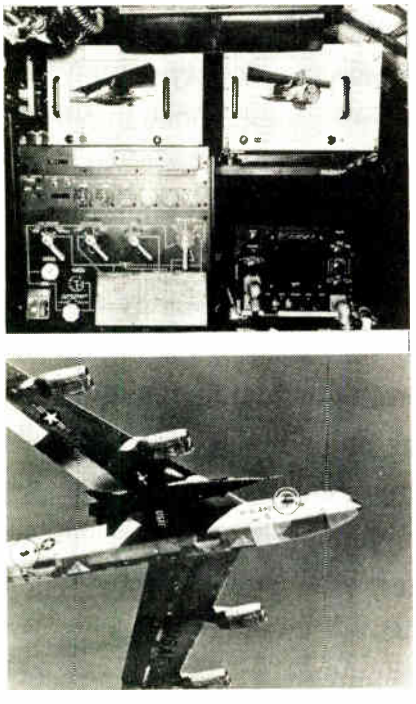
An electronic eye that can detect a single photon—the smallest particle of light—and multiply it a million times has been developed at Imperial College, London.

It promises to enable man to see farther into space and deeper into the atom than ever before. In modified form, it is hoped that it will drastically reduce the X-ray dosage that the average person receives in a lifetime.

From the military point of view, this type of image intensifier seems to offer a solution to the problem of starlight reconnaissance by earth satellites. It also has a number of other applications in space research and laboratory spectroscopy.

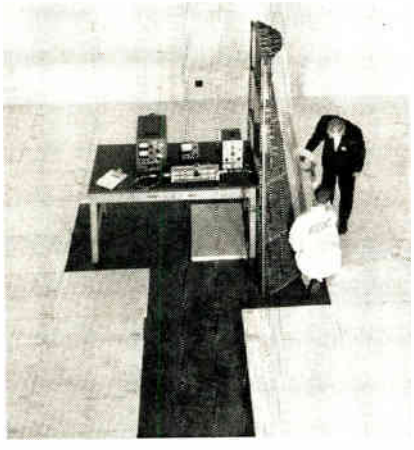
Several of the intensifiers have been sent to the United States for experimental use with telescopes. Preliminary tests have been carried out in Arizona. The equipment is now being tried out at the Mount Wilson Observatory in California.

MOST "WATCHED" AIRCRAFT



Two TV cameras made by KinTel watch the North American Aviation's X-15 while it is carried aloft. This permits the launch operator, inside the mother ship, to observe the pilot and aircraft right up to launch time. After launch visual tracking is employed. Circles show cameras.

FREE-SPACE ROOM



Free-space room in antenna and radar lab at Boeing Airplane Co., Wichita, is used for aircraft and weapon system research. Walls, ceiling and floor are of r-f absorbing material which achieves non-reflecting properties of outdoor environment.

FAA Rules Recorders Must be Installed

All turbine-powered air carrier aircraft, including turbo-props, must be equipped with flight recorders, according to a recent Federal Aviation Agency ruling.

The recorder is a machine connected to the aircraft's instruments that automatically record the plane's air speed, altitude, vertical acceleration, heading and time. It will assist in determining the cause of in-flight incidents and accidents. The previous regulation required that the recorders be installed on air carrier airplanes that are certificated for flight operations above 25,000 ft. This did not cover turbo-prop planes, which operate at much lower altitudes.

Transistor Trainer Developed

Radio Corporation of America, Industrial Control Div., has developed a training device for instructing technical students in the use of transistors.

The training unit has a dozen separate circuits pre-wired on a perforated board. The student can mount solid state devices at indicated points to complete operating circuits for units such as a superheterodyne radio receiver, radar, computers and other transistor applications.

Douglas Gets Contract For High-Altitude Jet

The Douglas Aircraft Corp. has been awarded $6 million in Navy contracts to build the Missileer, a new carrier-based plane with twin turbo-fan engines capable of flying at altitudes of more than 100,000 ft.

Douglas will build about 120 of the planes, which will carry Eagle air-to-air missiles. Each aircraft will cost $5 million.

The plane's turbo-fan engines are now under development by the Pratt & Whitney div of United Aircraft Corp. The development of the plane and its missiles will cost a total of $3.4 billion over the next several years.

IRE Phoenix Section's First Annual Award to Dr. Hartig

Dr. E. O. Hartig, Assistant Mgr., Aerophysics Dept., Goodyear Aircraft Corp., Arizona Div., is the recipient of the first annual achievement award of the Phoenix Section of the Institute of Radio Engineers. The award was established to recognize individuals who have made major contributions in electronics.

Dr. Hartig was selected for his "contributions to the development of advanced radar systems and outstanding leadership in research."

WALKING TV STATIONS

News correspondents with tiny 4-lb transistorized Dage TV cameras having a 3-eye lens turret, and back-pack transmitters, are miniature TV broadcasting stations. Cameras were used recently during both Democratic and Republican Conventions.

More News on Page 8

ELECTRONIC SHORTS

▸ Tellurium, a promising metal in the thermoelectric field, is the object of intensified research at Bureau of Mines installations in Salt Lake City, Utah, and Spokane, Wash. The stepped-up program includes a wide search for new domestic sources and studies to develop faster and more accurate techniques for tellurium detection and analysis.

▸ Japanese electronic exports to the U. S. during the first three months of 1960 declined seasonally to approximately $16-million from the volume reached in the last quarter of 1959, though they were almost double the level of the first quarter of last year. U. S. Dept. of Commerce points out that domestic sales of radio receivers always decline in the months immediately following Christmas.

▸ Defense supports between 80 and 90% of our national electronic engineering resources according to James M. Bridges, Director, Office of Electronics, Office of the Director of Defense Research and Engineering. Recognizing that any serious fluctuations in the defense electronics program will be felt throughout the profession, he recommends that a thorough study be made by industry, DOD, and by industrial and professional organizations to prevent a disastrous situation in which widespread unemployment for electronics engineers could possibly occur.

▸ Explosive forgings made from aluminum alloys can be reproduced reliably, provided the design has no extreme contours, according to an Air Force-sponsored research study. During 14 months of explosive forging tests, high explosives proved feasible for producing close tolerance, one-sided, closed-die aluminum alloy forgings for aircraft and missiles. Though capital investments for this type equipment are lower than for conventional forging, overall operating costs are higher.

▸ The image tube, or photoelectric image intensifier, is proving itself a valuable new research tool for astronomers. Using the device, astronomers are receiving previously unobtainable data which may prove to be as great an advance over conventional astronomical photography as photography was over visual observations. The tubes have already increased telescope speeds as much as 30 times, and have the potential of increasing them by a factor of 100.

▸ Four additional intercomparisons of microwave power standards with Japan have just been completed by NBS. Made at the Boulder Labs, the intercomparisons show much better agreement than those made in December 1957 and closer agreement than intercomparisons made with Britain in July 1958. Earlier discrepancies were attributed to the long time interval that had elapsed between measurements in Japan and the U. S. respectively.

▸ Project SURIC—Surface Ship Integrated Control—is a study being conducted by the Navy to reduce crew requirements of surface ships by turning over many control functions to automated machinery. Project goal is to have Naval surface ships operate with fewer men, yet out-perform current operating ships, by simplifying and centralizing shipboard operations.

▸ The Army has taken measures to strengthen its research and development programs. Increased authoritative direction and control of all of the Army's R&D functions and installations used primarily for R&D have been vested in the Chief of Research and Development, Lt. Gen. Arthur G. Trudeau. Control over the R&D area in each of the technical services will be exercised by the Chief of Research and Development through the Chiefs of the Technical Services.

▸ A radar system designed to direct, by remote control, the descent and landing of spacecraft has been developed by Sperry Phoenix Co. When the system picks up an approaching craft, ground equipment feeds it information for approach and touchdown. Single radar installation can cover a range of 350 miles.

▸ Titanium alloy was used in the third stage Minuteman rocket engine case. The engine was recently test fired by Aerojet-General. It was a first for a working rocket motor case made from the lightweight strong metal. Previous attempts to fabricate titanium alloys have been unsuccessful due to difficulties encountered in welding pieces together, and in heat-treating the metal to a desired strength.

Hire More Women: But Learn How They Operate—

Many of industry's problems with women employees stem from failing to recognize that women are different from men and failing to use women workers' special abilities. So says Industrial Relations News, 230 West 41st St., New York 36, N. Y., in a Special Report, "Industry's Growing Stake in Womanpower."

Says the report, "More detailed knowledge of the motivations, goals, and abilities of women workers might result in a substantial rise in their productivity as employees." This information could help to break down traditional barriers against female employees. Even though there is a severe shortage of engineers, a study of male execs indicated that 81% wouldn't hire female engineers and the ones who would were dead set against permitting them to reach middle-management levels.

Appointed New Member of NAC-NRC Patent Committee

Dr. Robert J. Jeffries, President, Data-Control Systems, Inc., Danbury, Conn., has been appointed a member of a committee of the National Academy of Sciences' National Research Council which is analysing the role of patents in research.

As a result of its reviews, the committee is expected to recommend changes in the country's patent policies and structure. Patents, both existing and potential, may stimulate or handicap the initiation or progress of research.

WORK MODULE COMPRESSED

Allen B. Dumont Co., Indus. Electronics Div., Clifton, N. J. has shortened individual assembly modules from 6 ft. to 3 ft. using Bathey Flobins arranged on a bench-type rack mounted on a Lazy Susan capable of revolving 360°. Gilbert-Tucker Assoc. is the designer.

P-N-P PICKING?

HUGHES HAS THE WIDEST LINE OF P-N-P SILICON ALLOY TRANSISTORS

You get a big choice at Hughes. Here's the greatest selection of p-n-p silicon alloy transistors you'll find anywhere.

These are the top-grade transistors that have found favor with systems manufacturers all over the country. They are especially designed for small signal amplifiers, DC amplifiers, low-noise amplifiers, as well as low-level switches and many more. They are available in a rugged 1-watt coaxial package and a 400mw TO-5 package.

Check the types shown here. Then, for immediate delivery, call the Hughes Semiconductor sales engineer in your area. Or write Hughes Semiconductor Division, Marketing Department, 500 Superior Avenue, Newport Beach, California.

For export, write: Hughes International, Culver City, California.

TYPES		SPECIFICATIONS: HA7587 SWITCHING		
GENERAL PURPOSE	MEDIUM POWER amplifier & switching	BV_{CEO}	—40V dc	
2N327A 2N328A 2N329A	2N1238 2N1239 2N1240 2N1241 2N1242 2N1243 2N1244	BV_{CBO}	—40V dc	
2N1025		BV_{EBO}	—40V dc	
2N1034 2N1035 2N1036		I_{EBO}	—0.002 μA	
		Offset Volt.	.003V dc	
	LOW NOISE		min	max
2N1228 2N1229 2N1230 2N1231 2N1232 2N1233 2N1234	2N1037	h_{fe}	28	65
			min	typ
		f_{ab} (Mc)	0.5	1.2

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SEMICONDUCTOR DIVISION
HUGHES AIRCRAFT COMPANY

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Coming Events in the electronic industry

Sept. 4-24: Int'l Summer Course on Solid State Physics, Italian Physical Soc., in co-op with NATO, EURATOM and the Comitato Nazionale per le Ricerche Nucleari, Italian Nuclear Energy Center; Varese, Italy.

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Sept. 12-16: 2nd Int'l Congress, Int'l Council of the Aeronautical Sciences, IAS; Zurich, Switzerland.

Sept. 12-23: Vibration Testing Course, Ling-Altec Electronics, Inc.; Anaheim, Calif.

Sept. 13-14: Symp. on Infant Science of Bionics, Air R&D Command's Wright Air Develop. Div.; Dayton Biltmore Hotel, Dayton, Ohio.

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(Continued on page 30)

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You get a big choice at Hughes. Here's the greatest selection of p-n-p silicon alloy transistors you'll find anywhere.

These are the top-grade transistors that have found favor with systems manufacturers all over the country. They are especially designed for small signal amplifiers, DC amplifiers, low-noise amplifiers, as well as low-level switches and many more. They are available in a rugged 1-watt coaxial package and a 400mw TO-5 package.

Check the types shown here. Then, for immediate delivery, call the Hughes Semiconductor sales engineer in your area. Or write Hughes Semiconductor Division, Marketing Department, 500 Superior Avenue, Newport Beach, California.

For export, write: Hughes International, Culver City, California.

TYPES		SPECIFICATIONS: HA7587 SWITCHING		
GENERAL PURPOSE	MEDIUM POWER amplifier & switching	BV_{CEO}	—40V dc	
2N327A 2N328A 2N329A	2N1238 2N1239 2N1240	BV_{CBO}	—40V dc	
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2N1034 2N1035 2N1036	2N1243 2N1244	I_{EBO}	—0.002 μA	
		Offset Volt.	.003V dc	
2N1226	LOW NOISE		min	max
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			min	typ
		f_{ab} (Mc)	0.5	1.2

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HUGHES AIRCRAFT COMPANY

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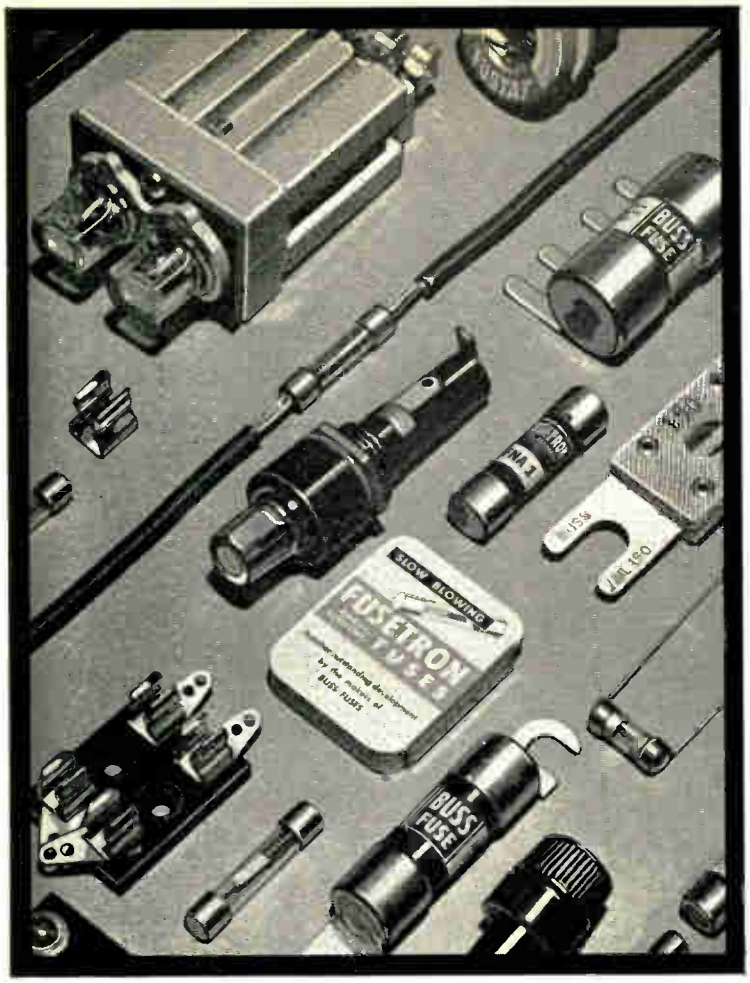

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7221	5″	P20	Electrostatic
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7033	5″	P20	Electromagnetic
H1028	4″	P1	Electrostatic
H1033	10″	P20	Electromagnetic
H1034	10″	P20	Electrostatic
H1041	7″	P20	Electrostatic
H1042	7″	P20	Electromagnetic
MEMOTRON TUBE			
6498	5″	P1	Electrostatic
TYPOTRON TUBE			
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VACUUM TUBE PRODUCTS DIVISION

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(Continued on page 30)

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In missiles, avionics, astrionics, or any electronic application requiring the closest temperature control, check into Stemco Type MX Thermostats first. They're compact for minimum cubage . . . light in weight . . . withstand high G loads . . . are absolutely reliable under wide ambient temperature swings.

Basic design flexibility of Stemco Type MX Thermostats means they can be supplied from regular production runs in a wide variety of models. Semi-enclosed types with metal bases; hermetically sealed types in round enclosures or crystal cans. Wide selection of terminal arrangements, mounting provisions, brackets, etc., available. Units individually packaged in polyethylene with inspectors' readings of disc opening and closing temperatures.

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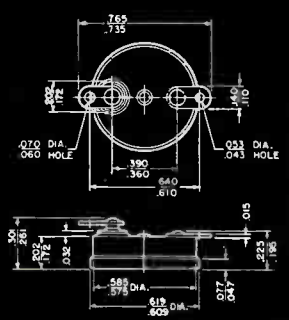
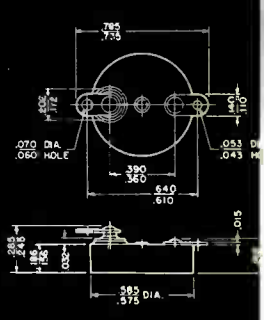


TYPE MX HERMETICALLY SEALED—Electrically independent bimetal disc. Rated 3 amperes, basis 250,000 operations.



TYPE MX SEMI-ENCLOSED—Electrically identical to Type MX Hermetically Sealed. Both Types available with one terminal grounded or both terminals insulated.

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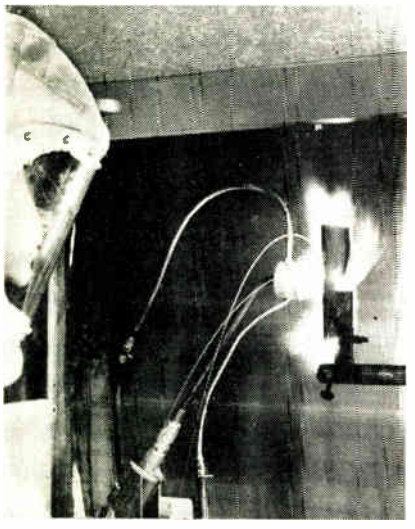
THERMOSTATS

As We Go To Press *(Continued)*

HIGH TEMP LAMINATE



A new grade of Dilecto laminated plastic, still classed as a development item, has been announced by Continental-Diamond Fibre Corp., Newark, Del. Designed for use in missiles and for other applications that require exceptional heat resistance, it is designated N-104-84-2. A 6 in. square piece, ¼ in. thick exposed to 5000°, took more than 10 min. to burn through.

W. U. Extends Microwave System

Originally scheduled to serve major cities enroute from Los Angeles North to San Francisco and across the U. S. to Boston, Western Union's new $41 million ultramodern transcontinental microwave beam system, slated for completion in 1961, will include extensions from Boston to New York City and to Albany, Syracuse, Buffalo, Cleveland, Toledo, Detroit and Chicago and from Kansas City to Dallas.

Broadband facilities to provide high-speed transmission of data, alternate record - voice, facsimile, digitalized TV and other known methods of communication at extremely high speeds and large volume will multiply W. U.'s existing circuit network more than 10 times its present capacity, producing more than 50 million channel miles with a capacity of 2.4 million words per minute.

Broadband channels for the world's largest and most advanced digital data system, all electronic, and completely transistorized, will link Air Force bases and other installations at 240 points nationwide for efficient control of personnel and material.

Kansas Salt Mines to Act as Storage Depot

Catacombs through Central and Southwest Kansas are beds of salt from 650 to 1000 ft. below the surface. Carved-out hollows offer storage of various materials from liquid radioactive wastes to valuable art works. A total of 1,680 acres is available, 128 of which has been leased by the Underground Vaults and Storage Co., Inc., for storage of records, microfilm and magnetic tapes.

Other facilities, expected to be ready by January 1, 1961, are already leased by six companies.

The Atomic Energy Commission, in another part of the same group of mines, is making tests to see if radioactive wastes can be stored in the salt beds. Success of the tests could mean that Kansas would become a major reactor fuel center in the future. It is felt that the Kansas mines are both near the center of the U. S. mainland and are far from high priority targets and out of the fallout pattern of other targets.

Perpetual Motion?

General Electric Co., at their General Engineering Lab. in Schenectady, N. Y., has suspended a small body in a vacuum and rotated it at high speeds essentially without friction. The object was held aloft in a magnetic field. The magnetic force which provided a stable support for the suspended body was made possible through cryogenic techniques.

At extremely low temperatures, certain materials become "superconductive" and also highly efficient magnetic insulators. GE's scientists are conducting tests on a golfball size sphere in temperatures approaching absolute zero (—460°F). Rotation speeds will be about 20,000 rpm.

The experiments, an independent effort on the part of GE, have led to a development contract with the Army Ballistic Missile Agency. Identified as "Project Spin," the military contract looks to the perfection of a "cryogenic Gyroscope." The Gyroscope would eliminate or reduce the general causes of unpredictable gyro error by reducing friction, eliminating mechanical bearings, and reducing electrical losses.

GE Granted Patents On Man-Made Diamonds

Patents on the process and apparatus for the manufacture of artificial diamonds have been granted to GE Co. by the U. S. Patent Office.

The company said that the patents covered "man-made" diamonds, the development of which was first announced in February, 1955. GE was unable to file patent applications in many foreign countries on its diamond-making process until last year because of a secrecy order of the Federal Government. The company said that the secrecy was maintained because industrial diamonds, which had to be imported before GE learned how to make them, were of strategic importance to national defense.

New Materials Research Center

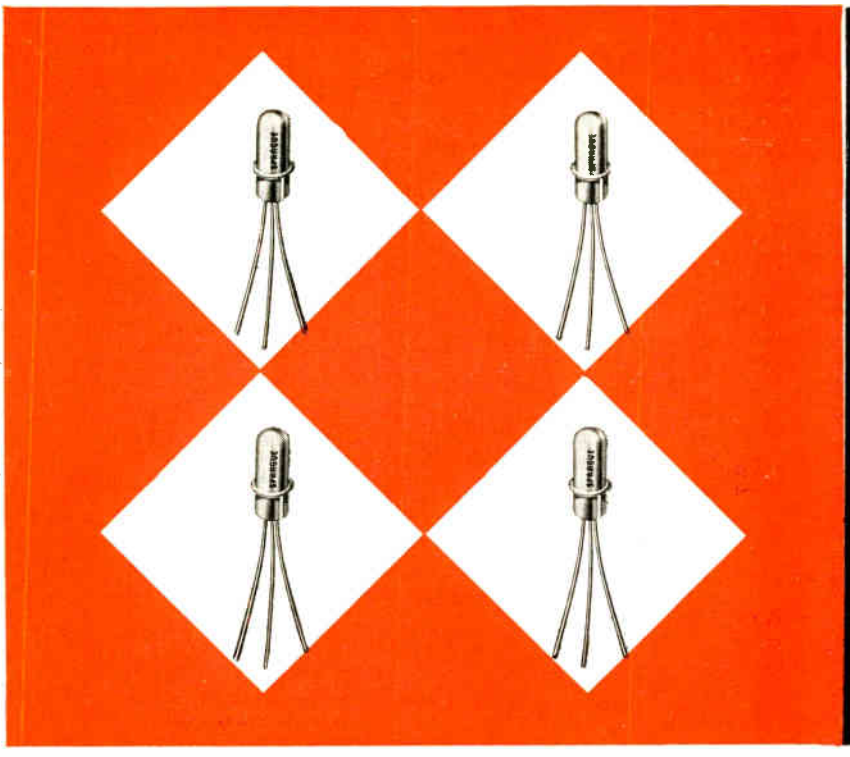
Northwestern Univ. and ARPA (Advanced Research Projects Agency) have established a basic materials research center in the Technological Institute on the Evanston, Illinois campus. Dr. Morris E. Fine, will be Chrmn. of the center.

Purpose is to do fundamental research into relationships "between composition and structure, and between properties and behavior of materials." Metals, semiconductors, plastics, and ceramics will be among the materials studied.

NEW POTTING TECHNIQUE

To increase reliability of digital computers, logic cards are now potted in pairs and dipped in epoxy resin at the Librascope Div., General Precision, Inc.

More News on Page 16



AVAILABLE NOW IN MASS PRODUCTION

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Sprague Germanium Micro-Alloy Diffused-Base Transistors, well-known for their rugged vhf performance, are now *priced below other transistors* with comparable electrical characteristics. In many areas, this permits designers to improve circuit techniques without necessarily increasing costs. Expanded production facilities enable us to *ship quantity orders on short notice.* Add to this their *ultra-fast switching time,* and you have three good reasons why Sprague MADT® Transistors have achieved their high level of acceptance.

With Sprague Transistors, circuits in vhf amplifiers and oscillators can now operate with collector currents as high as 50 ma . . . with power dissipation up to 50 mw . . . with collector to base voltages to 15 v. They have been application tested through the entire military electronics vhf spectrum.

The application table may well suggest the use of one or more Micro-Alloy Diffused-Base Transistor types in your latest circuit designs.

For complete engineering data on the types in which you are interested, write Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Massachusetts.

• • •

**Sprague micro-alloy, micro-alloy diffused-base, and surface barrier transistors are fully licensed under Philco patents. All Sprague and Philco transistors having the same type numbers are manufactured to the same specifications and are fully interchangeable.*

MICRO-ALLOY DIFFUSED-BASE TRANSISTOR APPLICATIONS	
Type	**Application**
2N499	Amplifier, to 100 mcs
2N501	Ultra High Speed Switch (Storage Temperature, 85 C)
2N501A	Ultra High Speed Switch (Storage Temperature, 100 C)
2N504	High Gain IF Amplifier
2N588	Oscillator, Amplifier, to 50 mcs

You can get off-the-shelf delivery at factory prices on pilot quantities up to 999 pieces from your local Sprague Industrial Distributor.

SPRAGUE®
THE MARK OF RELIABILITY

SPRAGUE COMPONENTS:

CAPACITORS • RESISTORS • MAGNETIC COMPONENTS • TRANSISTORS • INTERFERENCE FILTERS • PULSE NETWORKS
HIGH TEMPERATURE MAGNET WIRE • CERAMIC-BASE PRINTED NETWORKS • PACKAGED COMPONENT ASSEMBLIES

News Briefs

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

EAST

ITEK CORP., Waltham, Mass., and **HERMES ELECTRONICS CO.**, Cambridge, Mass., have agreed to merge. Hermes retains its name and becomes a subsidiary of Itek.

GENERAL ELECTRIC, Waterford, N. Y., is constructing a $3 million plant to manufacture basic silicone intermediate chemicals. The plant is expected to go into operation by late 1961.

FAIRCHILD CAMERA AND INSTRUMENT CORP., New York, and **ALLEN B. DU MONT LABS., INC.**, Clifton, N. J., have agreed on a merger, with Fairchild as the surviving company.

RCA ELECTRONIC DATA PROCESSING DIV. has opened a new branch and district offices at 2 Penn Center, Phila., to provide sales and service for computer system customers in Eastern Penna., Southern New Jersey and Delaware.

ARTHUR D. LITTLE, INC., Cambridge, Mass., has established a Life Sciences Div. with Dr. Charles J. Kensler, in charge.

SYLVANIA ELECTRONIC SYSTEMS, Div. of Sylvania Electric Products, Inc., has formed a Product Support Organization (PSO) to assure maximum customer utilization and field support of advanced electronic systems. Headquartered in West Roxbury, Mass., PSO was formed by combining the division's Data Systems Operations Training Center and its Field Engineering Organization.

WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa., has completed a feasibility study and is now building equipment for a portable nuclear power plant being developed by the Nuclear Div. of The Martin Co. for the AEC. The feasibility study conducted by Westinghouse involved the plant's steam generator, a turbine-generator, switchgear, and a unique condenser for the prototype model of the plant.

FXR, INC., Woodside, N. Y., producer of precision microwave test equipment, has acquired the Budd-Stanley Co., Inc., Long Island City, N. Y., manufacturer of custom microwave components for systems application.

MAGNETICS, INC., East Butler, Pa., has begun construction of a $400,000 single-story brick building. The 22,000 sq. ft. structure will house expanded R&D facilities as well as company offices.

AMPEREX ELECTRONIC CORP., Hicksville, L. I., N. Y., has completed a new wing, adding 13,000 sq. ft. of production area to the 113,000 sq. ft. of the present building.

RCA ELECTRONIC DATA PROCESSING DIV. has established three new integrated departments—Commercial Systems, Data Communications and Custom Projects, and Industrial Computer Systems.

GE's RECEIVING TUBE DEPT., Owensboro, Ky., has initiated a $2,860,000 expansion program, including plans for two new buildings and increased engineering equipment.

ITT's FEDERAL ELECTRIC CORP., Paramus, N. J., has been awarded a $40,763,711 U. S. Air Force contract to operate and maintain the DEW (Distant Early Warning) Line with 60 Dew Line Stations, spanning the northernmost reaches of the American continent from Northwestern Alaska to the Eastern coast of Baffin Island.

INSTRUMENTS FOR INDUSTRY, INC., Hicksville, N. Y., major independent manufacturer of electronic countermeasures systems and related components, has purchased the assets of the George Rattray & Co. division of Hardwick, Hindle, Inc., producer of precision potentiometers.

SYLVANIA'S Advanced Device Research Lab of the Semiconductor Div. has moved from Northlake, Ill., to Waltham, Mass., to provide "a closer liaison between semiconductor device development and manufacturing operations."

BULOVA WATCH CO., Photographic Div., Woodside, N. Y., is developing a new type of special recording camera embodying a unique optical system (classified) for the Air Force under a $198,000 prime contract.

MID-WEST

ELGIN MICRONICS, a div. of the Elgin National Watch Co., broke ground for its new 15,000 sq. ft. Research & Engineering Lab. in Rolling Meadows, Ill. The plant, with an initial staff of approximately 45 research engineers, will open on October 1, 1960.

THE ARMOUR RESEARCH FOUNDATION OF THE ILLINOIS INST. OF TECH., Chicago, Ill., began converting the decennial "head count" to facts and figures by use of its giant Univac 1105 computer for the state of Illinois and for about 45% of the U. S. population (about 80 million inhabitants).

MINNESOTA MINING & MFG. CO., St. Paul, Minn., has purchased Revere Camera Co. of Chicago. Revere's management and operating policies will continue without basic change. Theodore S. Briskin has agreed to serve as Vice-President and Chief Operating Officer of Revere.

MOTOROLA'S COMMUNICATION & INDUST. ELECTRONICS DIV., Chicago, Ill., has developed new data transmission multiplex equipment capable of transmitting 62,000 characters/sec. over a microwave relay system.

THE VICTOREEN INSTRUMENT CO., Cleveland, has transferred its Standard Felt Div. to its recently-acquired subsidiary, Federal Mfg. & Engineering Corp. to give Federal new working capital and a combined backlog of orders totalling $6 million.

PHILCO CORP., has opened its Midwestern Computer Div. office in Room 1100 at The Merchandise Mart, Chicago. The office serves a 15-state midwest sales area for Philco sales representatives, systems and procedure analysts, instructors, programmers, coders and other sales support personnel.

A.S.C. TABULATING CORP., data processing center headquartered in suburban Lake Bluff, Chicago, Ill., has revealed a low-cost electronic data processing available to the small businessman. A Bendix G-15 electronic digital computer has been programmed to process large volumes of data at high speeds via punched paper tape input.

METROPOLITAN TELECOMMUNICATIONS has purchased the Capacitor Div. of Electra Mfg. (privately controlled) and will transfer the operation to its Brooklyn plant from Kansas City.

FEDERAL MFG. & ENGINEERING CORP., subsidiary of The Victoreen Instrument Co., Cleveland, has acquired the Design Tool Co., Brooklyn, N. Y., manufacturer of precision tools for the electronics industry.

WEST

HUGHES AIRCRAFT CO.'s Ground Systems Group has established a Systems Laboratory. The laboratory's function includes development of new product lines, operations and systems analysis, direction and coordination of general research and development engineering programs and systems engineering.

ELECTRA MFG. CO. has established its first district sales office at 5260 E. Beverly Blvd., Los Angeles 22, Calif., headed by Andrew J. Callanan.

BECKMAN INSTRUMENTS, INC., has begun construction of a $500,000 addition to its Fullerton, Calif., headquarters plant. The 28,000 sq. ft. building will house administrative, sales, and engineering personnel.

SOUTHWESTERN INDUSTRIAL ELECTRONICS CORP., Houston, Tex., designer and manufacturer of seismic and geophysical instruments, is extending its activity to industrial and military control systems. The company expects to add more than 1,000 technically trained people in engineering during the next 5 years.

LITTON SYSTEMS, INC., wholly-owned subsidiary of Litton Industries, has been created, and will be responsible for the parent company's numerous expanding defense equipment and systems activities.

ELECTRONICS DIV., CHANCE VOUGHT is establishing a new $3.5 million facility in the Great Southwest industrial district between Dallas and Ft. Worth. A $1.5 million, ultramodern, air conditioned building with 80,000 sq. ft. of floor space will be constructed.

INTERNATIONAL RECTIFIER CORP., El Segundo, Calif., developers and manufacturers of semiconductor devices, has acquired Dallons Labs., Inc., of Los Angeles. Dallons Labs is a supplier of specialized medical electronic equipment and is currently producing aerospace medical instrumentation for the Project Mercury Astronaut program.

LIBRASCOPE DIV., GENERAL PRECISION, INC., Glendale, Calif., has formed a Los Angeles District Military Sales Office in the Airport Arcade Bldg., 8820 S. Sepulveda, (nr Los Angeles International Airport).

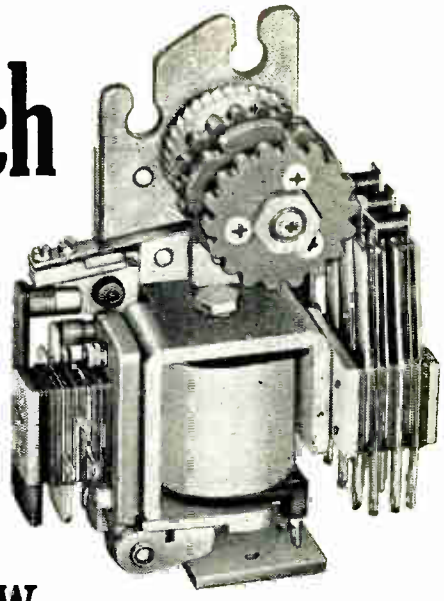
WESTREX CORP., div. of Litton Industries, has installed a Communications Command Center engineered to improve police radio communications in the new Long Beach, Calif., Public Safety Bldg.

HUGHES AIRCRAFT CO., Culver City, Calif., has changed the name of its Airborne Systems Group to Aerospace Group. The group has been engaged in the development and manufacture of Falcon guided missiles, radar armament control systems and communications systems for the Air Force.

AMPHENOL-BORG ELECTRONIC CORP. has purchased a 109,000 sq. ft. parcel of land adjacent to their West San Fernando Valley, Calif., plant to be utilized for additional parking facilities until development plans are completed.

ELECTRO ENGINEERING WORKS, San Leandro, Calif., manufacturer of transformers for industrial and military electronic applications, has acquired a manufacturing plant in Forestville, Calif., to house its new division for miniature encapsulated and resin-potted transformers.

Here's a Memory Switch You Won't Forget...



the New CLARE CAM-OPERATED type 200

offers a program control unit in reduced space and with simpler wiring. Actuating cams can be cut with a sequence of notches and lobes programmed to meet the contact switching desired. In addition, the Type 200 acts as a memory switch of unusual dependability and long life.

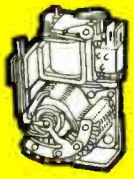
Operating life is measured in millions of steps. Over 30,000,000 operations have been logged with two cams and a 36-tooth ratchet; 10,000,000 with eight cams. Models are available with from 1 to 8 cams. Operating speed is 60 sps, self-interrupted, 30 sps, remote-impulsed.

The Type 200, as are all CLARE stepping switches, is available with a wide variety of hermetically sealed enclosures or dust covers to insure precise operation under all conditions.

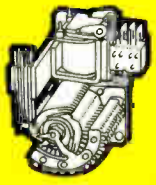
Production quantities available in late fall. Send for Bulletin CPC-7

C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario. Cable Address: CLARELAY

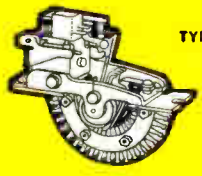
A FULL LINE OF CLARE STEPPING SWITCHES WITH MANY IMPROVED FEATURES



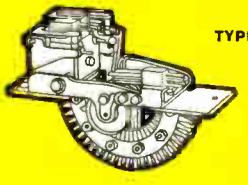
TYPE 210
Has 10 points, with as many as 120 contacts in twelve 10-point levels or four 30-point levels.



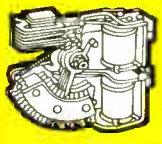
TYPE 211
Offers up to 132 contact points on twelve 11-point levels or four 33-point levels.



TYPE 20
Up to 480 contact points in twelve 40-point levels or 320 in sixteen 20-point levels.



TYPE 26
Up to 624 contact points in twelve 52-point levels or 416 in sixteen 26-point levels.



DIRECT DRIVE
Up to three 10-point levels, plus an off position.

new!

Most complete Stepping Switch Catalog ever offered!

Complete data on construction features, circuitry, performance characteristics and application advantages of the entire CLARE line.

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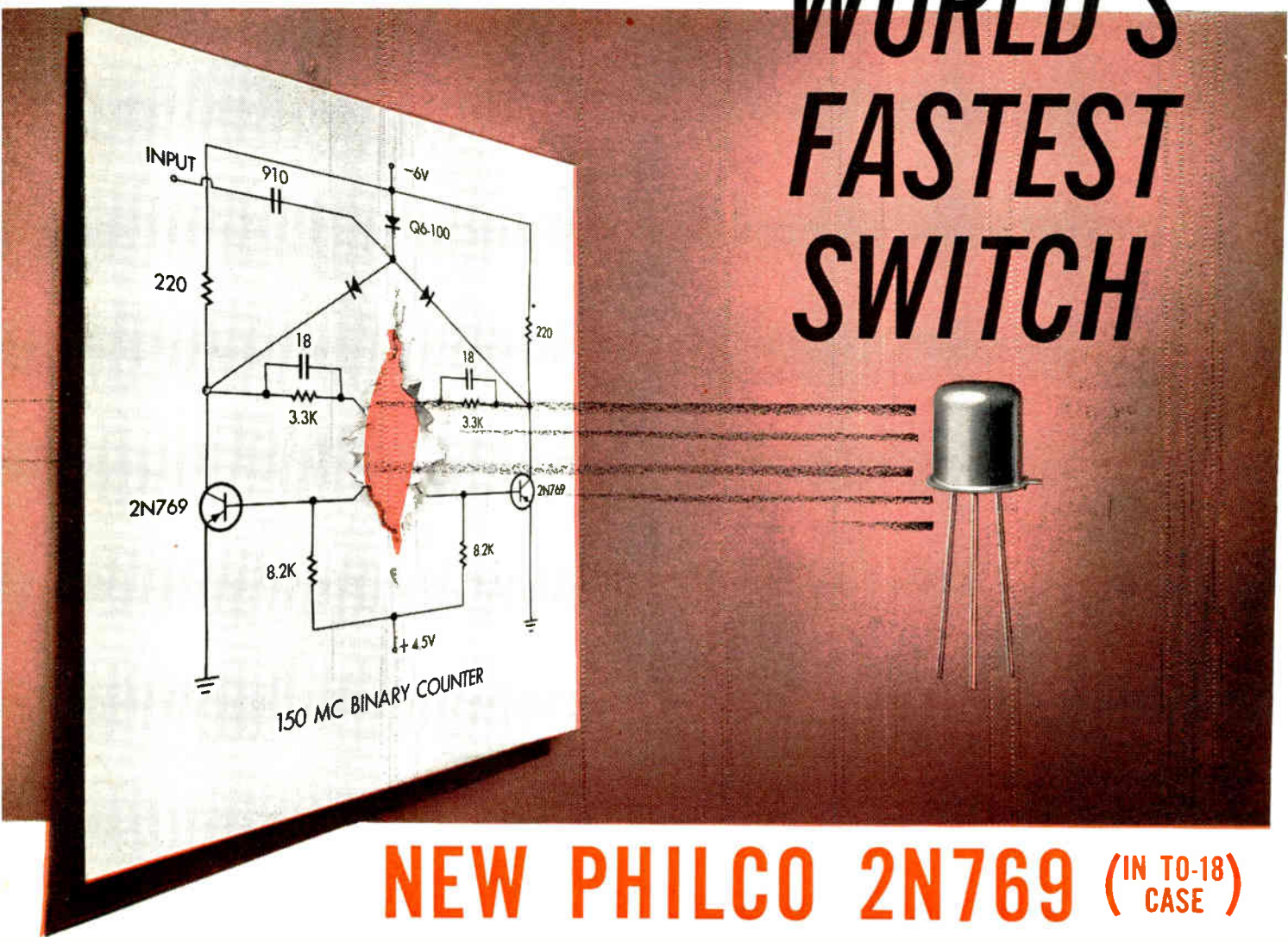
Relays and Related Control Components

For Bulletin CPC-7 please circle number 98 on Inquiry Card
For Catalog 202 please circle number 99 on Inquiry Card

WORLD'S FASTEST SWITCH



NEW PHILCO 2N769 (IN TO-18 CASE)

THE TRANSISTOR FOR 100 mc COMPUTER CIRCUITS

Philco's new 2N769 is the world's fastest commercially available switching transistor! This new addition to the Philco line of MADTs features an 800 mc gain bandwidth product, low hole storage factor, and low emitter and collector diode capacities. It is intended for use in saturated switching circuits at switching rates up to 300 mc. For complete information, write Dept. EI960

ABSOLUTE MAXIMUM RATINGS

Storage Temperature	100°C
Collector Voltage, V_{CBO}	−12 volts
Collector Voltage, V_{CES}	−12 volts
Collector Voltage, V_{CEO}	−7 volts
Emitter Voltage, V_{EBO}	−2 volts
Collector Current, I_C	−100 ma
Device Dissipation @ 25°C	35 mw

ELECTRICAL CHARACTERISTICS (T=25°C)

Characteristics	Condition	Min.	Typ.	Max.
Collector Cutoff Current, I_{CBO}	$V_{CB}=-5v$			−3 μa
Current Amplification Factor, h_{fe}	$V_{CE}=-0.5v$, $I_C=-20$ ma	25		
Collector Saturation Voltage, V_{CE} (SAT)	$I_C=-10$ ma, $I_B=-1$ ma			−0.24 volt
Base Input Voltage, V_{BE}	$I_C=-10$ ma, $I_B=-1$ ma	−0.30		−0.45 volt
Output Capacitance, C_{ob}	$V_{CB}=-5v$, $I_E=0$		1.5	3 μμf
Gain Band-Width Product, f_T	$V_{CE}=-5v$, $I_E=7$ ma	600	800	mc
Hole Storage Factor, K's	$I_B=-2$ ma		15	30 mμsec
Emitter Transition Capacitance, C_{TE}	$V_{EB}=-1v$, $I_C=0$, f=4 mc		5	8 μμf

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LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

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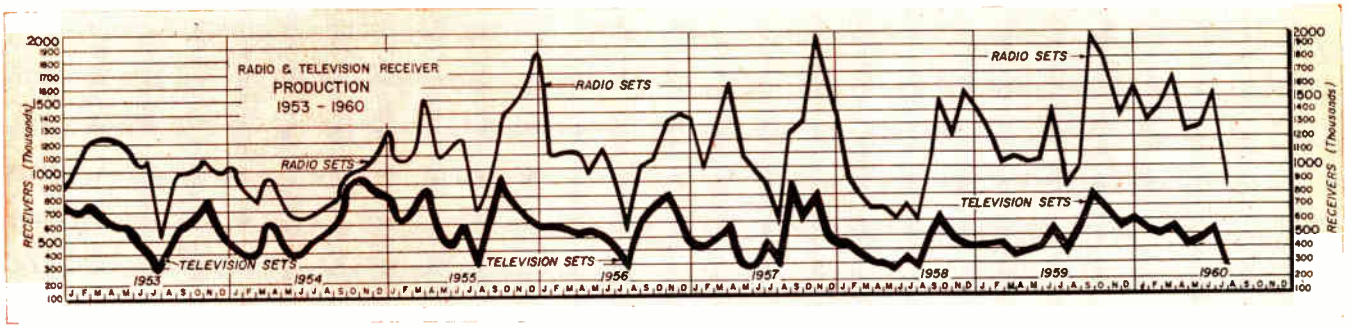
Circle 8 on Inquiry Card

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

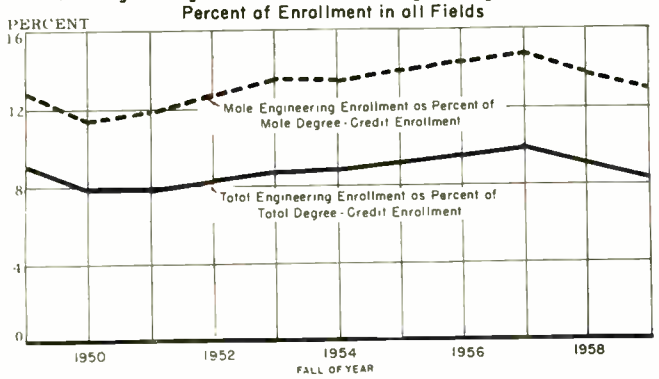
This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in June 1960.

Amplifiers	1,362,008
Amplifiers, control	80,004
Amplifiers, r-f	83,429
Amplifiers, servo	131,378
Analyzers, atmospheric	213,923
Analyzers, distortion	11,829
Analyzers, spectrum	173,874
Antennas	3,233,974
Batteries, dry	890,901
Batteries, storage	381,949
Beacon, radar	92,000
Cable	138,369
Cable assemblies	637,481
Cable, telephone	32,650
Capacitors	157,140
Cells, standard	43,486
Communications equipment, VHF	1,499,697
Communications equipment, radio	175,012
Components, radio systems	1,056,800
Components, UHF radio	1,232,825
Computers	69,650
Computer equipment, analog	1,509,999
Computing systems, flight path	126,008
Computers, telemetry	119,043
Connectors, test set, r-f	148,700
Contacts, crystal	73,295
Counters, alpha	49,755
Couplers, sonar	104,127
Data recorders	239,099
Decommutator, telemetry	36,815
Degreaser, ultrasonic	307,704
Discriminators	31,480
Dome, sonar	912,630
Enclosures, electromagnetic shielding	35,288
Environmental chambers	99,875
Fans	60,886
Feed horns, radar	73,169
Filters	31,560
Filters, antenna	1,219,204
Generators, trigger	364,845
Generators, function	60,000
Handsets	37,131
Headsets	781,221
Hydrophones	50,720
Indicators, elapsed time	40,540
Inverters	36,823
Inverter synchronizers	27,900
Isolators, waveguide	26,718
Mapping set, video	852,500
Measuring set, transmission	59,834
Memory, magnetic core	47,753
Meters, frequency power	30,876
Meters, volt	40,250
Meters, watt	48,265
Microphones	43,200
Monitors, r-f	193,136
Multimeters	64,150
Oscillators, power	525,812
Oscillators, transmitters	78,425
Oscillographs	133,706
Oscilloscopes	572,969
Plotter, systems	61,700
Potentiometer assemblies	36,000
Power supplies	73,324
Pre-amplifiers	32,471
Radar systems	1,675,461
Radio sets	290,828
Radomes	648,988
Reactors	28,853
Receivers	4,110,000
Receivers, countermeasures	52,316
Receivers, radio	682,780
Recorders	33,760
Recorders, amplifiers	42,000
Recorders, pulse	205,200
Recorders, radio	58,501
Recorders/reproducers	538,003
Relays	233,004
Relays, armature	83,742
Relay assemblies	45,721
Relays, control	52,500
Resistor assemblies	35,739
Resistors, variable	72,001
Semiconductor devices	27,068
Servo equipment	391,964
Signal generators	188,519
Sonar equipment	75,000
Switchboard equipment	170,053
Switches	99,422
Switches, pressure	37,400
Systems, jamming	197,447
Systems, microwave	243,456
Systems, telemetry	238,777
Systems, tropospheric scatter	185,902
Tape handler, digital	50,410
Telemetry equipment	253,478
Test equipment	820,650
Test sets, radio interference	185,176
Trainer, computer	115,785
Trackers, digital celestial	310.125
Transceivers, radio	470.040
Transducers	99,930
Transponders	63,878
Transistors	42,947
Transmitters, synchro	67,080
Tubes, cathode ray	92,485
Tubes, magnetron	600,225
Tuning unit, r-f	100,205
Television, closed circuit	158,137
Tube, electron	3,200,078
Wire, electronic	128,074

Contract Awards for May on page 213

U. S. ENGINEERING ENROLLMENT

Total Engineering Enrollment and Male Engineering Enrollment as Percent of Enrollment in all Fields



Fall	Total Number	Total Percent change from previous year	Number enrolled for: First level degree[1]	Master's degree[2]	Doctor's degree
1959	278,348	— 3.9	242,992	29,713	5,643
1958	289,680	— 2.5	256,779	28,138	4,763
1537	297,077	+ 7.2	268,761	24,136	4,180
1956	277,052	+13.8	251,121	22,529	3,402
1955	243,390	+13.5	221,448	18,779	3,163
1954	214,414	+10.9	193,692	17,441	3,281
1953	193,333	+ 9.5	171,725	18,607	3,001
1952	176,549	+ 6.6	156,080	17,539	2,930
1951	165,637	— 8.1	145,997	16,765	2,875
1950	180,262	—18.0	161,592	15,869	2,801
1949	219,712	....	201,927	15,242	2,543

[1] The first-level degree is the bachelor's or first-professional degree.
[2] Includes also enrollments for other postgraduate predoctoral degrees.
—"Engineering Enrollments & Degrees 1959," U. S. Dept. of Health, Education, and Welfare.

—"Engineering Enrollments & Degrees 1959," U. S. Dept. of Health, Education, and Welfare.

EI's International News

Trade Need Seen Between Small U. S. & European Firms

A six-weeks' technical survey of European electronic companies by Stephen V. Hart, M.S.E.E., Director of the newly formed Electronic Engineers International, Wilton, Conn., reveals that most companies are too busy with their own research and marketing problems to notice technical developments in the U. S.

This narrow focus causes much duplication of effort and, consequently, important markets are missed. For example, in Germany, Switzerland, and France—of the ten top companies manufacturing electric meters, none had heard of the U. S. firm, "Assembly Products, Inc." a contact-making meter manufacturer.

By the same token, American electronic equipment manufacturers are unaware of European counterparts for the most part since they tend to concentrate on the home front. Only those companies of considerable size seem to have the resources to divert time and personnel to overseas interests.

However, Mr. Hart's survey has revealed differently since profitable overseas contacts by means of licensing agreements can be established.

Puerto Rico Gets GE-311 Process Computing System

A GE-311 process computing system, including a new GE-312 digital control computer, under a $200,000 contract, will supervise and protect Puerto Rico's newest and largest power generating station late this year.

The system will supervise operation of two new GE 82,500 kilowatt turbine-generators, which will increase the island's generating capacity by more than 50% of present capacity. An outdoor plant, it will be located at Palo Seco on the western side of San Juan harbor.

The new computer system will help assure efficient operation of the turbine generators at all times. It will alarm against potentially dangerous situations and measure and monitor some 300 different inputs at the rate of 10 per second. Each hour the computer system will type out operating conditions and perform calculations to determine if the plant is operating as efficiently as it should be. This information will be of valuable assistance to the operators in running the plant at highest possible efficiency, and should result in substantial savings.

Litton Signs Agreement With Japanese Firm

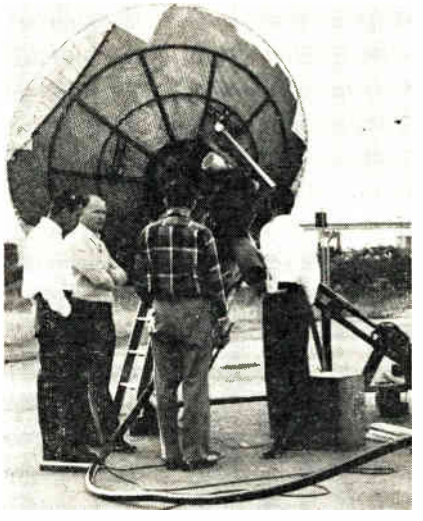
Litton Industries and Kobe Kogyo Corp., Japan, have agreed on a working relationship in the microwave and other electron tube fields on a long-term basis. This is Litton's first manufacturing relationship in Japan.

Kobe Kogyo Corp. manufactures electron tubes and other electronic devices, semi-conductors, nuclear equipments and precision machinery.

Litton Industries' Westrex Corp. Div. for many years has maintained an office in Tokyo. This office, with branches throughout Japan, also represents the other divisions of Litton Industries.

The agreement must be approved by the Japanese and U. S. governments.

HAM RADIO MOON-BOUNCE



First amateur radio moon-bounce two-way microwave communication took place recently between Eimac Radio Club members in San Carlos, Calif., and Sam Harris, Rhododendron Swamp VHF Society, Medfield, Mass. First transmission on 1296 Mc was from West (W6HB) to East (W1BU).

New Automated Glass Plant Constructed in Philippines

Republic Glass Corp., Manila, commenced operation of its new window and sheet glass plant costing $5,000,000, which incorporates advanced automation equipment—the first producing sheet glass plant in the Philippines.

Equipment includes three Fourcault glass-making machines and electronic systems providing automatic weighing and mixing of raw materials before they are fed into a giant 130-foot furnace. Drawing and precision cutting of glass is done through automatic controls.

German Company Formed By Bendix and Telefunken

A new company called "Teldix" has been created by the Bendix Corp. and Telefunken G.m.b.H. of Germany, with headquarters in Heidelberg, Germany.

Teledix will handle the research, development, manufacture, service and the sale of aircraft systems and equipment, such as airborne flight-control equipment and navigation instruments including airborne computers.

Installation of these units are planned on both the Lockheed F-104 and Fiat G-91.

James B. Treacy, former manager of the B-58 systems project at the Eclipse-Pioneer Div. of Bendix in Teterboro, N. J., and Fritz Krumling of Telefunken, have been named Managing Directors of Teldix.

RCA Opens Telex Service To India

Teleprinter exchange (Telex) service now joins the U. S. and India. Fifty overseas points are now included in RCA's global network.

Initially, the service will be restricted to the continental U. S. and the Indian cities of Bombay and Ahmedabad. Later it will be extended to other cities inside India.

The new service permits subscribers to engage in two-way teleprinter conversations. Rates for telex calls to India have been set at $4.00 per minute, with a minimum charge of $12.00 for a three-minute call.

Navigation & Control Equipment On Display at Farnborough

Over 40 electronic firms with joint exhibits worth millions of pounds are represented this month at the 1960 Flying Display and Exhibition, Farnborough, England; organized by the Society of British Aircraft Constructors.

Electronic methods of controlling the world's airways and coping with increasing traffic density, while still strengthening the safety factor, is the underlying theme of the display and exhibit.

Several of the firms exhibiting under the flag of the Electronic Engineering Association are showing new methods of aircraft control, in which the complexities of traffic are simplified for the ground controller. At busy terminals on international routes, traffic density is already acute and is threatening to limit the expansion of air services.

(*Continued on page* 32)

Creative Microwave Technology

Published by MICROWAVE AND POWER TUBE DIVISION, RAYTHEON COMPANY, WALTHAM 54, MASS., Vol. 2, No. 3

RAYTHEON 1,000,000-WATT MAGNETRON LOGS OVER 13,000 HOURS IN MOBILE RADAR

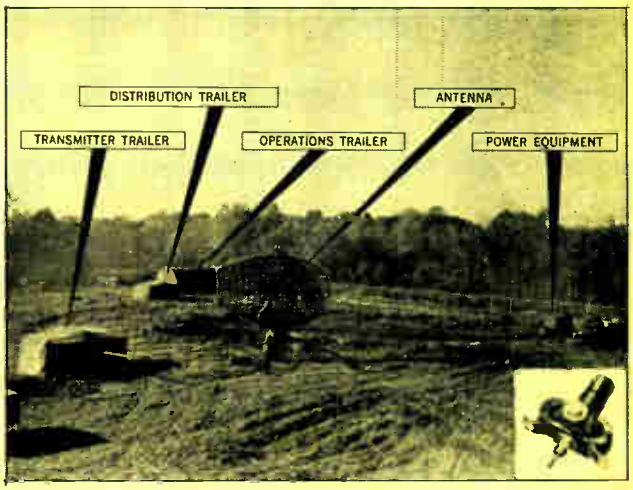
This is the first reported history of a Raytheon QK-358 magnetron substantiated with an exhibit. Still, there are numerous other cases in which these exceptional Raytheon tubes have been clocked in excess of 10,000 hours, radiating at peak power.

The case in point concerns the application of a QK-358 magnetron in an AN/FPS-8 radar, for which the General Electric Company is the prime contractor. When the tube was replaced after 13,000 hours of service for "preventative maintenance" reasons, it was returned to Raytheon where the tube was found to be operating within specifications. Findings showed it to be highly stable and still capable of radiating more than one megawatt of power.

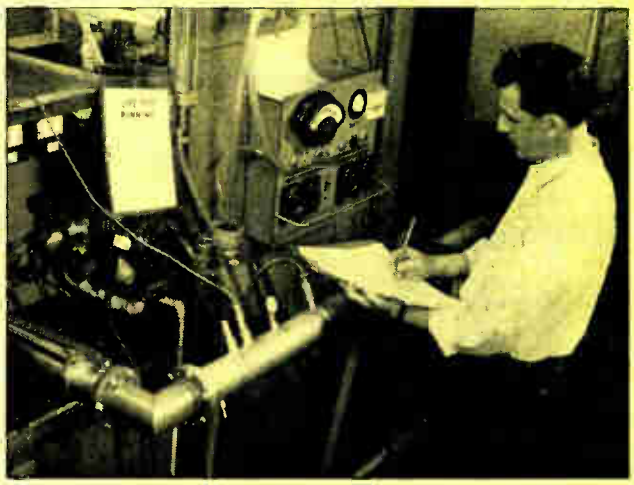
A large measure of the reliable operation and outstanding life of the QK-358 was achieved through special attention given to its unique characteristics in the overall design of the radar transmitter.

For your information, the QK-358 is a mechanically tunable pulsed-type oscillator with an integral magnet and is designed for coupling to a standard 3" x 6" waveguide. Typical operating characteristics include:

Frequency Range	"L" Band
Peak Power Output	1.3 Mw
Average Power Output	1,630 W



AN/FPS-8 high-power search system by General Electric, used primarily in aircraft control and early-warning operation. The complete mobile version (AN/MPS-11A) shown here, can be airlifted or carried on nine trucks and two trailers.



Life testing of Raytheon tubes, such as the QK-358 magnetron, for six weeks or more serves as a quality check of their performance characteristics as recorded and plotted against time.

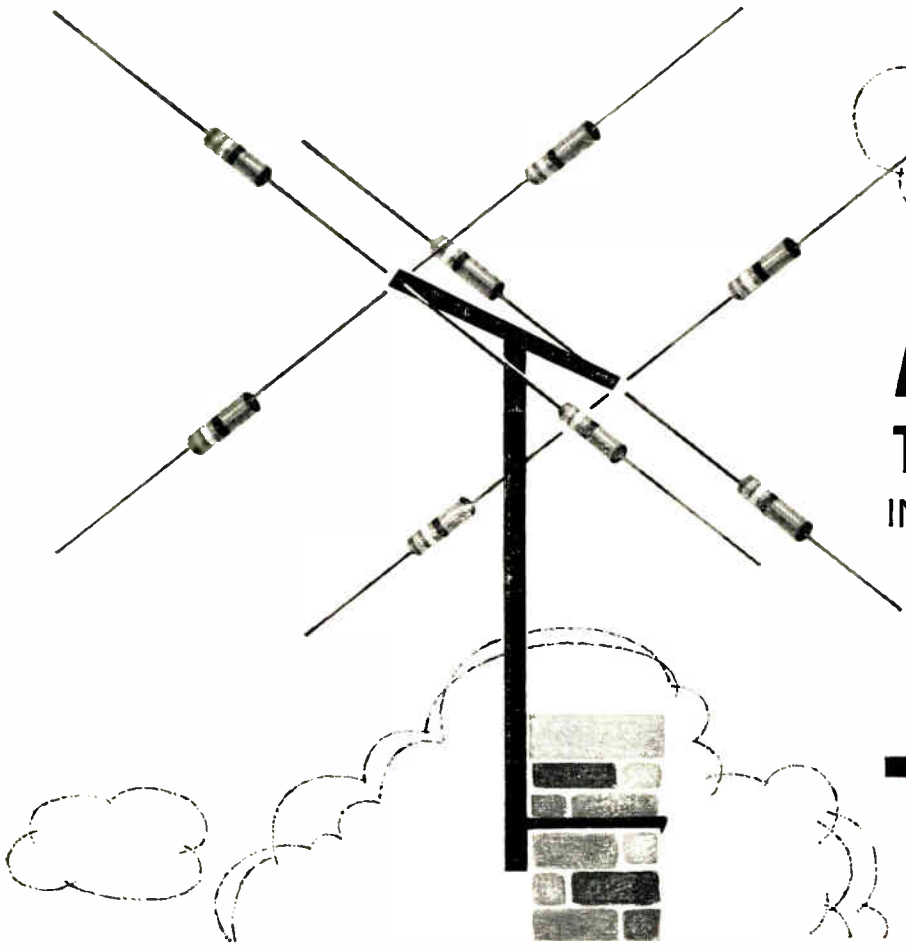
Excellence in Electronics

RAYTHEON

You can obtain detailed application information and special development services by contacting: Microwave and Power Tube Division, Raytheon Co., Waltham 54, Mass. In Canada: E. Waterloo, Ontario. In Europe: Zurich, Switzerland.

A LEADER IN CREATIVE MICROWAVE TECHNOLOGY

Circle 9 on Inquiry Card



ATTUNED
TO YOUR NEEDS

INDUCTANCE INCREASED
TENFOLD IN NEWEST

JEFFERS
MINI-STAB INDUCTORS

MINIature-**STAB**le

NEW TYPES EXTEND MINI-STAB INDUCTANCE RANGE TO 10,000 MICROHENRIES!

Now, from Jeffers Electronics, pioneers in MINIature, STABle inductors, come the most recent additions to the line—MINI-STAB Inductors Types 2 and 3. Supplementing the Jeffers Type 101 and MINI-STAB Type 1 line, the two new miniatures increase the inductance values available from Jeffers to a range of 0.15 to 10,000 uh.

Miniaturization PLUS Stability

In Jeffers MINI-STAB inductors, *miniaturization* is achieved through more efficient use of coil winding space. *Stability* is made possible through the use of an open magnetic circuit as obtained with a conventional powdered iron coil form.

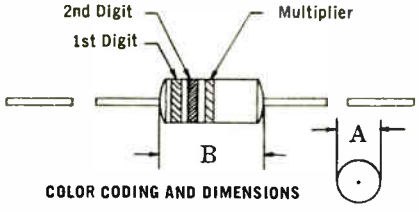
TYPICAL CHARACTERISTICS OF INDUCTOR DESIGNS BASED ON 1000 UH VALUE

INDUCTOR CHARACTERISTICS	JEFFERS MINI-STAB DESIGN	CONVENTIONAL DESIGNS	
		MINIATURIZED*	NON-MINIATURIZED
Miniaturization (wt. in grams)	1.0	0.5 to 2	2 to 10
Stability of Inductance with temp. −55 to +125°C	±2%	±10%	±2%
with applied current (zero to 90 MA)	−1%	−30%	NIL
with applied voltage (test or signal)	GOOD	POOR	GOOD

*Utilizing closed magnetic circuits such as toroids, cup-cores, etc.

A comparison of typical MINI-STAB performance with that of conventional miniaturized and non-miniaturized inductors appears above. Inductor designs of the closed magnetic circuit type such as toroids, cup cores, etc. tend to be inherently unstable.

THIS IS THE EXPANDED MINI-ST



COLOR CODING AND DIMENSIONS

TYPE
1
2
3

LEADS
AWG. #22 1 5/16 Min. Length
AWG. #21 1 5/16 Min. Length
AWG. #20 1 5/16 Min. Length

MINI-STAB T

PART NUMBER	TYPE	INDUCTANCE (Microhenries)	MEAS. FREQ. (MC)	Q MIN.	SRF MIN. (MC)	D MAX (Ω	COLOR-CODING 1st	2nd	3rd
1311-1	1	18 ± 10%	2.5	50	25	1	BRN	GRY	BLK
1311-2	1	22 ± 10%	2.5	50	24	2.0	RED	RED	BLK
1311-3	1	27 ± 10%	2.5	50	20	2.8	RED	VLT	BLK
1321-1	1	33 ± 10%	2.5	50	19	2.5	ORG	ORG	BLK
1321-2	1	39 ± 10%	2.5	50	18	3.0	ORG	WHT	BLK
1321-3	1	47 ± 10%	2.5	50	17	3.5	YEL	VLT	BLK
1321-4	1	56 ± 10%	2.5	50	15	4.2	GRN	BLU	BLK
1321-5	1	68 ± 10%	2.5	50	14	5.0	BLU	GRY	BLK
1321-6	1	82 ± 10%	2.5	50	12	5.5	GRY	RED	BLK
1321-7	1	100 ± 10%	2.5	50	11	6.0	BRN	BLK	BRN
1321-8	1	120 ± 10%	0.79	50	9.0	7.0	BRN	RED	BRN
1321-9	1	150 ± 10%	0.79	50	8.6	8.0	BRN	GRN	BRN
1321-10	1	180 ± 10%	0.79	50	8.0	9.0	BRN	GRY	BRN
1321-11	1	220 ± 10%	0.79	50	6.6	10.0	RED	RED	BRN
1331-1	1	270 ± 10%	0.79	45	4.0	6.r	RED	VLT	BRN
1331-2	1	330 ± 10%	0.79	45	3.6	7.4	ORG	ORG	BRN
1331-3	1	390 ± 10%	0.79	45	3.4	10.6	ORG	WHT	BRN
1331-4	1	470 ± 10%	0.79	45	3.1	11.5	YEL	VLT	BRN
1331-5	1	560 ± 10%	0.79	55	2.9	15.2	GRN	BLU	BRN
1331-6	1	680 ± 10%	0.79	50	2.6	17.0	BLU	GRY	BRN
1331-7	1	820 ± 10%	0.79	50	2.4	19.0	GRY	RED	BRN
1331-8	1	1000 ± 10%	0.79	45	2.2	21.3	BRN	BLK	RED

NEWEST MINI-STAB TYPES

1312-1	2	1200 ± 10%	.25	60	2.2	21.0	BRN	RED	RED
1312-2	2	1500 ± 10%	.25	60	2.1	24.0	BRN	GRN	RED
1312-3	2	1800 ± 10%	.25	65	1.9	27.0	BRN	GRY	RED
1312-4	2	2200 ± 10%	.25	70	1.7	30.0	RED	RED	RED
1312-5	2	2700 ± 10%	.25	70	1.6	33.0	RED	VLT	RED
1312-6	2	3300 ± 10%	.25	70	1.4	37.0	ORG	ORG	RED
1313-1	3	3900 ± 10%	.25	75	1.5	44.0	ORG	WHT	RED
1313-2	3	4700 ± 10%	.25	80	1.4	49.0	YEL	VLT	RED
1313-3	3	5600 ± 10%	.25	80	1.2	54.0	GRN	BLU	RED
1313-4	3	6800 ± 10%	.25	80	1.1	60.0	BLU	GRY	RED
1313-5	3	8200 ± 10%	.25	80	1.0	67.0	GRY	RED	RED
1313-6	3	10000 ± 10%	.25	80	0.9	75.0	BRN	BLK	ORG

*Based on a 25° C Maximum Temperature Rise.

MINI-STAB inductors are capable of meeting the requirements of MIL-C-15305, Grade 1, Class B, as outlined in Jeffers Product Specification SK-393. Details are available on request.

$856,000 Award to ITT Provides DME to FAA.

The Federal Aviation Agency is purchasing 20 units of the ground station DME (distance measuring equipment) and spare parts.

The DME combines with VOR (very high frequency omnidirectional radio range) to make up the DME/VOR or directional distance navigation systems, enabling pilots to locate their aircraft's position accurately in relation to the ground station as it flies cross-country in either good or bad weather.

In the U. S. an augmented version called VORTAC is being installed to meet military and civil requirements through a common system.

FAA's acquisition of the new DME is another link in the planned short range navigation system for the entire U. S. that will meet international standards.

DME can also serve the instrument landing system (ILS), now in world-wide use to give distance data.

New Alloy Process

Dr. Pol Duwez, California Institute of Technology, has reported a new process for creating metallic alloys. It is informally called "splat cooling." A molten droplet of a pure metal or an alloy is blasted against the rim of a refrigerated metal wheel spinning at high speed. This cools the droplet at the rate of 2,000,000°F/sec. quick-freezing the droplet as a small piece of thin foil before the atoms have time to realign themselves. A fine grain structure is created with each individual grain too small to be seen with an optical microscope.

Dr. Duwez states two purposes for the technique. One is to synthesize new alloys to gain an insight into the fundamental theory of their formation. The other to fabricate alloys of predetermined properties. Future applications are still speculative—only small quantities can now be made.

Russian Translator Works at 35 Words/Sec.

The Air Force has developed an electronic translator which can translate Russian into English at 35 words per sec. Translation is on a word-for-word basis, which normally is sufficient for getting a very good idea of the general content of the Russian article. A so-

phisticated word analyzer with logic circuits for sentence structure is expected to be ready for incorporation into the translation complex by the end of this year. A special input machine is being designed by Baird Atomic, Cambridge, Mass. Present input is by tape which must be prepared manually (40 words/min.). A Russian print reader will scan the material electronically and automatically make tapes at 2400 words/min.

A "photostatic memory" invented by Dr. Gilbert W. King, of IBM's Research Center, Yorktown Heights, N. Y., is the heart of the system. It is a transparent disc, 10 in. in dia., which stores 550,000 Russian-English words in binary code. IBM Research is working to improve this section and also developing a lexical "buffer" which stores words coming from the photoscopic dictionary in complete sentences.

More Measurements of Radiation Belts

America's newest entry in the race for space will be a probe vehicle. It may be boosted as far as 10,000 miles into space and then recovered back on Earth.

The National Aeronautics and Space Administration (NASA) has awarded General Electric Company's Missile and Space Vehicle Department, in Philadelphia, a $536,000 contract to develop a device for measuring the radiation belts surrounding the earth. The device, called a nuclear emulsion recovery vehicle (NERV) is designed to obtain more complete measurements of the Van Allen Radiation Belts surrounding the earth. These measurements may help determine design factors involved in protecting man from radiation hazards in deep space flights.

Instrument Soc. Show In NYC—Sept. 26-30

The Instrument Society of America's Fall Instrument - Automation Conference and Exhibit meets September 26-30 at New York's Coliseum.

The theme of "Progress through Instrumentation" will be supported with some 50 technical conferences, clinics and workshops, as well as exhibits by more than 400 of the nation's leading instrument manufacturers.

GL-2C40A

GL-2C43

Z-5033

GL-6442

LIGHTHOUSE – GLASS

Typical output is 75 mw as a CW oscillator at 3370 mc. Greater output obtainable at lower frequencies. Features include low interelectrode capacitances, low lead inductance and low loss. Performance-proved and economy-priced. Height is 2 9/16".

Typical applications are as a Class A RF amplifier, a Class C CW oscillator and a plate-pulsed oscillator.

Typical output is 1.75 kw as a pulsed ascillatar at 3370 mc. Greater output obtainable at lower frequencies. This single-ended tube features low impedance and is 2 11/16" high. Like the GL-2C40A, this tube is economy-priced.

Typical applications are as a Class C RF amplifier, a Class C CW oscillator, and a plate-pulsed oscillator.

A lang-life version of type GL-2C43. The objective far this tube is 15,000 hours at 1000 mc. While designated developmental until this objective is proved, the tube is available from production. Like the GL-2C43, it is single-ended, features low impedance, and is 2 11/16" high.

It is designed to serve as a Class C CW oscillator.

LIGHTHOUSE

A general purpose, medium-mu JAN triode, this tube is especially suited to pulsed operation up to approximately 5000 mc. It gives 2 kw useful pulsed power output at 3500 mc, and approximately 500 watts at 5000 mc. Height is 2 39/64".

Typical applications include Class C amplifier, oscillator, mixer and amplifier in both CW and pulsed service.

TO MEET ALL APPLICATION REQUIREMENTS . . .

General Electric Now Offers You Industry's

LIGHTHOUSE – MINIATURE CERAMIC

GL-6299

GL-7391

GL-7644

Z-5435

Ultra-reliable for high-gain, low-noise applications to 3000 mc. Noise figure of 4.3 db and gain of 18.5 db at 450 mc. Operational warranty is 1000 haurs. This UHF-SHF tube has high shock and vibration resistance and is conduction-cooled. This tube and its derivatives are only 1" high.

Its application is os a Class A_1 RF amplifier.

This is a Class C version of tube type GL-6299. It operates up to 6000 mc. Its power output is 65 mw at 5400 mc. Moreover, its power output is greater than 0.5 watts at 500 mc. This new, metal-ceramic UHF-SHF low-power triode features conduction cooling and has a grounded grid.

Principal application is as a Class C CW ascillator.

This derivative of type GL-6299 operates up to 3000 mc, and is notable for its high spike resistance capabilities. The tube is unilaterally interchangeable with type GL-6299. Only recently announced, this sturdy, UHF, low-noise and low-power triode features a grounded grid and conduction cooling.

It is especially suitable for application as a Class A_1 RF amplifier.

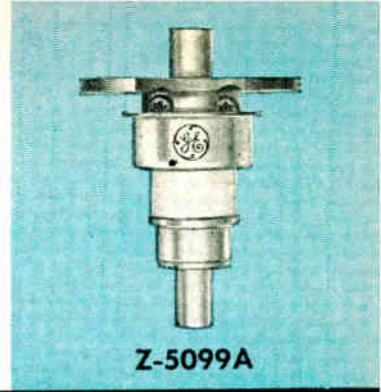
The frequency range for this tul is up to approximately 3000 m It is a low-noise, high-gain UI triode, similar in all respects ta t GL-6299 except that it is design with an isolated heater. It featu a grounded grid and is conductic cooled.

It is recommended for applicat as a Class A_1 RF amplifier.

GL-6771

GL-6897

Z-5387



Z-5099A

CERAMIC

A high-gain, high-mu, closed-spaced triode with useful output in excess of 500 mw at 4000 mc, CW and under pulsed conditions. Several hundred mw obtainable at 6000 mc. Features low interelectrode capacitances and rugged planar construction. Height is 2 39/64".

Recommended for low and intermediate level amplifier and multiplier applications because of its exceptional gain.

This version of the 2C39 family is especially suited to high-frequency operation. Has 100 watt anode dissipation. Gives 30% efficiency and 10 db gain at 1860 mc and 600 volts. Height is 2 11/16". Efficient pulse performance to 3000 mc.

Notable for consistent high-gain performance, resulting from closely controlled manufacturing and processing tolerances and thorough characteristic testing in accordance with MIL-E-1/1037B.

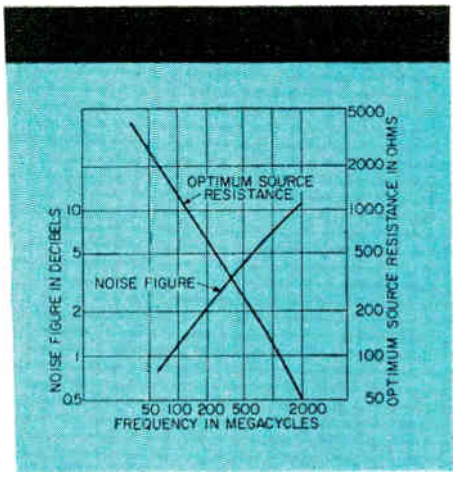
This tube is a finless version of type GL-6897 for applications where there are space limitations, and the full plate dissipation of the GL-6897 is not required. Height is 2¾".

Possible applications include pulsed airborne navigational equipment and airborne communications. The tube is operable as a Class C pulsed or CW amplifier, oscillator, and frequency multiplier.

A conduction-cooled version of type GL-6897, for grounded-grid Class C power amplifiers, oscillators, or frequency-multiplier circuits up to 2500 mc. 35 watts plate dissipation readily obtainable. Features same rugged disc-seal construction as type GL-6897. Gives consistent high performance. Height is 2⅝".

Designed specifically for missile and other non-air-cooled applications.

Most Complete Line of Microwave Triodes



Calculated Noise Performance for Noise-matched, Grid-return Circuit Operation, Input Circuit Losses Neglected.

GL-6299 • GL-7644 • Z-5435

Operating Conditions

$E_f = 6.3$ volts

$E_c = 0$ volts

$E_b / I_b = 10$ milliamperes

Illustrated on these two pages are just twelve of the more than twenty microwave triode types General Electric now offers . . . industry's most complete line. Rugged, versatile G-E "lighthouse" triodes are now available for all types of microwave communication, navigation, identification and radar equipment . . . for all ground, sea and airborne applications.

For more information on General Electric's complete line of microwave triodes, and for competent application engineering assistance, contact your General Electric Power Tube Sales Office.

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701 Washington Street
Newtonville, Massachusetts
Telephone: WOodward 9-9422

SYRACUSE
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Syracuse, New York
Telephone: HArrison 2-1030

SCHENECTADY
Building 267
Schenectady 5, New York
Telephone: FRanklin 4-2211
Ext: 5-3433

EASTERN
200 Main Avenue
Clifton, New Jersey
Telephone: GRegory 3-6387
Dial direct from New York City
WIsconsin 7-4065-6-7-8

CENTRAL
3800 No. Milwaukee Avenue
Chicago 41, Illinois
Telephone: SPring 7-1600

DAYTON
118 West First Street
Dayton 2, Ohio
Telephone: BAldwin 3-7151

WESTERN
11840 West Olympic Boulevard
Los Angeles 64, California
Telephone: GRanite 9-7765

WASHINGTON
Wyatt Building—Room 1313
777—14th Street, N. W.
Washington, D. C.
Telephone: EXecutive 3-3600

POWER TUBE DEPARTMENT

GENERAL ELECTRIC

265-01-8481-28

Circle 13 on Inquiry Card

Coming Events

(*Continued from page* 12)

Sept. 23-25: Chicago High Fidelity Home Entertainment Show, Int'l Sight and Sound Expos., Inc., Palmer House, Chicago, Ill.

Sept. 26-27: Machine Knife Assoc.: The Homestead, Hot Springs, Va.

Sept. 26-28: American Management Assoc. Fall Personnel Conf., Q. & A. Session on "Where is Personnel Going?"; Statler Hilton Hotel, N. Y. C.

Sept. 26-28: 9th Annual Meeting, Standards Engineers Soc.; Pittsburgh-Hilton Hotel, Pittsburgh, Pa.

Sept. 26-28: Petroleum Mechanical Eng'g Conf., ASME; Jung Hotel, New Orleans, La.

Sept. 26-29: American Welding Soc., National Fall Meeting, Amer. Soc. Civil Eng., Column Research Council, Eng. Foundation; Hotel Penn-Sheraton, Pittsburgh, Pa.

Sept. 26-30: Fall Instrument-Automation Conf. & Exhibit and 15th Annual Meeting, ISA; Coliseum, N. Y., N. Y.

Sept. 27-28: Metal Cutting Knife Assoc.; The Homestead, Hot Springs, Va.

Sept. 27-30: American Rocket Soc.'s Space Power Systems Conf., NASA, AF, AEC, ARPA with co-op of IRE and AIEE; Miramar Hotel, Santa Monica, Calif.

Sept. 28-30: Thermoplastics Pipe Div. Meeting, the Soc. of the Plastics Indus., Inc. (SPI); Dearborn Inn, Dearborn, Mich.

Oct. 2-4: Cellular Plastics Div. Meeting, The Soc. of the Plastic Industry (SPI); Galen Hall, Wernersville, Pa.

Oct. 3-5: Nat'l Midwestern Conf. on Air Logistics, IAS; Tulsa, Okla.

Oct. 3-5: 6th Nat'l Communications Symp. IRE (PGCS); Rome-Utica Section; Hotel Utica & Utica Memorial Audit., Utica, N. Y.

Oct. 3-5: 7th Annual Meeting, IRE (PGNS), Oak Ridge Nat'l Lab.; Gatlinburg, Tenn.

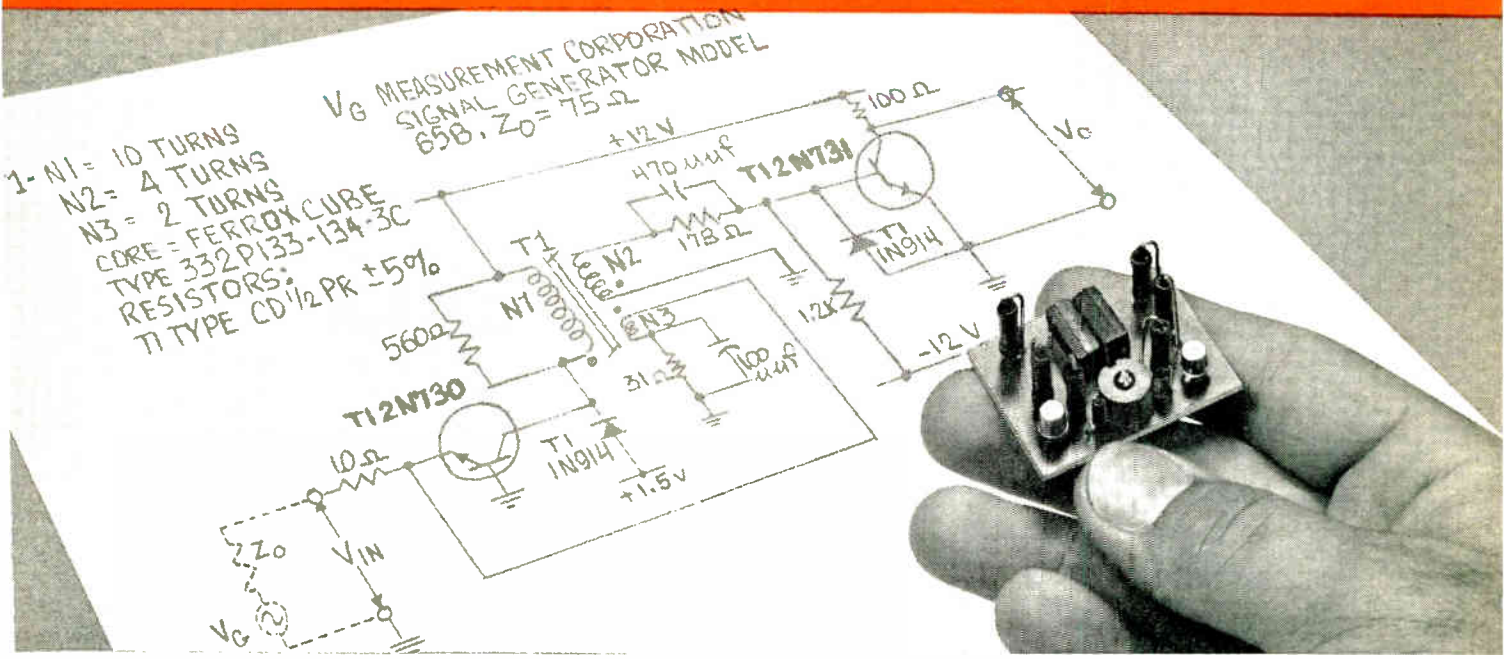
Oct. 4-6: 6th Conf. on Radio Interference Reduction and Electronic Compatibility, All 3 Military Services, Armour Research Foundation, IRE (PGRFI); Museum of Science and Industry, Chicago, Ill.

Oct. 4-7: 8th Annual Human Eng'g Instit., Dunlap & Assoc., Inc.; Stamford, Conn.

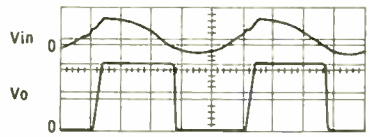
Abbreviations

AEC: Atomic Energy Committee
AIChE: Amer. Inst. of Chem. Eng's.
AIEE: Amer. Soc. of Electr. Eng's.
ASME: Amer. Soc. of Mech. Eng's.
ASQC: Amer. Soc. for Qual. Control
EIA: Electronic Industries Assoc.
IAS: Instit. of Aeronautical Sciences
IRE: Instit. of Radio Eng's
ISA: Instrument Soc. of America
NASA: Nat'l Aeronautics & Space Admin.
NATO: North Atlantic Treaty Organ.
SMPTE: Soc. of Motion Picture & Tv Eng's
SPE: Soc. of Plastics Eng's
SPI: Soc. of the Plastics Indus., Inc.

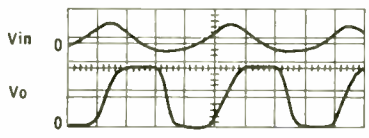
HOW TO GENERATE 100-ma PULSES AT 10 mc



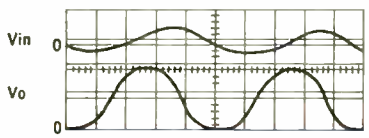
. . . WITH TI 2N730 and 2N731 SILICON MESA TRANSISTORS



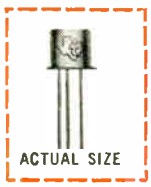
1 Megacycle
VERT.—5v /cm
HORIZ.—.2 μsec /cm
T_A—25°C



5 Megacycles
VERT.—5v /cm
HORIZ.—50 mμsec /cm
T_A—25°C



10 Megacycles
VERT.—5v /cm
HORIZ.—20 mμsec /cm
T_A—25°C



See how these performance-proved characteristics apply to your high-current, high-speed switching circuits . . .

High-current loads — Switch *100 ma* at 10-mc rates using TI 2N730 and 2N731 transistors (see applications circuit) • *Fast switching* — Note *20 millimicrosecond* rise and fall times on the waveforms illustrated • *Size and weight* — Save *both* size and weight with the subminiature TO-18 packaging of the TI 2N730 and 2N731 'mesas' • *Dissipation* — Get a full *500 mw* (T_A=25°C) or *1.5w* (T_C=25°C) with beta spreads of 20-60 (2N730) and 40-120 (2N731) • *Reliability* — TI Quality Assurance *guarantees* you performance to specifications • *Applications* — Use the TI 2N730 and 2N731 guaranteed performance in your digital computer clock pulse generators and similar high-load, high-speed, high-reliability circuits. Check these specifications:

electrical characteristics at 25°C ambient (unless otherwise noted)

	PARAMETER	TEST CONDITIONS		2N730 min	2N730 max	2N731 min	2N731 max	unit
I_{CBO}	Collector Reverse Current	V_{CB}=30v	I_E=0	—	1.0	—	1.0	μa
I_{CBO}	Collector Reverse Current at 150°C	V_{CB}=30v	I_E=0	—	100	—	100	μa
BV_{CBO}	Collector-Base Breakdown Voltage	I_C=100μa	I_E=0	60	—	60	—	v
BV_{CER}	Collector-Emitter Breakdown Voltage	I_{CER}=100ma, R_{BE}=10 ohms		40	—	40	—	v
BV_{EBO}	Emitter-Base Breakdown Voltage	I_E=100 μa	I_C=0	5	—	5	—	v
h_{FE}	DC Forward Current Transfer Ratio	I_C=150ma	V_{CE}=10v	20	60	40	120	
$V_{BE(sat)}$	Base-Emitter Voltage	I_C=150ma	I_B=15ma	—	1.3	—	1.3	v
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C=150ma	I_B=15ma	—	1.5	—	1.5	v
h_{fe}	AC Common Emitter Forward Current Transfer Ratio	I_C=50ma, f=20mc	V_{CE}=10v	2.0	—	2.5		
C_{ob}	Common-Base Output Capacitance	I_E=0	V_{CB}=10v	—				
		f=1mc		—	35	—	35	μμf

*Pulse conditions: Length = 300μs, duty cycle < 2%

Collector-Base Voltage	60v
Collector-Emitter Voltage	40v
Emitter-Base Voltage	5v
Total Device Dissipation	0.5w
Total Device Dissipation at Case Temperature 25°C	1.5w
Storage Temperature Range	−65°C to +175°C

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the FIRST silicon transistor manufacturer

TEXAS INSTRUMENTS
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Industry News

(Continued from page 20)

Fairchild Acquires Interest in Italian Manufacturing Co.

Fairchild Semiconductor Corp. has acquired a one-third interest in SGS, a Milan, Italy, semiconductor producer, for the overseas manufacturing and marketing of Fairchild silicon semiconductor devices.

Fairchild Semiconductor is a wholly-owned subsidiary of Fairchild Camera and Instrument Corp., Syosset, L. I., N. Y.

SGS (Societa Generale Semiconduttori, S. p. A.) was founded 2½ years ago in Milan by two companies, Olivetti and Telettra, and has been producing germanium alloy junction transistors, silicon diodes, gold bonded diodes and silicon rectifiers for the past year and a half. Olivetti is a business machine producer, while Telettra is a microwave communications manufacturer. Ownership will now be held equally by the three companies.

SGS will commence production of the latest types of Fairchild silicon devices, including transistors, dioded and eventually micrologic elements. SGS will market the Fairchild devices produced in Milan, in Europe and the Middle East.

Fairchild already has a plant in Emmen, the Netherlands, and a marketing headquarters in Amsterdam for the production and sale of its graphic arts electronic products in the overseas market.

U. S.—U. K. Telephone Cable Will Be Laid During 1963

AT&T plans to lay a new U. S.-Gt. Britain telephone cable, the first direct cable across the Atlantic from the U. S.

The system, scheduled for 1963, will cost $35,000,000. It will be jointly owned by AT&T and the British Post Office.

A single cable system, designed for two-way transmission, it will stretch some 3,400 nautical miles and provide initially the equivalent of 128 voice-grade circuits—more than three times the initial capacity of the first trans-atlantic telephone cable system placed in service four years ago.

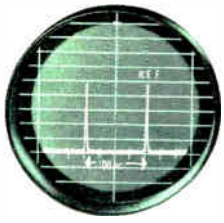
The Long Lines Dept. of AT&T, and the British Post Office will jointly construct and lay the cable. A new type of submarine telephone cable will be used which gets its strength from a steel wire core and does not require the armoring used in previous deep-sea cables.

VISUAL MICROWAVE ANALYSIS 10 to 44,000 mc

MODEL TSA
DIRECT-READING SPECTRUM ANALYZER

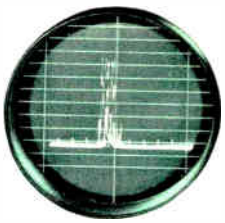
10 to 44,000 mc with five plug-in tuning units

0.4 μSEC PULSE



STANDARD SIGNAL

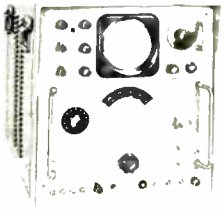
DECODED MULTIPULSE SPECTRUM

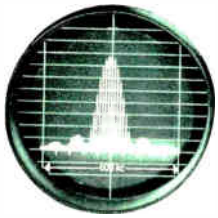


INCIDENTAL FM ANALYSIS

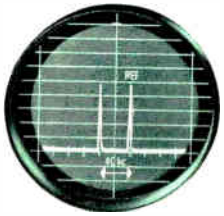
MODEL TSA-S
COMBINATION SYNCHROSCOPE-SPECTRUM ANALYZER

10 to 44,000 mc with five plug-in tuning units

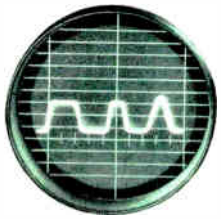




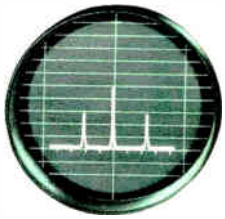
10 μSEC PULSE



STANDARD SIGNAL



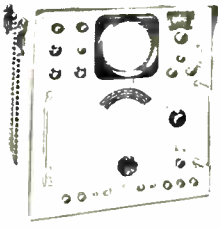
ANALYSIS AS A FUNCTION OF TIME

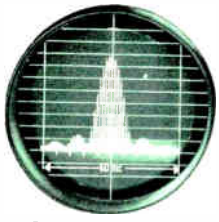


IDENTIFICATION OF AMPLITUDE MODULATION

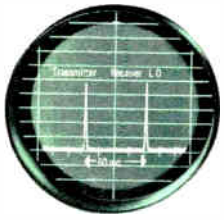
MODEL TSA-W
WIDE DISPERSION SPECTRUM ANALYZER

10 to 44,000 mc with five plug-in tuning units—70 mc dispersion



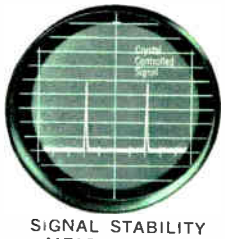


0.1 μSEC PULSE



AFC ACTION

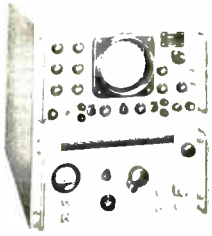
LOG DISPLAY



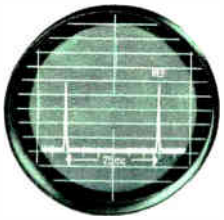
SIGNAL STABILITY MEASUREMENT

MODEL SA-84
UNIVERSAL SPECTRUM ANALYZER

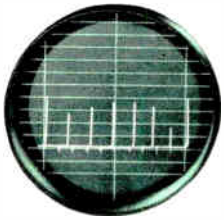
10 to 44,000 mc in one integrated self-contained unit



4 μSEC PULSE



STANDARD SIGNAL

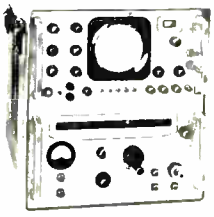


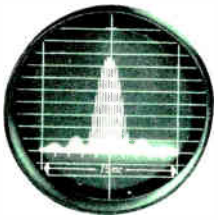
FM SIGNAL ANALYSIS

LEAKAGE AND RADIATION MEASUREMENT

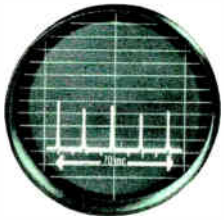
MODEL SA-84W
WIDE DISPERSION UNIVERSAL SPECTRUM ANALYZER

10 to 44,000 mc in one integrated self-contained unit—features over 80 mc dispersion

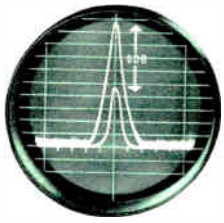




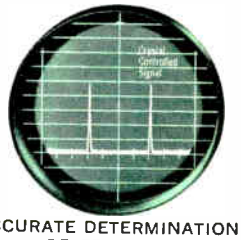
0.08 μSEC PULSE



CRYSTAL HARMONICS



PRECISION ATTENUATION



ACCURATE DETERMINATION OF FREQUENCY

The scope displays shown opposite each Polarad Spectrum Analyzer serve two basic purposes—first, they illustrate the significant analysis capability of each instrument; second, they demonstrate the many microwave parameters that can be measured and displayed visually on Polarad's versatile analyzing equipment.

FREE LIFETIME SERVICE

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for "Handbook of Spectrum Analyzer Techniques."

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- ☐ Model TSA-S
- ☐ Model TSA-W
- ☐ Model SA-84
- ☐ Model SA-84W
- ☐ Model SV-1 (see reverse side)

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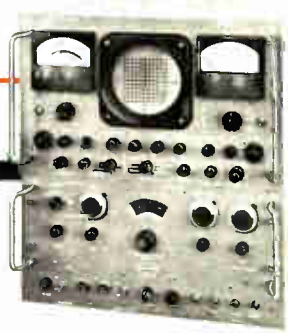
NEW FROM POLARAD— UNIVERSAL SERVO ANALYZER —.001 TO 100 CPS

MEASUREMENT	METHOD OF MEASUREMENT	INPUT TO SERVO SYSTEM	APPLIED TO SCOPE'S VERTICAL PLATES	APPLIED TO SCOPE'S HORIZONTAL PLATES	RESULTING SCOPE PATTERN Typical Response	RESULTING SCOPE PATTERN 0° Phase Shift
PHASE RESPONSE OF A-C SERVO SYSTEMS	Bowtie	50 cps to 6000 cps carrier, modulated at rate of 0.001 cps to 100 cps.	Modulated Return Signal	Low-Frequency Sine Wave		
	Double Bowtie	50 cps to 6000 cps carrier, modulated at rate of 0.001 cps to 100 cps.	Modulated Return Signal	15kc Reference Envelope		
	Sweep	50 cps to 6000 cps carrier, modulated at rate of 0.001 cps to 100 cps.	Modulated Return Signal	Linear Sweep	Fig. 5-a	Fig. 5-b
	Sweep	50 cps to 6000 cps carrier, modulated at rate of 0.001 cps to 100 cps.	Demodulated Return Signal	Linear Sweep	Fig. 5-c	Fig. 5-d
	Lissajous	50 cps to 6000 cps carrier, modulated at rate of 0.001 cps to 100 cps.	Demodulated Return Signal	Low-Frequency Sine Wave		
PHASE RESPONSE OF D-C SERVO SYSTEMS	Bowtie	Low-Frequency Sine Wave 0.001 cps to 100 cps	Sine Wave Return Signal	15-kc Reference Envelope		
	Double Bowtie	Low-Frequency Sine Wave 0.001 cps to 100 cps	Modulated Wave Return Signal	15-kc Reference Envelope		
TRANSIENT RESPONSE OF A-C SERVOS	Analysis of Returned Square Wave, Triangular Wave, Ramp, or Impulse Functions	Function with Carrier	Modulated or Unmodulated Return Signal	Linear Sweep	Square Wave, Triangular, Ramp, Impulse	
TRANSIENT RESPONSE OF D-C SERVOS	Analysis of Returned Square Wave, Triangular Wave, Ramp, or Impulse Functions	Function without Carrier	Modulated or Unmodulated Return Signal	Linear Sweep	Same as Figures 5a, 5b, 5c, and 5d except without carrier. Waveshapes without carrier are indicated by heavy outlines.	
AMPLITUDE RESPONSE OF A-C SERVOS	Oscilloscope Calibration	50 cps to 6000 cps Modulated Carrier	Modulated Return Signal	Linear Sweep (if desired)		
AMPLITUDE RESPONSE OF D-C SERVOS	Oscilloscope Calibration	Low-Frequency Sine Wave	Modulated Return Signal	Linear Sweep (if desired)		



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The new Polarad MODEL SV-1 SERVO ANALYZER is a complete instrument for testing AC and DC servo mechanisms in all applications. It combines a multiple precision signal generator and oscilloscope. Internally generated reference signals are compared with servo outputs and are displayed visually for quick servo analysis.

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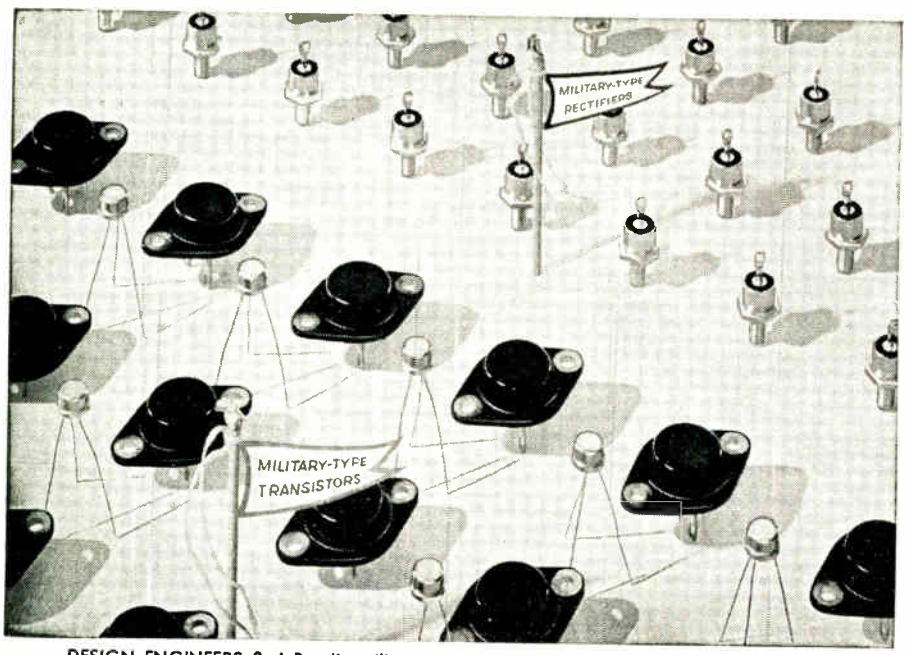
EXTRA QUALITY AT NO EXTRA COST WITH BENDIX TRANSISTORS

Bendix Bulletin

Up-to-the-minute news about transistors and rectifiers

MIL-TYPE SEMICONDUCTORS CREATE NEW DESIGN FREEDOM



DESIGN ENGINEERS find Bendix military-type power transistors and rectifiers a virtual "parade" of ruggedness and reliability. They also find Bendix engineers most helpful with circuitry and application problems.

MAXIMUM RATINGS AND TYPICAL OPERATION OF MILITARY POWER TRANSISTORS

TYPE NUMBER	MIL-T-19500	MAXIMUM RATINGS						TYPICAL OPERATION	
		Vce Vdc	Vcb Vdc	Ic Adc	Pc W	Tj °C	T storage °C	h_{FE} at Ic Adc	
2N297A	/36A (SigC)	−50	−60	5	35	95	−65 to +95	70	0.5
2N331	/4A	−12	−30	0.2	0.075	85	−65 to +85	50	0.001
2N1011	/67 (Sig C)	−70	−80	5	35	95	−65 to +95	55	3.0
2N1120	/68 (Sig C)	−70	−80	10	45	95	−65 to +95	35	10.0

Ideal for such applications as:
HIGH CURRENT SWITCHING • AUDIO AMPLIFICATION
SMALL MOTOR AND SERVO DRIVERS

MAXIMUM RATINGS OF MILITARY POWER RECTIFIERS

TYPE NUMBER	MIL-E-1	Io at 150°C	PRV Vdc	Ilb at 25°C	Epp	Ilb at 150°C
1N1614	/1240	5 Adc	200	50 μAdc	140	750 μAdc
1N1615	/1241	5 Adc	400	50 μAdc	280	750 μAdc
1N1616	/1242	5 Adc	600	50 μAdc	420	750 μAdc

Ideal for such applications as:
MAGNETIC AMPLIFIERS • DC BLOCKING CIRCUITS
POWER RECTIFICATION

Broad Bendix line meets both electrical and environmental military specs.

Here, in Bendix* Power Transistors 2N297A, 2N331, 2N1011, and 2N1120, and Bendix* Power Rectifiers 1N1614, 1N1615, and 1N1616, is a versatile line completely designed to meet military specifications. This combination—most extensive series of its type—permits unusual design latitude on military equipment applications. All units feature outstanding ruggedness and reliability to meet both electrical and environmental conditions.

The four transistors are especially suited to high-current switching, audio amplification, small motor and servo driver applications. The three rectifiers, with their low forward drop and low reverse leakage current, are ideal for magnetic amplifier and DC blocking circuits, in addition to power rectification.

Write today for NEW BENDIX SEMICONDUCTOR CATALOG on our complete line of power transistors and power rectifiers. Bendix offers engineers many challenging opportunities in semiconductors. Write Personnel Manager for full details.

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Circle 19 on Inquiry Card

Tele-Tips

RFI-ODDITIES: A Navy installation in Maryland complained of interference to the FCC. Investigators traced the radiation to a transmitter in the British West Indies, left on and unattended.

A multitone emission which intruded on a radiotelegraph circuit between the U. S. and Brazil turned out to be a spurious emission of a radio-telegraph station in Hawaii.

In another case, jumbled air-ground communication at an airfield near Washington, D. C., was shown to be caused by a defective transmitter in the Azores.

ELECTRONIC "STOOL PIGEON" —an all but invisible fence—was demonstrated last month to officials of Stateville Prison, Joliet. The 3-wire fence, actually a delicately tuned circuit, sounds alarm when anyone approaches within 6 ft. Airtronics International Corp. of Ft. Lauderdale is the manufacturer.

WHAT LURES SCIENTISTS? At the Air Force Cambridge Research Center they believe their most potent attraction is—their library. Once a scientist sees it, there is a good chance he will stay. The library "the best this side of the Iron Curtain" is used by three research directorates—electronics, geophysics and operational applications.

ARE NUMBERS easier to remember than names? Computer manufacturers apparently think so—with hardly an exception. RCA replaced the "Bizmac" with the snappy "301," "501," "601" designations. Burroughs came out with the 201 and 205. And Philco dropped the TRANSAC name, for their transistorized computer, in favor of a model number—2000. IBM, of course, has a full complement of numbers—the 400 series of tabulating machines, the 600 and 700 series of computers. It's no accident, either, that most of the numbers are euphonious.

(*Continued on page* 41)

presenting 182 high quality

FULL-RANGE TESTED microwave measuring instruments

Your hp representative offers two very important advantages

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- **complete assurance that the equipment will perform precisely as specified**

hp makes sure you get what you pay for by rigid quality control plus 100% electrical testing using hp developed methods including reflectometer and swept frequency techniques. hp *knows* when a parameter is out of spec; never gambles your money and time that 3 or 4 sample measurements taken across an instrument's range truly indicate its full-range performance.

See your hp rep now for FULL-RANGE TESTED microwave equipment . . . *get what you pay for.*

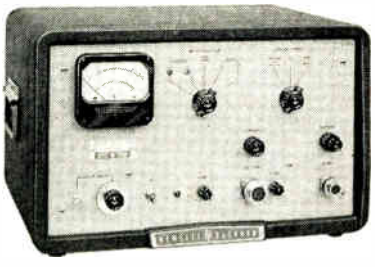
FREE TEST METHOD DESCRIPTION

Interested in swept frequency testing? Ask your rep, or write direct for "Applications of hp 416A Ratio Meter," describing reflectometer systems and hp swept frequency measuring techniques.

NEW hp NOISE MEASURING EQUIPMENT

hp 344A Noise Figure Meter

Quickly, accurately measures noise figure of operating radar sets. Automatic operation; simple front panel calibration. Militarized, transistorized, reliable in extreme environments, minimum size and weight. Continuous noise figure presentation on most radar receivers. Extremely high sensitivity permits decoupling noise source up to 20 db from main transmitter line to minimize system degradation. Provision for automatic alarm, remote noise figure monitoring, modulating. Meter scale/excess noise options; 30 MC input frequency, 1 MC bandwidth, 75 ohms input impedance. Approx. $1,600.00 (depending on options and modifications selected).



hp 340B/342A Noise Figure Meters

General-purpose instruments making possible, in minutes, receiver and component alignment jobs that once took hours. Simplifies accurate alignment; encourages better maintenance; better performance.

hp 340B automatically measures, continuously displays IF or receiver noise figure at 30 or 60 MC; other freq. on order. $715.00 (cabinet) $700.00 (rack).

hp 342A, similar, operates on 30, 60, 70, 105, 200 MC. 30 MC and 4 other frequencies between 38 and 200 MC on order. $815.00 (cabinet) $800.00 (rack). (Note: Models 340B and 342A available only in the U.S.A. and Canada)

hp 343A vhf Noise Source, temperature limited diode broadband source, 10 to 600 MC, 5.2 db excess noise, $100.00.

hp 345B IF Noise Source, 30 or 60 MC (others to order); 4 impedances, 5.2 db excess noise. $75.00.

hp 347A Waveguide Noise Source, Argon gas discharge tubes in waveguide section; for bands S, G, J, H, X, P, 2.6 to 18.0 KMC, 15.2 db excess noise. $190.00 to $250.00.

Basic test, power and impedance measuring equipment

World's largest line of FULL-RANGE

BASIC TEST EQUIPMENT

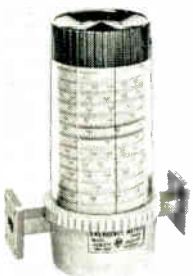
382A Precision Attenuators

Popular 382A series precision attenuators now include in "K" and "R" bands, 18.0 to 40.0 KMC. "K", "R" band attenuators are of new, space-saving design (see photo). Direct reading, one-control setting, high power handling capacity. Attenuation 0 to 50 db full range, independent of frequency. Phase shift constant with attenuation. G, J, H, X, M, P, K, R bands, $275.00 to $500.00.

421A, 420A/B Crystal Detectors

421A (shown), silicon crystal detector of rf signals in waveguide systems. High sensitivity, for H, X, M, P bands, 7.05—18 KMC. 421A, $75.00 to $105.00. 420A, similar but for Type N coax lines, 10 MC to 12.5 KMC. $50.00 each. Also 420B, same in matched pairs, $150.00 pair.

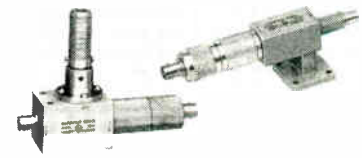
532 Waveguide Frequency Meters



New design for H, M, P, K, R bands. Wide band, direct reading, no interpolation or charts. Has a high Q resonant cavity tuned by choke plunger; no sliding contacts. Transmits almost full power at resonance; resonance indicated by 1.5 db dip in output. Similar model for X-band. $150.00 to $275.00.

914 Moving Loads

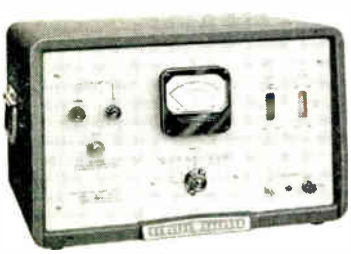
Waveguide section containing sliding, tapered, low-reflection load. Plunger controls load position, travels ½ wavelength at lowest frequency to reverse phase of residual load reflection. Models for S, G, J, H, X, M, P, K, R bands, 2.6 to 40.0 KMC. $55.00 to $250.00.



P932A/934A Harmonic Mixers

Mixer for wide band beat detecting, beat frequency mixer for stabilizing a signal source. P932A 12.4 to 18.0 KMC; 934A (coaxial) covers 1 to 12.4 KMC. Both models: max. input power 100 mw. P932A, $250.00 934A, $150.00.

POWER MEASURING EQUIPMENT



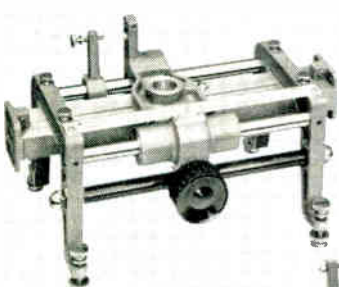
434A Calorimetric Power Meter

Connect and read powers 10 mw to 10 watts, dc to 12.4 KMC. No barretter, thermistor needed, no external terminations or plumbing. Measures CW or pulsed power. Two simple controls. Dc input impedance 50 ohms approx.; input SWR less than 1.7 full range, less than 1.3 to 5 KMC. Accuracy within 5% full scale. $1,400.00 (cabinet) $1,385.00 (rack mount).

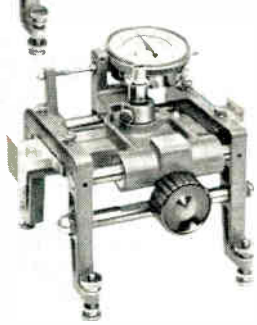
430C Microwave Power Meter

No computations! Provides instantaneous, automatic power readings *direct* in dbm or mw at all frequencies for which there are suitable bolometer mounts. For CW measurements, uses either 1/100 amp fuse or Sperry 821 barretter. Also measures CW or pulsed power with negative coefficient thermistor. Provides up to 16 ma bias current. Operates with 476, 477, 485, 487 mounts. Range 0.02 to 10 mw. $250.00 (cabinet) $255.00 (rack mount).

IMPEDANCE MEASURING EQUIPMENT

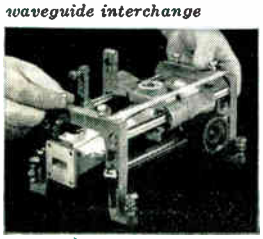


-hp- 809B and 810B



-hp- 814B, 815B, 446B

Quick, easy waveguide interchange



809B/814B Universal Probe Carriages

Models 809B and 814B are precision built mechanical assemblies operating, respectively, with 810B and 815B series slotted sections.

Combination of the 809B carriage and 810 slotted sections covers 2.6 to 18.0 KMC. Combination of 814B carriage and 815B series sections covers 18.0 to 40.0 KMC.

On either carriage, waveguides can be interchanged in seconds. Only one probe (for each carriage) covers full frequency range. Manufacture is of highest quality, assures positive mechanical positioning of interchangeable waveguides and precise installation of mating probes. 809B has vernier scale reading to 0.1 mm, is equipped for dial gauge mounting. 814B has dial read directly to 0.1 mm, interpolated to 0.01 mm. 809B, $160.00, 814B, $200.00.

444A/446B Untuned Probes

444A (shown) is modified crystal (1N76 or 1N26) plus small antenna in convenient housing. Probe penetration easily variable; locks in position. No tuning; sensitivity superior to elaborate single, double tuned probes. Range 3.0 to 18 KMC; fits ¾" bore. *New 446B* for 814 Probe Carriage, similar but covers K and R bands, 18.0 to 40.0 KMC. 444A, $40.00. 446B, $145.00. also offers model 440A, for barretter or crystal, Type N coaxial, $85.00.

TESTED *waveguide and coaxial equipment*

752 Multi-Hole Coupler

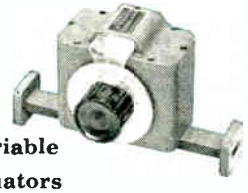
Precision directional couplers, 3 models, coupling factors 3, 10 and 20 db. Coupling accuracy ± 0.4 db or 0.7 db. Directivity better than 40 db full range, SWR less than 1.05. S through R bands, 2.6 to 40.0 KMC. $100.00 to $375.00.

372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models for S, G, J, H, X and P bands, 2.6 to 18.0 KMC. $100.00 to $375.00.

764D-767D Dual Directional Couplers

High directivity dual coaxial couplers make reflectometer measurements practical in vhf and uhf coax systems. Flat response, high power capacity, low insertion loss. Four models, covering 216 to 4,000 MC collectively. 764D/765D $160.00. 766D/767D $150.00.



375A Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range; attenuation variable 0 to 20 db, dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 KMC. $90.00 to $180.00.

870A Slide Screw Tuners

For flattening waveguide systems, matching, etc. Probe position, penetration adjusts to set up reflection canceling existing reflection. Precision lead screw or micrometer varies probe insertion; vernier adjusts probe position. Corrects SWRs of 20 with accuracy of 1.02 SWR. For S, G, J, H, X, M, P, K, R bands. 2.6 to 40.0 KMC. $125.00 to $300.00.

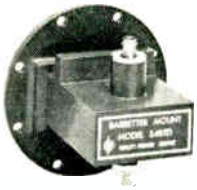
WR75 Components—10 to 15 KMC

An increasing number of precision waveguide instruments shown here are available in the M-band, recently allocated for private microwave communications.

SEE TABULAR LISTINGS NEXT PAGE FOR DETAILS

476A, 477B Detector Mounts

476A Universal Bolometer Mount, for rf power measurement 10 to 1,000 MC; no tuning, SWR less than 1.25. $85.00. 477B Coaxial Thermistor Mount (shown) for rf power measurement 10 MC to 10 KMC; no tuning, SWR less than 1.5, $75.00.



485 Detector Mounts

Three basic series offered: S485A for S band (no tuning, 1.35 SWR, 821 element); 485B, for G, J, H, X bands (tunable, uses 1N23, 1N21, 821 element, 1.25 SWR using barretter); 485D for S, G, J bands (factory-installed 821 barretter). $75.00 to $170.00.

487B Thermistor Mounts

Each covers full range of its waveguide. No tuning, SWR 1.5 or 2.0 max. Max. power 10 mw. Rugged construction, negative temperature coefficient thermistors virtually eliminate burnout. G through R bands. 3.95 to 40.0 KMC. $75.00 to $225.00.

810/815B Slotted Sections

810B Slotted Sections 810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. Available in 6 waveguide bands (including M-band), 3.95 through 18.0 KMC. $90.00 to $110.00.

S810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 KMC (S-band) size only. $450.00.

815B Slotted Sections For mounting in 814B carriage. Available in K and R bands, 18.0 to 40.0 KMC. Accurately machined; easy interchange, precise positioning. $265.

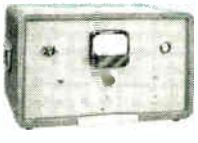
806B Coaxial Slotted Section 3 to 12 KMC, mounts in 809B, has Type N connectors. $200.00.

805A/B Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 KMC, reads in cm and mm to 0.1 mm. 805A, for 50 ohm Type N, 805B, for 46.3 ohm RG 44/U. 805A/B. $450.00.

415B Standing Wave Indicator

For all waveguide and coaxial slotted sections. Gives readings in SWR or db. Single frequency operation; 315 to 2,020 cps. Low noise level, 0.1 μv (full scale) sensitivity, 60 db calib. attenuator. $200.00 (cabinet), $205.00 (rack mount).



416A Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Ideal with directional couplers and swept frequency sources for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. Oscilloscope, recorder output. $475.00 (cabinet) $460.00 (rack mount)

HEWLETT-PACKARD COMPANY

1032B Page Mill Road
Palo Alto, California, U.S.A.
Cable "HEWPACK"
DAvenport 6-7000
Field representatives in all principal areas
HEWLETT-PACKARD S.A., Rue du Vieux Billard No. 1,
Geneva, Switzerland
Cable "HEWPACKSA"
Tel. No. (022) 26. 43. 36

Circle 21 on Inquiry Card

6271

WAVEGUIDE TEST EQUIPMENT—2.6 to 40 KMC

Instrument	Coaxial Type N	"S" 2.6 - 3.95 KMC	"G" 3.95 - 5.85 KMC	"J" 5.2 - 8.2 KMC	"H" 7.05 - 10 KMC	"X" 8.2 - 12.4 KMC	"M" 10 - 15 KMC	"P" 12.4 - 18 KMC	"K" 18 - 26.5 KMC	"R" 26.5 - 40 KMC
Adapter, Waveguide to Coax		S281A $50	G281A $40	J281A $35	H281A $30	X281A $25				
Cover to Choke Flange		S290A $65	G290A $50	J290A $35	H290A $30	X290A $15		P290A $25		
Waveguide to Waveguide		-hp- 292 Series: HX292B $25, MX292A $40, MP292A $40, NP292A $40, NK292A $40								
Attenuators Fixed 3, 6, 10, 20 db		S370A $75	G370A $75	J370A $65	H370A $60	X370A $55		P370A $60	K370A $100	R370A $100
Precision Fixed		S372 $375	G372 $250	J372 $140	H372 $120	X372 $100		P372 $115		
Flap, 25 db max.		S375A $120	G375A $110	J375A $100	H375A $90	X375A $90		P375A $100	K375A†† $140	R375A†† $180
Calibrated, precision		S380A $260	G382A $500	J382A $350	H382A $350	X382A $275	M382A $300	P382A $275	K382A†† $425	R382A†† $450
Detector Mounts	420A $50	420B $75			H421A $95	X421A $75	M421A $125	P421A $105		
	440A† $85									
		S485D° $170	G485D°$170	J485D° $170						
		S485A‡ $140	G485B† $95	J485B† $90	H485B† $85	X485B† $75				
Thermistor Mounts (Fixed tuned)■	477B $75		G487B $95	J487B $90	H487B $80	X487B $75	M487B $110	P487B $110	K487B†† $150	R487B†† $225
Frequency Meters, Reaction				J530A/B**	H530A $120	X530A $120		P530A $150		
Direct Reading					H532A $195	X532B $150	M532B $275	P532A $210	K532A $230	R532A $250
Directional Coupler, Cross Guide: 20, 30 db		S750 $150	G750 $120	J750 $80	H750 $70	X750 $50				
Directional Couplers, Multi Hole: 3,10, 20 db		S752 $375	G752 $250	J752 $140	H752 $120	X752 $100	M752 $130	P752 $115	K752†† $175	R752†† $200
Slotted Sections, Waveguide		S810A* $450	G810B§ $110	J810B§ $110	H810B§ $110	X810B§ $90	M810B§ $110	P810B§ $110		
Slotted Sections, Waveguide									K815B†† $265	R815B†† $265
Tuners, Slide Screw		S870A $225	G870A $185	J870A $150	H870A $130	X870A $125	M870A $130	P870A $130	K870A†† $250	R870A†† $300
E - H						X880A $130		P880A $150		
Waveguide Phase Shifter				J885A $500		X885A $400		P885A $550		
Terminations, Low Power		S910A $60	G910A $50	J910A $35	H910A $30	X910B $25		P910A $30		
Terminations, High Power		S912A $200				X912A $75				
Moving Load		S914A $100	G914A $75	J914A $70	H914A $60	X914B $50	M914B $65	P914A $55	K914B†† $250	R914B†† $250
Standard Reflections						X916 $100				
Adjustable Shorts		S920A $150	G920A $125	J920A $100	H920A $75	X920A $75	M920B $75	P920A $75	K920A†† $140	R920A†† $150
Waveguide Shorting Switch						X930 $100				
Harmonic Mixer		934A $150	1 to 12.4 KMC					P932A $250		
Broad Band Probe, Untuned			442B§ $40,	444A $40	2.4 to 18 KMC				446B $145	18 to 40 KMC

†For use with barretter or crystal. ‡For use with barretter only. *Complete assembly including carriage. §Mounts in 809B Carriage.
■Includes Thermistor, installed. **J530A, 5.85 to 8.2 KMC, $120; J530B, 5.20 to 7.05 KMC, $150. ° Includes barretter; checked for square law characteristics.
††Available with circular flanges equivalent to UG-425/u for K bands and UG-381/u for R bands. Specify by adding suffix "C" to model number: i.e., K487BC.

FULL-RANGE TESTED

MICROWAVE EQUIPMENT

Check these tables for detailed information, prices on hp microwave equipment you need. Call your hp representatives for more details, technical application help.

HEWLETT-PACKARD CO.
1032B Page Mill Road
Palo Alto, California, U.S.A.
DAvenport 6-7000
Cable "HEWPACK"
Field representatives in all principal areas

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

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MICROWAVE POWER MEASURING EQUIPMENT

Instrument	Primary Uses	Frequency Range	Characteristics	Price
-hp- 430C Microwave Power Meter	Measurement of rf power	Depends on Bolometer Mount	0.02 to 10 mw ±5% accuracy	$ 250.00
-hp- 434A Calorimetric Power Meter	Measurement of rf power	dc to 12.4 KMC	Direct reading, no barretters, thermistors or terminations; CW, pulsed	1,115.00△
-hp- 475B Tunable Bolometer Mount	Measurement of rf power (with 430B/C)	1,000 to 4,000 MC	Matches 50 ohm line to 100 or 200 ohms	225.00
-hp- 476A Universal Bolometer Mount	Measurement of rf power (with 430B/C)	10 to 1,000 MC	No tuning required SWR less than 1.25	85.00
-hp- 477B Coaxial Thermistor Mount	Measurement of rf power (with 430C)	10 MC to 10 KMC	No tuning required SWR less than 1.5	75.00
-hp- 764D/767D Dual Directional Couplers	Reflectometer and rf power measurements	764D, 216-450 MC; 765D, 450-945 MC; 766D, 940-1,975 MC; 767D, 1,900-4,000 MC	Coupling attenuation* 20 db, directivity 30 or 26 db	764D, 765D, $160 766D, 767D, $150

*Power handling capacity all 764/767 series couplers 50 watts CW, 10 Kw peak.

MICROWAVE IMPEDANCE MEASURING EQUIPMENT

Instrument	Primary Uses	Frequency Range	Characteristics	Price
-hp- 415B Standing Wave Indicator	SWR indicator or null indicator	Uses external detectors	0 to 70 db. attn. Max. sensitivity 0.1 μv	$200.00
-hp- 416A Ratio Meter	Reflection coefficient measurements	Uses external detectors	Continuous swept freq. pres'tat'n; accur. ±3%	475.00△
-hp- 417A vhf Detector	vhf bridge detector (for -hp- 803A)	10 to 500 MC	Approx. 5 μv sensitivity	350.00
-hp- 803A vhf Bridge	Measurement of vhf impedance, SWR	52 to 500 MC	2 to 2,000 ohms impedance —90° to +90° phase angle	800.00
-hp- 805A Coaxial Slotted Section	Measurement of SWR	500 to 4,000 MC	For Type N Connectors flexible cables	450.00
-hp- 805B Coaxial Slotted Section	Same as above	Same as above	For rigid 7/8" RG44/U line	450.00
-hp- 806B Coaxial Slotted Section	Same as above (mounts in 809B)	3,000 to 12,000 MC	For Type N Connectors flexible cables	200.00
-hp- 809B Universal Probe Carriage	G, J, H, X and P 810 Waveguide Sections Supports 806B section, also		Accepts 442B, 444A probes	160.00
-hp- 814B Universal Probe Carriage	Supports K and R 815B Waveguide Slotted Sections		Accepts Untuned Probe 446B	200.00

△Rack mounted instruments $15.00 less.

Circle 21 on Inquiry Card

Tele-Tips

(*Continued from page* 36)

AN IBM 704 Data Processing System cut years of time, labor and money in processing material for the massive volume, "A Concordance to the Poems of Matthew Arnold." The 965 page book, containing the occurrences of 10,097 words of Arnold's vocabulary and 70,000 references, took but 150 hrs. work of a key-punch operator and an editor. In contrast a similar task on the works of Wordsworth in 1911 took 67 people to cut, paste and alphabetize slips and to proofread the results.

SIGNAL CORPS celebrated its 100th anniversary with a coast-to-coast radio conversation by sun-powered equipment, the first time it has been done.

U.N. SOLDIERS flying to troubled areas aboard UNEF planes got this cryptic advice:

Don't visit with the crew. Remember, your first pilot is still learning to fly and is more scared than you are.

Be thankful if you arrive anywhere.

Always let the crew leave first. After all the plane may be on fire.

Don't show fear if the engine "conks" out; you might frighten the crew.

Don't expect the coffee to be hot. In fact, don't expect coffee.

The bail out signal is five white chutes passing the rear door. That's the crew.

IRRADIATED FOODS will be common in the supermarkets of 1970, say food specialists.

TINY TRANSMITTERS will be mounted on ruffed grouse in a National Science Foundation research project to study their movements. Six male birds will be equipped with battery-operated transmitters weighing 1 ounce each. The miniature transmitters will emit 10 milliwatt pulses continuously at a rate of one or two a second.

Books

Electromagnetic Energy Transmission and Radiation

By Richard B. Adler, Lan Jen Chu and Robert M. Fano. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 821 pages. Price $14.50.

This book treats electromagnetic waves and oscillations in 1, 2, and 3 space dimensions using time-domain, complex - frequency - domain, and energy points of view.

To insure a proper balance of emphasis between physical considerations and analytical technique, the authors avoid the more formal procedures of boundary-value problem solution by employing a method of field synthesis. This approach involves study of elementary solutions in empty space, in enough detail to make clear in advance the kinds of boundary conditions simple combinations of them will require.

The significance of the various solutions is further illustrated by the simplest analytical models suggestive of practical devices.

Infrared Radiation

By Henry L. Hackforth. Published 1960 by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. 303 pages. Price $10.00.

This volume is an outstanding reference and guide to infrared radiation . . . what it is, what it does, and how it is used. Brought together is information on components and the laws of physics by which they operate, sources of radiation, methods of transmission, and the analysis and design of systems.

Using a minimum of mathematics, many clear illustrations, and practical examples, the book explains the versatility and inherent possibilities of infrared. It also describes hundreds of applications in many fields, ranging from optical systems and medical devices to specialized instruments for satellites.

Clear understanding of the subject is aided by the development of a generalized infrared system. Step by step, the changes undergone by signal from its source, through the system, to the final display are shown. A detailed description is given throughout of the "building blocks" used in the model system.

Advances in Cryogenic Engineering, Vol. 5

Edited by K. D. Timmerhaus. Published 1960 by Plenum Press, New York, N. Y. 584 pages. Price $13.50.

Cryogenics — the science dealing with the behavior of materials at temperatures close to absolute zero— has become a practical tool for industry, particularly in the field of aircraft, electronics, metals, atomic energy, rockets and missiles. The physical properties of materials at very low temperatures differ so

NO POTS AT ALL

V44 - the new, ultra-stable, all-electronic digital voltmeter

No longer must you trim decade or amplifier gain potentiometers to make accurate, high-speed measurements with an all-electronic digital voltmeter. The new transistorized NLS V44 has *no pots at all* in its decade circuits because of ultra-stable electronic switches . . . *no pots at all* in the amplifier because amplifiers are used only within the feedback loop, where amplifier drift becomes inconsequential. Here is the speed you need — 3 milliseconds per reading — for measuring high-speed transient data . . . for multi-channel data logging. Contact NLS for complete information.

BRIEF SPECIFICATIONS: Accuracy ±0.01% . . . speed 3 milliseconds per reading . . . input impedance 10 megohms . . . "anti-jitter" circuit . . . DC voltage ranges ±9.999/99.99/999.9 . . . millivolt ranges with preamplifier ±99.99/999.9 . . . AC ranges with AC/DC converter 9.999/99.99/999.9 from 30 cps to 10 kc . . . 98% plug-in modular construction . . . digital output in both decimal and binary coded decimal form . . . simple plug-in accessories for automatic data logging and measuring systems . . . complete, $6,150.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (SAN DIEGO), CALIFORNIA

Books

(*Continued from page 42*)

vastly from those usually encountered that the engineer cannot rely upon ordinary experience, and so an entirely new and thriving industry developed.

This volume is actually the proceedings of the Fifth National Conference on Cryogenic Engineering held at the University of California in Berkeley, Calif., September 2-4, 1959.

Basics of Induction Heating (Two Volumes)

By Chester A. Tudbury. Published 1960 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York, N. Y. Volume 1, 140 pages; Volume 2, 144 pages. Price for set of two in cloth binding $8.90.

This book is written to present the fundamental principles of the induction heating art and of commercial induction heating equipment in a manner readily understood and enjoyed by any reader familiar with the simple rules of electricity. It explains what induction heating is and how it works; it describes and explains the operation of the more common types of industrial induction heating machines in use today; it presents material to assist in developing a quantitative understanding for new applications; and it deals with electrical and thermal aspects in detail and touches more briefly upon some of the mechanical problems associated with fixturing.

Photoconductivity of Solids

By Richard H. Bube. Published 1960 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 461 pages. Price $14.75.

This work is the first and only book to offer a comprehensive analysis of the photoconductivity of solids. It represents an important addition to the literature since photoconductivity is not only a phenomenon of great interest in its own right, but also a basic tool in solid-state research.

The book provides a unified physical description and interpretation of photoconductivity phenomena, drawing examples from many different kinds of materials. In addition, the correlation between photoconductivity and other related phenomena in insulators and semiconductors is given.

Other sections of this book examine the current theoretical understanding of the mechanisms of photoconductivity, together with a detailed exposition of particular phenomena which illustrate the variety of characteristics available.

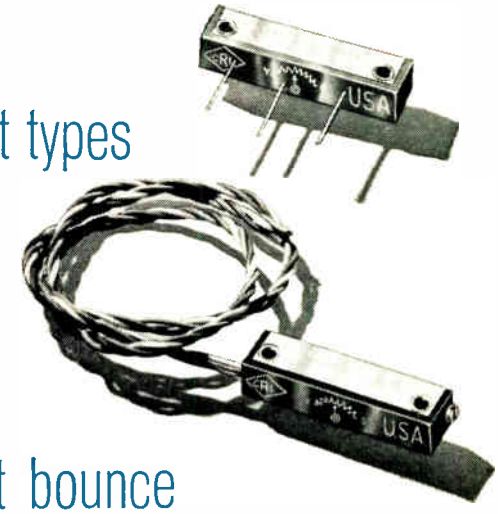
Fixed and Variable Capacitors

By G. W. A. Dummer and Harold M. Nordenberg. Published 1960 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. 281 pages. Price $10.00.

Here is a book which gives you a sound working knowledge of the de-

Centralab Model 7 Linear Motion Variable Resistors

11 different types



0 contact bounce

No contact bounce when vibration tested, 20-20,000 cps at 30 g's, loaded at 80% rated load, at 80% wiper travel, 3 planes, 10 minutes each. Induced noise less than 10 millivolts.

DESCRIPTION	MODEL	TERMINAL LEADS	RESISTANCE RANGE	POWER RATING (Watts)	MAXIMUM OPERATING TEMP.	ENCAP-SULATED
Gen. Purpose (Composition)	BA-701	Nylon or Teflon	10K to 2.5 Meg	0.25@ 50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-702	Nylon or Teflon	10Ω to 20K	0.25@ 50°C	+125°C	No
Gen. Purpose (Composition)	BA-703	Printed Circuit	10K to 2.5 Meg	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-704	Printed Circuit	10Ω to 20K	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-705	Nylon or Teflon	10K to 2.5 Meg	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Wirewound)	BA-706	Nylon or Teflon	10Ω to 20K	0.25@ 50°C	+125°C	Yes
Gen. Purpose (Composition)	BA-707	Printed Circuit	10K to 2.5 Meg	0.25@ 50°C	+125°C	No
Gen. Purpose (Wirewound)	BA-708	Printed Circuit	10Ω to 20K	0.25@ 50°C	+125°C	No
High Temp. (Wirewound)	BA-712	Teflon	10Ω to 20K	1.0 @ 70°C	+175°C	No
High Temp. (Wirewound)	BA-714	Teflon	10Ω to 20K	1.0 @ 70°C	+175°C	Yes
High Temp. (Wirewound)	BA-716	Printed Circuit	10Ω to 20K	1.0 @ 70°C	+175°C	Yes

Maximum end resistance: < 1% of total.

Size:
encapsulated 23/64" x 19/64" x 1-11/32", without encapsulation 5/16" x 1/4" x 1-1/4".

Resistances: Wirewound: 10-20-50-100-200-500-1K-2K-5K-10K-20K ohms. Composition: 10K-20K-50K-100K-500K, 1 Meg, 2.5 Meg.

Standard Tolerances: ±5% Wirewound, ±20% Composition. Closer tolerances available upon request.

Shock: Less than 1% change in resistance with JAN-S-44 apparatus at 100 g, 5 shocks in each of 3 planes, Method 202A.

Meet or exceed all specifications of applicable MIL-STD 202-A, MIL-R-19A and MIL-R-94B tests.

Industrial quantities of the Model 7 are available for immediate delivery at factory prices from your CENTRALAB industrial distributor.

Centralab CRL ®
B-6039

The Electronics Division of Globe-Union, Inc.
938J East Keefe Avenue • Milwaukee 1, Wisconsin
Centralab Canada Limited • Ajax, Ontario

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

Books

(*Continued from page* 44)

sign and construction of capacitors to help you select and use them effectively. In it you will find detailed information on construction characteristics and application problems of today's fixed and variable capacitors.

The book provides a wealth of facts and data on paper, mica, ceramic, glass, vitreous enamel, electrolytic, air, vacuum, and gas-filled capacitors.

This book also contains information on electronic part development; capacitor characteristics, selection, and techniques of measurement; modern experimental capacitors; and faults which may occur in capacitors.

Basics of Gyroscopes (Two Volumes)

By Carl Machover. Published 1960 by John F. Rider Publisher, Inc., 116 W. 14th St., New York, N. Y. Volume I, 112 pages; Volume II, 120 pages. Price, set of two, in cloth binding, $7.75.

A gyroscope is usually regarded as a mysterious instrument. One of the reasons for this is, that with few exceptions, books on the subject are inadequate. Because of the high level of many texts, one has to wade through a welter of mathematics to get at the meat of the topic.

Experienced gyro engineers have an almost adequate, directly usable supply of information; but non-specialists, students, technicians, engineers, salesmen, and managers who come in contact with gyroscopes in their work or studies have a definite need for a more descriptive, less mathematical presentation of the subject. This book fills that need.

The text is primarily descriptive and mathematics are kept to a minimum with only a basic knowledge of algebra and trigonometry needed for an understanding of the material. Every effort has been made to keep the book readable, resorting at times to humor.

BOOKS RECEIVED

Fundamentals of Transistor Physics

By Irving Gottlieb. Published 1960 by John F. Rider, Publisher, Inc., 116 W. 14th St., New York, N. Y. 152 pages, paper bound. Price $3.90.

Introduction to Electrical Engineering, 3rd Ed.

By Robert P. Ward. Published 1960 by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. 372 pages. Price $8.50.

Transformers and Generators for Power Systems

By R. Langlois-Berthelot. Published 1960 by Philosophical Library, Inc., 15 E. 40th St., New York, N. Y. 540 pages. Price $12.00.

Two-Way Mobile Radio Handbook

By Jack Helmi. Published 1960 by Howard W. Sams & Co., Inc., 1720 E. 38th St., Indianapolis 6, Ind. 208 pages, paper bound. Price $3.95.

(*Continued on page* 48)

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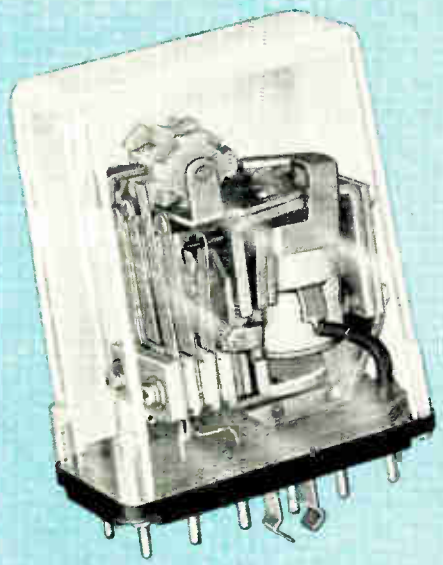

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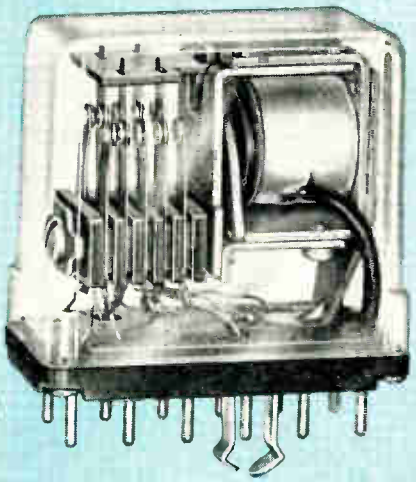

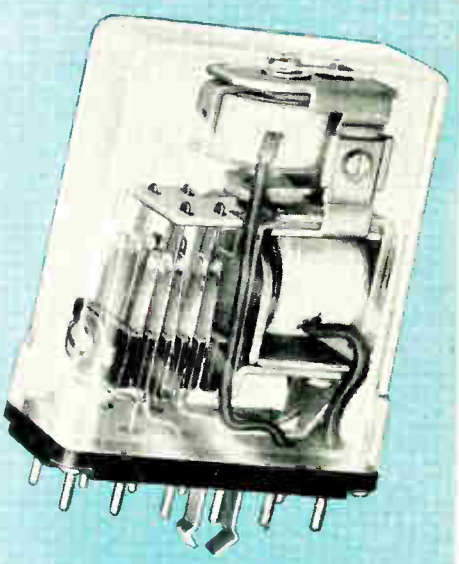

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Export: Langguth-Olson Co., New York

Books

(*Continued from page 46*)

AGARD 8-Language Aeronautical Dictionary

Edited by George H. Frenot and S. Holloway. Published 1960 by Pergamon Press, Inc., 122 E. 55th St., New York 22. 300 pages. $20.00.

Government Publications

Orders for these reports should be addressed to Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Make check or money order payable to "OTS, Dept. of Commerce." Prepayment is required. Use complete title and PB number for each report ordered.

Materials Research in the Navy, Vol. I and II

Refer to reports as PB 161470, Volume I, 386 pages, price $6.00, and PB 161471, Volume II, 378 pages, price $5.00.

The Analysis and Design of Digitally-Controlled Instrument Servos

By R. Scheidenhelm. Published 1959. 88 pages. PB 161020. Price $2.25.

A Simulator Study of Two Digitally-Controlled Instrument Servos

By R. Scheidenhelm and Y Lundh. Published 1959. 72 pages. PB 161021. Price $2.00.

Size, Blur, and Contrast as Variables Affecting the Legibility of Alpha-Numeric Symbols on Radar-Type Displays

By W. S. Howell and C. L. Kraft. Published 1959. 43 pages. PB 161454. Price $1.25.

Study of Electrical and Physical Characteristics of Secondary Emitting Services

By W. G. Shepherd. Published 1959. 65 pages. PB161491. Price $1.75.

Magnetic Properties of Some Ferrite Micropowders

By E. A. Berkowitz and W. J. Schuele. Published 1959. 15 pages. PB 161533. Price 50¢.

Physical Electronics at Millimeter Wavelengths

By T. C. Pang and M. O. Thurston. Published 1959. 17 pages. PB 161493. Price 50¢.

Pressure Induced Crystallization in Polyethylene

By S. Matsouka and B. Maxwell. Published 1959. 92 pages. PB 161455. Price $2.25.

Study of Equipment Cooling Systems

By F. E. Schroeder e.g. Published 1959. 173 pages. PB 161483. Price $3.00.

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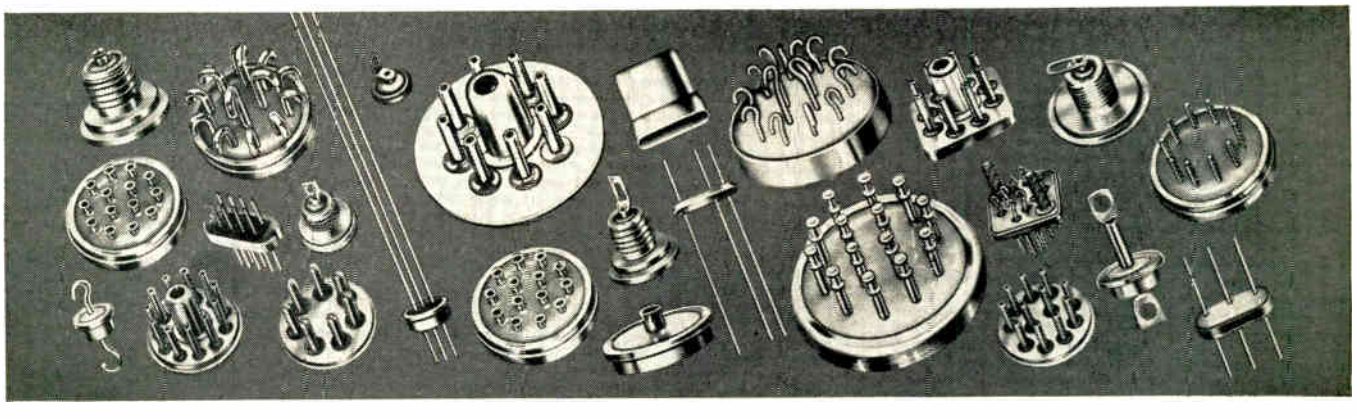

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Personals

Appointments and Promotions

Joseph D. Shantz . . . to Director of Engineering, Waltham Labs., Sylvania Electronic Systems Div., Sylvania Electric Products Co., Inc., Waltham, Mass.

Harold Jackson . . . Manager, Production and Engineering, **Edward Bisztyga** . . . Manager, Planning and Control (new posts) Industrial and Military Products Div., at Bulova Watch Co., Inc., Flushing, N. Y.

Dr. Nicholas Yaru . . . to Associate Lab. Manager, Research and Development; **Samuel Langberg** . . . Associate Lab. Manager, Product Engineering, and **William R. Welty** . . . Chief Scientist, Ground Systems Group, Hughes Aircraft Co., Fullerton, Calif.

Leslie L. Alt . . . to Physicist, Advanced Semiconductor Lab., General Electric Co., Syracuse, N. Y.

L. L. Alt

R. L. Rod

Robert L. Rod . . . (Founder) . . . Chairman of the Board; **Frank P. De Luca, Jr.** . . . to President, Acoustica Associates, Inc., and subsidiaries.

George A. Schupp . . . new Director of Engineering, Consumer Products Div., Magnavox Co., Ft. Wayne, Ind.

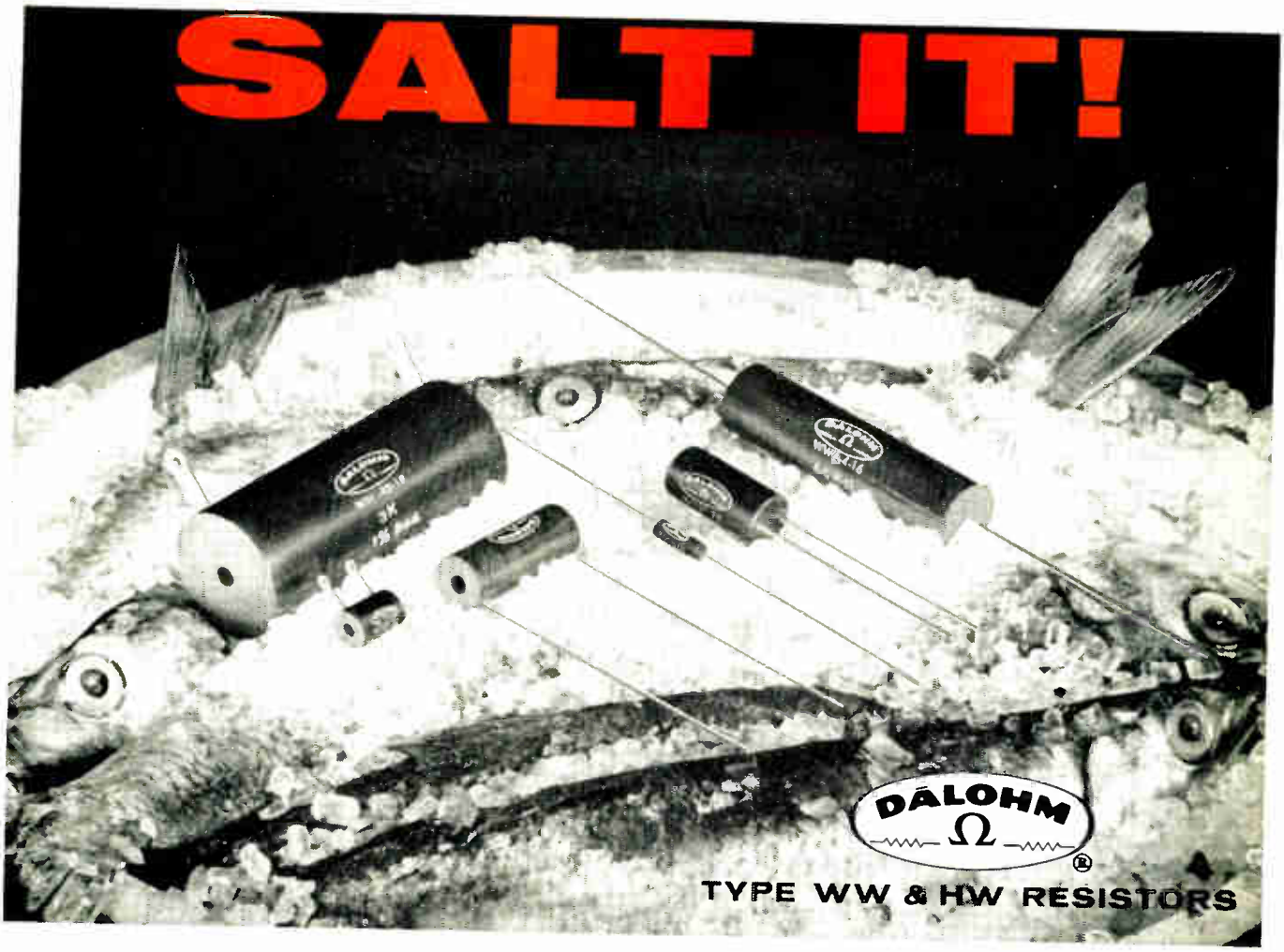
Robert L. Solnick . . . named Chief Project Engineer, Sample Handling Systems, Scientific and Process Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Dr. Leonard C. Maier, Jr. . . . Manager of Engineering, Semiconductor Products Dept., General Electric Co., Syracuse, N. Y.

Joseph Robert Lewis . . . to Director of Engineering, Sierra Electronic Div., Philco Corp., Menlo Park, Calif.

Wayne D. Moyers . . . Vice President of Engineering, EFCON, Inc., Garden City, L. I., N. Y.

Lynn C. Holmes . . . to Director of Engineering Operations, Stromberg-Carlson Div., General Dynamics Corp., Rochester, N. Y.



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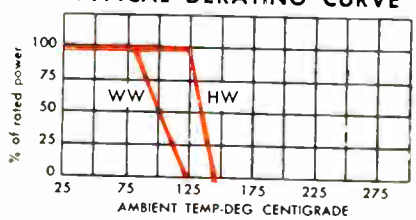

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Circle 31 on Inquiry Card

Letters to the Editor

(*Continued from page 52*)

and small companies is a wise, healthy and necessary thing.

The series you are running, "Searching for New Electronic Markets," will go a long way toward providing knowledge in this situation.

Your plan to coordinate the activities of Chilton editors to bring out new needs and to disseminate information regarding the ever-expanding electronics market deserves congratulations!

Nathaniel H. Sperber
Manager
Press and Community Relations
Raytheon Company
Waltham 54, Massachusetts

"June All-Reference Issue"

Editor, ELECTRONIC INDUSTRIES:

Please forward reprint of article "An Introduction to Boolean Algebra" that appeared in the Directory and All Reference Issue.

I might say at this time that you people did a wonderful job on this reference issue. You and your staff are to be commended for this effort.

Ronald Sarnie
Product Design Branch
Raytheon Company,
Missile Systems Division
Bedford, Massachusetts

"Support for Education"

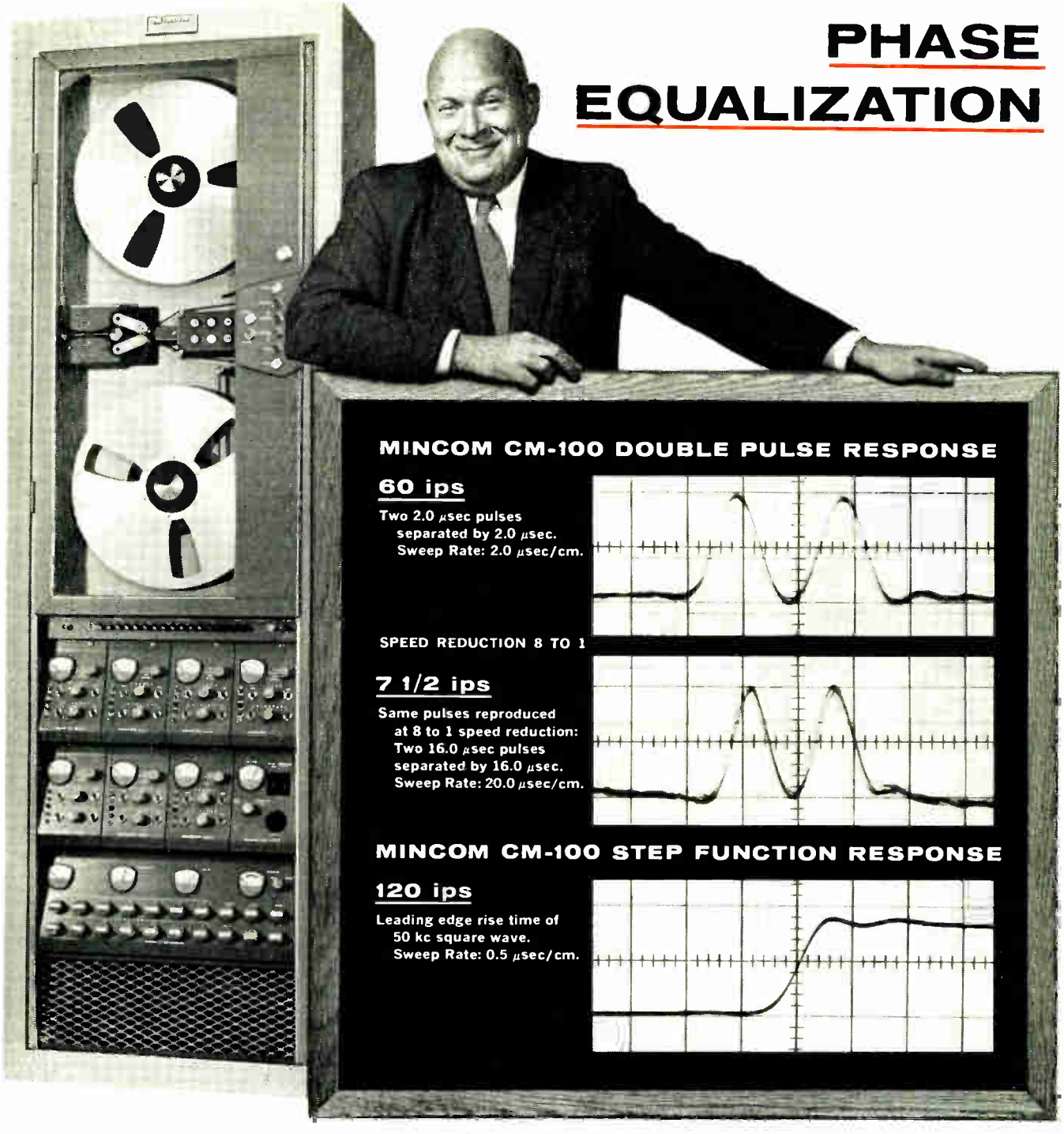
Editor, ELECTRONIC INDUSTRIES:

Your May editorial on "Support for Education" is very valuable since it touches on an important subject which is given by far too much lip service.

Your box score for "graduates" may not give the proper impression without further amplification. In comparing "graduates" in this country and some other country, we must keep in mind (1) whether equivalent levels of education are compared and (2) if these "graduates" are then employed in equivalent professional capacities. As for USSR, practically all their engineering-science graduates are employed in the general fields for which they were prepared; however, of our engineering graduates only a small fraction, less than 25 per cent, are still in engineering after a few years with industry. This fact alone suggests that the figures for USA should be divided by 4 if we want a comparative personnel ratio between this country and USSR—

(*Continued on page 56*)

PHASE EQUALIZATION



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Letters

to the Editor

(*Continued from page* 54)

hence the Russians will turn out about 10 times the number of engineer-scientists by 1960. Furthermore, a study of education in USSR shows that their engineers leave their schools at an academic level of at least our M.S. level; therefore, the scientific education of their engineers is at least by one year more advanced than that of the B.S. counterpart in this country. Where will this lead to?

Eric T. B. Gross, D. Sc.
Professor
Illinois Institute of Technology
Technology Center
Chicago 16

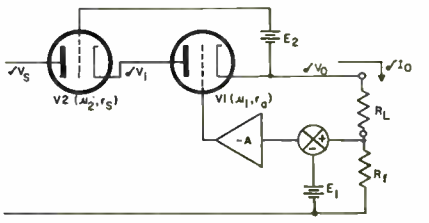
"Current Stabilizer . . ."

Editor, ELECTRONIC INDUSTRIES:

In connection with D. Allenden recent article on current stabilizer (Current Stabilizer . . . "Electronic Industries" May 1960 p. 87) I would like to raise some questions.

In the circuit analysis Allenden describes the main loop by the equation:

$$(\delta V_i - \delta V_o) = \delta I_o\, r_a - u_1\, V_{g_1} \quad (1)$$



But Eq. (1) must correlate with the well known triode equation.

$$i_k = K\left(e_c + \frac{e_b}{u}\right)^n \quad (2)$$

i_k = cathode current
K = const. of proportional
e_c = grid voltage
e_b = plate voltage
u = ampl. factor
n = exponent usually 3/2

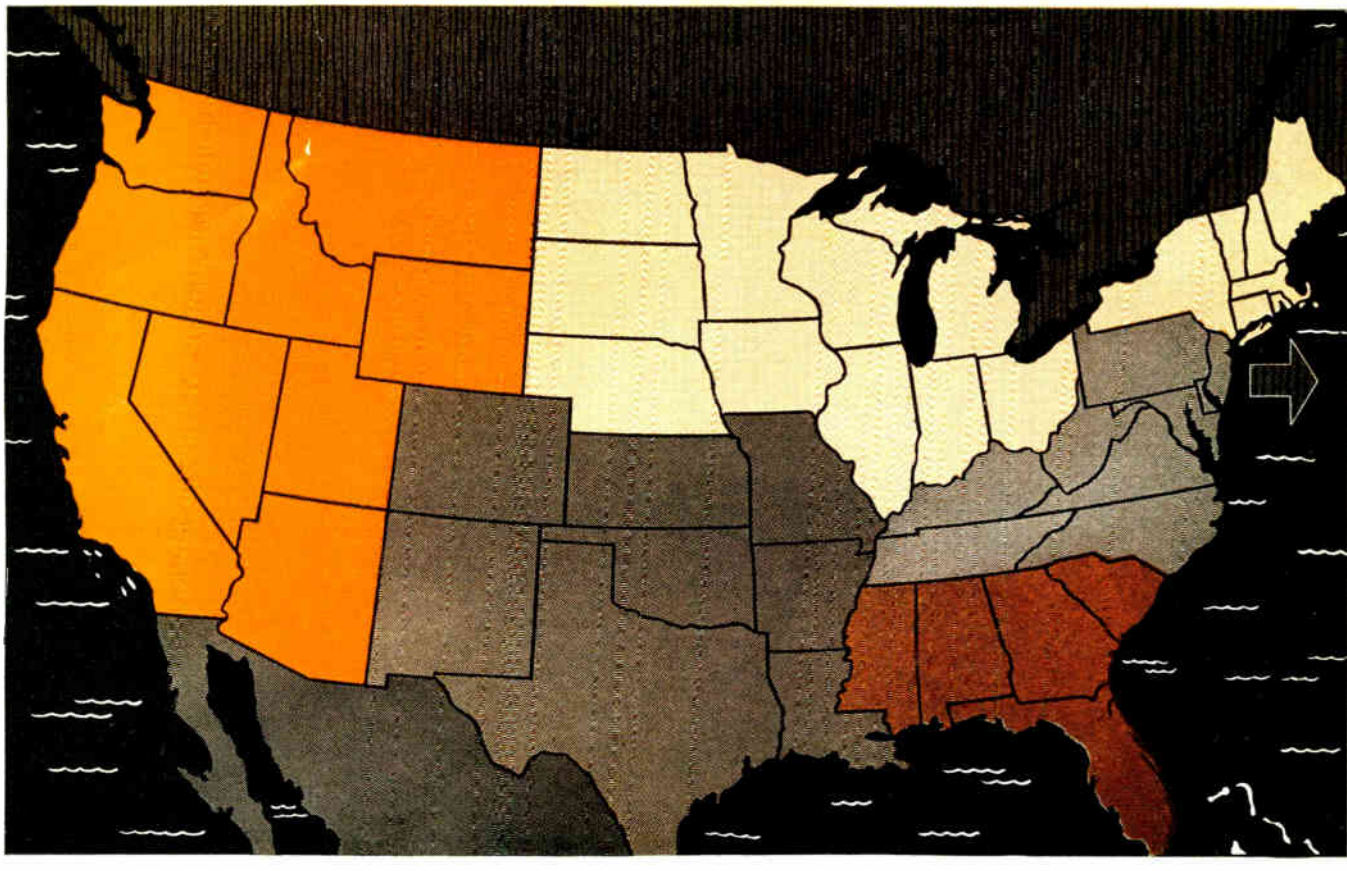
Deriving the corrolating formula of Eq. (2) with Eq. (1) we get immediately

$$\delta V_1 - \delta V_o = h\,\delta\, I_o^{2/3}\, r_a - u\,\delta\, V_{g1}$$
$$h = g/K^{2/3} \quad (3)$$

One may ask, how is this relatively big difference possible? The answer is simple: if changes of $(\delta V_1 - \delta V_o)$ are relatively small, one can use instead of the function, the function differential.

Switching back to the current stabilizer the error between Eq. 3

(*Continued on page* 58)



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THE Bendix CORPORATION

Letters

to the Editor

(*Continued from page* 56)

and Eq. 1 is small if the changes $(\delta V_1 - \delta V_o)$ are small. So the use of Eq. 1 is right. But it loses its trustworthiness if R_L load resistance drops from its 6,000-ohm nominal value to short circuit.

Geza Czanky
Globe-Union Inc.
Milwaukee, Wis.

"Current Stabilizer . . ."

Editor, ELECTRONIC INDUSTRIES:

Mr. Czanky's letter brings up, once again, the divergence between device operation over a limited range (where, as in the analysis given, differentials can be used) and wide-range operation, where the full analytical representation of the valve characteristic is required. As Mr. Czanky points out, there is a significant error if one uses the small signal equations to describe large-signal operation.

Small-signal theory is, however, applicable to the series valve of the stabilizer discussed because the auxiliary loop maintains the valve voltage drop $(\delta V_1 - \delta V_o)$ nearly constant; since the current does not change, it follows that the operating point of V_1 changes only slightly, even under the drastic conditions imposed by short-circuiting the load at full current.

The auxiliary loop, as pointed out in the article, is inevitably highly non-linear, but does not involve a valve characteristic.

D. Allenden
Head, Electronics Section
Associated Electrical Industries Limited
Research Laboratory
Aldermaston Court, Aldermaston, Berkshire

"Railway Signaling"

Editor, ELECTRONIC INDUSTRIES:

Please advise if any electronic industries are investigating the possibility of electronic control of wayside signals and interlockings for railroads.

We are also interested in electronic approach circuits for highway crossing protection.

Harry J. Davis
Circuit Engineer
Pittsburgh & Lake Erie R.R. Co.
Rm. 534, Terminal Bldg.
Pittsburgh 19, Pa.

Ed: Anyone know of activity in these areas?

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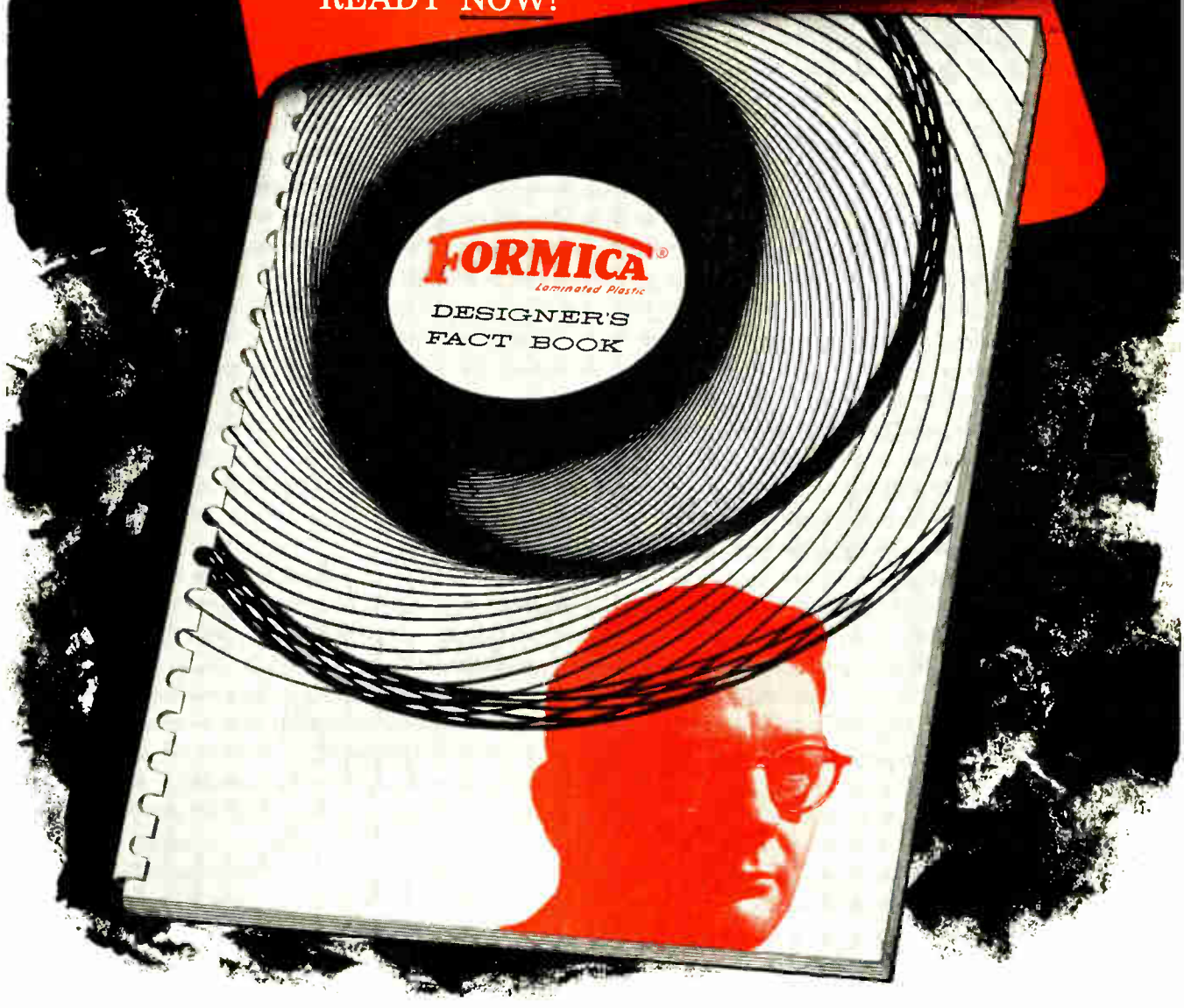

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News of Mfrs' Representatives

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Manufacturer of precision-machined metal parts and castings, and screw machine parts, wants representatives in Canada. Box 9-2, Editor, ELECTRONIC INDUSTRIES.

Glenn Soper has joined **Ed Landa Co.**, Los Angeles manufacturers' representative firm, as an associate, responsible for technical sales in the Southern Calif. area.

G. Soper

M. S. Symon

Maxwell S. Symon, Symon Assoc., New York, N. Y., has been appointed Eastern sales representative for Resistors, Inc., Chicago, manufacturers of ceramic wirewound resistors.

The Components Dept. of Curtiss-wright Electronics Div. has recently appointed the **J. T. Hill Co.** as its sales representative organization in California and Nevada.

Cannon Electric Co. has opened a new District Sales Engineering Office in Bensenville (Chicago area), Ill., to service customers in Wisconsin, Northern Illinois, Northern Michigan, and the bordering counties of Iowa and Indiana.

The Sperry Microwave Electronics Co. has appointed **J. T. Hill Co.**, 420 S. Pine St., San Gabriel, Calif., as their representative in California, Arizona, Nevada, and Hawaii.

Frank M. Oakes has been named Eastern representative for the Litton Industries' Electron Tube Div., San Carlos, Calif. His office is located in Manasquan, N. J. (P. O. Box 548).

Kemet Co. Div. of Union Carbide Corp., has appointed **G. S. Marshall Co.**, San Marino, Calif., its sales representative in California, Arizona, and Nevada.

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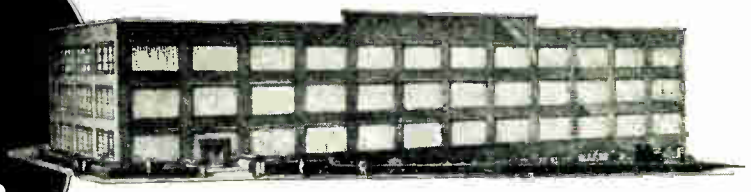

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Output, approx. 5V into 200,000 ohms

TYPE 2007-6

TRANSISTORIZED, Silicon Type

Size 1½" dia. x 3½" H. Wght. 7 ozs.

Frequencies: 360 to 1000 cycles

Accuracies:
2007-6 (± .02% at —50° to + 85°C
R2007-6 (±.002% at +15° to + 35°C
W2007-6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles

Accuracy: ±.001% at 20° to 30°C

Output: 5V. at 250,000 ohms

Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2

L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 30 KC.

M—Power Amplifier, 2W output.

P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High

Weight, 14 lbs.

Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel

Weight, 25 lbs.

Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.

Frequencies: 50 to 1000 cy.

Accuracy:
(±.002% at 15° to 35°C)

Output: 115V, 75W.

Input: 115V, 50 to 75 cy.

WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATP

American Time Products Inc.
61-20 Woodside Avenue
Woodside 77, N. Y.

News of Mfrs' Representatives

Charles F. Buehring has been appointed district representative for the South Pacific region by the POP Rivet Div. of United Shoe Machinery Corp.

Geo. Stevens Mfg. Co., Inc., Chicago, Ill., has named **Raymond Kimball**, Pasadena, Calif., to handle its complete line of coil winding machines in California.

S. Sterling Co., Detroit, Mich., has been appointed sales representative for The Birtcher Corp., Industrial Div., Los Angeles, Calif., in Michigan. **Electronic Components Sales, Inc.**, Albuquerque, N. M., has been assigned the states of New Mexico, Colorado, Utah, Wyoming, Montana and Idaho.

DENVER ELECTRICAL CLUB

Mr. C. L. Eckel, retiring Dean of Engineering at the Univ. of Colorado is presented $500 loan fund check for deserving junior and senior electrical engineering students. Shown (L-R) H. Woodard, Program Chairman; Dean C. L. Eckel (accepting check); G. Kaub, Denver ERC President; and C. D. Belt, Loan Fund Chairman.

Clevite Transistor, Waltham, Mass., has appointed the **M. F. Klicpera Co.**, P. O. Box 3113, Houston, Tex., as its sales representative in Texas, Oklahoma, Arkansas, Mississippi and Louisiana.

International Resistance Co. has appointed more than a dozen manufacturers' reps: Products of the Control components Div. will be handled by **Baehr-Greenleaf & Assoc.**, Cleveland; **Polymetric Devices**, Glenside, Pa.; **George J. Neuman**, Wellesley, Mass.; **Automation & Control**, Oil City, Pa.; **Memo, Inc.**, Hempstead, N. Y.; **Reed-Tollefson Corp.**, Rochester, N. Y., and **E. G. Holmes & Assoc.**, Atlanta. Items of the Plastic Products Div. will be sold by **Bonn & Assoc.**, Metuchen, N. J.; **Sales Engineering Co.**, Newton, Conn., and **H. E. Ransford Co.**, Pittsburgh, as well as by Baehr-Greenleaf, Reed-Tollefson and G. E. Holmes. Handling the precision potentiometer products of IRC's St. Petersburg Div. will be **Ray Perron & Co.**, Boston; **E.R.A., Inc.**, Great Neck, N. Y., and **Hollingsworth & Still, Atlanta**, as well as Baehr-Greenleaf, H. E. Ransford and Reed-Tollefson.

Circle 44 on Inquiry Card

Circle 45 on Inquiry Card →

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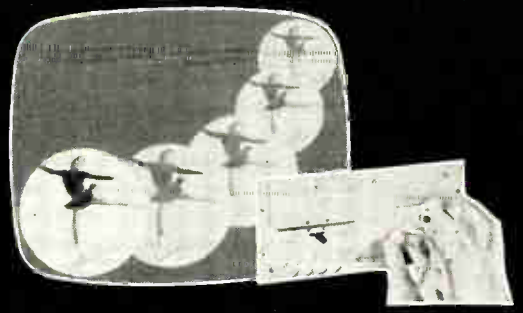
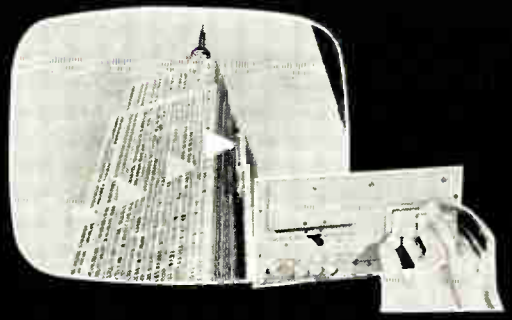
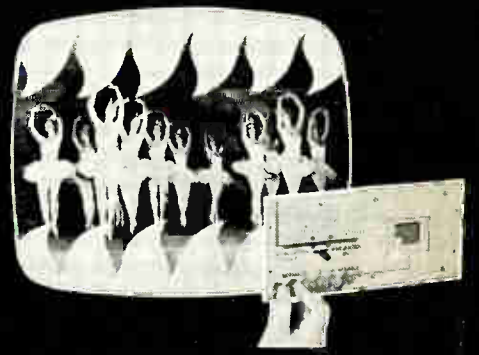
Insert May be Placed at Any Position on Raster



Electronic Spotlight



Electronic Pointer



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First, Telechrome provided broadcasters with a vastly improved system for producing a wider variety of dramatic wipes, inserts, keying and other special effects. Now, Telechrome engineering introduces the "Joy Stick" Positioner. This makes it possible to create many hundreds more effects and to move wipes, inserts, keying or other special effects to any place on the TV screen. The effects are startling! A new era in program creativity begins now! Ask to see the "Joy Stick" Positioner demonstrated, today!

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MODEL 491-A1

News of Mfrs' Representatives

The Sperry Microwave Electronics Co., Div. of Sperry Rand, Clearwater, Fla., signed two more manufacturer's representatives to handle their Microline products: **S. S. Lee Associates, Inc.**, will cover Maryland, Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Delaware, and the District of Columbia; Martin P. Andrews, Inc., Fayetteville, N. Y., will cover Upper New York State.

Osborne Electronic Corp., Hawthorne, Calif., has appointed four new representatives: **Myron Smith**, Kirkland, Wash., will cover Washington and Oregon; **Carlson Sales Co.**, Chicago, Ill., for Illinois, Wisconsin and Northern Indiana; **Wayne B. Palioca Co.**, Lexington, Mass., for the New England States and **Robert Finley**, Ridgewood, N. J., and Lutherville, Md., for Metropolitan New York, New Jersey, Pennsylvania, Delaware, Maryland, Washington, D. C., and Virginia.

Cannon Electric, Los Angeles, has named **Dula Associates, Inc.**, its new sales representative for North and South Carolina.

Bard Assoc., 328 Selbourne Rd., Riverside, Cook County, Ill., has been named the new manufacturer's representative for the central midwest including the Chicago area, Ill., Southern Wisconsin, Indiana and Iowa by Wayne Kerr Corp., Phila., manufacturers of electronic measuring instruments.

Marty Bettan Sales Co., Flushing, N. Y., is now representative for the Gonset Div., Young Spring & Wire Corp.'s Citizens Band and FM radio equipment lines. Area served is New York City and Northeastern New Jersey metropolitan area.

N. L. R. Associates, West Orange, N. J., has been appointed sales representative for Computer Engineering Associates, Inc.

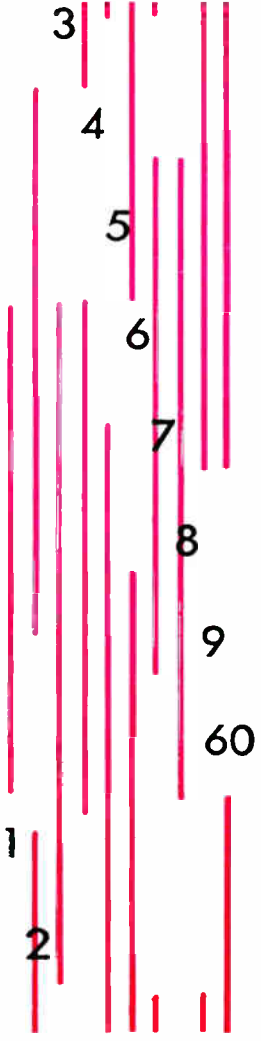
Western Transistor Corp. has appointed the following representatives for their line of silicon transistors: **Meredith Engineering Associates**, Pasadena, Calif., in the Southern California territory; **Featherstone & Salisbury**, San Francisco, in the Northern California territory; and **George Meeker Co.**, Seattle, Wash., in Washington and Oregon.

C. R. Dalton Associates, San Carlos, Calif., have been appointed northern California representatives for the Holtzer-Cabot Motor Div. of National Pneumatic Co. They will provide service for the company's line of instrument motors in all California north of Kern, San Luis Obispo and San Bernardino counties.

Circle 46 on Inquiry Card

Circle 47 on Inquiry Card →

verify events permanently in milliseconds



Brush Operations Monitors' response to signals is virtually instantaneous—less than 4 milliseconds. Multiple high-speed events are clearly defined from start to stop, on a common time base—and at rates up to 500 per second. Portable 30 channel or rack-mounting 100 channel models record sharp reproducible traces with fixed-stylus electric writing that provides the utmost in reliability. "Built-in" transistor switching to eliminate relays is optional. No direct writing recording system can match the capabilities of Brush Operations Monitors for industrial and military analysis and control. Write for complete specifications and application data.

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DIVISION OF
CLEVITE CORPORATION
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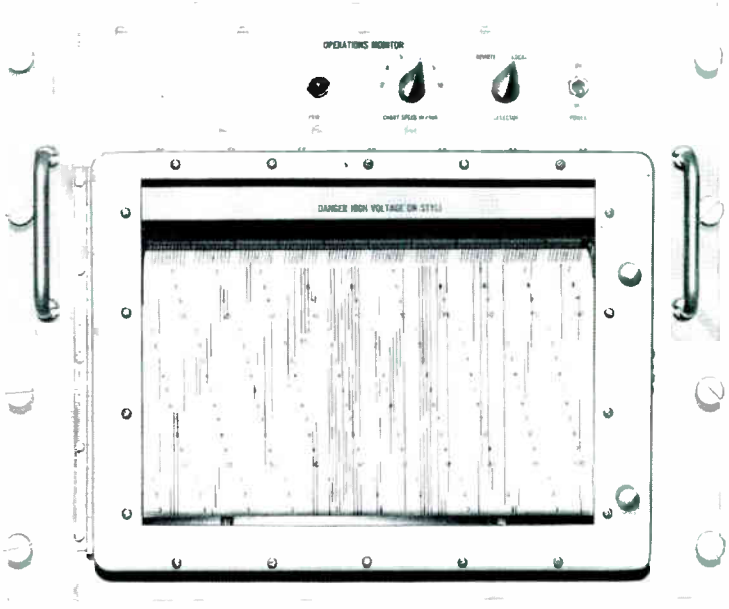
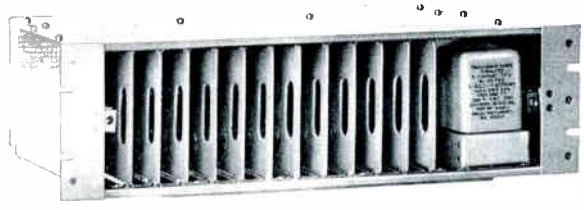
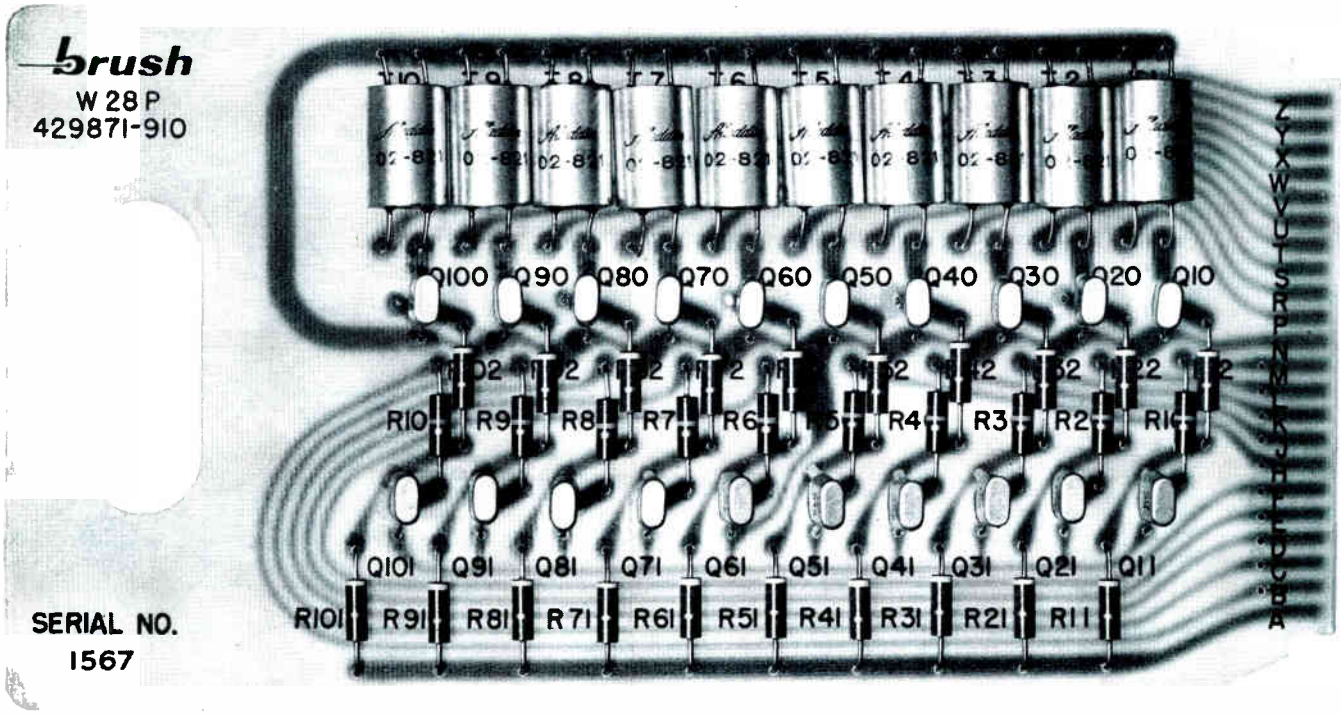


compact transistor switching for millisecond monitoring





The new Brush Trans-Switcher eliminates relays—greatly simplifies your problems of operations monitoring. Designed to take full advantage of the fast response and high resolution of Brush Operations Monitors, this compact, solid-state switching unit accepts up to 100 different "on-off" signals in a broad range of pulse shapes and amplitudes. Interchangeable, plug-in decade boards are designed to accept different voltage ranges and modes of operation. Avoid the "black box" approach—specify the *standard* Brush Trans-Switcher for the ultimate in precise, reliable monitoring. Write for complete details.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS — CLEVITE CORPORATION — CLEVELAND 14, OHIO

Next month

ORBIT DETERMINATION BY DOPLOC TRACKING

Engineers of the Ballistic Research Laboratories, Aberdeen Proving Grounds, are computing orbits of satellites from tracking measurements made on single passes of a satellite near the tracking station. In spite of the fact that measurements are made in a few minutes only, orbits tally closely with those determined by the National Space Surveillance Control Center.

NEW CIRCUIT FOR DOUBLE-BALANCED MIXING

Occasionally a mixer circuit is required in which both the local oscillator and the input signal frequencies are cancelled in the output, leaving only beat signals or sidebands. Such a circuit is called a double balanced mixer. Its characteristics will be described here.

DISPLAYING THE CHARACTERISTICS OF A TUNNEL DIODE

This article describes a simple circuit which may be used to trace on an ordinary oscilloscope the complete characteristic curve of a tunnel diode, including its negative resistance region. The method proposed uses the tunnel diode operating as a relaxation oscillator.

THE FCC AND MAN-MADE RADIO-FREQUENCY INTERFERENCE

This is another in EI's series on RFI. The article deals with the responsibility of the FCC in controlling interference. How they accomplish this, their enforcement procedures, and what they actually regulate are given in detail along with some of their problems.

Plus all our other regular departments

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

COMING SOON—IN THE NOVEMBER "MICROWAVE" ISSUE

FUTURE TRENDS IN MICROWAVE BEAM TUBES

In 20 years the basic principles in microwave beam tube development have been extended and refined so that current manufacture is on a highly competitive basis. The number and variety of tubes manufactured will be increased. What's ahead for the coming decade.

DESIGNING TEM MODE ROTARY WAVEGUIDE JOINTS

The theory of the probe type transition between rectangular waveguide and coaxial line is summarized from various sources in the literature and the design procedure of rotary waveguide joints employing these transitions is discussed. A typical rotary joint having a VSWR of 1.11 or less over the range of 8.8 to 10.4 KMC is discussed.

Watch for these coming issues:

***NOVEMBER**
Microwave Issue

***JANUARY**
Industry Review

***MARCH**
Annual IRE Issue

S. W. Torode

D. Disinger

Electronic Countermeasures Require . . .

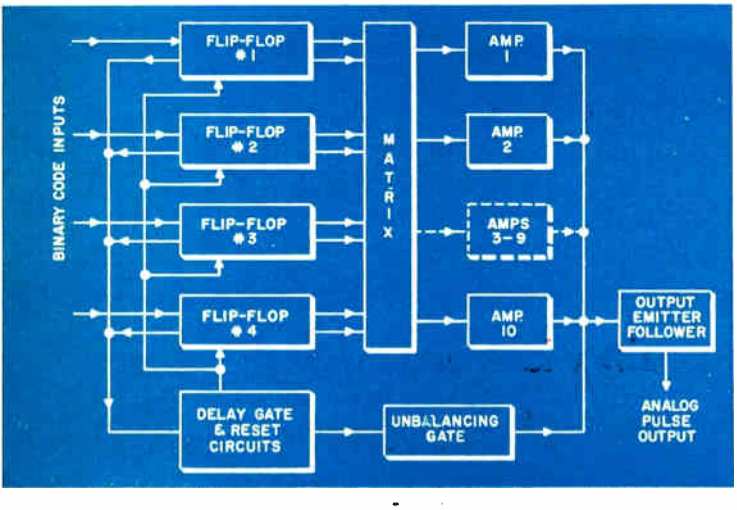
Conversion of Binary

Binary stored information, used in ECM receivers, is often needed in analog form for processes requiring a dc control voltage. The advantages, circuitry, and packaging of such a device are presented here.

IN electronic countermeasures (ECM) systems, remembering a received frequency, or portion of the frequency spectrum in which a received signal occurs, is essential. Since video pulses are much simpler to handle, store, and recall, than a high frequency r-f signal, the conversion of a received signal to a binary code representative of the original frequency, or segment of the spectrum in which the signal occurs is desirable.

This article describes a device for use in converting a binary coded signal to a stable analog pulse voltage. This voltage amplified and shaped, causes a frequency generating device, to sweep through the spectrum segment in which the original signal was received.

Fig. 1: System for converting binary coded signal to a stable analog pulse voltage which can be shaped to cause a frequency generating device to sweep through the original signal's spectrum segment.



Although the device is based on a four character code, an expansion can easily be incorporated to provide an increased signal handling capability.

Advantages

The advantages of converting to a binary signal for storage and handling are readily apparent. A six bit binary code, six identical circuits with only six lines for information carrying, can produce 64 different binary words.

The binary code inputs, Fig. 1, are converted in a diode matrix to a digital 1 through 10 code. Each amplifier has a separately adjustable voltage level. The resultant output is an analog pulse voltage whose amplitude is a function of the input binary code. Since the binary code has been determined by the segment of the frequency spectrum in which the received signal occurred, the amplitude of the output pulse also contains this information.

Circuitry

The matrix circuitry is shown in Fig. 2. The input flip-flops employ the conventional four transistor, non-saturated circuit. They provide both positive and negative going outputs as shown, when a positive pulse input is applied.

The output point to amplifier 1 is held at a +24 volt level by the diode connection to flip-flop 4. The remaining diodes to this point are connected to the normally low, +4 volt, sides of the other flip-flops. Therefore, a negative going output to amplifier 1 will occur only when an input pulse is applied to flip-flop 4, binary code 0001. If any other code is applied, no

By S. W. TORODE
Engineering Manager
and D. DISINGER
Senior Engineer
Sylvania Electronic Systems
1100 Wehrle Drive
Buffalo 21, New York

FOR OUTPUT TO AMP.	BINARY INPUT TO FLIP-FLOPS			
	1	2	3	4
1	0	0	0	1
2	0	0	1	1
3	0	0	1	0
4	0	1	1	0
5	0	1	0	0
6	1	1	0	0
7	1	0	0	0
8	1	0	1	0
9	1	0	0	1
10	0	1	0	1

Table 1

to Analog Codes

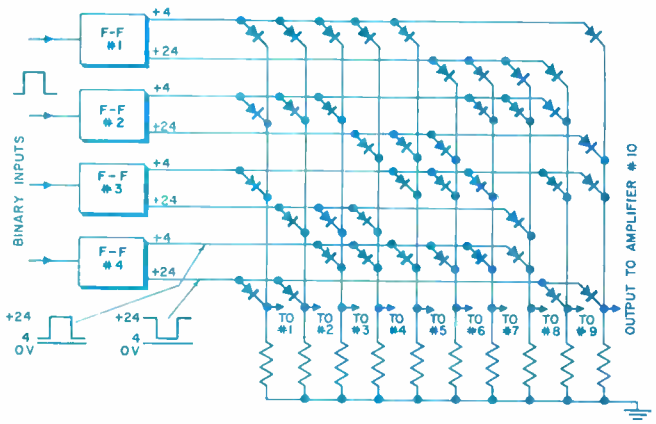


Fig. 2: Matrix circuitry for the converter system shown in Fig. 1.

signal will be present at the output to amplifier 1 since at least one diode at that point will hold the voltage at the +24 volt level for any other code. Similarly, an output to the remaining channels will occur only when the code is as shown in Table 1.

Due to operating system requirements, the code does not correlate directly with binary math, but a slight matrix modification and additional amplifiers for the unused codes could easily correct this condition.

Fig. 3 is a schematic of a channel amplifier showing the connection to the output emitter follower.

Transistor Q1 is normally conducting due to the +24 vdc coupled through the diode(s) of the matrix. When an input code signal is applied to the converter, the proper amplifier will receive a negative going pulse from the matrix. The discharge of C1 will cut off transistor G1 and the collector voltage will rise to the level set by the clipping potentiometer R4.

The signal is coupled through diodes CR3 and CR4 to the base of Q2. Transistor Q2 is an emitter follower which has a fixed bias applied to the base through CR5 and CR6.

The voltage present at the base of Q2 in the quiescent condition is greater than the voltage at the collector of Q1. This prevents the temperature variation effects in saturation resistance (RCS) of Q1 from affecting the output pulse amplitude.

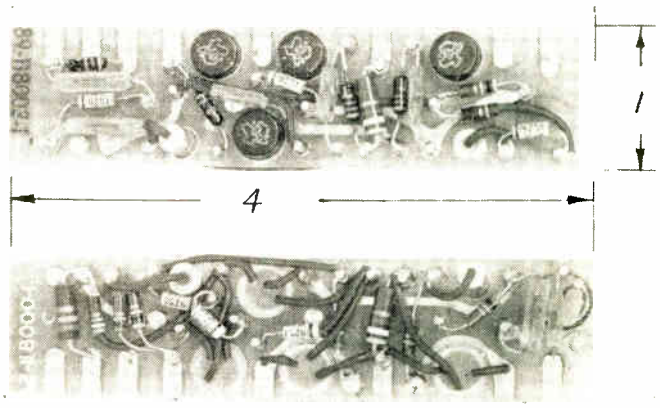
Diodes CR5 and CR6 were chosen to provide a temperature coefficient correction for the temperature variation of $E_{b_{e_1}}$ of Q2. This makes the quiescent level of Q2 emitter voltage independent of temperature. Diodes CR3 and CR4 provide similar temperature compensation for the clipping level. The result is an analog pulse whose amplitude is independent of thermal variations.

Fig. 4 shows an analog pulse output voltage in solid lines with reference to the Q1 collector signal.

Combining Pulses

When a code is applied which results in both a negative and a positive pulse combining at the input to an amplifier, e.g., amplifier 1 input for code 0011,

Both views of flip-flop board show the packaging density achieved.



Binary Converter
(Continued)

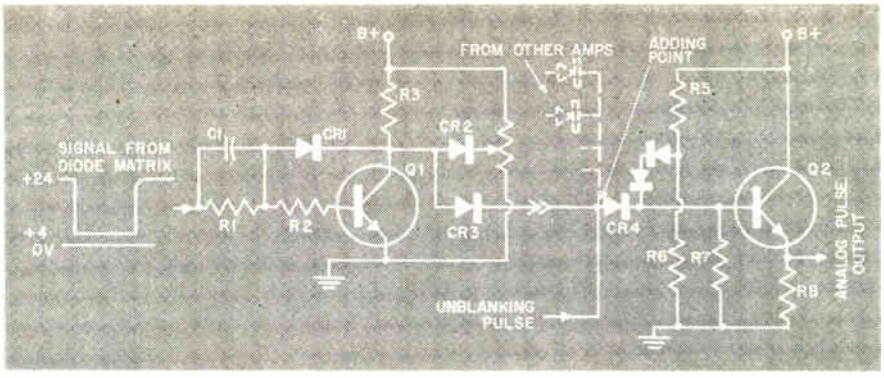


Fig. 3: Channel amplifier with proper connections to the output emitter follower.

The assymetry of the flip-flop outputs results in negative going spikes as shown in Fig. 5a.

Since the spikes have practically the same amplitude as a desired negative pulse or a different channel, spikes could be passed through one amplifier, be superimposed on the signal passing through another amplifier and result in a composite signal at the converter output as shown in Fig. 5b.

To prevent the possibility of this from occurring, the "adding" point, Fig. 3 is held blanked off except for the time between pulses.

The circuit shown in Fig. 6 provides the delay blanking pulse to the adder points as well as supplying the reset pulse to the flip-flops.

The positive binary input pulses are applied to the base of Q1 which is an amplifier inverter. The coupling circuitry between Q1 collector and Q2 base consists of an integrating network, R3 and C2, a current limiting resistor R4, and zener diode CR1. The action of this network results in a delay between the time that Q1 collector voltage drops and the time that Q2 collector current cuts off.

Rapid cut off of Q2 is achieved independent of variations in the parameters of different transistors through the action of CR2 which prevents the stage from saturating. The leading edge of this delayed output of Q2 is applied to Q3, one half of a monostable multivibrator. Q5 is the other half of the monostable and Q4 is an emitter follower isolation stage between edge of a negative going output pulse obtained from the output of Q3 and the input of Q5. The trailing edge of a negative going output pulse obtained from the emitter of Q4 provides the reset signal for the flip-flops which were triggered.

A negative gate is taken from the collector of Q3 and applied to emitter follower Q6. The discharge of C6 during the time of this pulse causes Q7 to cut off. The resultant positive pulse at the collector of Q7 is applied to Q8, a PNP transistor, causing it to cut off. Q8 effectively acts as a switch connecting the adding point, Fig. 3, to ground. This switch is not opened until after the first spike, Fig. 5a, has occurred and is closed coincident with the leading edge of the second spike.

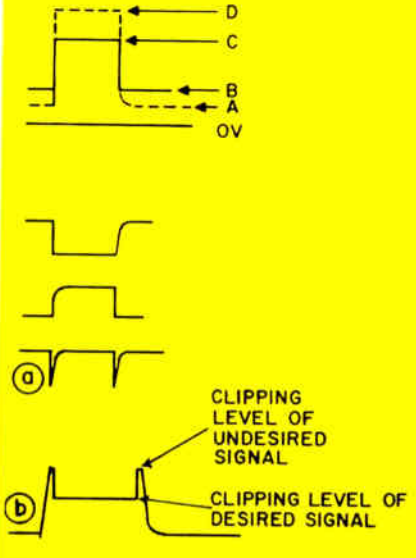
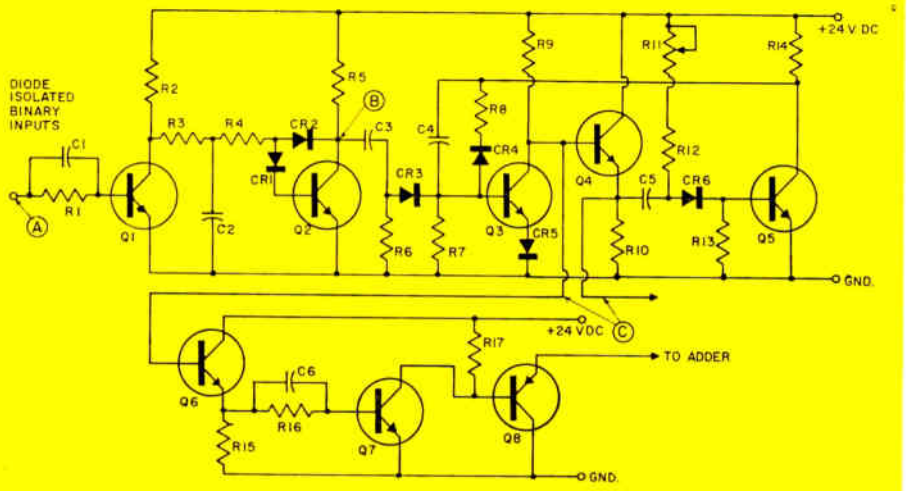


Fig. 4 (top, left): Analog pulse output voltage in solid lines with reference to Q1 collector signal; A, normal Ec of Q1; B normal Ee of Q2; C, clipping level set by R4; and, D, maximum signal available at Q1 collector.

Fig. 5 (bottom, left): When negative and positive pulse combine at amplifier input, assymetry of flip-flop outputs results in negative going spikes (a); this could result in a composite signal at the output of the converter (b).

Fig. 6 (below): This circuit provides the delay blanking and reset pulses.



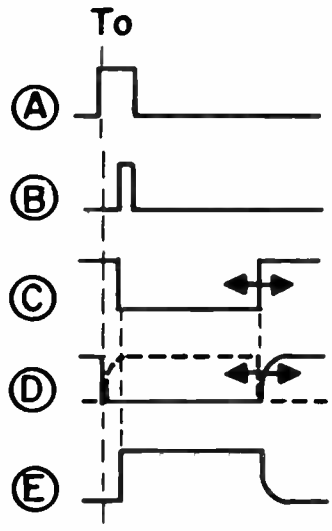
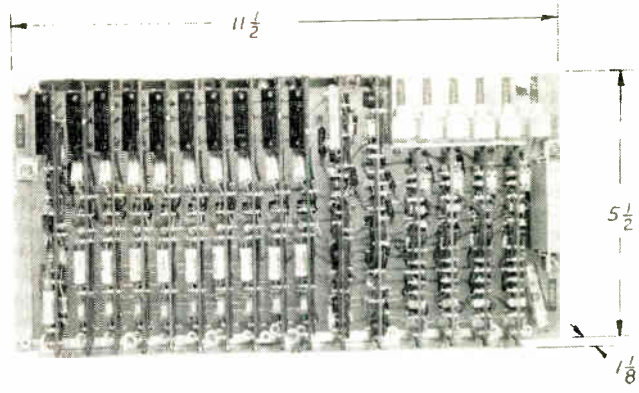


Fig. 7 (left): Pulse timing diagram letters refer to signals in Figs. 3 and 6: A, binary input; B, delayed trigger; C, monostable output (variable output); D, flip-flop outputs to amplifier; and E, the converter output.



(Right): There is a total of 16 plug-in boards in the unit. A notched key on the boards prevents their incorrect insertion.

Fig. 7 is a pulse timing diagram with reference letters referring to the signals as viewed in Figs. 3 and 6.

Packaging

The photographs show the packaging concept employed in the converter.

There is a total of 16 plug-in boards, 4 different types. Views of both sides of a flip-flop board show the packaging density achieved. There are 34 standard components—4 transistors, 12 diodes, 7 capacitors, and 11 resistors—on this board. The plug-in boards have a notched key to prevent them from being inserted in the unit incorrectly.

REFERENCE PAGES

The pages in this section are perforated for easy removal and retention as valuable reference material.

SOMETHING NEW HAS BEEN ADDED

An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

Breadboarding Without Solder

A COMPLETE digital data-processing system, involving hundreds of individual components, has been developed through the breadboard stage without use of a soldering iron, according to engineers at California Computer Products, Inc.

By avoiding the use of solder, company engineers have saved both time and money. Test circuits can be rapidly assembled by the engineer actually doing the design work. There is no need to send schematic drawings to the model shop for prototype buildup or revision. If the engineer decides to change a resistance or capacitance, he simply removes the component and replaces it with another of different value.

There has also been a sharp drop in component costs. Transistors valued at $30 to $50 each can be easily damaged by the soldering and resoldering that normally accompanies breadboarding work. But by using PA Circuit Builders supplied by Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif., a transistor may be introduced into a circuit by simply inserting its leads into appropriate junction cells on the face of the breadboard. Each cell, consisting of a gold-plated brass eyelet and a flexible rubber core, is capable of gripping up to six wire leads, providing an electrical connection of essentially zero resistance.

The Circuit Builders come in several sizes, with a varying number of junction cells. By using a number of units in tandem, as done at California Computer Products, circuits of any desired complexity may be assembled. The breadboarded circuit resembles both a schematic drawing and a printed circuit board card. In effect, the Circuit Builder is an intermediate step between the two, providing engineers with a fast, economical method for finalizing design concepts.

Components may be changed quickly and easily with a new type connector. Called a junction cell, it is mounted on the face of a breadboard. It consists of a gold-plated brass eyelet and a flexible rubber core which is capable of gripping up to six wire leads.

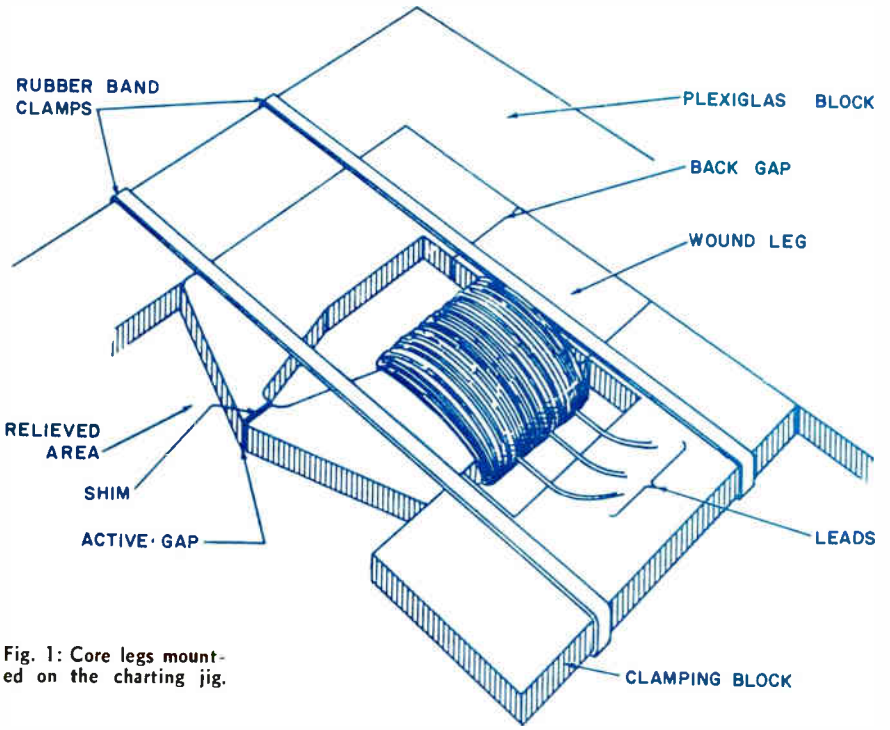


Fig. 1: Core legs mounted on the charting jig.

By GERALD SOLOMON
Asst. Research Engr.
Research Center
Burroughs Corp.
Paoli, Penna.

Mapping

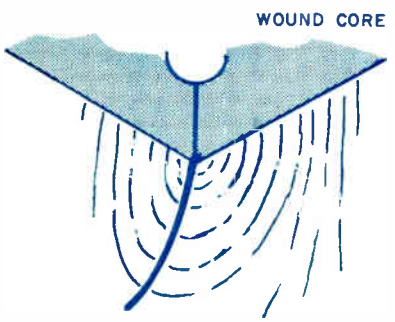


Fig. 2a: Loci of horizontal tangents with the active gap aligned.

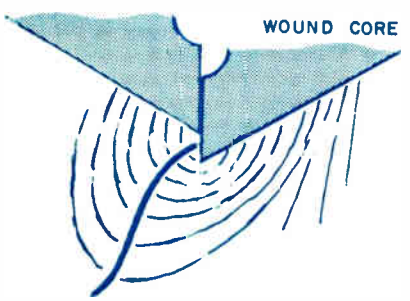


Fig. 2b: Tip of the wound core was displaced below that of the unwound core when this field was charted.

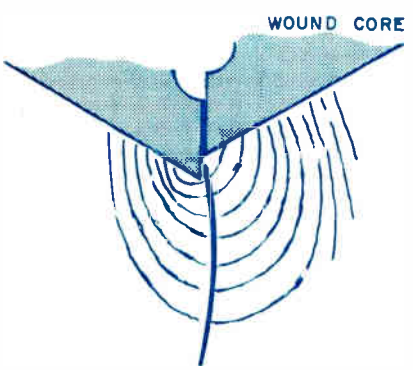


Fig. 2c: Tip of the unwound core was displaced below the wound core for this chart of the gap magnetic field.

WITH any attempt to design a magnetic recording system, an important consideration is the design of the recording and reading heads. In the systems being considered by our group the heads are of the read-write variety.

A magnetic head designed exclusively for writing has an optimum design that is rarely the optimum for reading. With head design comes a need for investigation of their characteristics.

Both reading and writing characteristics can be determined from actual recording and from study of the field patterns of the head, particularly at the active gap. Our purpose was to develop a qualitative method for studying the field around the active gap of a read-write head under write conditions.

There are two ways of describing a magnetic field: (1) qualitatively, showing flux paths; and (2) quantitatively, charting field strengths of these paths. For the latter it is very helpful to have some ideas as to the flux distribution with respect to pole piece surfaces.

The Approach

Conventional field mapping involves the simple procedure of sprinkling a magnetic material, granular in nature, on the area of a magnetic field—making visible that field configuration. These maps can be made permanent by spraying or by photographing.

This method must be modified for the particular fields under consideration. Modifications must be made because (1) the common magnetic materials have particle sizes much too large to properly resolve the fields under consideration; and (2) the field strength is so

Magnetic tape recording quality is being forced higher and higher. What actually happens at the recording head? To properly study this phenomenon a new magnetic mapping technique was developed. Here are the details.

Fig. 3: Typical chart of an active gap in a saturated condition.

Small Magnetic Fields

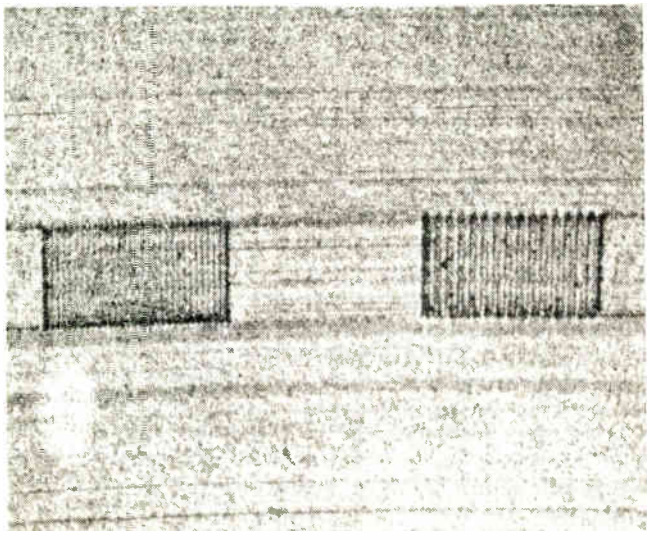
weak that friction of magnetic particles against the mapping surface prevent accurate maps.

Charting Medium

The search for a charting medium that meets these modifications brought to light several problems. The first was mobility of the particles forming a map. In making a map, the magnetic particles must be of a size that will permit the field to move them about.

In a low magnitude field there is often not enough attraction to overcome friction. This was remedied by placing the particles in solution permitting the particles to gain mobility. The solutions first used, green soap, water, and alcohol, permitted the particles to move too freely, so that they collected at the pole faces and did not distribute evenly along the flux paths.

Fig. 4: These examples show what 740 and 1480 pulses per inch look like when black ferrite is suspended out on a typical magnetic tape.



It became apparent that a fluid of variable viscosity was required. The fluid should exhibit a low viscosity long enough to allow the particles to align themselves; then set, fixing the particles in a permanent position. The fluid selected is plexiglass; its solvent, methyl dichloride (liquid plexiglass). The viscosity of this fluid can be controlled by adding the proper amount of the solvent. The amount of solvent added is dependent on the field strength. Plexiglass will quickly air harden and give a fixed field map that can be handled and studied.

Suspensions Investigated

Iron Powder

The iron in powder form did not give a chart of the field due to the fact that the magnetic field under examination is of a low value and has not enough force to overcome the frictional force between particles of the iron.

Magnetite in Green Soap

This suspension did not give satisfactory results because the low viscosity of the medium permitted the particles of magnetite to pile up at the poles obscuring much of the desired information.

Magnetic Mapping (Continued)

Lithium Ferrite in Solution

This material was ground and passed through a 323 mesh to the inch sieve, and then put into the solution of plexiglass in methyl dichloride. When the material was added it formed into large clusters. This is explained by the fact that lithium ferrite particles have residual magnetism and the mutual attraction between particles results in large clusters. These clusters were too large for use in the field area charted.

Iron Powder in Solution

The particle problem was attacked by grinding the iron, passing it through 323 mesh screen, and putting it in the plexiglass and methyl dichloride solution. This brought the particles down to a usable size, yet not the most desirable size.

Iron Flake in Solution

This suspension, solution is that previously mentioned, has all the desirable qualities of that above but further, has smaller particle size, giving finer line definition. This suspension was used for the remainder of our investigation.

Charting Jig

The fields investigated were at the active gap of a read-write head. Field maps with the core legs aligned and misaligned at the active gap were desired.

To do this, a jig, Fig. 1, was built to hold the core legs in a manner that would present the active gap area for charting. It is possible in this jig to apply the usual amount of pressure at the head gaps. It consists of a block of plexiglass with the face relieved to accept the two core legs and to maintain their alignment. The jig uses rubber bands to clamp the core legs and thus creates gap widths equal to those in the actual heads.

Mapping Procedure

The charts were made as follows:

1. The core legs were mounted in the jig.
2. Silicon grease was smeared on the jig at the active gap area and leveled to the upper surface of the cores.
3. A sheet of Mylar film was placed on the cores and care was taken to insure a flat, level surface.
4. The windings were connected to a current source and a known current caused to flow through the winding.
5. The charting suspension was painted on the Mylar with an artist's paint brush and let dry. The resulting chart formed by the magnetic materials in suspension was then observed and photographed.

Data Collection

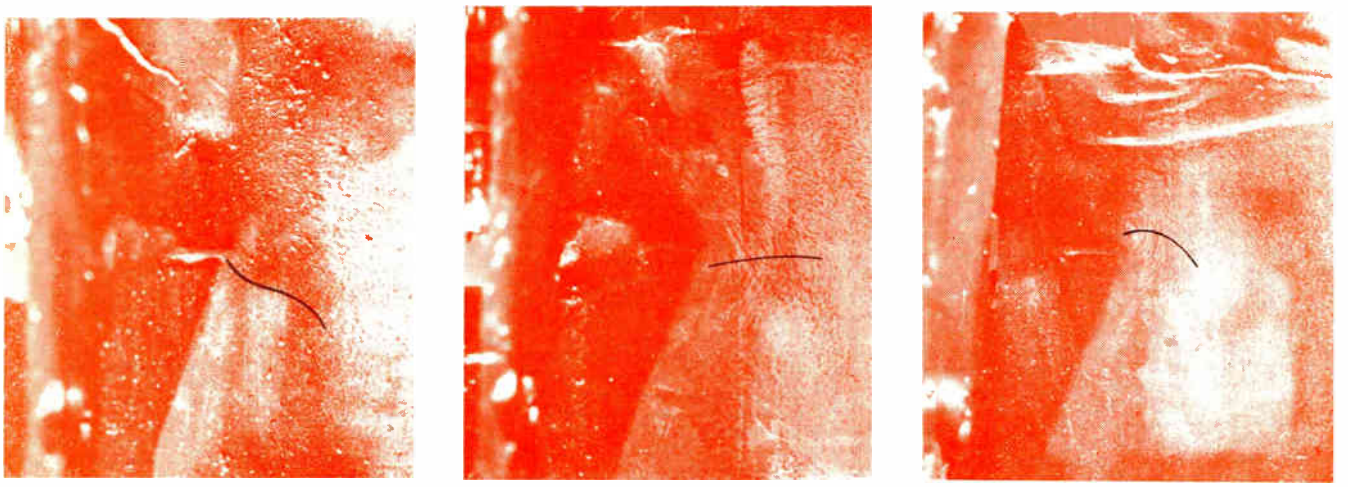
Data collected was in the form of photographs of the fields. The photographs were analyzed and presented in a form that could be used to compare fields of various core configurations. Initially the charts were made under dc conditions. Later experiments were made under pulse conditions.

The first series of tests, Fig. 5, were made with a set of cores of Stewart Lavite F112C ferrite material, with a 0.5 mil silver shim in the active gap. The wound core had a 200 turn center-tapped winding of #44 magnet wire. The current through the winding was 80 ma. dc. The fields were charted with three different gap alignments: with the active gap aligned; with the tip of the wound core displaced below the tip of the unwound core; and with the tip of the unwound core displaced below the tip of the wound core.

To make a qualitative comparison of the field maps obtained, the points of horizontal tangency of the flux paths were located, and were connected in a line called the loci of horizontal tangents. The slope of this line yields information about the field that can be used as a basis of comparison.

The resulting charts are shown in Fig. 2. There was a common characteristic in all the maps made in this study—the loci of tangents line always curved

Fig. 5: Results of first test series; (left to right) core with writing winding displaced to right of unwound core; aligned; and displaced to left.



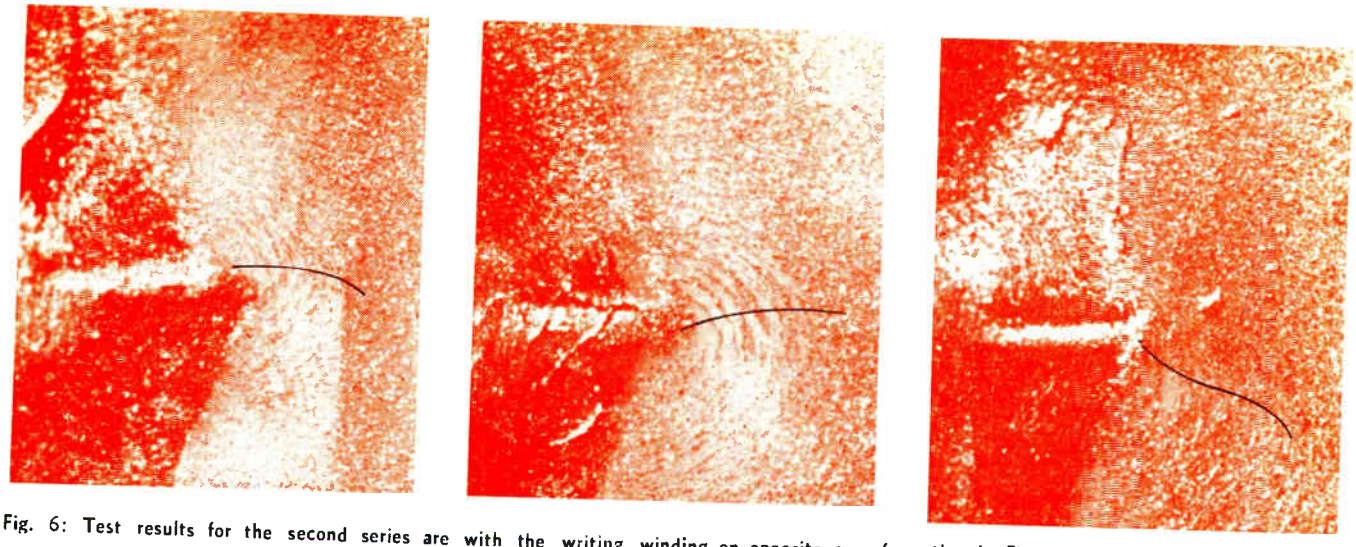


Fig. 6: Test results for the second series are with the writing winding on opposite core from that in Fig. 5, but the alignment is similar.

away from the core that had the write winding. The write winding was evidently causing this effect.

To prove the hypothesis, a second test series was run. This series used the same core pegs as the first series with the winding being shifted from one core leg to the other. All other test conditions were duplicated to match those of the first test series.

The results of the second series were the same as those of the first test series, Fig. 6. This ruled out any effect from difference in core material and made stronger the case for the effect coming from the coil.

A third series of tests was run to see how the field configuration looked under pulse conditions. The same physical conditions were maintained as in the first and second series. The current wave form was 1 microseeond pulses at a 3 microsecond repetition-rate of 150 ma. maximum current. The resulting configurations were similar to those obtained under dc conditions but of a greater magnitude.

An interesting effect noticed in this work was the distortion of the magnetic field when a saturating current was applied to the coils. Normally, with currents insufficient to cause magnetic saturation, the pole tips at the active gap acted like north and south poles. However, when the current was increased to a value large enough to saturate the pole tips, the apparent poles moved away from the vicinity of the gap and distorted the field pattern. Fig. 3 shows a typical chart of an active gap in a saturated condition.

This mapping method has proven to be a valuable aid in the qualitative study of magnetic fields. Its chief advantages are speed and almost trivial cost.

Quartz Threads by the Mile

THE shiny heart of a dosimeter is a platinum coated quartz thread.

Threads 5000 inches long are drawn from commercial quality quartz rods by a machine designed by the Landsverk Electrometer Co., Glendale, Calif. The rod is inserted in an electrically driven holder that automatically feeds it into a flame of natural gas and oxygen. When the rod melts, the first strand is hand drawn and attached to a 12 in. collecting wheel. The wheel spins at a speed of 120 ips.

Quartz threads are collected on the six-inch-wide rim of the wheel, and their diameter is controlled by the rate at which the rod is advanced. Proper attention to the flame heat and hand guidance of the thread on the wheel will produce constant yields of uniform diameter thread.

As used in dosimeters, threads of 130+1% millionths in. in diameter are required. The length of the thread from a piece of rod varies directly as the square of the relative diameters. At this rate, each inch of rod produces about 5000 in. of thread. The material, being five times as flexible as steel, serves as a pointer and meter movement, in addition to its electrical function.

After being drawn around the drum, the coil of fiber is cut to produce one straight thread for each turn, or about 100 strands per drawing. Strands of proper diameter are mounted in 1½ in. lengths on copper wire fixtures. These assemblies are put in a vacuum chamber whereplatinum is vaporized on the fiber, forming a conducting surface.

Quality control of fiber thickness can be determined by several methods including light refraction. However, Landsverk chooses as being best for production work a method which measures the capacitance resulting from the thread separating two pieces of metal. Two Johannson blocks are placed in a jig that has precise vertical movement on the top block. The fiber to be measured is placed between the two parallel blocks, and the capacitance created is measured on a General Radio instrument. The capacitance will increase inversely to the thickness of the fiber. A calibrated table is used to translate between the dial readings of the instrument and the fiber thickness.

Performing decimal rather than binary functions, this tube can replace up to 20 transistors in switching applications. But, high amplitude drive signals and impedance match are problems encountered when used with transistor logic. Here are some successful solutions.

Transistor Circuits . . .

Driving the Beam Switching

E. J. Oelbermann

H. E. Crecraft

BEAM switching tubes are being used regularly to perform such functions as distributing, switching, multiplexing, counting, sampling, coding, timing, gating, matrixing, etc. The beam switching tube, in performing decimal rather than binary functions, usually replaces from 8 to 20 electron tubes or transistors.

Difficulties

One of the difficulties associated with beam switching tubes when used with transistor logic, however, is the relatively high amplitude drive signal which is required when the device is to be driven at fast cycling rates. A normal low voltage beam switching tube, such as the Burroughs Model 6701, usually requires a square wave drive signal with a peak-to-peak amplitude of 20 to 25 volts when the tube is to be driven at 1 MC.

If the driving transistor is to be operated from the same B^+ voltage, which is normally around +24 volts, this means that the transistor drivers must operate in the vicinity of saturation when the device is to be driven at a 1 MC rate.

A second problem confronting logic circuit designers is impedance match. Beam switching tubes have inherently high impedance targets; transistor circuits, relatively low input impedance.

This article presents: two driver circuits used to drive a Burroughs Model 6701 beam switching tube at a 1 MC rate; a dc coupling circuit used to drive a beam switching tube at low speeds; and, a dc coupling network used to derive a signal from the targets of the 1 MC circuit and produce negligible "loading" of the beam switching tube.

Driver Circuit No. 1

Driver circuit number 1, Fig 1, uses two Texas Instruments 2N337 NPN transistors, Q1 and Q2. They are ac coupled to the odd and even grids of a Burroughs Model 6701 beam switching tube. Input signals for Q1 and Q2 are obtained from a saturated NPN or PNP flip-flop which commutates at a 1 MC rate. If PNP transistors are used in the flip-flop. R1 and R6 should be shunted with diode dc restorers so that sufficient positive pulse signals are obtained at the bases of Q1 and Q2.

Maximum collector dissipation on the 2N337 transistor is 125 milliwatts at 25°C with a rerating of 0.1 milliwatt per degree centigrade increase in temperature. The collector dissipation for Q1 and Q2 in Fig. 1 is approximately 87 milliwatts which should insure operation at elevated temperatures.

Although this driver circuit will operate reliably at lower frequencies using smaller B^+ voltages for Q1 and Q2, it was noted that a 25 volt swing is required to operate the tube at a 1 MC rate.

Driver Circuit No. 2

In the driver circuit of Fig. 2, the input signals are obtained from two saturated amplifiers, Q3 and Q4, which are dc coupled to the driver transistors. The use of a saturated amplifier permits the input signal to be derived from a sinusoidal source, or from an irregular waveform such as the output of an astable multivibrator.

Q3 and Q4 are Philco 2N499 PNP transistors. The 1N60 diode connected between the base and emitter breaks down in the forward direction at approximately +0.3v and thereby protects the 2N99 against excessive reverse voltages

By E. J. OELBERMANN, P.E.,
Sr. Engr.
and HAROLD E. CRECRAFT,
Sr. Tech.

HRB-Singer, Inc.
Science Park
State College, Pa.

Tube

between the base and the emitter. The maximum allowable reverse base to emitter voltage for the 2N499 transistor is 0.5v.

Q3 and Q4 trigger the driver transistors by means of divider networks. The voltage at the base of Q5, for example, is negative when Q3, is "off," that is when the collector of Q3 is negative. When Q3 saturates, the collector goes to ground potential and the base of Q5 becomes positive or "on" because of the divider action of R14 and R13.

Potentiometer R16 is used to control the amplitude of the drive signal for the beam switching tube.

DC Coupled Driver

Fig. 3 is the schematic diagram of the driver circuit for the Model 6701 beam switching tube which uses dc coupling.

Drive requirements are not critical at low frequencies as evidenced by the fact that the beam switching tube can be driven with a peak-to-peak swing of 10 volts at 50 KC. As the driving frequency is increased, however, the drive requirements increase and the B+ voltage on Q7 and Q8 must be increased by means of R32.

The range of frequencies which may be used with the circuit in Fig. 3 is from dc to 100 KC.

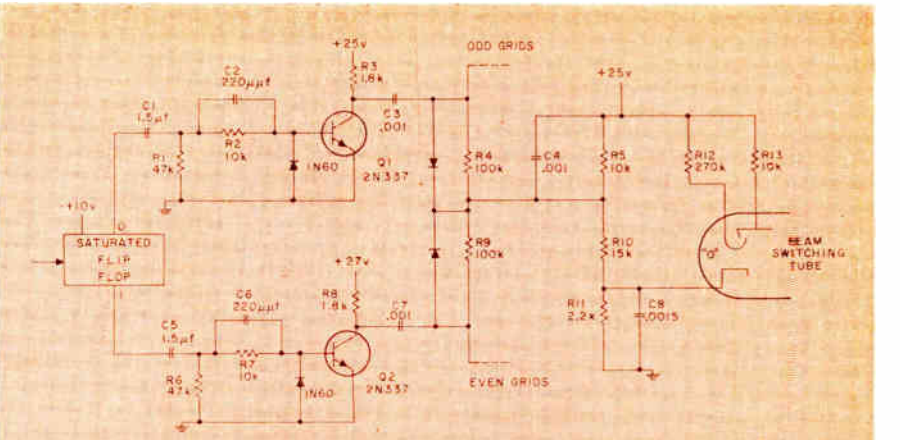


Fig. 1: This 1 MC driver circuit obtains its input signal from a saturated flip-flop.

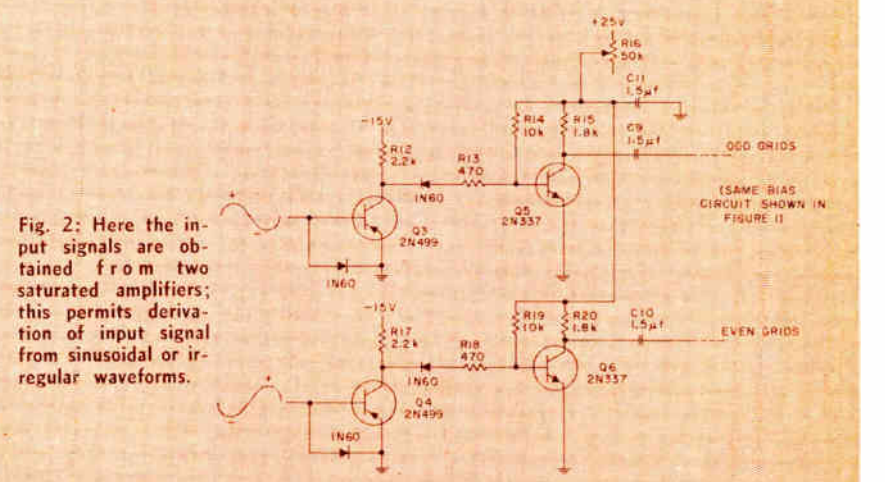


Fig. 2: Here the input signals are obtained from two saturated amplifiers; this permits derivation of input signal from sinusoidal or irregular waveforms.

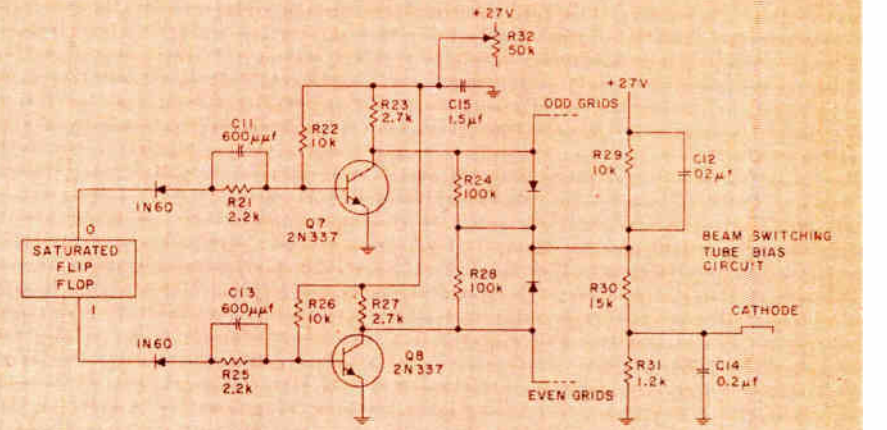


Fig. 3:The low frequency drive circuit handling dc to 100KC requires less B+.

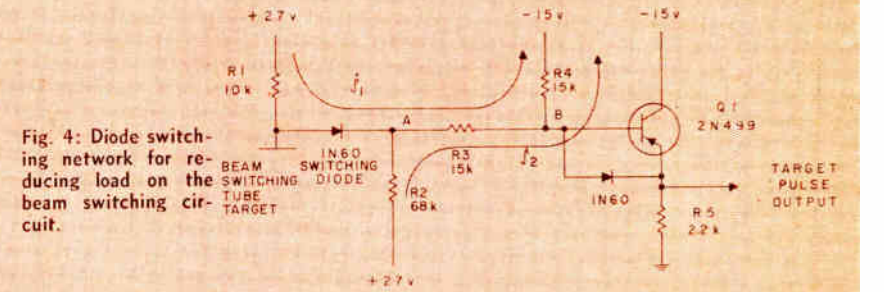


Fig. 4: Diode switching network for reducing load on the beam switching circuit.

Switching Tube *(Continued)*

Diode Switching Network

The circuit shown in Fig. 4 is a diode switching network used to reduce the "loading" on the beam switching tube. It disconnects the high impedance target of the tube from the low input impedance of a transistor stage during conduction by means of a series diode.

The principle of the diode switching network is as follows:

Initially the target of the beam switching tube is "off" and the target voltage is close to +27 volts. The potential at point A is less than +27 volts because of the voltage drop through R2 due to current i_2. Therefore current i_1 flows through R1, the switching diode, R3 and R4 and makes the potential at point B sufficiently positive to forward bias the protective diode on the base of Q1 insuring that Q1 is off.

When the target conducts, the voltage on the target decreases, the switching diode becomes back biased reducing current i_1 so that the potential at point B goes negative and turns on Q1.

It is noted here that almost immediately after the target begins to conduct, a series impedance of one megohm or more, the back resistance of the switching diode, isolates it from Q1. The negative base current is obtained directly from the −15 volt supply through R4 rather than through the target of the beam switching tube.

Considerable improvement in the target wave form is produced when this network is used as is evidenced by the photograph in Fig. 5. Fig. 5a is a 16 microsecond target output pulse obtained by capacitive coupling to the base of a transistor. Fig. 5b is the next output pulse obtained through the diode switching network in Fig. 4.

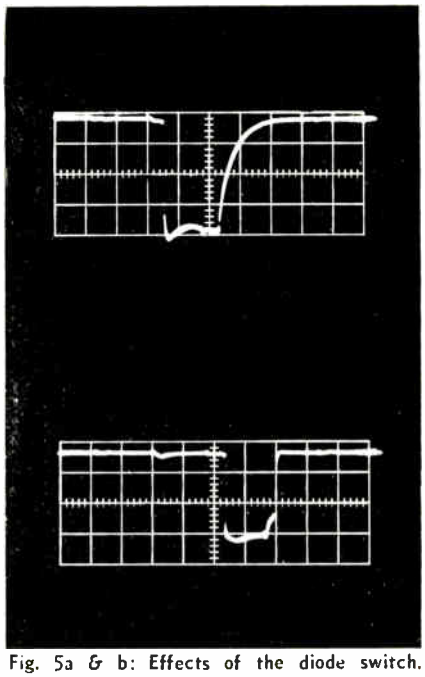


Fig. 5a & b: Effects of the diode switch.

Total Re-Design

TRADITIONALLY, the electronic industry has suffered from sameness-of-product. Buyers of components often have little more choice than buyers of commodities like sand. As a result, competition is on the basis of price or which supplier can provide the most entertainment—a situation detrimental to the entire industry.

"Total re-design" of component parts under the guidance of a competent industrial designer introduces a new competitive factor: Product differentiation. At the same time, it can cut costs, or at least prevent increases, improve function, and create a competitive advantage for the assembler of the end product.

"Total re-design" is more than just a face-lifting. It comes to grips with every aspect of a component, from a psychological as well as a physical standpoint. Like a well-designed finished product, a well-designed component gives the buyer the psychological assurance that it is basically a "correct" assembly of parts or shapes, fulfilling its assigned functions. When it does this, chances are that it can also be produced at less cost.

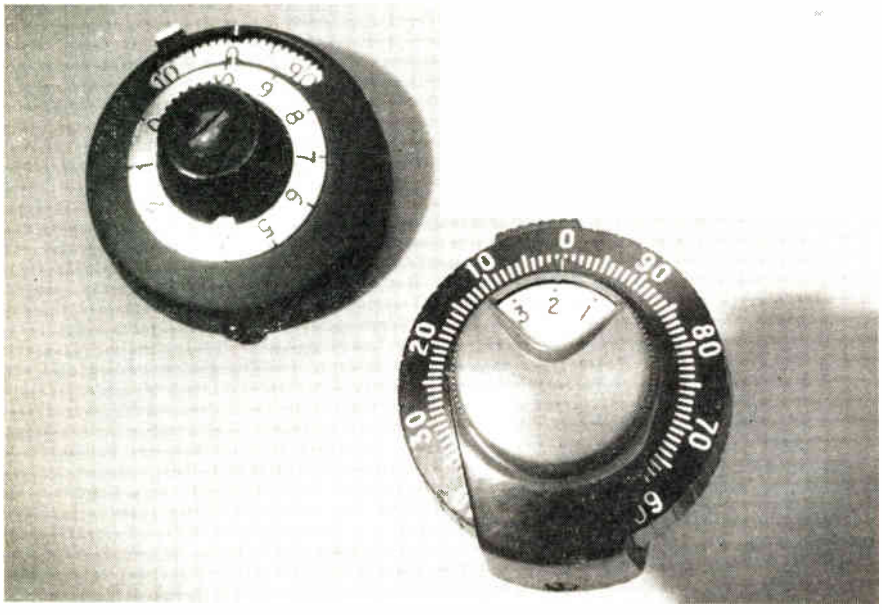
This is best spelled out by the experience of the Borg Equipment Div., Amphenol-Borg Electronics Corp. of Janesville, Wisc. The company makes a line of electronic control dials called Microdials (see illustrations). Faced with mounting costs and competition, the Borg engineers called in an industrial design firm, Palma-Knapp Associates, 412 Thatcher Ave., River Forest, Ill., to help them solve the problem.

The old dials were made of die castings with a drawn metal shroud. Their appearance was cut out of date and increasing costs threatened to force a price increase.

The design firm made drastic

(*Continued on page* 204)

"Microdial," an electronic control dial manufactured by the Borg Equipment Div. of the Amphenol-Borg Corp., Janesville, Wis., underwent this transformation. The old part, above, was replaced by the more saleable one which happens also to be less costly to produce.



Page from an Engineer's Notebook

#56—Amplifier Currents and Stabilization Factors

By **SERGIO BERNSTEIN-BERVERY**
Group Leader, Radar Dept.
General Precision Laboratory Inc.
63 Bedford Road
Pleasantville, New York

THE equations for the general, single stage, configuration of Fig. 1 can be used to derive the equations for the other five possible configurations.

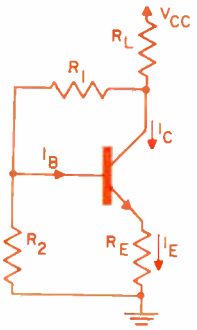
The following engineering approximations are made: $r_b = r_s = 0$ and $r_c = \infty$.

When solving for the currents in the circuit of Fig. 1, V_{be} is the dc base to emitter voltage drop.

The stabilization factor S is the coefficient of the I_{co} term in the expression for I_c, the collector current.

To obtain the expressions for the currents in Fig. 4, let $R_L = 0$ in the first 3 equations of Fig. 1.

Note that since it is assumed that r_c is infinite, the collector current in Figs. 4, 5, and 6, is independent of any collector load resistor. In practice this is true if $R_L \ll r_c\ (1-\alpha)$.



$$I_c = \frac{\alpha R_2 [V_{cc} - V_{bb}] - \alpha [R_L + R_1] V_{bc} + I_{co} [R_E (R_1 + R_2 + R_L) + R_2 (R_L + R_1)}{R_E (R_1 + R_2 + R_L) + R_2 [R_L + (1 - \alpha) R_1]}$$

$$I_B = \frac{V_{cc} R_2 (1 - \alpha) - V_{bc} (1 - \alpha) (R_1 + R_2 + R_L) - I_{co} [R_L R_2 + R_E (R_1 + R_2 + R_L)]}{R_E (R_1 + R_2 + R_L) + R_2 [R_L + (1 - \alpha) R_1]}$$

$$I_E = \frac{V_{cc} R_2 - V_{bc} (R_1 + R_2 + R_L) + I_{co} R_1 R_2}{R_E (R_1 + R_2 + R_L) + R_2 [R_L + (1 - \alpha) R_1]}$$

$$S = \frac{R_E (R_1 + R_2 + R_L) + R_2 (R_L + R_1)}{R_E (R_1 + R_2 + R_L) + R_2 [R_L + (1 - \alpha) R_1]}$$

Figure 1 General Case

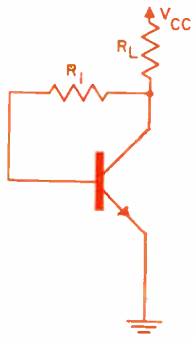
$$I_c = \frac{\alpha (V_{cc} - V_{bc}) + I_{co} (R_1 + R_L + R_E)}{R_E + R_L + R_1 (1 - \alpha)}$$

$$I_B = \frac{(1 - \alpha) (V_{cc} - V_{bc}) - I_{co} (R_L + R_E)}{R_E + R_L + R_1 (1 - \alpha)}$$

$$I_E = \frac{(V_{cc} - V_{bc}) + I_{co} R_1}{R_E + R_L + R_1 (1 - \alpha)}$$

$$S = \frac{R_1 + R_L + R_E}{R_E + R_L + R_1 (1 - \alpha)}$$

Figure 2 $(R_2 = \infty)$



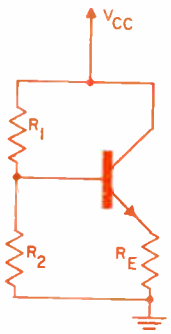
$$I_c = \frac{\alpha (V_{cc} - V_{bc}) + I_{co} (R_1 + R_L)}{R_L + R_1 (1 - \alpha)}$$

$$I_B = \frac{(1 - \alpha) (V_{cc} - V_{bc}) - I_{co} R_L}{R_L + R_1 (1 - \alpha)}$$

$$I_E = \frac{(V_{cc} - V_{bc}) + I_{co} R_1}{R_L + R_1 (1 - \alpha)}$$

$$S = \frac{R_L + R_1}{R_L + R_1 (1 - \alpha)}$$

Figure 3 $(R_2 = \infty, R_E = 0)$



$$I_c = \frac{\alpha R_2 [V_{cc} - V_{bb}] - \alpha R_1 V_{bc} + I_{co} [R_E (R_1 + R_2) + R_1 R_2]}{R_E (R_1 + R_2) + R_1 R_2 (1 - \alpha)}$$

$$I_B = \frac{V_{cc} R_2 (1 - \alpha) - V_{bc} (1 - \alpha) (R_1 + R_2) - I_{co} \cdot R_E (R_1 + R_2)}{R_E (R_1 + R_2) + R_1 R_2 (1 - \alpha)}$$

$$I_L = \frac{V_{cc} R_2 - V_{bc} (R_1 + R_2) + I_{co} \cdot R_1 R_2}{R_E (R_1 + R_2) + R_1 R_2 (1 - \alpha)}$$

$$S = \frac{R_E (R_1 + R_2) + R_1 R_2}{R_E (R_1 + R_2) + R_1 R_2 (1 - \alpha)}$$

Figure 4 $(R_L = 0)$

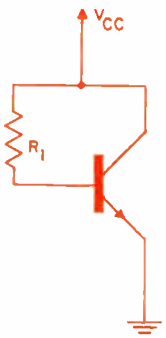
$$I_c = \frac{\alpha [V_{cc} - V_{bc}] + I_{co} [R_E + R_1]}{R_E + R_1 [1 - \alpha]}$$

$$I_B = \frac{(V_{cc} - V_{bc}) (1 - \alpha) - I_{co} R_E}{R_E + R_1 (1 - \alpha)}$$

$$I_E = \frac{(V_{cc} - V_{bc}) + I_{co} R_1}{R_E + R_1 (1 - \alpha)}$$

$$S = \frac{R_E + R_1}{R_E + R_1 (1 - \alpha)}$$

Figure 5 $(R_L = 0, R_2 = \infty)$



$$I_c = \frac{\alpha [V_{cc} - V_{bc}] + I_{co} R_1}{R_1 (1 - \alpha)} = \beta \frac{(V_{cc} - V_{bc})}{R_1} + (\beta + 1) I_{co}$$

$$I_B = \frac{(V_{cc} - V_{bc})}{R_1}$$

$$I_E = \frac{(V_{cc} - V_{bc})}{R_1 (1 - \alpha)} + \frac{I_{co}}{(1 - \alpha)} = \frac{(\beta + 1) (V_{cc} - V_{bc})}{R_1} + (\beta + 1) I_{co}$$

$$S = [\beta + 1]$$

Figure 6 $(R_L = 0, R_2 = \infty, R_E = 0)$

Progressing in a few short decades from an auxiliary design objective, reliability has achieved an importance equalling performance itself. Thousands of reports on components are being compiled. Among these components is the "electrical connector." Its story is told here.

Part One of Two Parts

Connector Problems . . .

Reliability . . .

AS long as equipments used the familiar AN-type connector, there was sufficient detail for the designer to approach reliability with a measure of confidence. Recently, however, the use of printed circuits has become commonplace, together with the concept of modularized equipment for increasing equipment versatility.

Where, in the past, a large system might use dozens of connectors, now, hundreds, or even thousands are required. And, the familiar knuckle-busting threaded collars or levers can no longer be used. Simple plug-in types are required.

One simple and direct approach to the problem has been to eliminate the problem by using all-soldered connections. This is one solution to the problem but it is basically invalid and totally unacceptable in most applications.

Operational Reliability

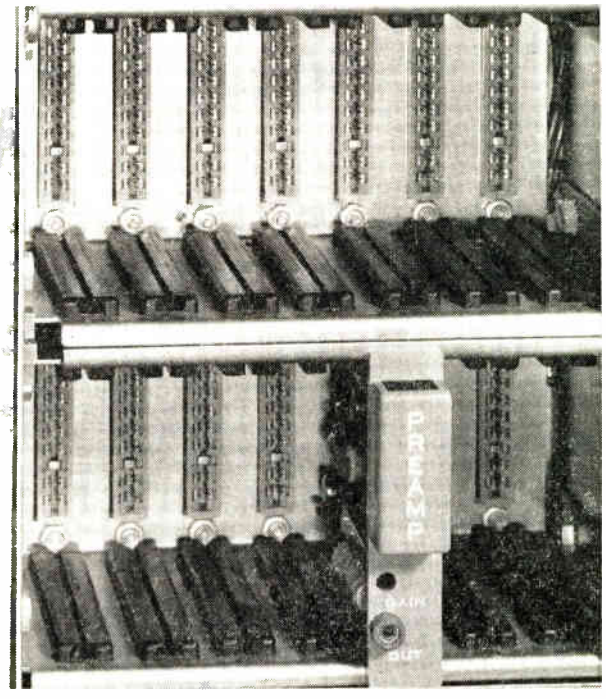
Despite the literally thousands of connector types and sizes available, often there is not an existing model which will meet a particular need. Many designers do not trust plug-in connections of any type. They are suspicious of any sliding or pressure contact, believing that the only truly reliable electrical connections are compounds or combinations of crimping, soldering, welding, etc.

Unfortunately, despite the attention paid to the design of the overall equipment, some down-time and training time for proper maintenance at the using level is mandatory.

Actually, no matter how reliable the type of joint between two conductors may be, some maintenance to the component or module level in high density equipment will be needed to minimize down-time and maintenance costs. In fact, where plug-in connectors are properly applied, the modular system of electronic packaging not only systemizes the basic design and the end product, but provides the necessary flexibility in assembly and manufacture which will improve reliability. The system also provides lower prime costs when extreme flexibility is required of one basic design. With the throw-away concept, the connector is still a necessary evil.

The proper use of plugs and connectors can greatly enhance the maintainability—and hence, the overall operational reliability—of electronic equipment. Obviously, by their mere presence, plugs and connectors do detract statistically from the absolute reliability of any equipment. But, a substantial gain is realized

A typical application of printed circuit connectors is this special housing, at the rear of the transport on the Ampex FR-600. Up to 14 preamplifiers may be plugged in, and held in place by a bar.



By D. R. SHERIFF
Senior Engineer
Ampex Data Products Co.
Box 5000, Redwood City, Calif.

and Printed Circuit Connectors

operationally through the use of connect-disconnect devices reflected in increased savings in maintenance man-hours and the higher in-commission rates. These savings represent a material gain comparable only to that which can be obtained from a great reduction of failure rates of connect-disconnect devices. Thus, the slight contribution of the connector to a lowering of the absolute reliability is more than offset by the improvement in operational reliability.

Fault Analysis

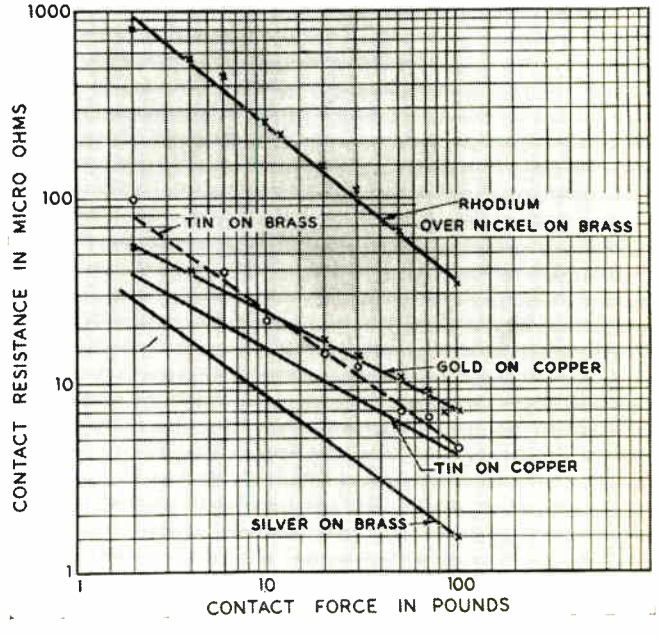
Reliable connector failure data indicate that 20% of all connector failures are caused by moisture. The survey also indicated that approximately 50% of the connector failures were caused by loose pins, breakage, bent pins, broken wires—the type of damage attributable primarily to mechanical abuse for the following reasons:

1. Careless mating of the plug and connector causing bent pins;
2. Deforming connectors that project from the equipment;
3. Snagging or stepping on cables that lead from connectors, causing wire breakage at the connector; and
4. Wire embrittlement due to improper soldering where crimp type snap-in contacts are not used.

Therefore, it may be concluded that most failures cannot be predicted because of variations in operational environments. Consequently, when connectors are properly protected and applied, they can be very reliable. In an assembly of many complex circuit functions, individual subassemblies are often interconnected with printed wire connectors operating in a form similar to rack and panel connectors. That is, they operate in a partially-protected environment and with proper guiding.

Considerable data have been taken on the failure rates of connectors and other components. Table 1 is taken from the studies of Rabbin and shows that connectors for pin-sockets are among the most reliable components used. This is also substantiated by the Stanford Research Institute. In fact, connectors are more reliable than the soldered connections with which so many designers wish to replace them. If used intelligently and within the limits of a satisfactory environment, the connector will improve the over-all reliability of the system. It should be noted that the data cited were obtained for pin-socket types of connectors, and that 50% of the total failures were caused by loose, broken, or bent pins, broken leads, and other

Fig. 1: Contact resistance vs force for various plated materials.



Connector Reliability

(Continued)

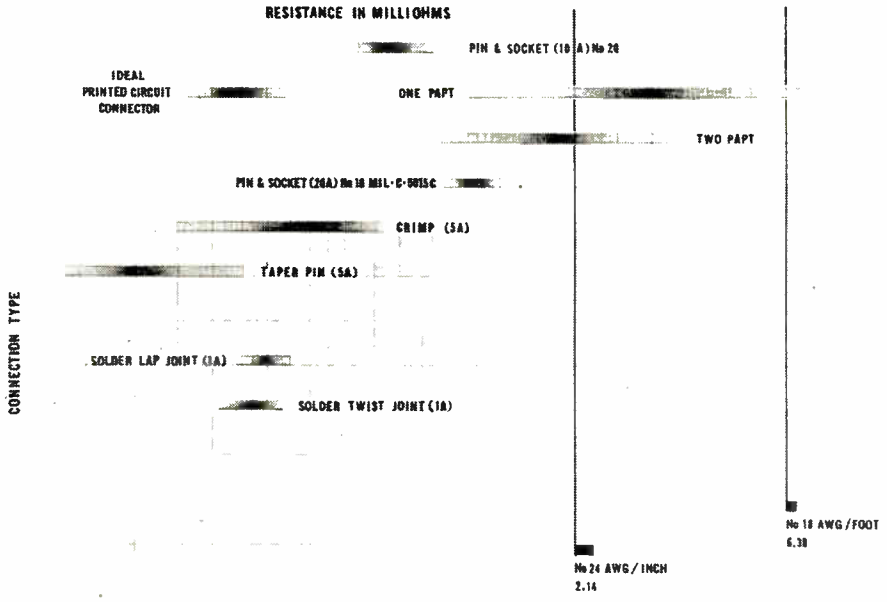


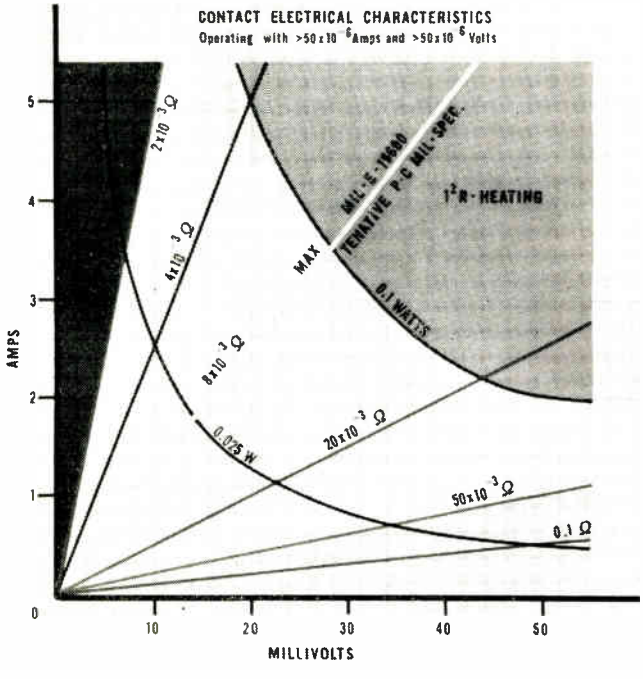
Fig. 2: The dc resistance of various means of joining conductors. Though some connectors have greater contact resistance than the soldered connections, other types approach the "ideal" printed circuit connector.

types of damage caused primarily by mechanical abuse. The printed circuit connectors, which do not have pinsocket arrangement, can have even greater reliability.

Printed Wire Connector Design

To enable the full potential reliability to be obtained from a connector, certain design criteria must be established. I have selected nine essential factors which I believe to be of paramount interest to the designer who must select a particular connector. There are others, and it is possible that certain specialized applications could make these criteria less important with reference to others.

Fig. 3: Conversion of contact resistance to millivolts/unit current.



Continuous Electrical Conductivity

Any connector should provide continuous electrical conductivity. This factor appears to be quite obvious, but is frequently compromised in connector design. Contact between the conducting surface irregularities of the printed board and the conducting surface irregularities of the connector must be provided. This requirement dictates some form of sliding contact. The wiping action will abrade and remove oxidation-reduction products and other bulk contaminents which form on the surfaces. However, a good thing can be carried too far. A slight sliding action is required, not an abrading action which will remove substantial amounts of the surfaces. This latter consideration is of particular importance with printed circuit boards when very thin foils of copper are used.

Force, properly applied, can enable this effect of continuous conductivity to be achieved. Fig. 1 shows typical relationships between contact electrical resistance and force for various plated materials. The relationship between force and electrical resistance is linear, and inversely proportional. Recent contact resistance measurement made by Ittner and Magill show that contact area can be expressed in terms of force applied and effective plastic yield pressure. The contact area, in square centimeters, for plastic yielding is given by $A = L/P_c$, where L = load in grams, P_c = effective yield pressure of metal or film. Therefore, the contact force should be as high as possible and relatively soft noble metals are advantageous.

Low and Stable Contact Resistance

Unfortunately, connectors add some resistance to the circuit, and the designer needs a connector with a very law, and stable contact resistance. The factor of continuous conductivity previously mentioned is related to contact resistance. The better the "contact," the lower the resistance. Contact resistance is the summation of specific resistance of the contact mate-

rial, the constriction resistance or area of conduction at the interface between the two effectively unsmooth surfaces, and the coherer resistance which varies with surface film thickness and metallic bridge characteristics after electrical breakdown.

Considerable misconception exists on the subject of contact resistance. Many engineers believe that the resistance of a soldered connection is essentially zero, particularly when compared to a connector. It is common knowledge that the contact resistance is directly related to the conductivity of the contact material, and is inversely proportional to the area of contact with normal pressure.

It is important not to confuse the normal spring or clamping pressure with the insertion force which is not easily related to the normal pressure, but is influenced by forces resulting from shear, adhesion, deformation, and other friction phenomena. The actual area of contact is quite small compared to the apparent area of contact, and consists of the junctions of the summits of the surface irregularities. The area of contact will differ in random pairs of the same contact design, thereby also contributing to the randomness of the contact resistance. The absolute value of contact resistance is generally not an important criterion in itself.

Of greater importance is the stability of the resistance with respect to various environments and circuit parameters. Obviously, greater efforts must be devoted toward establishing a more favorable surface condition between contacts. In addition, the contact materials must be selected to minimize parasitic voltages and resistance variations caused by thermal conjunctive effects. No loose metallic particles should be permitted to prevent triboelectric effects.

Fig. 2 shows data obtained on the dc resistance of various means of joining conductors. The dc resistance of 1-ft and 1-in. long segments of standard sizes of wire used in typical cables and harnesses is included for reference. It is true that some connectors introduce contact resistance in an order of magnitude greater than soldered connections; except some types approach the "ideal," too. However, even the simplest circuit has many times more soldered connections than connectors. Each capacitor, for example, represents four soldered, welded, or pressure connections—two internal and two external.

The ideal connector will approach the taper pin connection (limited to five operations) in contact resistance, and will essentially maintain that resistance over a wide range of environmental conditions.*

Characteristics of Materials

The materials used for the contact surfaces can, and do, affect virtually every property of the connector. The temperature effect of the materials is very important. In view of insulation, when ac and dc voltages are encountered, the sum of the peak ac and dc voltages must not exceed the value determined as a safe working dc voltage.

The dc working voltage is usually stated for sea-level conditions with normal humidity, temperature, dust, etc. Unless otherwise stated, the rating for current is usually in ambient or bulk air temperature of 25°C, and is often determined at the point of 30°C contact temperature rise.

The heat generated at the contact is proportional to I^2R and the heat generated causes the contact temperature to rise, which in turn increases the resistance heat generated, starting a heating cycle. If the correct contact materials have been selected, an equilibrium temperature is attained which is within the safe operating range of the contact materials and insulating block or housing.

Another possibility is that the vicious cycle will continue until the eventual temperature will distort the contact or insulating block or cause both to fail. Very few manufacturers' catalogs provide information on how the contacts were rated, such as the 30°C temperature rise. Proper application should analyze all questionable or marginal areas. This analysis is particularly important with respect to proximity effects caused by thermal environment and grouping of high-current contacts. The problems associated with low currents and low voltages (dry circuits) may be, and usually are, more severe and are less easily detected and understood than those previously mentioned.

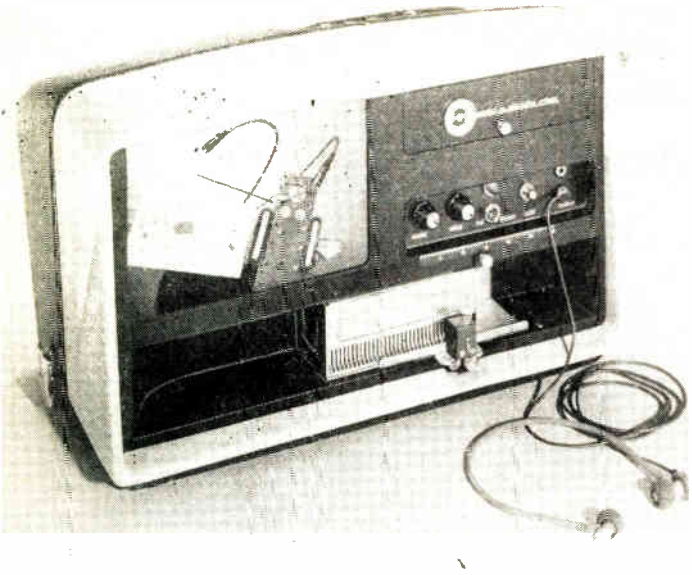
(*Continued Next Month*)

* Many sources in the literature quote contact resistance in terms of millivolts per unit current. Fig. 3 is a simple Ohm's law conversion, including the resistance specified in Specifications MIL-E-19600 and Tentative Printed Wiring Connector.

Table I — Comparison of Failure Rates of Connectors and Other Components

Component	Population density ratio	Quantity per system	Failure rate per 1,000,000 hr	System failure rate 1,000,000 hr	Failure rate %
Tubes, transistors	1	100	1	100	2.71
Connectors	1.01	101	0.8	80.8	2.2
Diodes	1.1	110	4.5	495	13.4
Gyros	0.01	1	50	50	1.35
Inductors	0.02	2	2	4	0.1
Motors	0.03	3	50	150	4.06
Potentiometers	0.26	26	40	1040	28.25
Relays	0.15	15	25	375	10.23
Resistors (fixed)	4.4	440	1.4	616	16.76
Switches	0.11	11	10	110	2.9
Transformers	0.09	9	10	90	2.44
Choppers	0.01	1	5	5	0.13
Printed circuit boards	0.2	20	1	20	0.54
Soldered connections	10	1000	0.4	400	10.84
Capacitors	1.8	180	0.84	151.2	4.09
				Total 3687.0	

What's New . . .



Audio-visual unit contains both a 35mm slide projector and a synchronized sound tape playback mechanism.

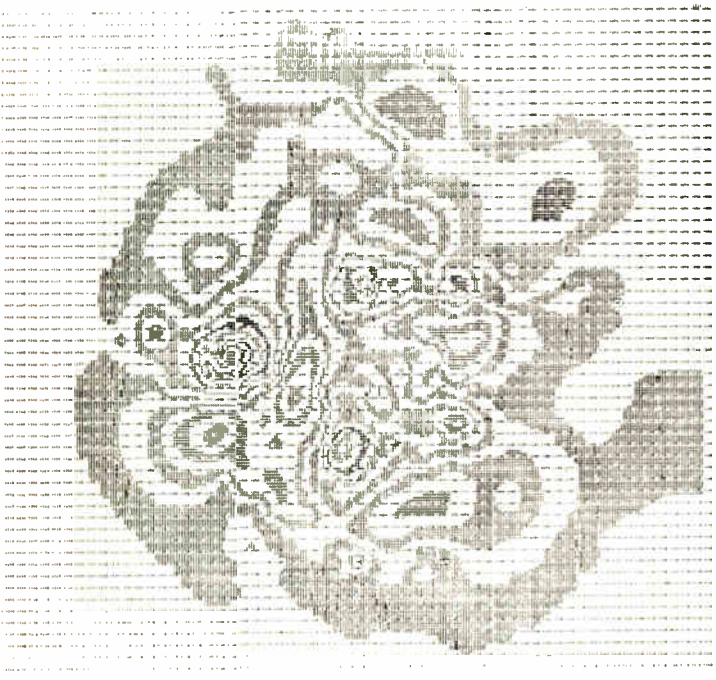
Audio-Visual Manufacturing

TO solve production problems in the manufacture of complex products and systems, a unique audio-visual manufacturing system has been developed. This new production method can be applied to both limited and volume production operations.

The skill of the trained engineer or production specialist can be captured on synchronized color slides and tape recordings. Translated into step-by-step production assembly instructions, this know-how can be passed on to every production line worker through the use of audio-visual equipment, mounted directly on each assembly work station.

Weather . . . By the Numbers

HIGH-SPEED magnetic-tape units and an all-transistorized digital computer have been teamed by the United States Navy at Monterey, Calif., to provide advanced weather information to fleet and other operational weather officers. The new system is being used by the Navy Numerical Weather Problems Group (NANWEP), recently established by the Navy.



Atmospheric weather map shows how data looks in graphical form. Map comes out of high-speed printer in 14 in. wide strips, three strips per map.

Mission of the new Group includes devising new and improved techniques for such things as weather and oceanographic forecasting for sub-surface, surface and air operations, sea, ice and amphibious problems, providing least-time routes for ships and aircraft, and determining the sea and atmospheric effects on electromagnetic wave propagation and sonar performance.

Since over 5,000 weather stations will be reporting to NANWEP, a major goal in establishing their data-reduction center was to minimize the time between observational report and analysis. Because progress in numerical prediction is very closely bound to computing equipment speed, this meant procurement of a system that would assure extremely high transfer rates between the computer and its peripheral equipment.

Bypassing much slower techniques previously used for weather prediction, NANWEP selected Control Data Corp.'s new 1604 computer which uses Ampex digital tape handlers to insure a highly reliable transfer of data.

Some 4,000 stations report surface weather by teletype. Another 1,000 stations include a balloon report (from balloons released and

The system was developed by Applied Communication Systems, 8535 Warner Drive, Culver City, Calif.

Resembling a portable TV set, the device displays a 5½ in. x 8 in. colored picture on a plexiglass screen and simultaneously instructs the worker through a new magnetic tape mechanism. The dual combination enables the worker to see and to hear each step of the assembly process simultaneously as he carries out the assembly operation. The resultant increase in productivity substantially reduces production costs.

The audio-visual equipment itself is simply an enabling device. It serves to focus complex technical information from product and industrial engineering, and to translate this information into easily understood audio-visual assembly instructions.

The system also eliminates the need for blueprints, assembly drawings and schematics on the production line. Defect rates, as well as employee training time, are thus markedly reduced.

The work station is designed not only for maximum efficiency, but also for the optimum worker's morale.

The work station, designed on the basis of careful micro-motion studies, organizes the operator's work space in the most efficient manner possible. The "total work environment" of the audio-visual system and the work station enables the operator to obtain his optimum efficiency from the system, thus insuring high productivity. The worker can control the devices at all times.

* * *

Nucleus of the new weather system is the Control Data Corp.'s 1604 computer. Ampex tape units which provide the system's high transfer rates are shown in the background.

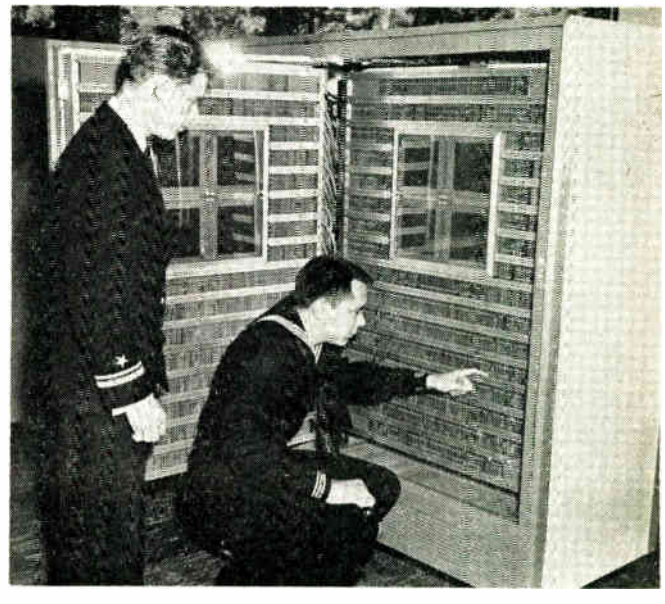
Magnetic Tape Units

Four tape transports are used with the system. This permits NANWEP to have one tape unit writing while another is reading information — and the remaining two are rewinding. All four tape units are contained in a single cabinet, with a set of cables connecting the system to an input channel, an output channel, and a function channel of the computer. Forward, reverse, and rewind speed is 150 inches per second. Recording density is 200 characters per inch— thus, the character transfer rate is 30,000 characters per second. Another bank of four tape units will be integrated into the system in the near future to increase the system's flexibility.

Six tracks of information and a parity track are recorded on ½-inch-wide Mylar (du Pont-manufactured plastic) magnetic tape. Reels, 10½ inches in diameter, store 2,400 feet of tape. The usefulness of this medium is dramatically illustrated by the fact that one reel can store 1,900 hemispheric weather maps.

ascending to a height of 100,000 feet). These combined observations on temperature, pressure, humidity, and wind velocity help to complete the picture of the atmosphere.

Essentially what is desired from the raw weather data are *height and temperature values* (specific conditions at 500, 850, and 1,000 millibars) at a regular network of points over the area to be analyzed. These must be determined and stored in the computer's memory before the machine can execute the mathematical instructions needed to begin its forecast.



Navy personnel discuss one of the printed circuit cards of the CDC 1604 computer. Sections of the magnetic core memory can be seen in the center of each chassis.

Comparison photos show (left) "portholing," darkness in peripheral areas, when standard 5820 camera tube was used and (right) sharp reduction in this problem with the new field mesh image orthicon. Note also the reduction of edge-effect at the fingers and collar.

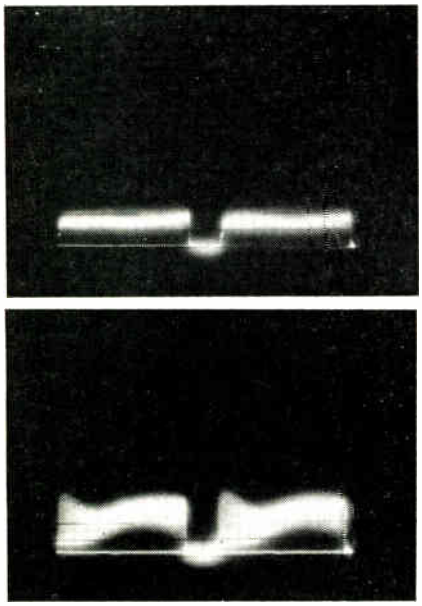
"Portholing" Cure

A FIELD mesh in the scanning section of a new image orthicon is responsible for curing "portholing" and "edge-effect." The electrical effect of the field mesh is to improve beam landing by creating a more uniform electric field in back of the target. This minimizes landing and shading errors, reduces geometric distortion, and provides sharper transition from black to white without spurious effect.

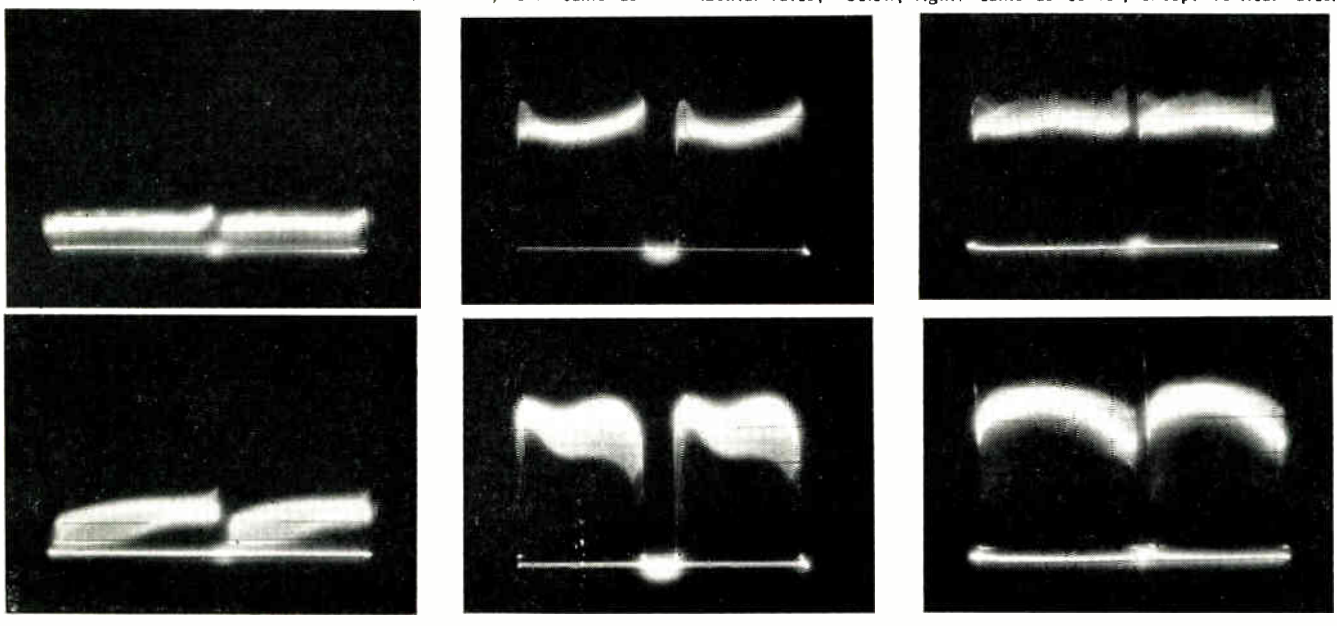
Corner resolution in the monitor presentation is nearly as sharp as at the center of the picture. The overall effect is a more realistic reproduction of the scene being televised.

The features of the new tube make it easier for television directors and camera crews to set up a picture, because fewer adjustments of camera controls are needed for optimum performance.

The GL-7293, introduced by G.E.'s Power Tube Dept., is interchangeable, electrically and physically, with the 5820, but differs slightly in construction and operation. Like the 5820, the new tube is designed primarily for studio use, and for outdoor pickup where light levels are adequate.



In these photos, the video wave form patterns of the new tube are on top, 5820 on bottom: (above) shading patterns in response to the same uniform black scene, horizontal rates; (below, left) same as above, except vertical rates; (below, center) a comparison of the landing patterns in response to the same uniform white scene, horizontal rates; (below, right) same as center, except vertical rates.



By PHILIP I. HERSHBERG
Project Engineer
Air Force Research Div.
Bedford, Massachusetts

For Computer Design . . .

Storing With Thin Films

The so-called fast, ferrite core storage unit has actually been the limiting factor in computer speed. All other central computer circuits are capable of operating at least ten times as fast. A memory using thin film techniques is presented which offers high potential.

UNTIL recently computer design has been limited to clock periods of no more than 200 KC. This is the speed of the central computer storage unit. Such units usually consist of ferrite core planes or aperatured plates.

Although the trap flux cryotron shows promise of providing a solution to the problem, the equipment needed for the required super-cooled environment has limited its use. For about five years, engineers have sought a reliable, economic means of fast storage. Recently, refinements in thin film technique have permitted clock periods of one-tenth, or even one-hundredth, the previous limit.

Before Thin Films

The common fast storage unit has consisted of ferrite magnetic core planes. Their production has been time consuming; their testing, difficult. The fastest cycles available with these units have been about 6 microseconds[1]. Since all other circuitry in the central computer units have been capable of rates ten times this figure, it is apparent that the fast storage unit limited the speed.

Attempts to increase the speed of fast storage units have been: delay lines[2], electrostatic systems[3], ferroelectric cells, capacitor storage, and various other means. All have had serious disadvantages. Inertia storage[4], though very fast (0.2 microsecond period), lacked the necessary high speed write feature. As a result, a faster storage device was required.

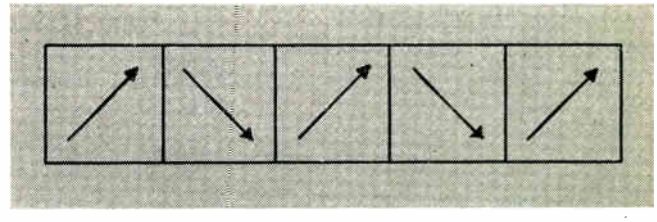


Fig. 1: A possible domain configuration of a magnetic material.

Why Are Magnetic Cores Slow?

To answer this question, we must look at one of the basic properties of a ferromagnetic material, the domain. Fig. 1 shows a sample of magnetic material, divided into domains. The residual magnetization, B, varies from domain to domain. The possible configuration of Fig. 1 results from minimum energy considerations at each point within the material, as discussed at great length by Kittel[5]. Note that Fig. 1 is only one of a large number of possible domain arrangements, quite a few of which have been photographed.

The same minimum energy considerations also account for the residual magnetization in ferromagnetic cores. Fig. 2a shows a core "set" by a current, I, in the winding, with the total residual magnetization indicated by the arrow. Fig. 2b gives a more detailed examination of a possible domain arrange-

ment within the core, only a small portion of which is shown. The total residual magnetization of Fig. 2a is the vector sum of the incremental domain components of Fig. 2b. In Fig. 2c, we begin to supply a current, $-I$, in the winding. The innermost domains reverse their magnetization first, followed later by the outermost domains; this accounts for the two magnetization vectors of Fig. 2c.

If we place another winding, called a "sense" winding, on a typical core and look at the voltage as a function of the driving current, $-I$, the plot of Fig. 3c will result. Fig. 3b shows the driving current, $-I$, as applied at the indicated winding and with the indicated residual magnetization. The plot of Fig. 3c is the voltage as seen at the sense winding and may be computed as follows:

$$V = N\, d\theta/dt = N\,(A\, dB/dt) \qquad (1)$$

The unshaded part of this voltage is the contribution of the irreversible domain boundary motion. This process consists of applying a field, H, to the core, permitting the domains to change their magnetization through a wave effect; the resultant magnetization remaining upon removal of the field.

To begin, this process requires a certain finite magnetic field, and consequent current. However, the shaded area of Fig. 3c is the result of temporary domain boundary motion, in which case the resulting magnetization does not remain upon removal of the magnetic field, and consequent current. This temporary motion can take place even in the presence of very small fields.

The sum of these two contributions is shown in Fig. 3c. Increasing the magnitude of the field decreases the time lag for complete magnetization reversal. However, due to the relatively slow process of domain wall motion, the fastest switching times

Table 1

Property	Ferrite Cores	Thin Magnetic Films
Bistable	Yes	Yes
Speed of coincident current switch	1 μsec.	3–10 mμsec.
Drive Power	800 ma into 50Ω (tube drive)	400 ma into 5Ω (transistor drive)
Repetition rate before adverse heating	500 KC.	At least 5 MC., probably much higher
Physical Size	1/16 in. diam.	1/16 in. diam.
Temperature range of operation.	Up to 50°C.	Should be higher
Reliability	100%	Should be comparable
Number in a system	2½ million	Unknown
Economy of fabrication	Expensive (about 5¢/bit)	Potentially cheap.

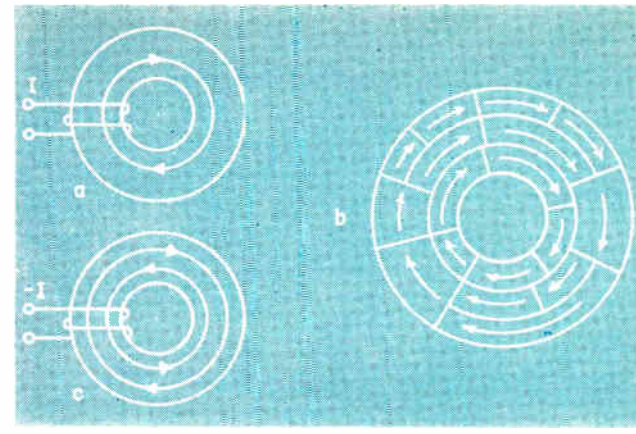


Fig. 2: Domain direction and configuration is explained in text.

produced in ferrite storage cores has been about 0.5 microsecond. This is, then, the reason for classifying magnetic cores as slow switching devices, although improved techniques may produce far better results than those mentioned above.

Thin Film Theory

Thin films use a means of magnetization reversal requiring an even greater magnetic field, H, than permanent domain boundary displacement. This magnetization reversal mechanism is called "spin" rotation—changing of the orbital momentum of individual electrons—and can take place in one-tenth or even one-hundredth the time required for domain boundary motion.

Although the magnetic storage core can be "set" into two different states of high residual magnetization, the mechanism for achieving this magnetization can, in actual practice, never provide faster switching times than were available through the relatively slow process of domain wall motion.

Consequently, three scientists at the Armour Research Foundation[6] decided to try using a thin film of ferromagnetic material. The problem with such a device was that there were not two different states of high residual magnetization, as was the case with cores; rather, there were an infinite number of different magnetic states. The problem was then to obtain a mechanism for forming two stable states of magnetization within the film. This was first done by Blois[7], who applied a dc magnetic field to a permalloy film as it was being formed on a glass slide. This process gave the permalloy film a preferred direction (axis) of magnetization, related to the direction of the applied dc field.

Upon the application of a dc magnetic field in a direction opposite to that of the original field, the direction of magnetization reversed into that direction opposite to the preferred axis. Moreover, relatively small fields could perform the reversal in measured time intervals as low as 20 millimicroseconds[8].

Conger[9] proved that the mechanism of magnetization reversal was one of spin rotation, which was found to be an impossible means of magnetization reversal in ferromagnetic cores. As a result of this means of magnetization reversal, thin films are

potentially capable of far more than are cores. Table 1 was compiled by Smith[10] and compares these two storage devices.

A Thin Film Memory

A thin film memory has been built by the M.I.T. Lincoln Laboratory as a control unit for its TX-2 computer. A plane of 16 x 16 storage bits, composed of 83-17 permalloy is evaporated onto ultrasonically cleaned 7 mil glass. For selection of the proper bit, No. 32 wire is run in horizontal and vertical grooves in the glass, to which it is firmly attached. An effective drive current of 150 ma. through two turns will switch the storage bit. As the voltage produced at the sense winding for a "one" output is only about one millivolt, extremely sensitive read amplifiers are required.

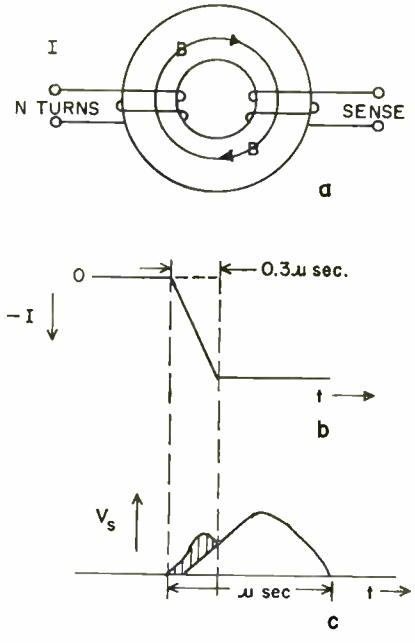


Fig. 3: Flux change in a magnetic core: the voltage curve in (c) may be readily computed from Eq. 1.

The Lincoln Laboratory memory is composed of two 16x16 bit storage planes. Problems encountered in the design of this equipment are discussed by Raffel[11]. However, as of now, the use of thin films in digital computers has been only partially investigated. Much remains to be done in applying this powerful tool to computing machinery of the future.

Acknowledgments

The author is indebted to Professor Richard Barker of Yale University for introducing him to the subject of non-linear magnetics. Also, he wishes to thank D. O. Smith and J. I. Raffel of the M. I. T. Lincoln Laboratory for providing him with much valuable information.

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Watchmaking and the Relay

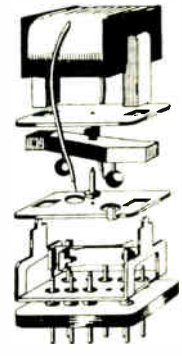
IN Switzerland there is not the same government sponsored research in electronics as in America and so most new developments come from individual concerns. Recently, one such firm designed an interesting new relay.

The primary objective of the designers was to have a high performance relay at low cost. This was obtained in two ways. First is the original type of design, and second is the use of the Swiss watchmaking industry. Most of the fine precision parts are sub-contracted out to watch parts manufacturers who are set up to make similar items at very low cost.

Construction of this double-pole, double-throw, rotating armature, sealed relay is unusual. The contact assembly is first welded to the multi-pin base. Spring tension is then adjusted once and for all. The rotating armature assembly follows and, finally, the coil and core. For applications where severe vibration is not expected, the armature and bobbin assemblies are not welded in position but are retained by pressure from the hermetically sealed case.

Presently, because the materials used (primarily the organic wire insulation in the coil) were not chosen with military specifications in mind, the relay will not pass the temperature requirements. However, by changing materials and making a few modifications the manufacturers feel they could submit a relay which would meet specs.

Assembly and adjustment could be carried out entirely automatically—though even with the present, partially automatic, assembly, manufacturing costs are well below those for more conventional relays. Dimensions are 1 x 1 x ½ in. approx. and the contacts are rated for 115 vac (resistive load). A life of 200,000 operations at rated load of 2 a is claimed.



Exploded view of the precision Swiss-made relay. Most of the fine parts are made by watch parts firms.

Any U. S. firms or individuals which might be interested in the relay for commercial purposes should contact: European Technical Coverage, Inc., 10 Rue Grenus, Geneva, Switzerland.

This is the seventh in a planned series of editorial features on Radio Frequency Interference arranged for by the editors of ELECTRONIC INDUSTRIES

By H. M. SACHS
Supervisor
and J. J. KRSTANSKY
Armour Research Foundation
Illinois Institute of Tech.
10 W. 35th St.
Chicago 16, Ill.

Controlling RFI Susceptibility in Receivers

With good basic design it is usually possible to produce receivers that have low susceptibility to undesired signals. Some of the factors to consider in the receiver's design are sensitivity, selectivity, spurious responses, intermodulation, and cross-modulation as well as standard shielding considerations.

THE general study of electromagnetic interference to communications-electronics equipment can be subdivided into three steps. The first is concerned with the generation of the undesired signals, the second with the mode of transfer of the undesired energy to the susceptible device, and the third with equipment susceptibility via the several possible paths of entry into the susceptible device. It is this last step with which this article will be concerned. Specifically, communications and radar receivers will be considered as the susceptible devices.

An undesired signal may enter a receiver by way of: (1) the antenna, (2) the power and control leads, (3) the output leads, and (4) case penetration. Since the antenna terminals are generally the most sensitive part of the receiver, antenna conducted signals will be most likely to affect its performance. It should be mentioned in passing that the directional qualities and sensitivity of the antenna as a function of frequency are an important factor in determining the level of the undesired signals that ultimately appear at the antenna terminals of the receiver.

The major receiver characteristics that influence its interference rejection capabilities include its sensitivity, selectivity, spurious response characteristic, desensitization, and intermodulation and cross-modulation characteristics. Some of these design parameters are relatively easy to measure and require straightforward measurement techniques. Other measurements are relatively tedious to perform if significant results are to be obtained. They are subject to variations which are unpredictable unless detailed information regarding the non-linearities which contribute to the variations is available. In general, the frequencies at which interference will occur are relatively easy to predict and measure. The amplitudes of the interference are much more difficult to predict and measure, because of the system non-linearities involved.

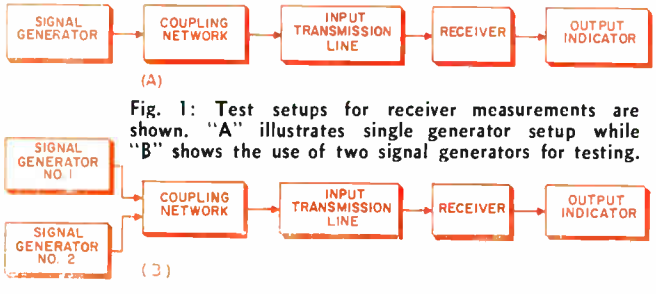


Fig. 1: Test setups for receiver measurements are shown. "A" illustrates single generator setup while "B" shows the use of two signal generators for testing.

A few general remarks can be made concerning receiver measurement philosophy. For the purposes of interference testing, the receiver may be considered as a "black box" having one or more sets of input and output terminals. Measurements are made at these terminals, and the results are used to describe the receiver performance. The parameters which are most conveniently measured at these terminals are generally the frequencies and power levels of the signals involved. In general, an input level or levels necessary to produce a specified reference level at the output of the receiver is recorded. Standard IRE type tests, using the specified dummy antennas at the input to the receiver are, in a large number of cases, satisfactory from the interference analysis viewpoint. Where IRE type tests are not applicable, input levels are based on signal generators having a 50 ohm internal impedance and signal levels are recorded in dbm available power at the signal generator output.

Due to the wide range of frequencies necessarily

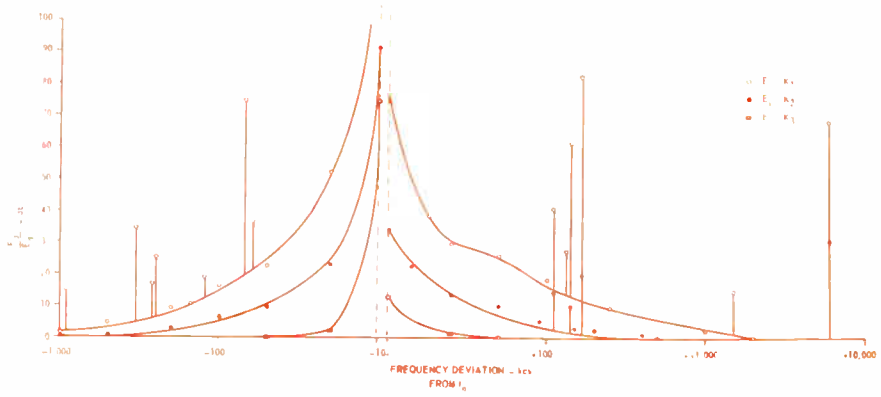


Fig. 2: AM receiver true selectivity curve

covered in testing for spurious responses and intermodulation, out-of-band analysis of the receivers is frequently involved. In the case of equipments that employ coaxial cable inputs, no particularly troublesome problems are encountered in this regard. However, when radar receivers or other waveguide systems are tested at frequencies much above their design band, multimode propagation in the transmission lines associated with these receivers becomes possible. Under these circumstances, the measurement problem becomes extremely complex and entails special measurement techniques and instrumentation. In addition, broad-band devices that also have low capability of higher order mode generation must be used to couple test equipment to the receiver to allow operation over the reasonably large ranges of frequencies involved.

The majority of receiver measurements can be made with either a single-signal generator test setup or a two-signal generator test setup. These test arrangements are shown in Fig. 1. Single signal generator tests are generally used for sensitivity, selectivity and spurious response measurements, while two signal generators are used in intermodulation, cross modulation, desensitization and some forms of selectivity tests.

Sensitivity & Selectivity

The "sensitivity" of a receiver is a measure of its ability to receive weak signals. This test is relatively easy to make, and need not be discussed in detail here. It is simply a measure of the input signal level at the receiver tuned frequency necessary to produce a reference output level, and is usually expressed in microvolts or available power (usually in db below 1 mw or dbm) at the antenna terminals.

The "selectivity" of a receiver is a measure of its ability to select the signal to which it is tuned, and reject all signals at other frequencies. Selectivity is usually shown as a curve of input signal level necessary to produce a reference output as a function of frequency off-resonance from the test frequency. Alternatively, it may be expressed as the receiver response as a function of input frequency. The most obvious property of the selectivity curve is its indication of the increase in signal level required of an off-frequency signal to produce the same receiver output level as an on-frequency signal.

Although the process of measuring a selectivity curve of a receiver is fairly straight-forward, some care must be taken in the selection of suitable modulation for the input signal. In the case of FM receivers, a two-signal generator test setup must be used, with one signal generator representing the desired signal and the other an interference signal. Details of these tests are described in the reference literature.

In dealing with a pulsed system, such as a radar, a special concept of the selectivity curve must be considered. If a pulsed signal is used to obtain a selectivity curve in the normal manner, the resulting curve will be dependent upon the spectrum of the pulsed signal as well as the receiver response. Such a curve is called a "Spectrum-Selectivity" curve. If the input signal spectrum is appreciably broader that the receiver bandwidth (much narrower pulse width than $\frac{1}{BW}$) this selectivity curve will be much broader than the conventional receiver selectivity curve and will, in most cases, have approximately the same shape as the envelope of the pulse spectrum.

If the response of a pulsed radar receiver to a CW signal is known (normal selectivity curve), its response to a pulsed signal of any arbitrary width can be analytically determined. In some receivers, a straightforward CW response can easily be obtained, in others, AGC effects preclude the use of a CW test signal. In these cases the test is performed with a wide pulse modulation on the test signal (narrow spectrum). The width of the pulse is a compromise between minimum AGC voltage variation (narrow pulse) vs. minimum spectrum width (wide pulse). A possible alternative method is to replace the AGC bias with a fixed bias during the test.

Another concept associated with receiver selectivity is known as the "true selectivity" curve[2] and denotes the special evaluation of a receiver which may have to deal with two signals simultaneously. The "true selectivity" curve embodies the effects of spurious responses, cross modulation, desensitization and breakthrough and therefore is representative of the selectivity of the receiver in the presence of interference. An example of typical results[2] of a true selectivity test on a receiver is shown in Fig. 2. A curve of this type is obtained with the two-signal generator method. A desired signal is placed in the passband while the other signal is scanned through the range of frequencies of interest. The effect of the undesired signal upon the desired signal is evaluated for various levels of undesired signal.

A selectivity curve of the type just discussed essentially reveals the "close in" selectivity which is

0.179" I.D
0.646" O.D
INSULATORS
0.352" I.D
1.271" O.D.

Receiver RFI *(Continued)*

Desensitization

Desensitization is the effect of an undesired signal in the passband of the receiver. It causes reduction of the desired signal level. The gain reduction is generally due to overload of some portion of the receiver, resulting in desired signal suppression because the receiver will no longer respond to incremental input voltages. The degree of desensitization experienced depends upon the dynamic range (linearity) and overload characteristics of the receiver. If the receiver has good linearity, the ratio of the signal-to-noise ratio in db, to an increase in undesired signal to db, is approximately 1 to 1.

In the case of pulse receivers, the sensitivity reduction due to a strong CW signal is on the order of 2 or 3 db if overloading is avoided. When intensity- modulated displays are used in radar receivers, video overload can occur in the presence of CW signals due to the limiting used with this type of display to prevent defocussing on strong signals. Use of a high-pass filter between the second detector and the video system to eliminate the dc component, due to the CW signal, precludes the possibility of video overload.

I-F amplifier saturation can also result because of a strong CW signal. If the amplifier is inadequately shielded and decoupled, i-f oscillations may result. The most significant test of radar receiver stability and saturation effects in the presence of CW interference is a plot of the sensitivity of the receiver as a function of on-frequency CW interference power. A stable receiver will exhibit relatively little reduction of sensitivity with increase in interference power up to a point where the receiver noise is no longer visible on the radar scope. Above this point, the curve displays a linear relationship between the interference power and sensitivity. The slope of the curve is such that for a one db increase in interference power, the sensitivity of the receiver is decreased one db. Any erratic departure from this linearity indicates an unstable receiver. An example of typical results of this type of test on a radar receiver is shown in Fig. 10.

Power & Control Leads

In addition to antenna conducted interference, other means of signal entry into a receiver are common. Because of the possibility of direct connection to many interference sources, the power leads can be a likely source of interference. The source of interference energy is usually coupled directly to the line. However, inductive or capacitive coupling of an interference source to the power line may exist in many cases. Control leads, although usually not directly connected to an interference source, are susceptible to these latter types of coupling. If the control lead is a long, high-impedance line carrying a low level signal, the susceptibility to interference is intensified. Antenna lead-ins are often susceptible in a similar manner. Plantz and Simms[7] discussed a case where a sense antenna lead-in to a radio compass picked up interference from a large bundle of electrical wiring into which it was laced for a distance of 8 to 10 feet.

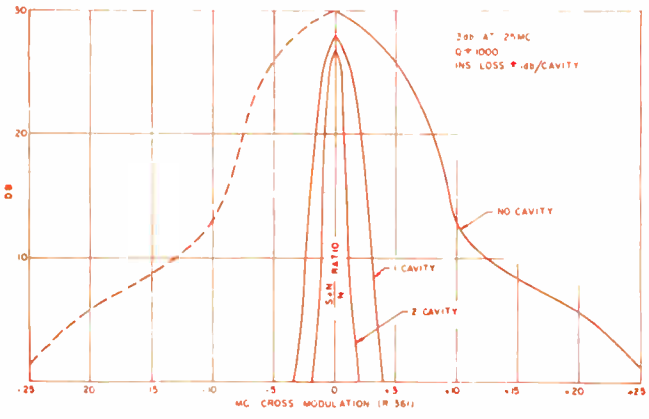
Power lead susceptibility tests on receivers have been found to produce interference effects at the r-f and i-f frequencies since these are the most sensitive ranges of the receiver. In the case of receivers with more than one local oscillator, it is not unusual to find more spurious responses due to interaction between the second oscillator and signals coming in on power and control leads than can be obtained through antenna conducted interference. Power and control lead susceptibility is by no means limited to r-f and i-f frequencies. Wade and Swanson[8] have reported interference to an automatic tuning system of a receiver-transmitter unit due to audio signals on the 28 v. supply line. The most common methods employed to suppress interference currents of these types are the introduction of a high impedance into the path of the interfering currents or by shunting them to ground through a low impedance. Bypass capacitors and filters are commonly employed to accomplish this task.

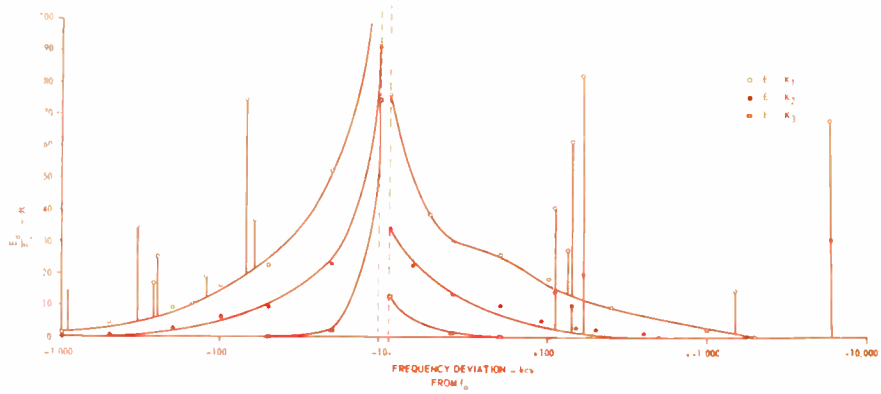
Although output leads generally carry a high level signal, they can also provide transmission paths for an interference signal in much the same manner as a control lead. Either the receiver, the remote indicator, or actuator can be interfered with under these conditions. Wolfe and Pnewski[9] reported a case of leads running to an indicator unit of a countermeasures receiving system being susceptible to radiated fields from a UHF transmitter. Interference to radar warning receivers was found by Collie[10] in a B-58 aircraft due to broadband interference induced in interconnecting harnesses between preamplifiers and the amplifier indicators.

In some instances where the sensitivity and directional qualities of the antenna attenuate the antenna conducted signal to a high degree, the attenuation of a signal passing through the case may be far less than for the antenna conducted signal. The shielding effectiveness of common case materials is generally very low for magnetic fields (low impedance fields) which are generated by small loop currents or loop antennas and therefore most receivers are very susceptible to low impedance fields.

In addition, the joints and/or holes in the case provide an easy point of entry for undesired signals at the higher frequencies. If the hole is an appreciable fraction of the interference wavelength, the shield will be violated. Screening material or waveguide-beyond-cutoff construction techniques can be utilized for large holes to maintain shielding integrity.

Fig. 9: Graph of cross-modulation vs. frequency separation





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Receiver RFI
(Continued)

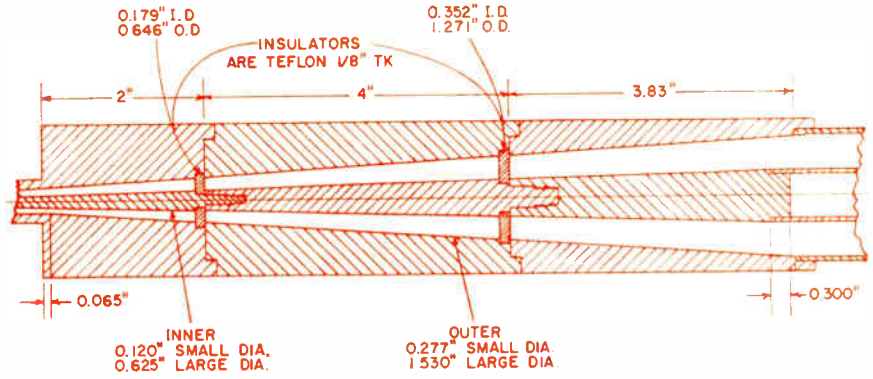


Fig. 3: Sketch shows a tapered transition cross-section for coupling a type N coax to a rigid coaxial guide

primarily determined by the i-f response and the wide band selectivity. This is primarily determined by the preselector stages of the receiver.

Spurious Responses

When an r-f voltage is applied to the antenna terminals of a receiver and varied over a wide range of frequencies, a large number of receiver responses may be noted. In a superhetrodyne receiver, these responses are ordinarily classified as the image response, i-f feedthrough response, spurious linear responses and spurious non-linear responses. The spurious non-linear responses require the presence of two r-f signals at the antenna terminals.

I-f feedthrough response is generally the result of r-f signals at the i-f frequency which are capacitively coupled through the r-f stages and enter the i-f amplifier directly. For example, radars employing 60 MC i-f strips could be susceptible to interference from strong emitters in the 50-70 MC band, such as commercial TV stations. Traps installed in the antenna input circuit and tuned to the receiver i-f frequency are generally employed to improve the i-f rejection capabilities.

Image response is a special case of the general category of spurious linear responses which are a result of product generation in a mixer. The results of mixing two signals in a mixer can be predicted from the equation:

$$f_r = \frac{Pf_{l.o.} \pm f_{i.f.}}{Q} \qquad (1)$$

where: P and Q are integers

f_r = the response

$f_{l.o.}$ = the local oscillator frequency

$f_{i.f.}$ = the intermediate frequency

For the case of the local oscillator tuned above the desired frequency, the fundamental response is that frequency for which $P = Q = 1$ and the sign is minus in this equation. The image response occurs at that frequency for which $P = Q = 1$ and the sign is plus. Image rejection is commonly achieved by the use of preselectors. A ratio of 60 db or greater is desirable in a good receiver.

Other spurious responses are possible at frequencies for which either P or Q both take on values other than unity. The frequencies of all of these responses can be predicted from the mixing equation stated previously. The responses are due to harmonics of the local oscillator beating with the incoming signal to produce the i-f frequency (i.e., $P = 2,3,4, \ldots, Q = 1$), and receiver-generated harmonics of the local oscillator (i.e., $P = 2,3,4, \ldots, Q = 2,3,4, \ldots$). The latter responses are generally strongest in a receiver when the values of P and Q are equal and low in value. These responses are readily identifiable, since they occur close to the fundamental frequency and are commonly called "close in" responses. They are clustered around the local oscillator frequency and occur at frequencies identified by:

$$f_r = f_{l.o.} \pm \frac{f_{i.f.}}{Q} \qquad (2)$$

where: ($Q = 2,3,4, \ldots$) notes: $P = Q$.

It will be noted that a solution of the mixer equation for values of P and Q from 1 through 30 will result in 1800 responses. Measured responses for input signals of 0 dbm or less at the antenna terminals of a particular radar receiver averaged about 16 responses per receiver tuned frequency. Considerably more responses can be calculated than measured because of preselection factors, crystal harmonic generation factors, and local oscillator harmonic generation. Considerably more responses could have been measured if larger interfering voltages were available.

A computer program which considers some of the factors just mentioned was used to calculate spurious responses for a R-388/URR receiver tuned to 20 MC.[2] Less than 5% omissions were noted when the computed and measured responses were compared, half of which were due not to spurious responses, but to stray resonance effects. Twenty percent of the predicted responses could not be measured because they were below the measurement threshold due to pessimistic weighting of the computation.

While the foregoing formulas can be used to predict quite accurately at what frequencies responses will occur, the prediction of the levels of the spurious responses is quite another matter. Any computation of estimated levels of spurious responses must necessarily be limited to order of magnitude ranges for the following reasons:

(1) The amplitude of a given spurious response is often strongly dependent upon the amplitudes of the harmonics in the mixer which, in turn, are dependent in some way on the amplitude of the applied signal and the order of the harmonic. The relationship between these effects can be arrived at experimentally, however, individual harmonics may differ widely from this form.

(2) The level of the signal reaching the mixer is a function of the selectivity of the circuits preceding the mixer, and the insertion and reflection losses therein. These parameters may vary over wide ranges with changes in receiver tuned frequency. As a result it may be impractical to attempt to predict or measure these parameters for a large number of receiver tuned frequencies. An estimate of the level of signal reach-

ing the mixer may at best be an approximation based on sampled experimental data.

(3) Stray resonances in the r-f stages or preselectors, especially at the higher frequencies, may account for variations between measured and predicted response levels.

(4) Leakage around the preselectors into the mixer may tend to reinforce or cancel the normal signal, resulting in variations in response levels. The nature of this leakage as a function of frequency may be difficult to predict.

(5) Predicted levels may be modified by AVC and grid rectification effects.

(6) Set to set variations, due to variations in wiring, parts placement, leakage paths, etc., may cause deviations from predicted values.

Other responses are possible in receivers having more than one mixer. Generally the effects of later mixers have been found to be relatively minor, however, the effects of signals from other local oscillators entering the first mixer are more serious. If leakage, of later oscillators into the first mixer is suspected as the cause of a spurious response, the source may be identified by coupling another receiver tuned to the first intermediate frequency to the output of the first mixer. If the response is not observed in the second receiver, it is the result of a response in a later mixer. If the response is present, the other oscillators are disabled one at a time until the response is no longer observed. In some cases, leakage of the incoming signal into the second or third mixer may cause a spurious response. This type of response may be located by disabling preceding local oscillators. It should be noted that this procedure may alter the leakage characteristics in some cases.

Occasionally receivers use two oscillators to produce the local oscillator frequency by mixing action. In this case, it is possible that both oscillator frequencies and/or their harmonics may be present at the mixer in addition to the desired local oscillator frequency. If this leakage effect is suspected, an external signal should be substituted for the local oscillator signal to check the leakage. Care should be taken to minimize changes in leakage paths under these conditions.

Another condition under which interference is occasionally encountered is when the harmonics of the intermediate frequency at the 2nd detector are coupled back into the r-f stages. This type of feedback may cause instability or annoying hetrodynes when the incoming signal is near the harmonics of the i-f frequency.

In review, spurious responses are generally due to the following causes:

1. An emitter operating on the intermediate frequency of the receiver.
2. An emitter operating on the image frequency of the receiver.
3. A combination of other signals or harmonics with harmonics of the local oscillator.
4. Intermediate frequency harmonic feedback.

Type 1 interference can be reduced by adequate preselection and care in shielding and decoupling to minimize leakage paths around the preselector stages.

Type 2 interference can be reduced by adequate preselection (high image ratio).

Type 3 interference has been described in detail and its causes are the result of a complicated interaction of preselection, mixer non-linearities, local oscillator harmonics, leakage, etc. Good preselection, shielding, decoupling, local oscillator harmonic reduction and optimum operation of the mixer all contribute to minimizing spurious responses due to these factors.

Type 4 interference can be minimized by adequate shielding of the mixer stages and r-f decoupling in the AVC and a-f circuits.

After the foregoing precautions have been taken in the design of a receiver it is still necessary to evaluate the interference susceptibility of the receiver to its electronic environment. An example of the spurious response test techniques applied to a radar receiver will be described.

Fig. 4: With these power loss curves, the limits of the power loss can be determined for a given set of VSWR's

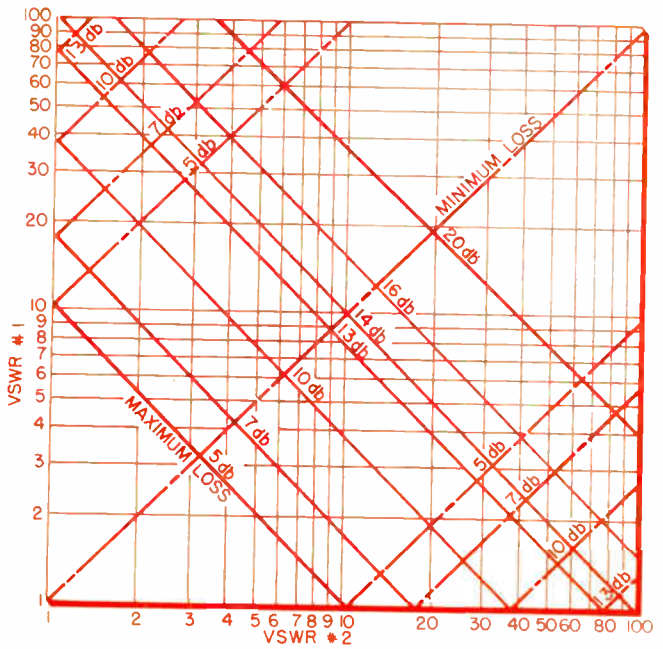
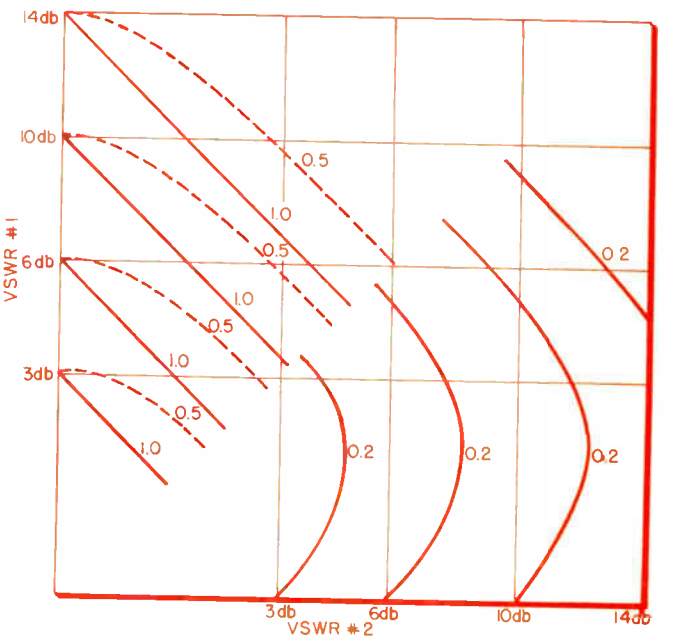


Fig. 5: Probability contours for specified losses are shown. Only half of each curve is given for clarity (curves are symmetrical)



Receiver RFI *(Continued)*

Test Techniques

In general, the signal generators used in spurious response tests have outputs terminated in type N coaxial connectors. The input to the radar receiver is generally by means of coaxial or rectangular waveguide. Coupling of the signal generator to the receiver must be accomplished through a transition which introduces minimum reflections (losses) and generates minimum higher order modes over the frequency range of interest. Such a transition for coupling from type N coax to 1⅝ inch rigid coaxial guide over the range of 900 to 11,000 MC is shown in Fig. 3.[21] The transition had a maximum VSWR of 1.2 over the frequency range of interest.

In testing for spurious responses, the signal generator is coupled to the radar receiver via the transition. The signal generator is modulated with the nominal radar pulse width and is synchronized to the radar repetition rate. Visual observation of the radar scopes is used to determine the presence of an output indication. The standard reference is minimum visible signal.

The signal generator is first tuned to the receiver tuned frequency and all controls are adjusted for maximum response. The normal receiver sensitivity is then measured by adjusting the output of the signal generator to produce a minimum visible signal on the radar scope. The reading of the output attenuator of the signal generator is then recorded. This is the available power from the signal generator. The signal generator is next tuned to the image and adjusted to produce minimum visible signal. The available power from the generator to produce the image minimum visible signal is compared with the sensitivity at the fundamental (receiver tuned frequency) to determine the image ratio. The signal generator(s) is next slowly tuned through the range of interest with maximum power output. Each time a response is noted, the available power necessary to produce a minimum visible signal is recorded. The frequency of each noted response is then compared to the predicted responses from the mixer equation to determine the cause.

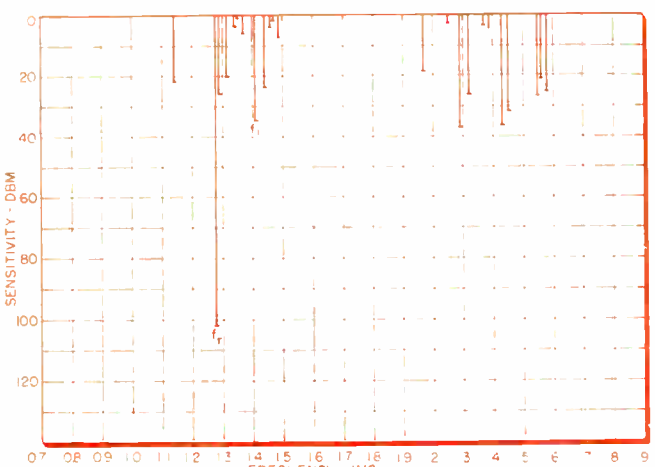
With the available power and frequency of each spurious response known, the next step is to determine the mismatch loss between the signal generator and the receiver for each spurious response. This mismatch loss is due to the mismatch between the signal generator output and the receiver input. Assuming that all of the components connecting from the signal generator to the receiver input are well matched to the 50 ohm coaxial system, the mismatch loss can be determined by measurement of the receiver input VSWR at the spurious response frequency. Knowing the input VSWR, the mismatch loss can be determined from Fig. 4. Assuming the VSWR of the source is 1.0, the loss can be determined from the ordinate corresponding to a source VSWR of 1. For example, assume the measured VSWR of the receiver input were 8.0, referring to Fig. 4, at the ordinate corresponding to a source VSWR of 1 and a load VSWR of 8, the power loss is 4.0 db. The power loss determined in this manner is then subtracted from the available power to give the true receiver sensitivity at the given spurious response frequency.

One more operation is needed to complete the spurious response analysis. Generally it is desired to know the signal power at the "antenna terminals" necessary to produce a response at the receiver output. In the case of radar receivers, the antenna and receiver are joined by some arbitrary length of transmission line. If a portion of this transmission line is arbitrarily considered as part of the receiver, the power loss through the junction of these two transmission lines can be computed exactly if the input impedance of both is known in amplitude and phase.

Ordinarily, it is more likely that the mismatch will be expressed in VSWR. In this case, the limits of the power loss can be determined and estimates of the probability of specified losses can be made[3] Referring to Fig. 4, the limits of power loss can be determined for a given set of VSWR's, the lines with positive slope represent the maximum limit and the lines with negative slope represent the minimum limit. For example, consider VSWR's of 2 for the source (antennas) and 5 for the load (receiver), the maximum loss (Fig. 4) would be 4.8 db. and the minimum loss would be 0.8 db. Probability contours are shown in Fig. 5[3] for probability of loss being less than certain specified values. Since the curves are symmetrical, only one half of each curve is shown for the sake of clarity. From these curves, the probability of the mismatch loss being less than the specified value can be determined.

It should be noted that the method of determining spurious response levels described above will give the probability that a given level of signal at the "antenna terminals" will produce a reference output at the receiver. In addition, the method assumes propagation in the transmission line in only the dominant mode. Application of the technique to conditions of multi-mode propagation is currently under study. A typical example of spurious response measurements on a radar receiver is shown in Fig. 6.

Fig. 6: Example of radar receiver spurious response measurements



Receiver Intermodulation

Receiver intermodulation interference can occur whenever two or more undesired signals enter a receiving system. The intermodulation signals are also the result of such system nonlinearities as the r-f

amplifier characteristic curve or the mixer response, and are actually a more general representation of spurious response signals. It can be shown by means of a Taylor Series expansion of the nonlinearity that undesired frequencies may be generated at

$$f_i = mf_a \pm nf_b \pm pf_c \pm \cdots \quad (3)$$

where f_a, f_b, f_c, etc., represent the receiver input signals, and m, n, p, etc., are positive integers.

With the exception of receiving equipment with extremely wide front ends, the most serious of the intermodulation products is the third order effect. These are the spurious signals arising from the cubic term in the Power Series expansion. The major offender in this group (in the case of two undesired signals) is the product

$$f_3 = 2f_a - f_b \quad (4)$$

where f_a is that frequency closer to the receiver tuned frequency. The amplitude of this intermodulation product signal (E_3) is related to the amplitudes of signals at frequencies f_a and f_b (E_a and E_b) by

$$E_3 = kE_a^2 E_b \quad (5)$$

The next most troublesome intermodulation signal is generally a fifth order product

$$f_5 = 3f_a - 2f_b \quad (6)$$

with an amplitude relationship given by

$$E_5 = h^1 E_a^3 E_b^2 \quad (7)$$

It should be pointed out that all even-order intermodulation products as well as many of the odd-order

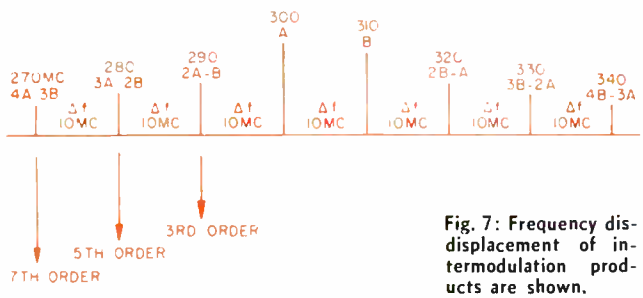


Fig. 7: Frequency displacement of intermodulation products are shown.

signals frequently do not deteriorate receiver performance, because one or more of the interfering signals is always far from the receiver tuned frequency, and is thus attenuated appreciably before reaching the nonlinear device.

Fig. 7 illustrates the spacing of typical intermodulation products.[4] As an example of the levels involved, tests on UHF receivers with a group of frequencies separated from 2 to 18 MC. resulted in the measurement of $2f_a - f_b$ levels 70 to 86 db below the desired carrier.

The most straight-forward approach to the reduction of intermodulation interference might be by the assignment of compatible frequencies to the communication links that could be instrumental in generating such interference. It is immediately obvious, however, that for many practical situations, this can result in a prodigious, and perhaps impossible, task.

At the receiver design level, the reduction of certain circuit nonlinearities have resulted in improved performance with regard to intermodulation effects. Linear mixers (product mixing), or variable-mu tubes with inherently low third-order curvature, have been employed. Improved receiver preselection characteristics is another obvious but effective approach.

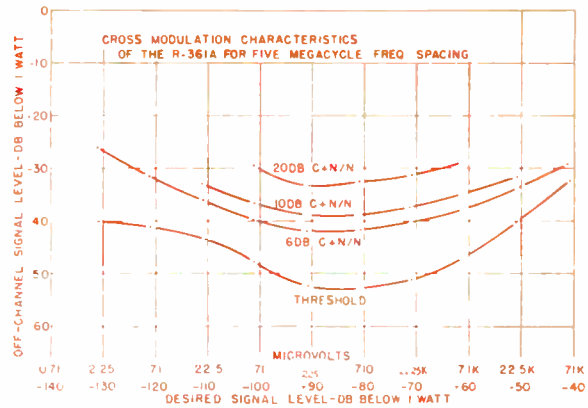


Fig. 8: Typical cross-modulation characteristics of a UHF receiver

An improvement of 6 to 8db in intermodulation rejection on an R-361A/GR receiver was recently obtained by the use of a pre-receiver attenuator as a means for achieving more linear system operation. The attenuator was a coaxial ferrite structure whose insertion loss was controlled by the receiver AVC voltage.[5]

Passive nonlinear effects can also result in the generation of intermodulation products. Tests on a UHF antenna multicoupler, for example,[6] have indicated $f_a - f_b$ and $2f_a - f_b$ products existed in the unit at levels of -140 db to -110 db below the desired signal, and $3f_a - f_b$ products at -160 db for equal energy signals. The primary mechanism of generation in this case appeared to be the nonlinearities created by the metal-to-metal pressure contacts in the r-f connectors in the multicoupler.

Cross-modulation results from the interaction between one or more undesired AM-modulated signals with the signal to which the receiver is tuned. It is an amplitude-modulation phenomena, and therefore does not occur in FM systems. It is essentially a special case of third-order intermodulation, since it arises as a result of the third-order input circuit non-linearity of the receiver. It is characterized by existing only when the desired carrier is being received.

Cross-modulation is that type of interference generally encountered when several equipments must be operated in close proximity to one another. It is most severe at high desired and undesired signal levels, and when the receiver input stage is operating near cutoff.

Fig. 8 shows typical cross-modulation characteristics of a UHF receiver.[4] This plot is for a 5 MC separation between the desired and undesired signals, and illustrates the variation of effective receiver sensitivity as a function of the desired and undesired signal levels. The level of cross-modulation reduces with increased frequency separation, other parameters remaining constant.

The same remedial approaches must be employed in the reduction of cross-modulation, as it used to reduce intermodulation effects. The results of tests performed by Collins Radio for Rome Air Development Center, for example, indicate that cavities ahead of an R-361 receiver are very effective in this regard. Fig. 9 is a graph of cross-modulation vs. frequency separation, and give an idea of the improvement that might be expected using preselection.

Desensitization

Desensitization is the effect of an undesired signal in the passband of the receiver. It causes reduction of the desired signal level. The gain reduction is generally due to overload of some portion of the receiver, resulting in desired signal suppression because the receiver will no longer respond to incremental input voltages. The degree of desensitization experienced depends upon the dynamic range (linearity) and overload characteristics of the receiver. If the receiver has good linearity, the ratio of the signal-to-noise ratio in db, to an increase in undesired signal to db, is approximately 1 to 1.

In the case of pulse receivers, the sensitivity reduction due to a strong CW signal is on the order of 2 or 3 db if overloading is avoided. When intensity- modulated displays are used in radar receivers, video overload can occur in the presence of CW signals due to the limiting used with this type of display to prevent defocussing on strong signals. Use of a high-pass filter between the second detector and the video system to eliminate the dc component, due to the CW signal, precludes the possibility of video overload.

I-F amplifier saturation can also result because of a strong CW signal. If the amplifier is inadequately shielded and decoupled, i-f oscillations may result. The most significant test of radar receiver stability and saturation effects in the presence of CW interference is a plot of the sensitivity of the receiver as a function of on-frequency CW interference power. A stable receiver will exhibit relatively little reduction of sensitivity with increase in interference power up to a point where the receiver noise is no longer visible on the radar scope. Above this point, the curve displays a linear relationship between the interference power and sensitivity. The slope of the curve is such that for a one db increase in interference power, the sensitivity of the receiver is decreased one db. Any erratic departure from this linearity indicates an unstable receiver. An example of typical results of this type of test on a radar receiver is shown in Fig. 10.

Power & Control Leads

In addition to antenna conducted interference, other means of signal entry into a receiver are common. Because of the possibility of direct connection to many interference sources, the power leads can be a likely source of interference. The source of interference energy is usually coupled directly to the line. However, inductive or capacitive coupling of an interference source to the power line may exist in many cases. Control leads, although usually not directly connected to an interference source, are susceptible to these latter types of coupling. If the control lead is a long, high-impedance line carrying a low level signal, the susceptibility to interference is intensified. Antenna lead-ins are often susceptible in a similar manner. Plantz and Simms[7] discussed a case where a sense antenna lead-in to a radio compass picked up interference from a large bundle of electrical wiring into which it was laced for a distance of 8 to 10 feet.

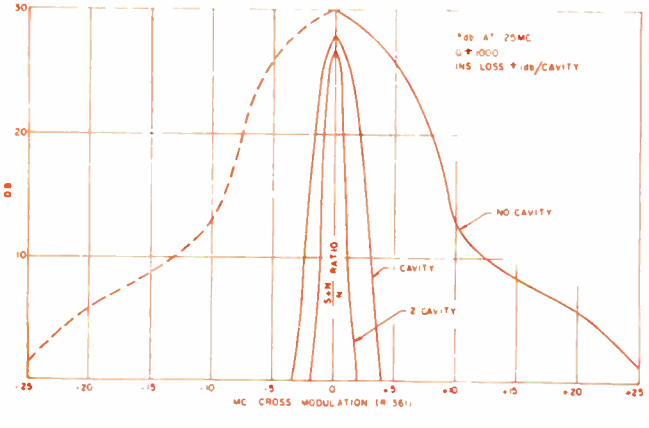
Power lead susceptibility tests on receivers have been found to produce interference effects at the r-f and i-f frequencies since these are the most sensitive ranges of the receiver. In the case of receivers with more than one local oscillator, it is not unusual to find more spurious responses due to interaction between the second oscillator and signals coming in on power and control leads than can be obtained through antenna conducted interference. Power and control lead susceptibility is by no means limited to r-f and i-f frequencies. Wade and Swanson[8] have reported interference to an automatic tuning system of a receiver-transmitter unit due to audio signals on the 28 v. supply line. The most common methods employed to suppress interference currents of these types are the introduction of a high impedance into the path of the interfering currents or by shunting them to ground through a low impedance. Bypass capacitors and filters are commonly employed to accomplish this task.

Although output leads generally carry a high level signal, they can also provide transmission paths for an interference signal in much the same manner as a control lead. Either the receiver, the remote indicator, or actuator can be interfered with under these conditions. Wolfe and Pnewski[9] reported a case of leads running to an indicator unit of a countermeasures receiving system being susceptible to radiated fields from a UHF transmitter. Interference to radar warning receivers was found by Collie[10] in a B-58 aircraft due to broadband interference induced in interconnecting harnesses between preamplifiers and the amplifier indicators.

In some instances where the sensitivity and directional qualities of the antenna attenuate the antenna conducted signal to a high degree, the attenuation of a signal passing through the case may be far less than for the antenna conducted signal. The shielding effectiveness of common case materials is generally very low for magnetic fields (low impedance fields) which are generated by small loop currents or loop antennas and therefore most receivers are very susceptible to low impedance fields.

In addition, the joints and/or holes in the case provide an easy point of entry for undesired signals at the higher frequencies. If the hole is an appreciable fraction of the interference wavelength, the shield will be violated. Screening material or waveguide-beyond-cutoff construction techniques can be utilized for large holes to maintain shielding integrity.

Fig. 9: Graph of cross-modulation vs. frequency separation



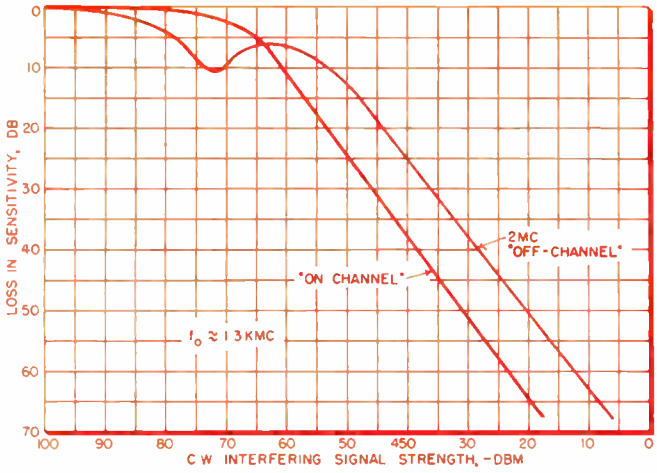


Fig. 10: The most significant test of radar receiver stability and saturation effects in the presence of CW interference is a plot of the sensitivity as a function of on-frequency CW interference

Measurements, General

A word about precautions to be observed when making receiver evaluation measurements is considered germane to the subject of this article. Due to the wide range of frequencies involved in measurements of this type, certain precautions must be taken which are normally taken-for-granted for in-band, on-frequency type measurements.

Signal generators used in interference tests must have accurately calibrated output attenuators, low case leakage, low harmonic content, uniform spectrum characteristics, and constant known output impedance. Precautions to be taken in wide-band tests include:

1. Low pass filters are recommended, especially when testing below the receiver tuned frequency where a signal generator harmonic may fall in the pass-band of the receiver.

2. Cable losses, especially at the higher frequencies should be accounted for.

3. Mismatch losses when the generator is working into other than a matched load should be considered. Attenuator calibrations are in terms of available power and considerable error can accrue from mismatch effects.

4. Isolation of the generator from the load is desirable. Attenuators, couplers and ferrite isolators can be utilized for this purpose.

5. Transitions from signal generator output to receiver input (such as in radar receivers having waveguide inputs vs. signal generators having type "N" outputs) must be broad-band and lossless over the range of interest.

6. When testing radar receivers, the propagation of higher order modes becomes a contending factor in test results. It is important to reduce the possibility of exciting higher order modes in cables, adapters and measuring equipment associated with the test setup. Data interpretation must be based on cognizance of the presence of the higher order modes.

In summary of what has been said, good basic design of a receiver with attention to interference reduction includes: adequate r-f shielding and decoupling, good preselection characteristics, optimum mixer bias conditions, and low local oscillator harmonic content to reduce spurious and intermodulation responses, adequate dynamic range to provide good overload characteristic, and use of AGC circuity to prevent i-f saturation effects.

In addition to the above receiver characteristics, attention should be paid to bandwidth control. The bandwidth of the receiver, in general, should be no greater than necessary to perform its intended function. The use of unnecessary receiver bandwith increases the possibility of co-channel interference.

Although not strictly a part of receiver design, techniques such as pulse synchronization, sector blanking, PRF discrimination and time sharing can be used to alleviate interference difficulties in congested installations.

E. R. Davis[10] has cited 45 cases of the more common sources of interference found aboard vessels of the U. S. Navy, the effects and causes of the interference as well as remedial measures used were tabulated. In the instances of corrective measures being applied to the receivers, the remedial techniques includes separation of antennas, installation of the line filters, shielding of antenna and other receiver leads and bonding of cases, cables, and leads.

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Page from an Engineer's Notebook

#57 — Bandwidth-Risetime Nomographs

By SAMUEL DERMAN

Pupin Cyclotron Laboratory
Columbia University
New York, New York

THESE nomographs give the upper 3 db frequency and pulse rise time response of a parallel R-C circuit. They also determine the bandwidth of a tuned parallel R-L-C circuit.

The equivalent circuit of an uncompensated video amplifier may be represented as in Fig. 1. A constant current generator[1] feeds a parallel R-C combination. C consists of the inevitable stray output capacitance plus any capacity deliberately added to the circuit. R represents the amplifier's output and load resistance.

The output voltage, e_o, of such an arrangement decreases with increasing frequency, approaching zero at infinite frequency. At a point where the capacitive reactance is equal to R the output voltage has dropped 3 db from its value at dc.

Since

$$R = \frac{1}{2\pi f_2 C} \qquad (1)$$

$$f_2 = \frac{1}{2\pi RC} \qquad (2)$$

In video work, f_2 is known as the 3 db frequency or upper bandwidth limit.

If a current step is applied to such a circuit, the rise time of the output pulse is given by:[2]

$$\text{Rise time} = \frac{0.35}{f_2}$$

where f_2 is the 3 db frequency.

By shunting R and C with an inductor L, the circuit of Fig. 1 becomes the equivalent circuit of a tuned amplifier, Fig. 2, such as the i-f stages of a receiver. The bandwidth of such a circuit is exactly the same as the upper 3 db frequency of the video amplifier,

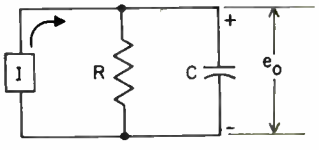
$$BW = \frac{1}{2\pi RC}$$

and is independent of L.

The first nomogram is a plot of BW (or f_2) *vs.* R and C. Knowing any two of the variables, the third may be quickly read from the plot. The second nomogram plots rise time as a function of R and C.

1. For a pentode amplifier, $I = g_m e_g$ where e_g is the signal voltage between grid and cathode. For a grounded emitter amplifier, $I = \beta I_b$ where I_b is the base signal current.
2. For derivation of this expression, see *Pulse and Digital Circuits* by J. Millman and H. Taub, McGraw-Hill Book Co., New York, 1956, page 41.

Fig. 1 (below): The equivalent circuit of an uncompensated video amplifier



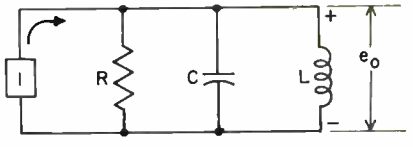
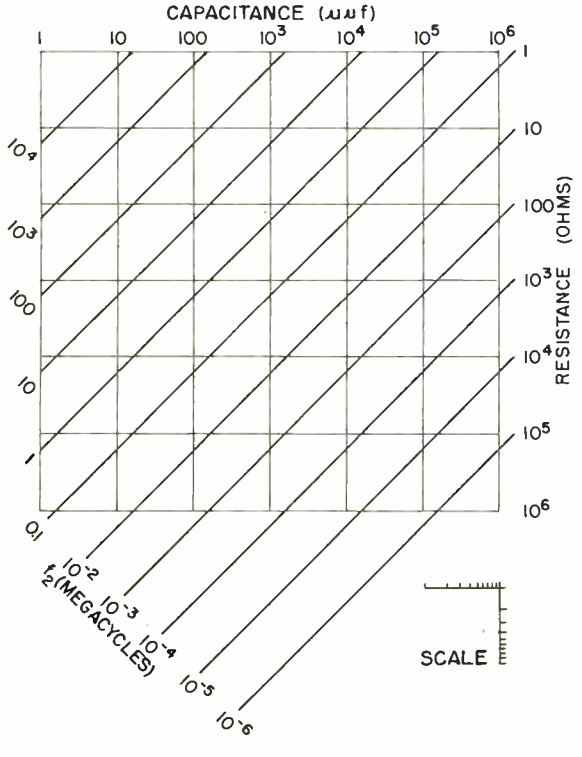
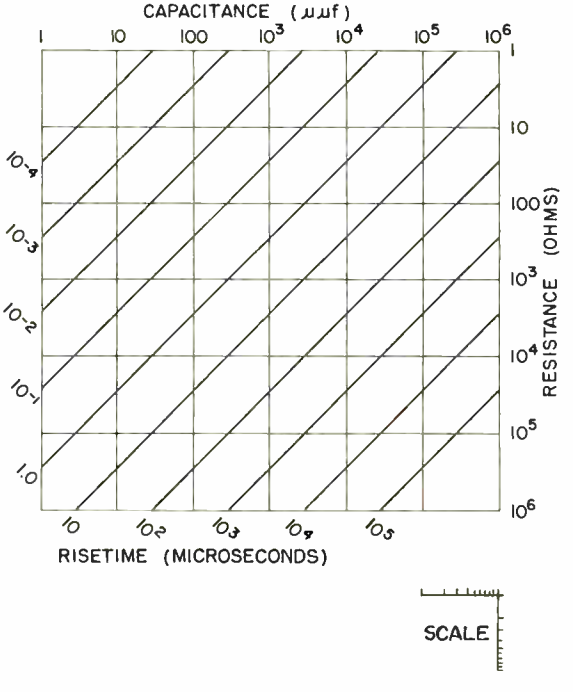
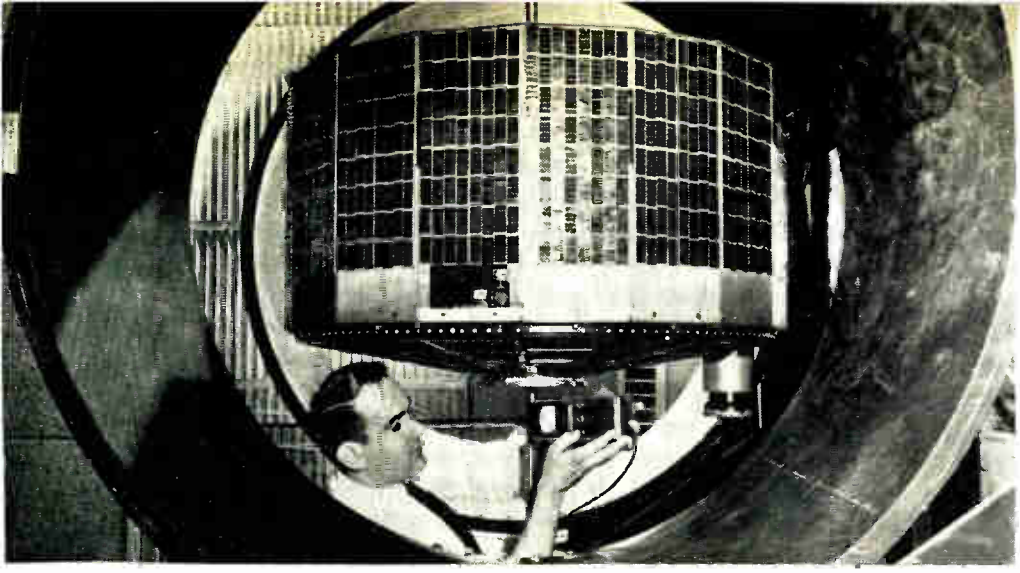


Fig. 2. (above): Inductive shunt changes equivalent circuit to that of tuned amplifier

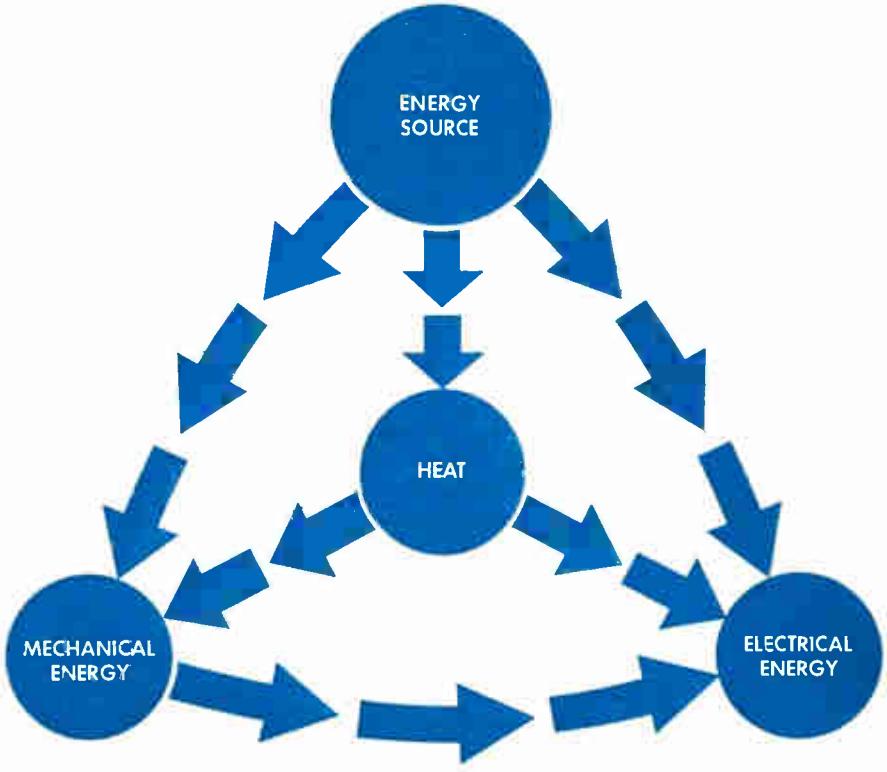


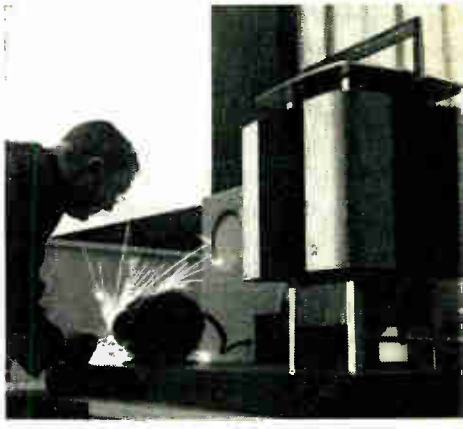




ELECTRONIC INDUSTRIES Looks At . . .

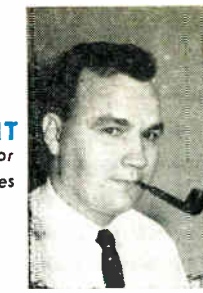
Unconventional Power Converters





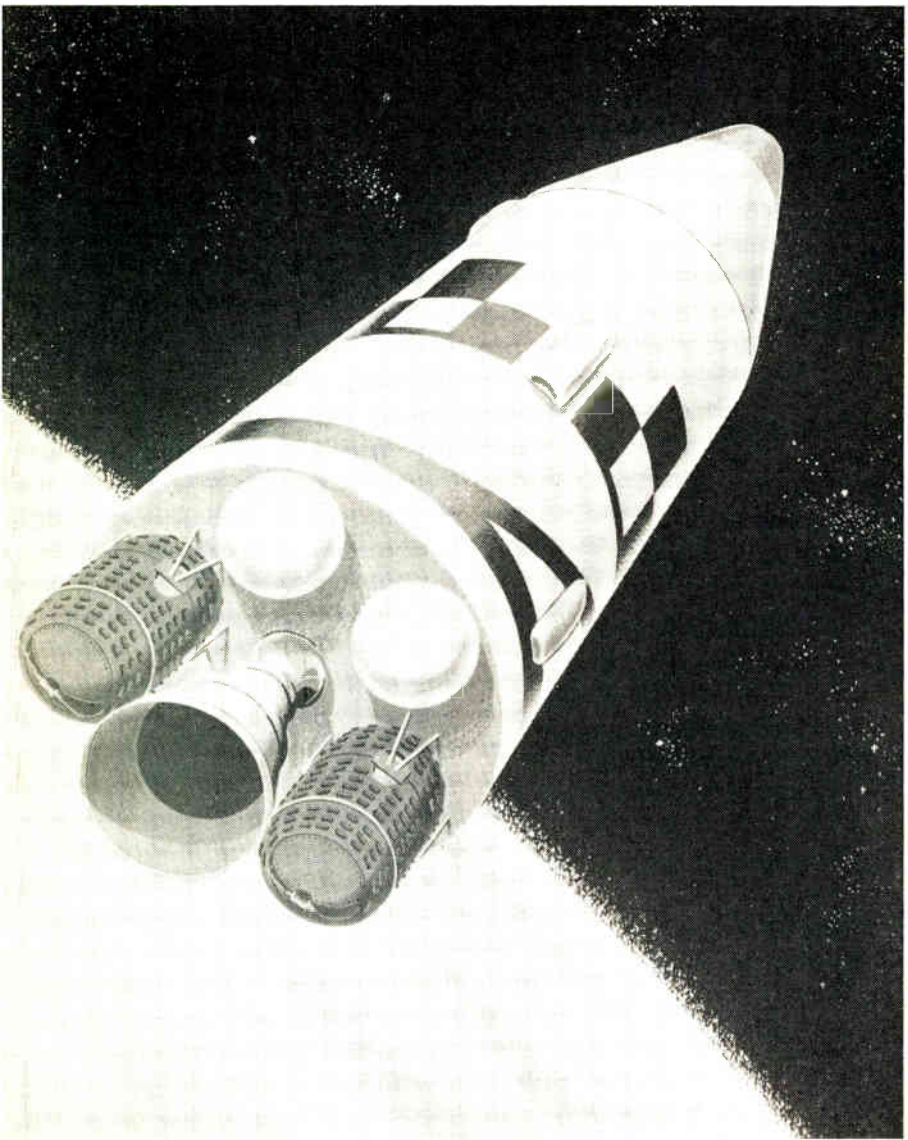
An ELECTRONIC INDUSTRIES Staff Report

By CHRISTOPHER M. CELENT
Assistant Editor
Electronic Industries



ELECTRONIC INDUSTRIES Looks at . . .

Unconventional



ELECTRONIC INDUSTRIES is watching closely the tremendous effort being made to develop new methods of generating electricity. "State-of-the-art" reports from major research and development groups indicate that theory is now being translated into devices. These may soon be widely used in our industry. They may also soon appear in "practical" consumer-type devices.

There are many ways to generate electricity, but they all have this in common: each takes some form of stored energy and converts it to electrical energy. There may be one, two, or more conversion steps between the original stored energy form and the final electrical energy output.

Since each conversion step uses up some of the available energy, the fewer the steps—and more direct the conversion—the more efficient the process. This is one

Fig. 1: Two SNAP-1A units could be used on a satellite to provide 250 w for auxiliary power. Prototype generator, using Cerium-144 fuel, is undergoing tests.

Courtesy of Martin Co.'s, Nuclear Division

The search for new ways to generate electricity is concentrated on six basic conversion devices:

- *Magnetohydrodynamic Generators*
- *Fuel Cells*
- *Thermoelectric Generators*
- *Thermionic Generators*
- *Nuclear Batteries*
- *Solar Cells*

As practical devices emerge from this research, electronic equipment will be moving into areas, both on earth and in space, where they were heretofore limited by lack of reliable, long-lived power supplies.

Courtesy of Radio Corporation of America

Fig. 2: F. D. Rosi (R) and E. F. Hockings test thermal diffusion in a semiconductor crystal at the David Sarnoff Research Center. Crystal will be heated in the cylindrical chamber lowered from above.

Power Converters

of the reasons why the industry is developing these new power converters—some of them, thermoelectric generators and thermionic converters, for example, convert heat to electricity directly.

The electric utility power station is a good example of a conversion process which requires several steps between the source and electrical energy. Fuel —coal, oil, natural gas, etc.—is burned and the heat changes water to steam. The steam drives a turbine. The turbine drives an electromagnetic generator which furnishes the electrical output.

Besides being more efficient, these new systems being investigated may also be able to use energy sources that heretofore were too expensive, less versatile or too hard to control. Solar energy, which represents a tremendous potential source of energy, is a good example.

Everyday about 580 kw-hr of solar energy falls on the roof of an average home in the temperate zone. Five percent of this energy (29 kw-hr) is enough to supply over 2½ times the needs of most homes. Actually, better than 5% conversion efficiency has already been achieved experimentally—the problem now is to do it economically. By products of nuclear reactions are also potential energy sources that are now being wasted. The heat wasted in conventional* energy converters is still another source.

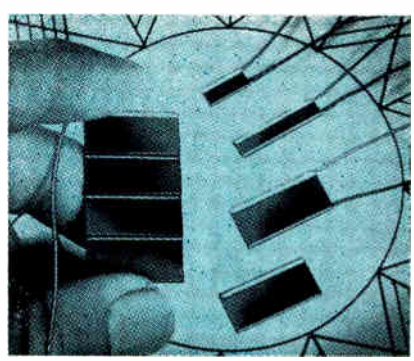


Fig. 3: Rugged new high efficiency Solar Cells are built by International Rectifier Corp. Company recently mounted 10,640 cells on a panel Solar King and used it to power an electric auto.

Scientists in a position to know say that conventional fossile fuels are in relatively short supply. Opinion (depending on estimates of population growth, known reserves, growth in standard of living, etc.) varies as to the amount of our reserves, but whether they take an optimistic or a pessimistic viewpoint the scientists agree that we will probably soon run out of conventional fuels. Any device which adds to the possible fuels or stretches conventional supplies will be most welcome.

We will find in discussing power converters that each is designed for a specific application. Each device is not simply "good" but "good for some specific purpose." Why? There is a vast difference between the requirements of a system that delivers large blocks of power (central power stations) and one that delivers low level power (for the operation of a remote weather station). For the latter the question often is: can it be done? For the former: can it be done economically?

This Editorial Staff Study is designed to give our readers a basic understanding of several of the more important new systems. We will talk about: thermoelectric generators, thermionic converters, solar energy converters, magnetohydrodynamic generators, fuel cells, and nuclear batteries. A comprehensive bibliography is included for those wanting more details on each system.

*Throughout this article, "Conventional energy converter" will mean a rotating electromagnetic generator, a dry cell, or a storage battery.

Power Converters *(Continued)*

Magnetohydrodynamic Generators

The basic principle of the rotating electromagnetic generator is well known—when a conductor is moved through a magnetic field a voltage is induced in it. When we say conductor however, we generally think of a solid bar or wire. But an ionized gas is also a conductor and so are many fluids (mercury), and if an ionized gas is moved through a magnetic field it satisfies this basic requirement for a generator. This, briefly, is how the magnetohydrodynamic generator (MHD for short) works. See Fig. 4. An ionized gas is moved through a magnetic field applied at right angles to the direction of gas flow. Electrodes project into and at right angles to the gas flow. Electrons in the ionized gas are deflected by the field and make their way to the electrodes. These electrons, flowing from one electrode through an external circuit and back to the other electrode provide the MHD generator power output.

The gas doesn't have to be completely ionized since a gas which is 0.1% ionized is almost as good a conductor as one completely ionized. One way to partially ionize a gas is to heat it. However, the temperatures needed are rather high and are near or beyond the limits of most known materials.

Gas can also be ionized by "seeding" it (adding a small amount of an easily ionized element like potassium or cesium). With seeding an adequate electrical conductivity is realized at somewhat lower temperatures. Even with seeding, however, the temperatures are so high that getting materials for an MHD generator is a tough problem.

State of Development

Several large companies in the electronic industry have built and demonstrated experimental MHD generators. Fig. 6 shows one built at the Avco-Everett Research Laboratory which has produced at 10,000 watts. This generator, built under the direction of Dr. Richard J. Rose, is one achievement of a joint research program of Avco and the American Electric Power Service Corp., an association of 10 leading power companies. Under study are two types of MHD power plants. One uses a coal-fired furnace to heat and ionize the gas and the other a nuclear reactor for the same purpose.

Fig. 5 shows an MHD generator demonstrated last spring by Westinghouse Electric Corp. This unit,

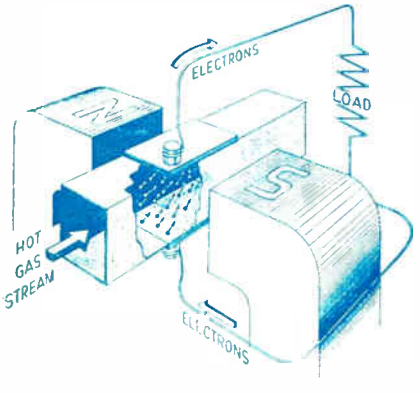


Fig. 4: How the MHD Generator works. Electrons in the hot ionized gas are deflected by the magnetic field. Electrodes, projecting into gas stream, collect electrons and deliver them to the external circuit.

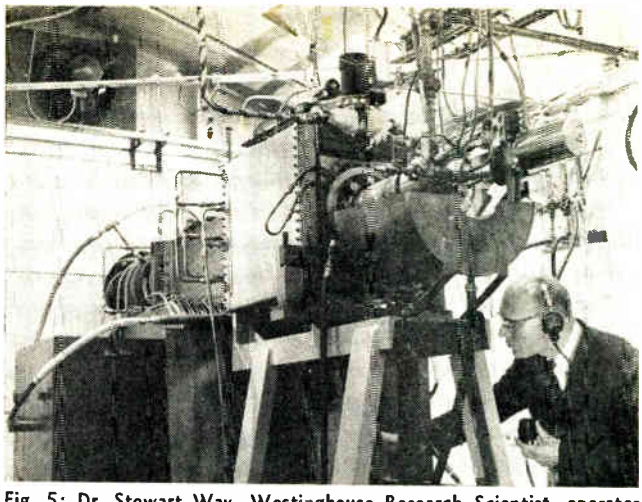


Fig. 5: Dr. Stewart Way, Westinghouse Research Scientist, operates Company's experimental MHD generator. It has operated at 2½ kw for 4 min. He expects future MHD units to operate above 100,000 kw.

tested at 2½ kw and designed to produce about 10 kw, has been operated for over four minutes. Hot ionized gas from an oil-oxygen flame, seeded with potassium soap dissolved in the oil, speeds through the magnetic field at 1800 miles per hour. Fig. 16 (on picture spread) shows a lab unit designed by Dr. Werner Emmerich. It burns hydrogen and oxygen seeded with potassium. The larger model is being used to study generator side-wall designs, electrode materials and configurations, chemical reactions with the seeded gas, operating characteristics, electrode potential drops, and temperature distributions.

General Electric Co.'s Missile and Space Vehicle Dept. recently demonstrated an experimental MHD device. Approximately 1 kw was obtained with the generator for about 5 seconds. Dr. George Sutton is project engineer and Drs. J. McGinn and Willard Sutton are principal scientists on the project. Improved devices such as this are expected to reduce weight and increase reliability and efficiency of power sources for space vehicles.

MHD Applications

Of all the proposed new systems for generating power, MHD generation is most often proposed for large scale applications. Conventional power plants have overall efficiencies of approximately 40% (available figures range from 35 to 42%). And MHD plant efficiency could be as much as 60%, and capital costs are expected to be competitive with conventional plant costs. But don't expect to see MHD plants springing up overnight. There are too many knotty problems still to be solved.

Some problems which must be solved before MHD generators become practical are: The development of materials which will stand up under very high temperatures, sudden temperature changes, and chemical interactions with seeding materials. Scientists need more data on the conduction of electricity in gases, and they want a better understanding of the basic mechanisms of energy and momentum exchange in the MHD generator.

Figs. 8 and 9 show two possible cycle arrangements suggested by Westinghouse Engineers. Fig. 8 is a closed cycle system. They believe this plant would generate 380 megawatts of ac power (The

MHD generator output is dc—a converter is needed to get ac). Fig. 9 shows an open system in which the combustion gases flow directly through the generator. In open type systems, care must be taken that exhaust gases from the plant do not pollute the surrounding atmosphere.

Fig. 7 shows two arrangements that scientists at General Electric Co.'s MSVD have suggested for using MHD for space power. In the closed system a solar reflector or nuclear device would concentrate thermal power in a boiler to ionize the conductor gas. After the gas is used in the generator it would be cooled and re-cycled through the boiler. The open system would use the relatively brief thermal power provided by a rocket motor with the exhaust providing the ionized conductor gas.

Fuel Cells

In a fuel cell, the energy released during a chemical reaction between two elements is converted directly into electricity. The reaction is much like that of the familiar storage battery, but there is one significant difference. In the fuel cell, the active materials are stored outside the device and are fed to it only when electrical output is wanted.

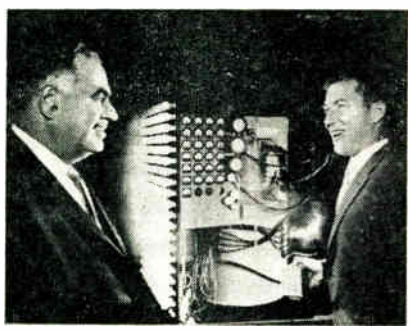


Fig. 6: Dr's A. Kantrowitz (L) and R. J. Rosa, Avco - Everett Scientists, operate Co's MHD generator. It lights a bank of 288 bulbs (50 w each).

They are called fuel cells because they usually use common type fuels such as hydrogen, coal, oil, gas, carbon monoxide, etc.

The oxygen concentration cell (Fig. 10), is one of the simplest. An electrolyte, in this case a carrier of oxygen ions but an insulator to electrons is sandwiched between two electrodes. A voltage is developed across the electrode-electrolyte sandwich when the oxygen is at different concentrations at the electrodes. Here's how it works.

How They Work

The electrodes (anode and cathode) are porous. Oxygen molecules move through the cathode to the point where cathode and electrolyte meet. Here they pick up 4 electrons forming oxygen ions which migrate into the electrolyte. This leaves a positive charge on the cathode. The ions move through the electrolyte to the anode where they release their electrons and combine again to form oxygen molecules. The anode, since it receives electrons, becomes negatively charged. If the anode and cathode are connected through an external circuit, current will flow and will continue to flow as long as there is a difference in the oxygen concentration at each electrode.

Fig. 19 (on picture spread) shows a high temperature fuel cell built by Westinghouse scientists to demonstrate this principle. This type fuel cell is rather simple but it is still in the early stages of development. Most of today's fuel cells use more complicated reactions, other fuels, and more involved designs. Another type of cell (experimental also) is shown in Fig. 14.

This cell, developed by Drs. W. Thomas Grubb and Leonard W. Niedrach of General Electric Co.'s Research Lab, is a plastic disc, one half inch in diameter. The disc is hollow and separated into two chambers by a special plastic membrane called an ion exchange membrane. Electrodes touch both sides of this membrane. Hydrogen, the fuel, is fed into one chamber and oxygen (air can be used) into the other. Here is how this one works.

At the hydrogen electrode a chemical reaction occurs and the hydrogen molecules break up into electrons and positively charged hydrogen ions. Since the plastic membrane will conduct hydrogen ions but not electrons, the hydrogen ions move through the membrane to the second electrode. The electrons travel through an external circuit, providing the output current, to the second electrode. At this second electrode, the electrons from the external circuit, the hydrogen ions from the membrane and oxygen from outside the cell combine. The reaction at this second electrode is the reverse of the familiar electrolysis process, so the product is water.

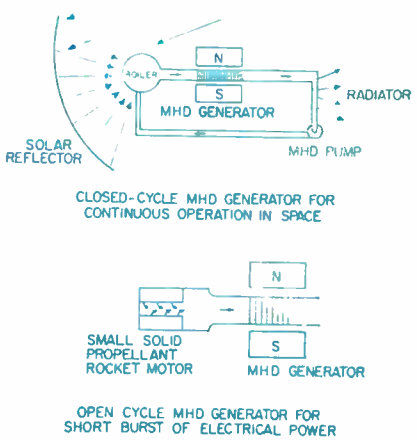
Variations in Design

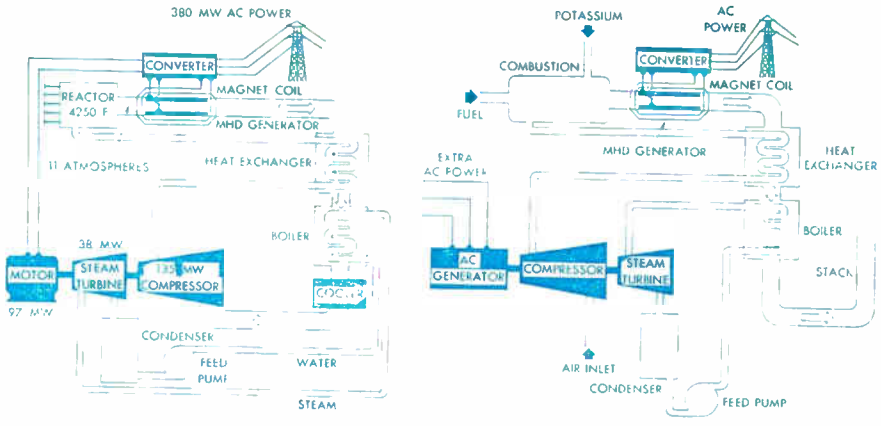
All fuel cells have the same basic components (electrodes, electrolytes, etc.), they all use some type of fuel and oxident, and they have similar principles of operation. But, there are many different fuel cells being studied and developed. They use different types of electrodes, electrolytes, fuels and oxidents. The reactions differ and so do the temperatures and pressures at which they operate.

For a reaction to occur in the fuel cell, the electrode, fuel (or oxidant), and electrolyte must meet at a common point. Because of this, there is a problem of getting enough points of reaction or sites. Some cells use a porous electrode structure to obtain enough reaction sites.

If either the gas or the electrolyte should cover the electrode, the cell output would decrease or even stop entirely. In one case the reaction stops—in the other case, the ion flow is interrupted. This means that with a liquid electrolyte, the pressures of the

Fig. 7: General Electric Co's, Missile & Space Vehicle Dept. proposes these systems for space power. In the closed cycle, solar heat ionizes the gas; in the open system, rocket exhaust provides the heat.





Figs. 8-9: Two possible MHD cycle arrangements proposed by Westinghouse. Closed system is on the left; open system on the right.

Courtesy of Westinghouse Electric Corp.

reactants must be closely controlled to prevent this and to prevent the gas from bubbling through the electrode or into the electrolyte. The cells that use a solid-type electrolyte, such as the ion-permeable membrane used in the GE cell, eliminate the liquid stage entirely.

Where water is formed at one electrode, it must be removed since it may dilute the electrolyte. The obvious solution is to pump it out, but this may not always be practical or easy. For instance, if you're trying to reduce the weight and/or complexity of the power source, the extra equipment needed to pump the water out may do just the opposite.

Another solution to the problem is to have a reservoir of electrolyte that is so large that dilution never becomes a problem. Still another way is to convert the water back into hydrogen and oxygen and recycle these gases through the cell. This last solution may be ideal for applications where low level power is available for long periods of time and relatively large bursts of power are needed only at intervals. The low level power could be used to make hydrogen and oxygen. These gases then could be used in the fuel cell whenever large bursts of power were needed. This type of system has, in fact, been proposed for space use where a steady supply of solar energy is available.

The speed of reaction has long been a thorny problem. Scientists and engineers are tackling this problem in several ways. They are increasing pressures and temperatures; they are increasing electrode areas; using additives and catalysts; and using more reactive fuels and intermediate reaction techniques.

Fuel cells may be "direct acting." That is—the reactants are consumed directly in the cell to produce electricity. They may be "regenerative" cells where primary reactants are used outside the fuel cell to regenerate secondary reactants which are then used in the cell. The reactants may be thermally or chemically regenerated. For space applications, it may be advantageous to use solar or nuclear power to regenerate these materials. Energy could be stored during periods of low demands for use during peak demand periods.

What fuels should be used? Theoretically, any gas which can be oxidized may be used as the anode and any gas which can be reduced may be used as the cathode. But some gases have a slow rate of reaction and some of the reactions do not go to completion. The cost of the fuels must also be considered. Practically, only a few fuels can be used. Most of the experimental cells demonstrated use fossil fuels or substances made from them. Among these are coal, naturally occurring hydrocarbons, hydrogen, and carbon monoxide.

The temperature of operation is important. Most cells which operate below 250°C use hydrogen or some other special fuel, and generally some type of catalyst is needed to speed up the reaction. Hydrogen is relatively expensive so if this type of cell is to become practical, a way must be found to produce it cheaply, or develop cells which use cheaper fuels.

One way to use cheaper fuels is to operate the cells at higher temperatures (above 500°C). Higher operating temperatures, however, introduce other problems. The cell components, for example, must be highly resistant to corrosion for long periods of time at high temperature and still retain useful conductivity properties.

State of Development

The fuel cell isn't really "new." The concept dates back to 1802, but early fuel cells were very complicated.

In 1952, Francis T. Bacon of Great Britain received a patent for a "Hydrox"* fuel cell which operated at temperatures of from 400° to 500°F and at pressures of from 400 to 600 psi, using hydrogen and oxygen as reactants. The emf of the cell was about 1 v. and current densities up to 1000 amp/ft² were reported but the electrodes had a life of only 16 or 17 hours. A later improvement in fabrication techniques increased this life to 1500 hours.

The Patterson, Moos Research Div. of Leesona Corp. (formerly Universal Winding Company), 90-28 Van Wyck Expressway, Jamaica 18, N. Y., has a licensing agreement with the National Research Development Corp. (British), holders of the Bacon

*A trade name of Leesona Corp.

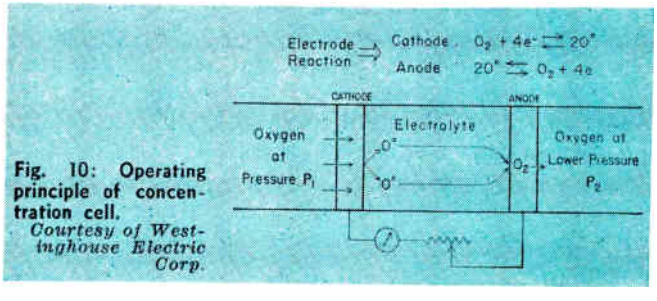


Fig. 10: Operating principle of concentration cell. *Courtesy of Westinghouse Electric Corp.*

patents. The Company has an agreement with United Aircraft Corp., E. Hartford, Conn., for the joint development of fuel cells for space and military applications. Leesona also holds patents on the "Carbox" fuel cell, a carbonaceous fuel cell developed by two other English scientists—Dr. H. H. Chambers and Mr. A. D. Tantram.

This Carbox cell operates between 500° and 600°C. It uses air as oxident and can use a variety of fuels ranging from hydrogen-carbon monoxide mixtures to petroleum, hydrocarbons, and vaporized kerosene. Unit cell voltage is 0.7 v., current density is 60 amps/ft², and energy conversion efficiency is 64%.

The Company is presently working under an Air Force contract to build a 1.5 kw fuel cell system and under a Navy Bureau of Aeronautics contract to build a 10 kw system. Both systems are for aircraft application. Fig. 13 shows a typical single cell and shows a "Hydrox" system in operation at the Company's Jamaica, L. I., research plant.

GE's Aircraft Accessory Turbine Dept., Los Angeles, recently announced development of a portable power supply for the Electronics Div. of the Navy's Bureau of Ships and the Radar Div. of the Army Signal Corps. The unit (carried by Marine on first page) produces 200 w at 24 vdc for 14 hours. It weighs 30 lbs. 72 lbs. of fuel is enough for a week's operation. It is designed to operate for a minimum of 2000 hours without maintenance, but a much longer life is expected.

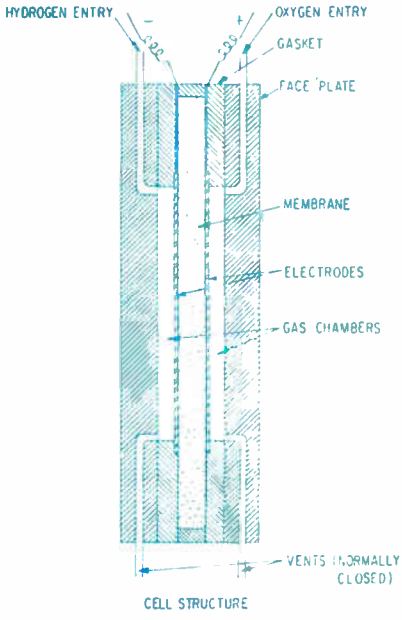


Fig. 11: Construction of fuel cell developed by General Electric Co. Ion exchange membrane is a conductor of ions but an insulator to electrons.

Heart of the unit is a series of 30 ion-membrane fuel cells, each an 11 in. sq. assembly approximately ¼ in. thick. It uses oxygen from the air and hydrogen produced by the decomposition of a metal hydride "fuel." It operates at 50°F above ambient (ambient temperature range is from —65 to 160°F), and essentially at atmospheric pressure. Efficiency is 50% at full load and increases under partial load.

The Exide Industrial Div. of the Electric Storage Battery Co., Philadelphia, Pa., and 12 material handling equipment manufacturers are jointly developing an adaptation of an Exide fuel cell to power electrical industrial trucks. The Company's cell is a rechargeable zinc-oxygen unit (zinc is the fuel and compressed oxygen is the oxidizer). This cell is already beyond the basic and applied research stage. The zinc is oxidized in a potassium hydroxide electrolyte as oxygen is admitted under low pressure.

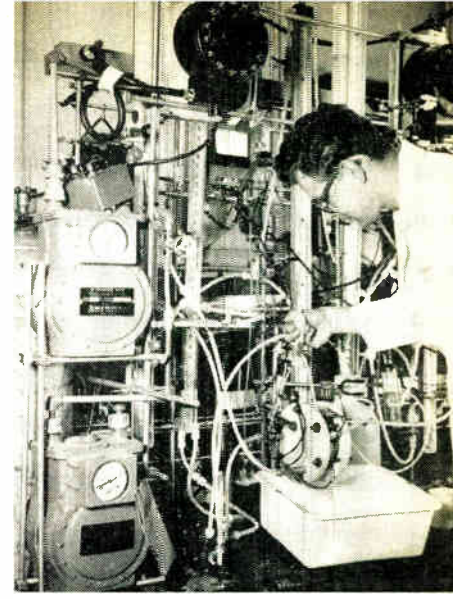


Fig. 12: Dr. Morris Eisenberg, Mngr., Electrochemistry, studies experimental fuel cell built by Lockheed Aircraft Corp., Missile Systems Div.

The Missile and Space Div., Lockheed Aircraft Corp., Sunnyvale, Calif., has a contract from the Army Signal Corps to explore the possibilities of systems dealing with regenerative methods of using solar energy and designed to operate continuous fuel cells.

Since the fuel cell is so efficient, developers expect to see it used in fields where the cost of electricity is significant. Example of such use include industrial power generation, vehicle propulsion, electric welding equipment, etc. It can provide steady dc power and it can serve as a standby source of power should a normal source fail. Because it is silent, odorless, has no moving parts, can operate at low temperatures and pressures, and produces a high power output per unit of weight, the fuel cell will probably have many military and space applications.

Thermoelectricity

Thermoelectricity actually describes any phenomena involving heat and electricity (heat generated by a resistor, for example), but we are thinking here of the Seebeck effect and the Peltier effect. These effects describe what happens when the junctions of a loop of two different materials are maintained at different temperatures.

The loop is the familiar thermocouple. When one junction is heated a current flows in the loop. This is the Seebeck effect. The force driving the current is the thermoelectric force (or the Seebeck emf). The rate of change of thermoelectric force with temperature is the thermoelectric power.

How is this emf generated? When a section of thermoelectric material is uniformly heated the electrical charges are uniformly distributed. When heat is applied to one surface only, the electrons tend to move to one end or the other depending on the type of material used. The positive ions remain fixed. With the electrons concentrated at one end there is a potential difference between ends. If an external circuit is connected to these ends, a current will flow.

The Peltier effect—actually the reverse of the Seebeck effect—is demonstrated when a current is passed

Power Converters *(Continued)*

through the loop. One junction is heated and the other cooled. This phenomena is being widely used for cooling devices especially for devices for cooling small electronic components like transistors.

Both the Seebeck effect and the Peltier effect—and their interrelationships—have been known for a long time, but the materials available were not very efficient so the principles were little used for power generation. They were widely used, however, for temperature measurements (see Fig. 25) and in safety devices.

The discovery of semiconductors really pushed thermoelectricity for power generation into prominence. Where former thermoelectric materials were only about 1% efficient, the new semiconductor materials can produce at better than 10% efficiency and theoretically the efficiency of conversion can be much higher.

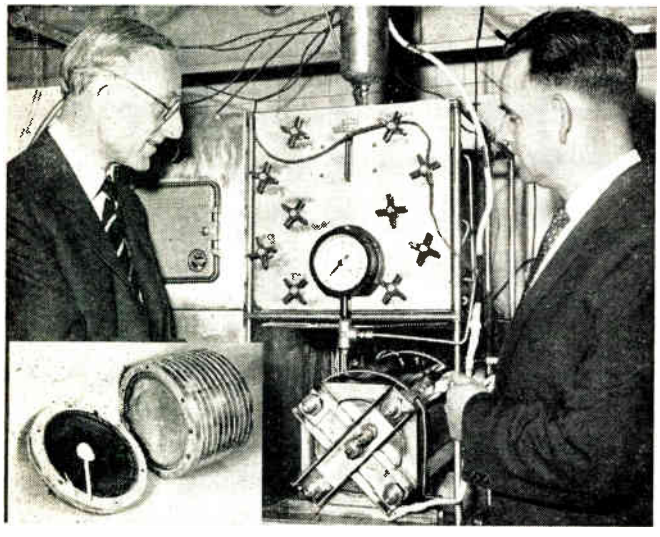
Scientists can pretty well tell how good a material is for thermoelectric use from its figure of Merit ($Z=S^2/\rho K$). S is the Seebeck coefficient (or thermoelectric power) expressed in volts/degree; ρ is electrical resistivity in ohms-cm; and K is thermal conductivity in watts/cm/degree. Generally speaking, the higher the value of Z the better the material is for thermoelectric use.

A look at the figure of merit shows that a good thermoelectric material should have a high value of S and relatively low values of ρ and K—this means that the thermoelectric power should be high and the electrical resistivity and thermal conductivity low.

Metals aren't too good because they have high thermal conductivities and low thermoelectric powers. Insulators on the other hand, have low thermal conductivities but very high electrical resistivities. Semiconductors, so far, seem to be the best suited. The number of free electrons in the material can be adjusted by doping and thus the electrical and to some extent the physical properties can be adjusted. Thermoelectric scientists are also studying ways to adjust the thermal properties.

Fig. 13: Francis T. Bacon (L) and Dr. H. H. Chambers examine a "Hydrox" Fuel Cell at the Jamaica, L. I. plant of Patterson Moos Co. Hydrox cell uses hydrogen and oxygen. Company is also working on the "Carbox" cell. Insert is a 5 in. dia. Hydrox fuel cell electrode for a 12-volt battery.

Courtesy of Leesona Corp.



The figure of merit is a point function of temperature since S, ρ, and K are point functions of temperature. This means that a maximum value of Z for any single thermoelectric material occurs at one temperature and falls off on either side of this temperature. To make use of wide temperature ranges, thermoelectric designers fabricate their generator elements from several different materials so that each segment operates at the temperature which gives the highest efficiency. The doping of a single semiconductor element can also be varied from end to end to give the same effect.

Optimum density of free electrons for maximum power output is about 10^{19} electrons per cubic centimeter. This value is well within the range of good-operating semiconductors and one which gives Seebeck voltages around 175 microvolts/degree C. Some typical materials which exhibit acceptable properties are zinc antimony, lead telluride, bizmuth telluride, and germanium telluride.

Materials

Most semiconductors for thermoelectric use are binary and ternary alloys. One promising ternary system is silver-antimony-telluride. General Thermoelectric Corp., P.O.B. 253, Princeton, N. J., recently announced a quaternary (four element) alloy for thermoelectric applications. The material (Neelium^R) is a solution of bismuth, tellerium, selenium, and antimony. The figure of merit quoted by the company for this element is 3×10^{-3} C^{-1}, measured with the hot junction at +55°C.

When the temperature gets up around 1000°C, the value of known semiconductor materials for thermoelectricity drops off. A rather simple explanation of this is that near this temperature a point is reached where the positive ions and the electrons migrate in equal numbers and no output voltage is available. At and above these temperatures, other materials must be found.

Scientists at the Westinghouse Research Labs have been investigating a class of materials which theoretically offers efficient thermoelectric power generation in the 2000°F range. These materials are the "transition metals," a group of elements lying near the center of the periodic table. The particular family which shows a great promise is the mixed valence compounds of the transition metals. These compounds are characterized by the presence of ions of the same element having different degrees of electrical charge. An example of this type of material is samarium sulphide, which has a good figure of merit at temperatures as high as 1100°C.

General Electric Co. scientists at the Syracuse Lab have been studying the thermoelectric properties of liquids and encapsulated solids. They believe higher efficiencies at higher temperatures can be achieved using these techniques.

Getting good thermoelectric materials is not the end of the problem. The materials must be made into a useable device, and building the device often becomes the bigger problem. For example, we generally think

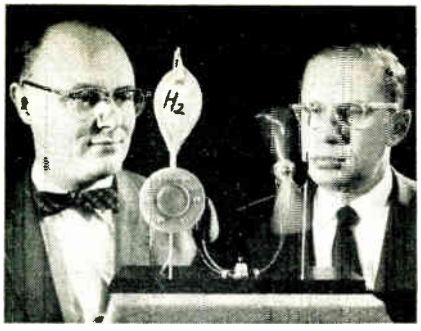


Fig. 14: Fuel cell produces electricity directly from gaseous fuel while GE Scientists, Drs. L. W. Niedrach (l) and W. Thomas Grubb look on. Fuel (hydrogen) is in balloon marked "H_2." Water is by-product.

of thermocouples as made in wire form. But these new thermoelectric materials are not ductile and can't be prepared this way. Most of the elements are prepared as rods or cylinders. Fig. 24 shows a typical configuration (this is a cooling device but power generators use the same form). The ends are connected with a metal strip whose only function is to carry current from one leg to another.

These connections are important. Contact resistance must be minimized since a large resistance here has the same effect as a large internal resistance. Then too, the electrode material may diffuse into the semiconductor material and reduce its effectiveness. Researchers hope to solve this knotty problem in several ways. One is to find electrode materials that will not affect the electrical properties and another is to find materials that will not diffuse into the element.

Thermoelectricity and Nuclear Energy

Thermoelectric generators are being studied for use with nuclear reactors. There are several reasons why. One reason is that conventional rotating equipment cannot take advantage of the very high temperatures (around 4100°F) which are available. There are several heat transfer processes between the fuel element in a nuclear reactor and the medium (steam) used by the mechanical equipment and a significant drop in temperature occurs during each process.

The materials used in mechanical equipment must have high ductility and high tensile strength but the materials which will withstand the high temperature of the reactor are generally of low ductility and low tensile strength. These materials (ceramics for example) are better suited for static type converters such as the systems being discussed here.

The hot end of the thermoelectric generator could be exposed directly to the high temperature at the fuel element and the cool end to moderator-coolant water but this raises another problem. The thermoelectric element is exposed to radiation which may adversely affect its performance. Westinghouse is studying the performance under radiation of a number of materials in their Testing Reactor at Waltz Mill, Penna.

An indirect method can be used to get away from the radiation problem. Here the moderator-coolant water is used as the hot temperature source. In other words, the tubes in the boiler are made out of thermoelectric materials. Secondary water flows around the outer surface of the tubes to cool the cold junction of the thermocouple.

Westinghouse believes a thermoelectric generator of the indirect type to be practical in the 1 watt to 10 kw size. They are, in fact, building models of generators in this power output range. For generators above 10 kw, they believe the indirect system to be too cumbersome and inefficient. They are studying the direct type for this application.

The thermionic generator*, often analyzed as a thermoelectric generator is generally more suited for operation at high temperatures than the thermoelectric generator. It is also being considered for use with nuclear reactors often in combination with a thermoelectric generator. The thermionic device would be used at the higher temperatures and the heat rejected would operate thermoelectric devices.

Fig. 27 shows a combined unit which Westinghouse built into a nuclear fuel assembly and inserted into a reactor at Waltz Mills. The experiment, to determine feasibility, was conducted by Peter J. McCoy.

The University of Michigan and the Los Alamos Scientific Laboratory have jointly announced using a variation of the thermoelectric principle in an atomic reactor. This thermocouple substituted ionized cesium gas (plasma) for one of the thermoelements.

State of Development

Probably the most significant development in thermoelectricity since Electronic Industries' Survey last July is the appearance on the market of useable thermoelectric devices. The devices are primarily for cooling purposes except for prototype models of power devices produced for the military.

A lot of the support for these thermoelectric programs comes from the military and space agencies. This is understandable since these agencies should find wide use for these new converters. But the support is not entirely government. Industry itself is spending a considerable amount of time and money on R & D programs. One company has over 40 people working on the program, and several new companies have been formed whose primary interest is in these new devices.

Thermoelectric scientists and engineers are enthusiastic about the future for these devices. One company

*To be discussed in the next section of this article.

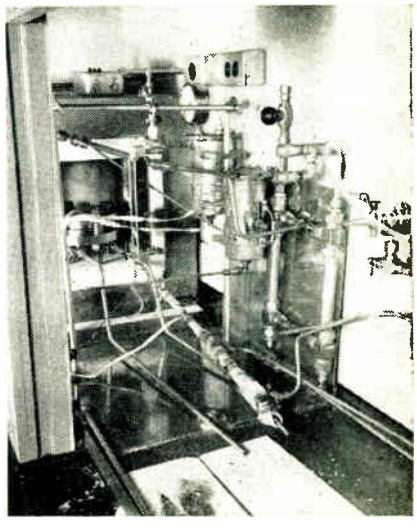


Fig. 15: Thermally Regenerative Fuel Cell. After use in the cell, the reactants are thermally regenerated and re-cycled thru the cell.

Courtesy of Lockheed Aircraft Co., Missile Systems Division

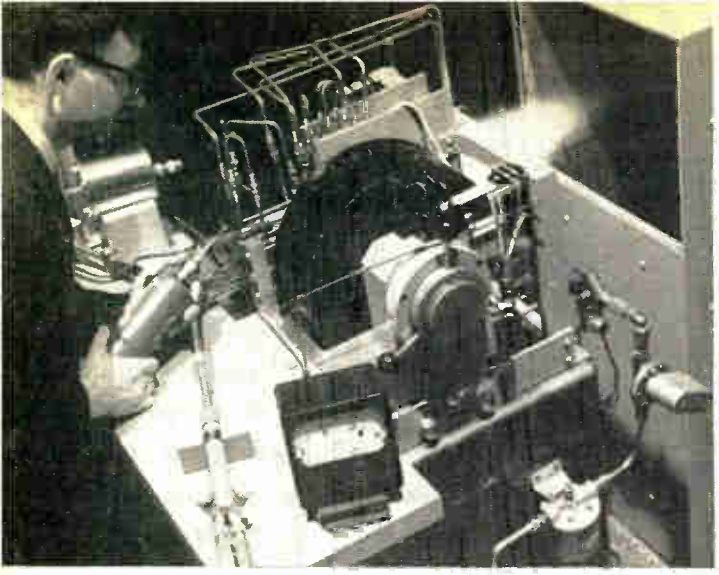


Fig. 16: Dr. Werner Emmerich, Westinghouse research Physicist, demonstrates experimental MHD generator. For experiments with combustible fuels, this lab device produces approximately one watt. Gas speed is 1,100 mph.

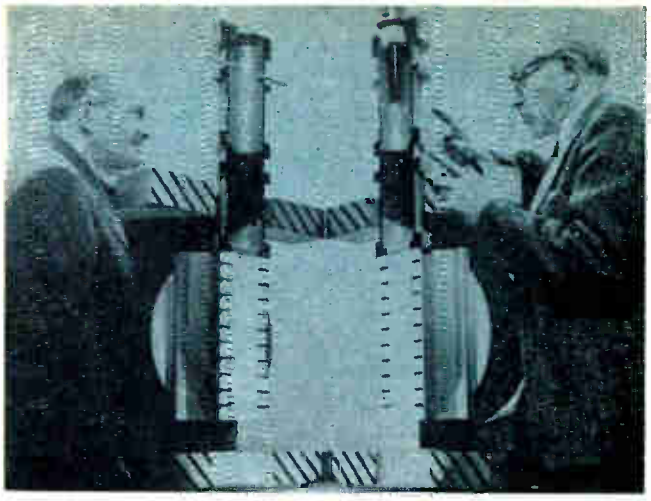


Fig. 17: Model of Avco Corp's Experimental MHD generator. V. Emanuel (L), chairman of Avco, and Philip Sporn, Pres., American Electric Power Service Corp., discuss device. Avco and 10 leading power companies have a joint research project to study large scale use of MHD.

Power Converters *(Continued)*

we talked to estimated the potential market for thermoelectric devices at more than $3 billion annually a nice chunk of change in any man's language.

The Santa Barbara Research Center of Servomechanisms Inc., Building 114, Santa Barbara Airport, Goleta, Calif., is studying high efficiency thermoelectric materials for the Army-Navy Instrumentation Program. The work is sponsored by the El Segundo Div., Douglas Aircraft Co., Inc., through funds allocated by the O.N.R. They are looking for materials which can retain thermoelectric properties at very high temperatures. A good portion of their program is devoted to mechanical construction. They have developed a unique washer type configuration which shows promise at high output levels.

Westinghouse has built a 5,000 watt thermoelectric generator for the Navy's Bureau of Ships. Heat is obtained from burning kerosene and the cool end is maintained with water. Operating temperature at the hot end is about 1,200°F and at the cool end about

Fig. 18: Martin Co's Nuclear Div. (Baltimore, Md.) designed this remote weather station powered by a TE generator using nuclear heat.

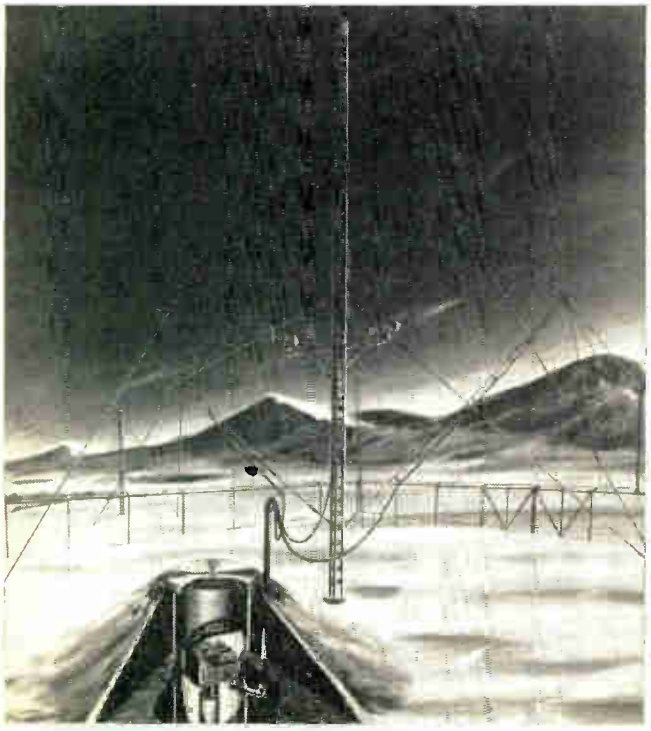


Fig. 19: Dr. H. J. Ruka, Scientist, Westinghouse, tests new high-temp. fuel cell in a furnace. It uses Carbon fuel and oxygen or air.

Fig. 20: J. Donald Rauth (R), VP, Martin Co., and Dr. Mostafa E. Talaat, Head of new Energy Conversion Group at Martin, examine Russian-built thermoelectric Generator. Kerosene lamp supplies heat for generator used to power radios in remote Asian areas. Martin acquired the generator to evaluate Soviet technical approaches.

On The Cover (Page 101)

(Top L to bottom R): Tiros satellite used 9,200 silicon solar cells made by International Rectifier. 2: Marine carries GE's AE-12 fuel cell power pack. 3: Dr. Angello demonstrates Westinghouse's TE generator. 4: Karl Hennqvist (RCA) slides rocket tube into Company's thermionic generator.

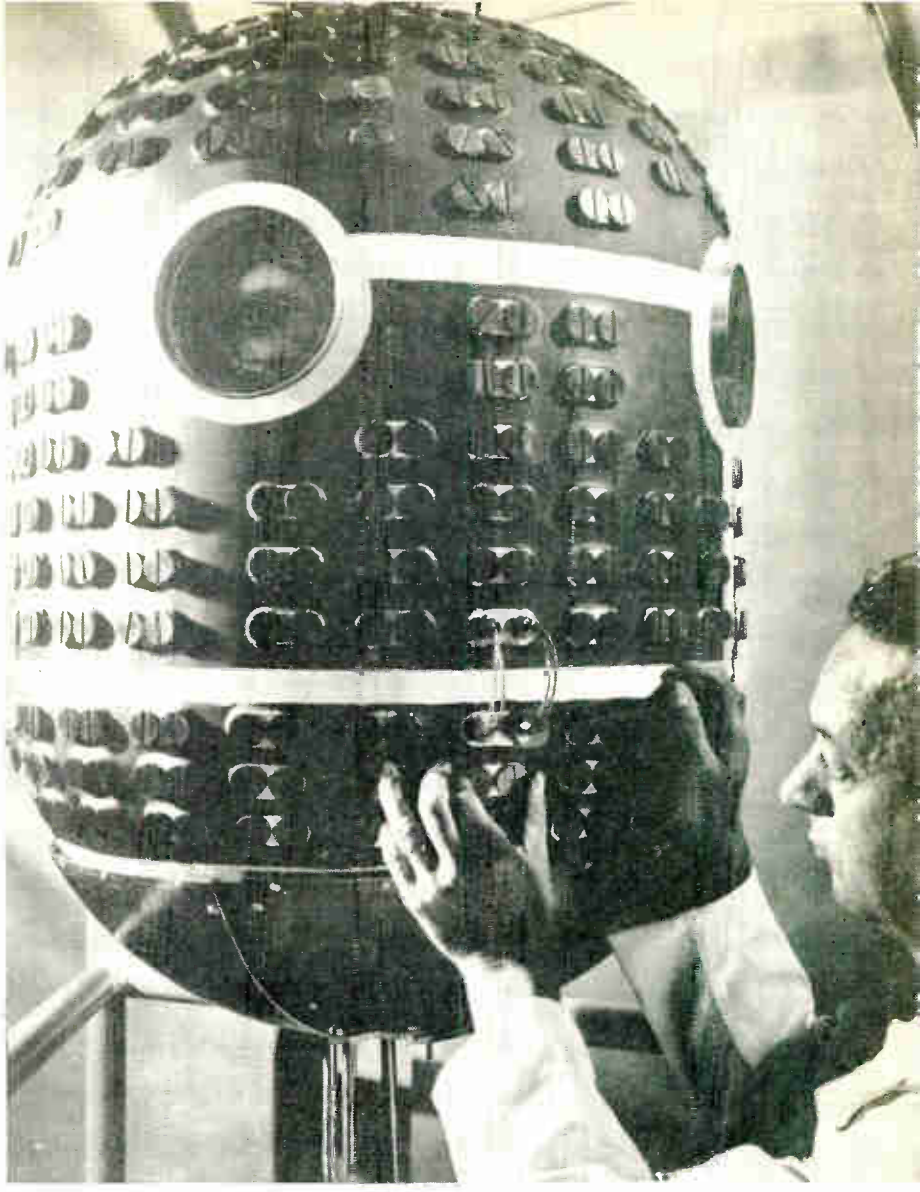
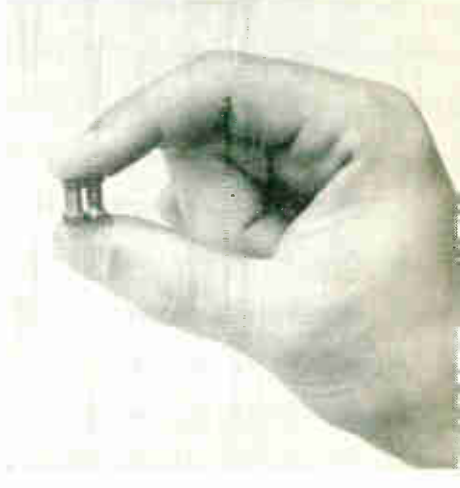


Fig. 21: SNAP-1-A is prepared for electrical tests at The Martin Co. in Baltimore. Heat from tightly-sealed pellets of Cerium-144 will be converted into 125 w by hundreds of thermocouples which dot the outer skin of the device.

Fig. 22: M. Paradise, Exec. VP, Hoffman Electronics Corp., Semiconductor Div., and Kojo Botsio, Ghana's Minister of Trade and Industries, examine Hoffman solar powered radio. Hoffman is studying use of solar power in underdeveloped areas like Ghana.

Fig. 23: Dr. J. W. Coltman, Mngr., Electronics and Nuclear Physics Dept., Westinghouse Research Labs., demonstrates experimental thermionic generator. Capsule at base of tube holds Cesium used for neutralizing the space charge effect.

Fig. 24: Thermoelectric unit built by Materials Electronic Products Corp., Trenton, N. J. Fig. of Merit (p-type) is 4 to 4.5 x 10^{-3}; (n-type) is 2.7 to 3 x 10^{-3}. This is a cooling unit. Generator elements are similar in physical structure.



50°F. Six different thermoelectric materials are used in the device which operates at 10% efficiency.

Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass., is producing lead telluride thermoelectric units for use over the 0 to 1,000°C range. Efficiency over this range is quoted at about 14% per couple. They are working on generators powered by isotopes, nuclear reactors, and solar energy.

Martin Co.'s Nuclear Div. has designed a remote automatic weather station (see Fig. 18 picture page) for the U. S. Atomic Energy Commission. Power is supplied by nickel-cadmium batteries trickle charged by a radioisotope-fueled thermoelectric generator. The fuel is Strontium-90 in the form of Strontium Titanate pellets (about one pound). Output of the generator is 5 watts at 4.0 vdc. The fuel is enclosed in 3 layers of 0.250 in thick Hastelloy C because Strontium-90 is extremely toxic.

Fig. 25: Dr. Sebastian Karrer (R) and Dr. Robert Fritts, Minnesota Mining and Manufacturing Co. scientists, hold components of thermoelectric generator made by Baso Inc. (Milwaukee). System, part of a self-energized control system for gas burning equipment, uses 3M elements.

Minnesota Mining and Manufacturing Company, pioneers in this field, have come up with an interesting application for their thermoelectric generators. A Northern Illinois gas company has ordered several 10-watt, gas burning generators for providing cathodic protection to gas lines. This application requires a steady supply of low power direct current—requirements that fit well the qualities of the thermoelectric generator.

The 3M company recently received a contract from the Navy Dept. for a 500 watt gasoline fueled thermoelectric generator. The portable generator designed to power surveillance radar, communications equipment, and other field gear will weigh less than 35 lbs. Dr. Robert W. Fritts, manager of 3M's program, says that the major market for thermoelectric generators in the next few years will be for devices producing 1000 watts or less.

Thermoelectric materials and thermoelectric generators are already available but generally for experimental and prototype applications. Minnesota Mining and Manufacturing Co., Dept. D9-401,900 Bush Ave., St. Paul 6, Minn., for example, offers elements TEG #2P (positive type) and TEG #2B (negative type). Calculated thermal efficiency at matched load conditions for the elements under a temperature differential of 1000°F is 7.85%.

Whirlpool Corp., St. Joseph, Michigan, recently announced two new applications of their thermoelectric devices for power and two for cooling. The two for power were: a device for operating a Sprengel type mercury pump suitable for gasses and liquids; and a device using a thermal junction and mercury to operate gas or fluid valves.

The Thermionic Converter

The thermionic converter is somewhat like a vacuum tube diode. Physically it consists of two electrodes—cathode and anode—enclosed in an evacuated case. The cathode is heated and emits electrons as in most thermionic vacuum tubes. The electrons travel through the interelectrode space and are collected by the anode. Anode and cathode are connected through an external circuit. The electrons do work in traveling from the anode to cathode.

Actually almost any diode can be used as a thermionic converter but generally the efficiency is too low to be practical. Engineers and scientists have known about this phenomena for a long time. Edison observed it during one of his earliest electric light experiments. He had several filaments in one bulb and noticed that current could be drawn from one filament when the other was heated. Our scientists today are using special techniques and materials to make this phenomena practical for power conversion.

If the thermionic device is considered as a thermoelectric generator, its theoretical efficiency can be appreciated. The anode here is the cold junction—the cathode the hot junction. As we pointed out in the section on thermoelectricity, the thermal and electrical conductivity of the thermoelectric material are very important. The lower the thermal conductivity and the higher the electrical conductivity the more efficient the thermoelectric device. The space between the hot junction (cathode) and the cold junction (anode) in this case is vacuum or a gaseous plasma which meets those conditions admirably.

How it Works

The cathode and anode materials are selected so that there is a relatively high contact potential difference which means that there is a large difference between the anode and cathode work functions. The space between the electrodes is evacuated (or filled with a gas like cesium) and the cathode is heated.

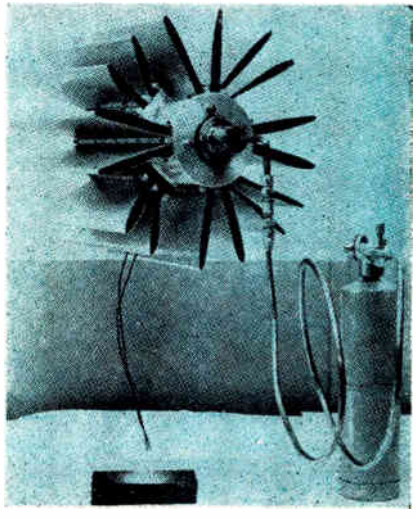


Fig. 26: Thermoelectric generator made by General Instrument Corp. uses propane gas. The 10 lb generator runs for a year on $10 worth of gas.

The heat raises the energy of some of the electrons high enough for them to leave the cathode's surface. They travel through the space between the electrodes and enter the anode. The electrons lose some energy when they enter the anode since the anode has a lower work function than the cathode. This energy loss appears as heat so the anode must be cooled to remove it. Also, if the anode were at the same temperature as the cathode it could emit more electrons than the cathode. These electrons at the anode now have a potential energy (negative) with respect to the cathode. Connecting the anode to the cathode through an external circuit allows the electrons to do work.

Space Charge Barrier

The cloud of electrons in the interelectrode space builds up a space charge which limits the current flow. This space charge is one of the biggest problems in developing these devices and scientists have proposed at least four different ways to reduce or eliminate it.

One way is to get the anode and cathode as close together as possible. J. E. Beggs of General Electric's Research Labs, for example, has built thermionic converters with less than 0.001 in. spacing between the electrodes.

Another way to reduce this space charge is to fill the interelectrode space with positive ions which neutralize the space charge effects. RCA recently demonstrated a device which used cesium gas for this purpose.

A third method uses electric and magnetic fields to conduct the electrons from cathode to anode and a fourth method uses a grid to accelerate the electron flow. Of course, the benefits of the grid are lost if the grid itself collects excessive current. When nuclear heat is used, the gamma radiation may be used to reduce the space charge effect.

Temperature Range

The thermionic converter becomes more efficient as its operating temperature increases. In fact, the practical operating temperature range of the thermionic converter begins where the thermoelectric generator's temperature range ends.

Solar Batteries

Harnessing the tremendous energy which reaches the earth daily from the sun has long been a dream of mankind. Solar energy is cheap, plentiful, and the monopoly of no nation.

Many devices have been built which concentrate the sun's heat, creating hot water or steam which in turn is used to develop mechanical power in steam engines. Solar heat has also been used to operate thermoelectric and thermionic devices, but what we will talk about here is the direct conversion of light energy to electrical energy. The techniques we are interested in use the photoemission effect and the photovoltaic effect.

The Photoemission Effect

In the thermionic diode, heat applied to the cathode furnishes enough energy to some electrons to allow them to escape from the cathode's surface. A similar effect can be achieved with light energy. This effect, the photoelectric effect, was explained by Einstein in 1902 and confirmed by Millikan in 1906.

Einstein showed that a beam of light consisted of small, discrete bundles of energy (photons) and that this energy is directly proportional to the frequency of the light. When these photons strike a photoelectric material they can transfer their energy to electrons (the transfer is an all or nothing affair). If this energy raises the energy of the electron above the work function of the material, the electron will leave the material's surface. These electrons can be captured by another electrode, the anode. Connecting anode and cathode externally completes the circuit.

An interesting point here is that the maximum velocity of the emitted electron is independent of the intensity of the light, but does depend on the wavelength. However, the current does increase with increasing intensity because there are more electrons emitted.

Fig. 27: Dr. William E. Shoupp (Westinghouse) holds combination thermoelectric thermionic test device designed to extract power directly from the fuel elements in a nuclear reactor. Thermionic unit is in the center and thermoelectric elements surround it.

Where the anode of the thermionic converter must be kept cool to prevent generating an opposing current, the anode of the photoemissive device must be kept dark for the same reason. The space charge problem is also present in the photoemissive device, and as in the thermionic diode, one solution is to fill the interelectrode space with an ionizing gas.

This type of solar energy converter hasn't been used much as a power converter but it has been widely used in measuring and control devices. Two devices which immediately come to mind are the electric eye and light meters. Efficiency is rather low (about 3%) but several research groups are working on the devices and higher efficiencies are expected. The advantages of this type of conversion are in their low cost and possible high power to weight ratios.

The Photovoltaic Converter

Right now, silicon solar cell is the most efficient and most widely used photovoltaic device. The first practical silicon conversion device (a p-n junction) was reported by Chapin, Fuller, and Pearson of the Bell Telephone Labs in 1954. Efficiency was about 6% —a year later this had been raised to about 11%. Cells with guaranteed efficiencies of 10% have been available for some time and Hoffman Electronics Co- Semiconductor Div., El Monte, Calif., recer-

nounced cells with guaranteed 13% efficiency. Laboratory devices having efficiencies greater than 15% have also been reported. Theoretical maximum efficiency is about 22%.

How it Works

Silicon solar cells (Fig. 3) are p-n junction devices. Typical n-type silicon is prepared by doping with small amounts of an element such as phosphorus, antimony, or arsenic. The p-type is prepared by introducing an element such as indium, aluminum, or boron.

When light shines on the cell, many of the energy-containing photons penetrate the silicon and are absorbed near the junction. Some of these photons have enough energy to break a crystal valance bond in the dipole layer and create a hole-electron pair. The hole and electron separate. The junction field causes the holes to flow into the p-type material and the electrons into the n-type material. Since there are millions of holes and electrons created, an external voltage is built up. Current will flow through a load connected to the two sides of the cell.

When the current flows through the load, the hole-electron pairs that were formed recombine. Nothing is added to or removed from the silicon during the process. As long as there is light energy available the process can continue.

How they are Made

Very pure silicon (about 1 part impurity in 10^{19} parts) is first placed in a special controlled-atmosphere furnace in a quartz beaker, heated to about 2,000°F., and melted. Then a very small quantity of very pure arsenic is mixed with the molten silicon. When the batch reaches a certain temperature, a quartz rod with a piece of silicon in a single-crystal form mounted on the lower end, is dipped into it and withdrawn very slowly. The rate of withdrawal is about one foot per hour. If the temperature and rate of withdrawal is right, the molten silicon will form on the master crystal lowered into the mix in the exact crystalline form of the master crystal. The result obtained is a single crystal ingot, about six inches long and one inch in diameter, of pure silicon containing a small amount of arsenic.

Fig. 28: RCA and Hunter-Bristol Div., Thiokol Chemical Corp. built this thermionic generator which uses rocket exhaust heat. It produced 270 w (80 w/lb) under test. Hollow cylinder fits over rocket-flame tube.

The ingot is cut into slices 16/1000th of an inch thick. Each slice is checked for resistance. The usable ones are placed in an electric diffusion furnace which heats them to a point just below their melting point. During this process, boron gas is forced across the surface of the silicon. As the boron diffuses into the silicon, the slices assume a smoked, blackened look.

After cooling and removal from the furnace, the silicon slice is etched with acid on one side to get to the base material (the depth of penetration of the boron is controlled by the length of time the slice is in the diffusion furnace and affects the spectral response of the completed cell). At the same time, another point on the cell, usually on the opposite side around the outside edge, is etched and prepared for plating to make the positive terminal.

After the etching is completed, both the positive and negative terminals are plated with pure nickel. Both plated terminals then are coated with lead-tin solder, so that wire leads may be easily attached and the cell is ready for testing.

Some Problems

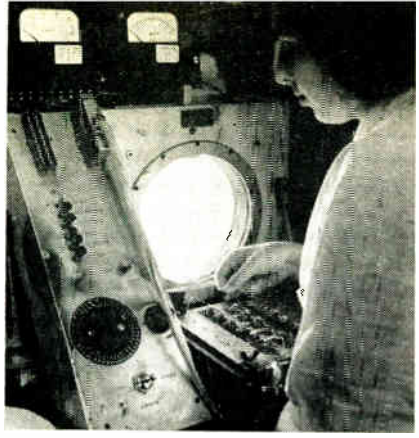
Two basic problems associated with the development of solar cells are efficiency and cost.

The cost of solar converters is still a major consideration mainly because of the price of the hyperpure silicon ($100 per pound) and the many hand operations required in production. But, the cost per completed cell has been reduced from $25 in 1955 to less than $3 today. A watt of power from high efficiency cells costs about $200 today. Cost is about $100 per watt for low efficiency units. Hoffman Corp. expects to cut this price by one-half in 1961 and by another one-quarter of the present cost by 1965. These reductions will be made possible by reduced cost of silicon, improved efficiencies, and lower production cost.

The output of the solar cell decreases with increasing temperature and one problem is to design solar arrays with adequate heat dissipation. For application in satellites and other space vehicles, the active cell surface may be covered with a very thin glass cover slip which yields a high value of thermal emittance at infrared wave lengths (the spectral response of silicon solar cells lies mainly in the visible and near infrared regions of the solar spectrum).

Another problem is to effectively use all of the energy available. For a given material, some photons may be too weak and the higher energy of some photons imparted to the electron-hole pairs is dissipated as heat. One way the scientists propose to correct this is to make the cells out of a combination of differing band gap materials (or make one cell with several different band-gaps). Each section would absorb part of the spectrum and transmit the rest to the next widest gap material.

Another problem is the resistance of the leads and interconnections between individual cells. One way to decrease the cells series resistance is by "gridding" the cells thereby allowing the surface current of the cell to be picked up nearer the point where it is gen-



Courtesy of International Rectifier Corp.

Fig. 29: Making silicon solar cells: Cells are first "grown" in the furnace in 'B.' After slicing into thin slices, they are formed into p and n type material in the fusion furnace in 'C.' 'A' shows the cell being graded for efficiency. A completed cell is shown in fig. 3.

erated instead of forcing it to flow through a resistive-layer to the edge contact.

Another technique is "Shingling" which is a simplified method of interconnecting the cells to provide desired voltages and currents. This method overlaps the edges of cells to provide a bond or solid connection between the positive terminal of one cell and the negative terminal of the next cell in the series.

Other Improvements

Other programs for the improvement of solar cells include a search for new materials, building larger cells, multiple junctions on a single thin film of silicon, and research on high temperature cells.

Although silicon is presently the most efficient and most highly developed material for solar cells, other materials have been and are being investigated. Some of the materials being studied are gallium arsenide (efficiences to 6½% achieved); cadmium sulphide (efficiencies around 6 to 9%); indium phosphide and gallium phosphide. Recent progress reports from RCA describes a gallium arsenide solar battery which they say can operate at high efficiency over a wide temperature range.

Cadmium sulfide is a particularly promising material. CdS cells have been made with an efficiency up to 7%. One advantage of CdS is that the decrease in efficiency with increase in temperature is so small that CdS and silicon are equally efficient at about 150°C. A high-voltage photovoltaic effect has also been observed in vapor-deposited cadmium telluride.

Nuclear Batteries

Nuclear energy can be converted to electrical energy in several ways. The large nuclear reactor used to generate steam for operating conventional generators is by now familiar to most of us, and we have mentioned the use of nuclear reactor and isotope heat for powering thermionic, thermoelectric, and MHD generators. But isotope energy can also be collected directly as electrical energy.

An isotope-powered electrostatic converter has three main parts. These are: a radioisotope source from which is obtained beta particles (the only suitable sources are those that emit mainly beta particles or fast electrons); a collector which captures these electrons; and the dielectric through which the particles pass and across which is developed the voltage. Let us consider each of these in turn.

Isotope Sources

The first important nuclear batteries (not considering very early devices such as Moseley's radium battery in 1913) used Strontium 90 as a source of beta particles. Some early devices which used this material produced potentials up to 17 kv and were less than 2 ft^3 in volume. But Strontium 90 is so toxic (the early batteries had over 1000 times the amount a human body could take) that few batteries using this material are being used today except for application where there is little danger to human beings.

Radiation Research Corp., 1114 First Ave., New York 21, N. Y., a pioneer in this field, is working on batteries (for the AEC) that use Tritium (H^3), Krypton-85 (See Fig 38) and Cerium $^{144}Pr^{144}$ as source materials.

Krypton is not metabolized in any way by the body so batteries using this material are hazardous only if unshielded. Even if the battery is accidentally opened, the Krypton dissipates harmlessly into the atmosphere. RRC is now manufacturing Krypton batteries. One Krypton battery built by RRC puts out 5 kv per cell (open circuit), 100$\mu\mu$a at no load and 50 $\mu\mu$a at 3 kv. The battery is ½ in. in dia. and 1 in. long.

RRC is building a prototype Cerium-144 battery with an output measured in watts compared to the microwatt output of previous batteries. It will contain about 2000 curies of cerium which has a half life of about 280 days. A stacked battery like this could deliver about 5 watts per cubic inch of radioactive material.

One significant property of electrostatic conversion nuclear batteries is that they develop very high voltages and low currents. Cerium-144 has a beta particle distribution with a mean energy of approximately 1,000,000 volts, and in the present design the output voltage is expected to be in the neighborhood of 250,000 volts. Stepping this voltage down to more usual power requirements (say 250 volts) can be done with a specially designed relaxation oscillator. Under these circumstances the power delivered to the load would be about 0.066 watts per gram (30 watts per pound) at the end of three years, with a capability of about 700,000 watt hours per pound.

Dielectric

The dielectric used is important. If air were used, for example, it would be ionized by the radiation and set up a current flow in the reverse direction. Vacuum

Power Converters *(Concluded)*

is the best dielectric for these devices which makes them ideal for space use because of the natural high vacuum there. Radiation Research Corp., has studied the use of solid dielectrics. They found that most materials were lowered in electrical and physical properties by the radiation but they also found that the resistivity of certain dielectrics was found to increase under continuing radiation and in some cases to approach the original unirradiated values.

Fig. 30: Krypton Nuclear Battery made by Radiation Research Corp. The company is using this battery in a Nuclear Delay Timer which can deliver a shot of power in a very fast pulse at a selected delay interval.

Acknowledgments

The author wishes to thank the staff of the Westinghouse Research Laboratory, Pittsburgh, Pa., for their efforts at the Company's Power Sources Conference in March this year. This well-presented program was the nucleus around which this article was built.

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36: Shoupp, Dr. W. E., "Thermoelectric Direct Conversion in Nuclear Reactors." (Delivered at Westinghouse Corp.'s Power Sources Conf., see item 20.)

37: "Some Plain Talk About Fuel Cells," Booklet published by General Electric Co.'s Aircraft Accessory Turbine Dept., Lynn, Mass.

38: Stauss, Dr. H. E., Rosenbaum, B. B., Maycock, P. D., and Cooper, J. C., "Status Report(s) on Thermoelectricity, NRL Memorandum Reports 901 and 969, Feb. and Dec. 1959. (Received from U. S. Naval Research Lab.)

39: Steele, A. D., "A thermoelectric Generator." (Received from 3M, see item 11.)

40: Way, Dr. Stewart, "Magnetohydrodynamic Generators." (Delivered at Westinghouse Corp.'s Power Conference, see item 20.)

41: Webster, H. F., "Calculation of the Performance of a High-Vacuum Thermionic Energy Converter," *Journal of Applied Physics*, Vol. 30, No. 4, pp. 488-492, April 1959.

42: Wilson, Volney C., "Conversion of Heat to Electricity by Thermionic Emission," *Journal of Applied Physics*, Vol. 30, No. 4, pp. 475-481, Apr. 1959.

43: Wilson, Volney C., "Thermionic Emission," Proceedings — 13th Annual Power Sources Conf., Power Sources Div., U. S. Army Signal R & D Lab., Fort Monmouth, N. J., 1959.

44: Zarem, A. M., "Power Systems—State of the Art, 1959," for the American Rocket Society Power Systems Committee.

45: Ellis, B., and Olds, Dr. Robert, "Thermionic Power Conversion" (received from Lockheed Aircraft Corp., Sunnyvale, Calif.).

Thermionic Converters on Production Line

Ultra-clean assembly line techniques are used in thermionic converter assembly line at GE's Schenectady tube plant. Techniques are needed because of small tolerances (0.5 mil) between cathode and anode of vacuum thermionic converters.

CLOSE-SPACED vacuum thermionic converters are being made on a pilot line operation with a capacity of 60 a week which can be stepped up to 100 a week. They will be available to the public in October. The pilot line is at General Electric Company's power tube plant in Schenectady, N. Y.

Each converter, type Z-5386, is about the size of a silver dollar and weighs 3 oz. The one-watt devices have a minimum power density of 0.2 watts/cm² of cathode surface and a minimum thermal efficiency of 2.5%. Cathode operating temp. is approx. 1,000°C.

Until now the Company's output of vacuum thermionic converters has gone to their Missile and Space Vehicle Dept. (Phila.) for development work in power supplies for space vehicles.

The major accomplishments which make these devices possible in quantity are: the development of reliable, long-life spacing techniques by which two large, optically flat surfaces, which must operate at high temperatures, can be precision spaced consistently at 0.5 mil.; and the development of a practical and reliable ultra-high temperature converter envelope for operation in an oxidizing atmosphere.

The Company is planning to produce vapor thermionic converters in the near future. They have already produced sealed-off, reproducible vapor thermionic converter structures using proprietary GE ceramics and ceramic-to-metal sealing techniques. They are working on the development of a lower-temperature vapor converter, and have already achieved power outputs of 2 w/cm² at cathode temperatures of approx. 1300°C in a sealed-off production-type converter. Efficiency for this operation was estimated to be between 8 and 12%.

Both close-spacing and use of cesium vapor are methods of overcoming space charge effects in the converters (see section on thermionic converters in "Unconventional Power Converters," this issue).

Vacuum Thermionic Converter. This 1-watt, close-spaced, sealed-off unit is the kind GE's Power Tube Dept. will market starting in October. Production depends on knowledge of state-of-the-Art in high temperature.

Vapor Thermionic Converter. Device uses Cesium gas to help overcome space-charge effect between cathode and anode. Power density is 2 w/cm²; efficiency (operating at 1300°C) is from eight to twelve per cent.

Photoelastic Delay Lines

CAPABILITIES of photoelastic delay lines include delay variability, multiple fixed taps, addition and multiplication of input signals, and exceptional second time signal suppression. Also, tapping of photoelastic delay lines does not attenuate the acoustic signal.

The devices are called photoelastic because an acoustic signal in a solid, transparent delay line is detected by optical means. The term photoelasticity itself refers to certain changes in the optical properties of isotropic, transparent dielectrics when subjected to stresses. In the case of photoelastic delay lines, an acoustic signal provides stress and an allied optical system detects the change in optical properties caused by the stress.

Multiple fixed tapped delay lines having delays up to 150 microseconds have been produced by use of this technique on an experimental basis. The feasibility of constructing lines having delay variability has been demonstrated. In addition, operation of two lines in tandem with appropriate optical elements has yielded a device which displays auto and cross-correlation.

The essential elements of the optical system include a photocell detector with a slit aperture. The slit width, is a function of the

(*Continued on page 234*)

New Tech Data for Engineers

Solving Quadratics

Illustrated brochure outlines step-by-step programming and solution of quadratic equations (such as: $ax^2 + bx + c = 0$) on the DE-60 computer. Programming of repetitive problems on the computer as shown on the coding sheet and wiring on a plugboard are described in detail. Instructions to the computer can be written and executed by non-technical personnel. The DE-60 is a low-cost, compact general-purpose all-transistor digital computer. Clary Corp., San Gabriel, Calif.

Circle 241 on Inquiry Card

Power Tetrode

Bulletin PT-35, 24-pages, contains detailed information on application and operating characteristics of the GL-6283 metal-ceramic tetrode for military and UHF uses. Tube features long life and reliability; has full power output to 900 MC, 300 w useful CW power and 100 w linear AM output at 400 MC. Also includes complete tech. data on 4 other power tetrodes which can be used in conjunction with the GL-6283. General Electric Power Tube Dept., Schenectady 5, N. Y.

Circle 242 on Inquiry Card

Digital Communications

Reprints of the paper, "Recent Developments and Appliances of Kineplex," a 16-page story describes new Kineplex systems designed to provide global digital communications via wire line and radio facilities. Description of the problems and requirements for digital communications on a global basis are included plus recent techniques and equipments playing major roles in establishing world-wide digital communications networks. Collins Radio Co., Western Div., 2700 W. Olive Ave., Burbank, Calif.

Circle 243 on Inquiry Card

Inductors

"Designing for Stability," a 22-part technical article, is available from Trak Electronics Co., 49 Danbury Rd., Wilton, Conn., as Incroductor Notes #6 and #7. It was written to assist design engineers in the use of electrically controllable inductors in applications in which the effects of temp. change and hysteresis must be minimized. Part 1 describes the effects of hysteresis and temp. changes and various open loop methods for min. these effects. The principles and general considerations of closed loop, bellweather stabilization is also discussed. Part 2 deals with specific closed loop and bellweather stabilization circuits.

Circle 244 on Inquiry Card

Stereo & Hi-Fidelity

Four-page booklet entitled, "Stereo and High Fidelity," from Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y. It contains a definition of stereophonic sound. A discussion on the stereo Sources of live broadcasting, stereo discs and tape follows. Also: a section on stereophonic systems describing various combinations of component set-ups, using all stereo components, or all monaural components, or both stereo and monaural components.

Circle 245 on Inquiry Card

Tantalum Capacitors

Technical information on the subject of wet type tantalum capacitors. Booklet, "The Original Tantalum Capacitor," Bulletin 6.100-5, is designed to give the electronic engineer all of the information he requires for his military or industrial application. It contains specs, performance characteristics, ratings, curves, and application data. Also covers Company's "PP" type capacitors ranging from 325 to 1.75 mfd, 6 to 125 max. working voltages for operation at 85°C at full ratings. Fansteel Metallurgical Corp., Rectifier-Capacitor Div., N. Chicago, Ill.

Circle 246 on Inquiry Card

Relays

A 2-page data sheet illustrates and lists specs of the MV7033 crystal can size relay which conforms to Specs MS24250-6 (USAF), MIL-R-25018, and has been placed on the Military Qualified Products List. Includes dimensional drawing showing mounting and terminal arrangement. Also: a 2-page data sheet on hermetically sealed military relays and a 4-page bulletin (ARSP-8) which illustrates and lists over 115 Elgin Advance Relays available from stock. Included are antenna, coaxial, time delay, thermal delay, contactor, general purpose, latching, miniature, overload, power control, power transfer, radio control, sensitive and telephone types. National Watch Co., Electronics Div., 2435 No. Naomi St., Burbank, Calif.

Circle 247 on Inquiry Card

Synchronous Motors

Slo-Syn Data Sheet No. 1, 4-pages, explains the use of Slo-Syn synchronous motors as dc stepping motors. It also explains and graphically shows stepping principles of permanent magnet type motors. Contains diagrams and speed-torque characteristics charts. Details of bifilar motors are described also. In 4-colors. The Superior Electric Co., Dept. SS, Bristol, Conn.

Circle 248 on Inquiry Card

Decade Counter Tubes

New counter tube handbook describes the construction, operating principles and applications of a wide variety of decade counter tubes used in computers and tabulating machines, radiation measuring instruments, frequency dividers, and other electronic equipment. The 12-page handbook contains illustrated sections on design procedures, specs, and circuit information. Also, new drive circuits for medium speed and high speed (100 KC) types. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y.

Circle 249 on Inquiry Card

Checkout Equipment

Brochure, "Automatic Electronic Checkout Equipment," from Packard Bell Electronics, 12333 W. Olympic Blvd., Los Angeles 64, Calif. Folder contains 12 data sheets on these items: C-9 Systems Control Set; P6 Maintenance Unit; N1, N2 Display-Control Panels; B5 Pyrotechnical Test Unit; M3 Logic Switching Unit; C9 800 Cycle Amplifier Unit; M4 Amperage Switching Unit; S17 Attenuator Module (Servo Amplifier Tester); E7 Power Supply; P8 Pulse Generator; and T9 Signal Generator. Characteristics and applications are included.

Circle 250 on Inquiry Card

Computers

A preliminary brochure describes the products, facilities, and personnel of a relatively new company in the instrumentation, computers, controls, and data handling fields. Computronics, Inc., 5310 East Pacific Place, Denver 22, Colorado, is interested in undertaking study contracts and assignments to design and fabricate special computing and control equipment. The company already has a line of components and accessary products for computer systems use including analog system controls, servo set potentiometers and diode function generators.

Circle 251 on Inquiry Card

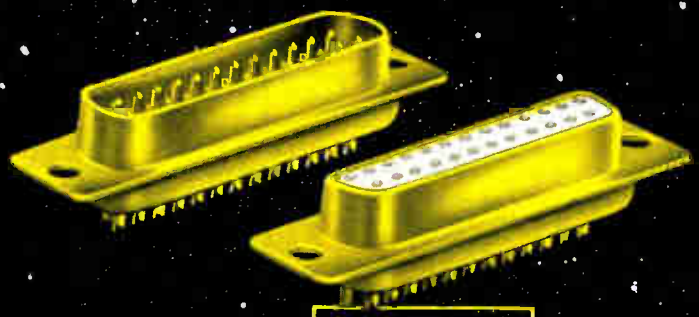
Optical Elements

Servofrax(R) arsenic trisulfide glass used in the fabrication of the optical elements for infrared pyrometers, spectrometers, gas analyzers, monochromators, military IR equipment, temp. control systems, and other infrared detection and control devices is analyzed in a new 8-page brochure from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y. Detailed drawings and specs are included on standard cell windows for use with Beckman, Baird Assoc., and Perkin-Elmer IR cells. Sections on meniscus lenses and Servocon® achromat lenses are included.

Circle 252 on Inquiry Card

For protection against

PROBE DAMAGE



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For Commercial Requirements

The CINCH STANDARD "D"*

designed to withstand rigid environmental conditions imposed by Military Specs—

*Manufactured by agreement with Cannon Electric Company

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Complete engineering data on both the Golden D Connector and the Standard D Connector is yours for the asking. Specification sheets and Catalog 100, cover Cinch Connectors. D Sub-Miniature, DPX and DPA types. Phone NE 2-2000 today or write/wire.

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Circle 49 on Inquiry Card

Division of United Carr Fastener Corporation. Boston, Massachusetts

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

New Tech Data for Engineers

Infrared Radiation

Infrared Bulletin 11-010, 8-pages, from Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn., gives a comprehensive outline of the historical development and the scientific principles of "black body" infrared radiators. It covers fundamental theory, the various radiation laws, and the curves and equations evolved by the major classical scientific contributors to the field. The bulletin includes a discussion of present-day design considerations for laboratory standard sources, as applied in Barnes Opti-Therm® instruments. Descriptions, photos and specs are given for the Company's infrared sources.

Circle 253 on Inquiry Card

Ultrasonic Generator

Data sheet from National Ultrasonic Corp., 111 Montgomery Ave., Irvington, N. J., describes the firm's Model G-310 generator. The generator is rated at an output of 1000 w ave. power and 2000 w peak at 38 to 42 kc and will drive 192 sq. in. of barium titanate crystal radiating surface. The 2-color data sheet includes equipment, photos, description, specs and ordering information.

Circle 254 on Inquiry Card

Cable and Hook-up Wire

New 18-page "Multi-Conductor Cable and Hook-up Wire" catalog—covering Teflon TFE, Teflon, FEP 100, and PVC—describes design and engineering capabilities, including round and ribbon cables and assemblies of Times Wire and Cable Div., The International Silver Co., Wallingford, Conn. Full lines of U/L Approved Teflon wire, and Teflon FEP 100 hook-up wires are included.

Circle 255 on Inquiry Card

Beam Pentode

Data sheet, Form 535, describes the P1-175A Beam Pentode made by Penta Laboratories, Inc., 312 North Nopal St., Santa Barbara, Calif. It is a 400 w plate dissipation beam pentode which may be used to replace directly the 4-400A, with no circuit modifications and only slight readjustment of tuning controls. In Class AB, amplifiers, this can result in 20 to 40% greater output.

Circle 256 on Inquiry Card

Microwave Communications

"B.E.C. Review" is a new bi-monthly publication containing news and technical information about microwave radio and telephone communications. Budelman Electronics Corp., 375 Fairfield Ave., Stamford, Conn.

Circle 257 on Inquiry Card

Direct-recording Oscillograph

The many applications of the Model 906 Visicorder, a direct-recording oscillograph, are illustrated with a selection of case histories in "A Manual of Visicorder Applications" from Minneapolis-Honeywell Regulator Co., Heiland Div., 5200 E. Evans Ave., Denver 22, Colorado. The 34-page booklet has illustrations from industrial, medical, military, nuclear, and research and test fields.

Circle 258 on Inquiry Card

Magnetic and Drum Heads

Complete specs covering magnetic recording and reproducing heads and drum heads are in Specs DS 3301a and DS 3400. Included are formulas for determining the correct magnetic heads, playback voltage and turns and gap. An application data sheet is also included. Included in the drum head specs are 3 representative types of Honeywell drum heads. Minneapolis-Honeywell Industrial Systems Div., 10721 Hanna St., Beltsville, Md.

Circle 259 on Inquiry Card

Trimmers-LC Tuners

A condensed listing and description of its latest entire line of variable trimmer piston capacitors and L-C tuners is offered by JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y. Capacitance range, dc working volts, dielectric strength, insulation resistance, Q factor, temp. coefficient, dielectric material and length are given for each component (single-page chart).

Circle 260 on Inquiry Card

Microwave Tubes

New product catalog contains specs on over 600 microwave tubes and components including: TR, ATR, pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers, pressurizing windows; noise source tubes; high frequency triode oscillators; and surge protectors. Bomac Laboratories, Inc., Salem Rd., Beverly, Mass.

Circle 261 on Inquiry Card

Semiconductors

Tabular listing of the semiconductor devices produced by North American Electronics, Inc., 212 Broad St., Lynn, Mass. Products include rectifiers and power regulators in stud and axial lead styles. Information includes electrical and mechanical specs and applications. Six-page folder is in two-colors.

Circle 262 on Inquiry Card

Switch Brochure

A 24-page brochure on Burroughs' BEAM-X switch, contains more than 50 illustrations, covers theory of operation, circuit design information, characteristic curves and many applications in counting, coding, distributing, converting, multiplexing, switching and sampling. Also contains a detailed glossary and maintenance and trouble-shooting section. Brochure BX-535 from Burroughs Corp., Electronic Tube Div., Plainfield, N. J.

Circle 263 on Inquiry Card

Selenium Rectifiers

New 8-page Selenium Rectifier Catalog No. 4002 carries cell ratings and detailed specs and dimensions with max. and min. voltage and current ranges of high voltage stacks, power stacks, and ac and dc surge suppressors. Booklet covers all types of construction, including open type, embedded and metal enclosed. Also included are stack connections for various types of circuits. Sarkes Tarzian, Inc., Semiconductor Div., 415 College St., Bloomington, Ind.

Circle 264 on Inquiry Card

DC to DC Converter

Single-page tech sheet from Transformer Electronics Co., Boulder Industrial Park, Boulder, Colorado, describes the Model 0164 Dc-to-Dc Converter which provides adjustable high voltage outputs of up to 2,000 v for operation of photomultiplier tubes, and other high voltage devices at currents of up to 100 μa. Input is 16 to 29 vdc and ripple not greater than 1% RMS at any voltage or current within ratings.

Circle 265 on Inquiry Card

Capacitors

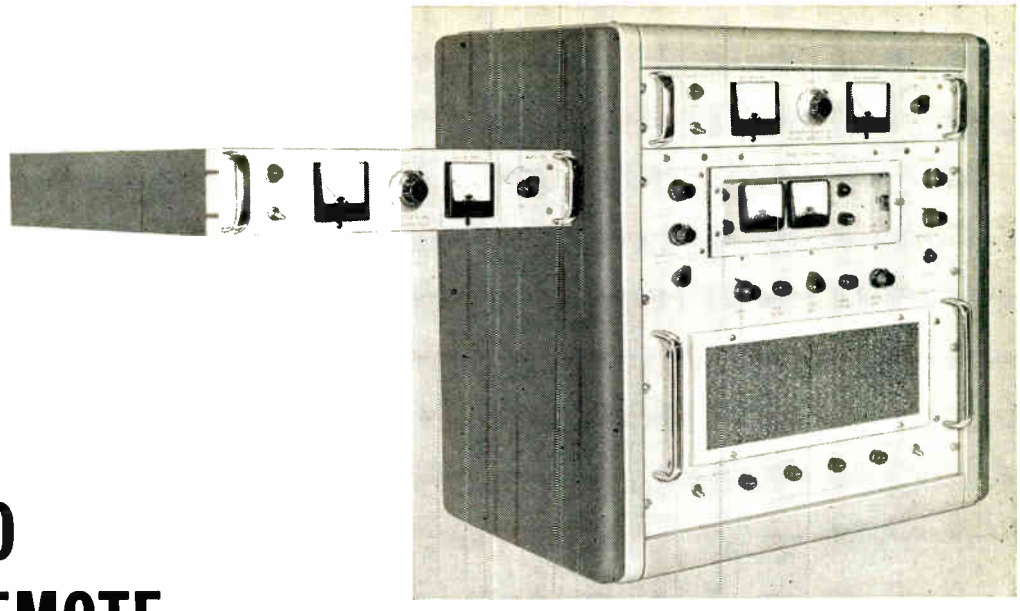
New 20 page manufacturer's capacitor catalog, #42-407, from Centralab, 900 E. Keefe Ave., Milwauke 1, Wis. It covers special purpose capacitors exclusively, and supplements the recently issued Centralab General Purpose Capacitor Catalog. It includes feed-thru, tubular and rotary trimmers, transmitting, flat plate, discoidal, precision, and high voltage units. Complete specs and dimensional drawings given.

Circle 266 on Inquiry Card

Component Dispenser

Spec sheet from Schmit Engineering Co., 4062 Fabian Way, Palo Alto, Calif., describes their Bend-Amatic Component Dispenser which has 48 in. of storage capacity in 6 hopper chutes and automatically or semi-automatically cuts and bends axial leads of electronic components.

Circle 267 on Inquiry Card



Model SS 20 Signal Source Power Supply with Tuning Unit. Tuning Unit is removed to control position for remote operation. Inset shows unit removed for remote operation. In this mode, control unit can be operated up to one mile away.

TWO REMOTE TUNED SIGNAL SOURCES

(50 mc to 2 kmc, and 1 to 37.5 kmc)

Now Scientific-Atlanta offers two remote tuned signal sources which provide complete frequency coverage from 50 mc to 37.5 kmc. These sources are primarily designed for use as transmitters for antenna test ranges but find many other applications where remote tuning at distances up to a mile or more is required.

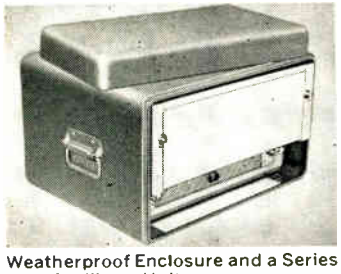
MODEL SS 30 (50 mc to 2 kmc)

Contains three GR Unit Oscillators mechanically ganged and servo driven. • RF output capable of being sine or square-wave modulated. • Frequency accurately resettable to within ±0.5%.

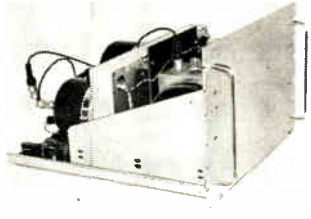
MODEL SS 20 (1 to 37.5 kmc)

Extended frequency coverage with seven Series RFO Oscillator Units. Integral-magnet backward wave oscillators are voltage tunable and require no mechanical peaking. • RF output capable of being square-wave modulated. • High signal purity, low residual fm. • Will operate cm and mm-wave klystrons. • Remote tuning unit will also operate SS 30 Signal Source.

KEY SPECIFICATIONS	MODEL SS 30	MODEL SS 20
Frequency Range	50 mc to 2 kmc	1 to 37.5 kmc
Tuning Chart Accuracy	±2%	±5%
Frequency Resettability	±0.5%	±0.1% or 5 mc, whichever is greater
Power Output	80 mw into 50-ohm load	see table of RFO Oscillators



Weatherproof Enclosure and a Series RFO Oscillator Unit.



Model SS 30 RF Oscillator Unit

SERIES RFO OSCILLATOR UNITS

MODEL	FREQUENCY RANGE	OUTPUT POWER
RFO 1	1.0 - 2.0 kmc	40 - 800 mw
RFO 2	2.0 - 4.0 kmc	100 - 800 mw
RFO 3.6	3.6 - 7.2 kmc	5 - 300 mw
RFO 7	7.0 - 11 kmc	20 - 300 mw
RFO 8.5	8.5 - 16 kmc	5 - 100 mw
RFO 15.5	15.5 - 24 kmc	5 - 125 mw
RFO 23.5	23.5 - 37.5 kmc	5 - 100 mw

PRICES

Model SS 30, $3,850; SS 20, $3,550; SSG 1 Sine-Square Wave Generator, $350; RFO 1, 2 and 3.6, $1,400; RFO 7, $1,900; RFO 8.5, $2,060; RFO 16, $3,330; RFO 23.5, $3,330. For more details, please contact your S-A representative or write directly. Address Dept. 44.

SCIENTIFIC-ATLANTA, INC.

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New Tech Data for Engineers

Capacitors

New full line catalog from EFCON, Inc., Patterson Pl., Roosevelt Field, Garden City, L. I., N. Y. Spiral bound book includes engineering bulletins, test information, application notes, dimensional drawings and rating charts for: Mylar miniature capacitors, teflon high temp., polystyrene miniature, polystyrene high stability, glasscon acetate high voltage, and the new line of miniature solid tantalum electrolytic capacitors.

Circle 268 on Inquiry Card

Electrostatic Generators

Six-page, illustrated pamphlet describes the SAMES line of industrial-type electrostatic generators. It includes electrical and mechanical specs on 18 electrostatic generators providing output voltages ranging from 50,000 to 600,000 vdc and power outputs as high as 2400 w. Sorensen & Co., Richards Ave., So. Norwalk, Conn.

Circle 269 on Inquiry Card

Language Translator

New language translator bulletin from Hermes Electronics Co., 75 Cambridge Pkwy, Cambridge, Mass., describes the various types and techniques of code conversion and the relative merits of different numerical codes which maye be employed. A discussion on the theory of numerical codes is included. Bulletin is 4-pages and 2 colors.

Circle 270 on Inquiry Card

Disc Type Thermistors

A listing of preferred parts taken from disc type thermistor catalog, "Keystone Thermistors Section 1: Disc Type (Feb. 1960)" from Keystone Carbon Co., Resistor Div., St. Marys, Penna. Listing includes 340 parts in a range of sizes and characters available from open stock. Included is a chart giving electrical characteristics and dimensions and other tech data.

Circle 271 on Inquiry Card

Diode

Spec sheet on the JAN approved type 1N251 diode is now available from Fairchild Semiconductor Corp., 4300 Redwood Hwy, San Rafael, Calif. In addition to meeting JAN specs MIL-E-1/1023, the Fairchild 1N251 features: Surface passivation and Planar structure. The 1N251 is useful in switching and r-f applications requiring low shunt capacitance.

Circle 272 on Inquiry Card

Silicon Stabistors

Bulletin 11-133, 2-pages, has tech data for silicon stabistor, Types STC 135 and STC 235. It includes specs, curves and illustrations for these units which are for use in transistor bias circuits, low level clipping or in reference and regulator service. Silicon Transistor Corp., Carle Place, N. Y.

Circle 273 on Inquiry Card

Infrared Calibration

Tech data sheet describes the Model PE-537 infrared source calibration system, which provides for checking, maintaining and adjusting infrared reference sources to a known IR radiation power level. Construction, operation, and specs are included. Electro-Optical Div., The Perkin Elmer Corp., Norwalk, Conn.

Circle 274 on Inquiry Card

Zener Diode Line

Information on an extension of its Zener Diode line (versions of the entire line with ratings increased to 750 mw) available from Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif.

Circle 275 on Inquiry Card

Speed Reducers

Reduction drives are discussed in an 8-page brochure from Black Tool, Inc., 1924 So. Navajo St., Denver 23, Colo. Torque ranges from 30 in.-lb/lb to 80 in.-lb/lb. The brochure explains how they work, and how to select the drives. Included is a chart of standard model's ratios, output RPM, and input and output hp.

Circle 276 on Inquiry Card

Pressure Transducers

Two new catalog sheets contain specs on Models 409 Absolute Pressure Transducer and 509 Differential Pressure Transducer. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 277 on Inquiry Card

Antenna Facilities

Antenna Systems, Inc., Hingham Industrial Center, Hingham, Mass., has released a 4-page file folder that briefly describes their areas of interest and capabilities for designing and manufacturing antennas. It also gives brief biological sketches and qualifications of the principals in the firm.

Circle 278 on Inquiry Card

Transistor Testing

A single-page tech. bulletin released by Dynatron Laboratories, 71 Glenn Dr., Camarillo, Calif., describes the operation of a transistor checker which permits direct reading of the following dc parameters: Beta, ICO, Inverted Beta, and IEO. A discussion is included regarding the testing of these important dc parameters.

Circle 279 on Inquiry Card

Facsimile Equipment

Line of facsimile communications equipment is described in a new 4-page brochure from Westrex Corp., 540 W. 58th St., New York 19, N. Y. It describes varied equipment for transmitting photos, messages, data, news and other types of graphic information by telephone or radio links.

Circle 280 on Inquiry Card

Log Amplifier

Information on a new logarithmic amplifier, Model LA, which makes 70 db dynamic sweep frequency filter measurements possible with standard oscilloscopes or X-Y plotters, is available from Jerrold Electronics Corp., 15th & Lehigh Ave., Philadelphia 32, Pa.

Circle 281 on Inquiry Card

Damping Materials

Six-page folder from Barry Controls describes Rigidamp®, a damping material which reduces the resonant-vibration response of structures subjected to shock or vibration. The folder describes the material and tells what it does, where it is needed, how it works, and how it is used.

Circle 282 on Inquiry Card

Creative Analysis

New, 10-page booklet describes Company's customer service program, "Creative Analysis." It has "Case Studies" on improving production methods and patterns through the use of solderless termination techniques and application tools. AMP Inc., Harrisburg, Pa.

Circle 283 on Inquiry Card

Circuit Breaker Control

New booklet tells how to apply electrical operators for the remote control of circuit breakers. The 4-page publication, booklet B-7534, is entitled, "Westinghouse Electrical Operators." Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 284 on Inquiry Card

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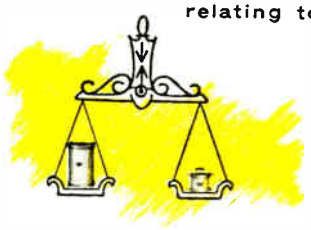
a continuing series on technical topics relating to electronic applications

Folio 11 REFERENCE DATA FILE SANGAMO



Considerations In Selecting Mica Capacitors

Mica Capacitors may have identical capacitance and voltage rating on their name plates, yet one may be up to a hundred times larger than another—why? It is the purpose of this article to discuss how the dc voltage rating, rf voltage rating, rf current rating, corona starting voltage, and pulse application affects size and physical configuration of mica capacitors. Examples will be given showing typical Sangamo types that are used to account for these electrical environmental variations.

DC Voltage Rating — Many electronic applications require that a mica capacitor be used in a circuit of moderate to high-voltage dc with a slight ac voltage superimposed on it. Because mica exhibits a very low dissipation factor, very little heat is generated due to the small amount of ac. Of primary concern is the dc voltage stress. Mica has a very high dielectric-strength capability. Hence, required capacity can be contained in a package that is significantly small such as Sangamo's Types D, DR, KR, CR, H and A. (Figure 1)

Fig. 1

Type-DR Type-H Type-A

RF Voltage and Current Rating — Like the small mica capacitors described above, capacitors of a larger size are frequently required to operate with a comparable dc voltage across their terminals. However, in transmitting rf oscillator tank circuits, radio frequency is predominant and the primary requirement is the ability to handle a large magnitude of rf current. It is therefore necessary to use a capacitor that can dissipate the heat generated

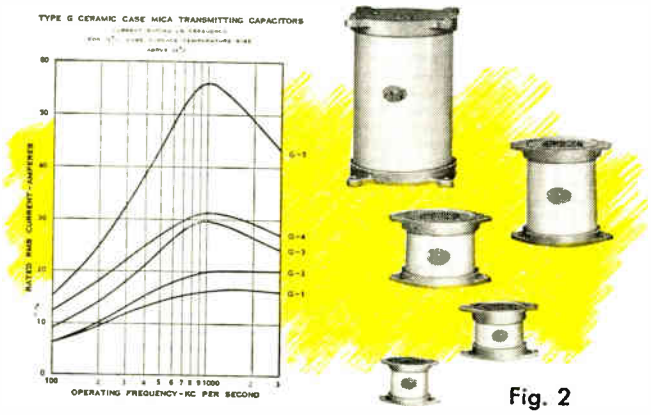


Fig. 2

by the rf field. Because these factors are so important, transmitting capacitors are rated in rms current and peak working volts. They are usually potted in a material that has a high thermal conductivity and packaged to have a large surface area. Sangamo's Types E, F, and G are examples of high rf current application capacitors. Figure 2 shows, for example, the relative size and current-carrying ability of Types G1, G2, G3, G4 and G5.

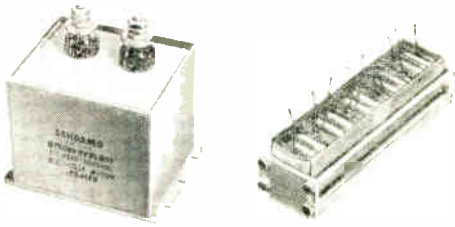
Corona Starting Voltage — Corona can occur in any capacitor where the conditions are right. Capacitor manufacturers are aware of this and design accordingly. Where amplitude and frequency of ac voltage across the capacitor are relatively low, a wax impregnant can be used. However, when voltage is low and frequency is high, a liquid impregnant is used. The difference is due to the physical nature of the impregnant. The wax, when cooling, leaves holes and promotes corona, while a liquid impregnant is homogeneous. A typical example of a liquid impregnated capacitor that is used for miniaturization, low distributed inductance, and high frequency applications is the Sangamo Button® Capacitor. (Figure 3)

Fig. 3

Type M-23 Type M-63 Type M-72

Pulse Application — Unfortunately there are no industry standards on capacitor ratings for pulse applications. Design and testing of these capacitors follow individual specifications at the present time. Applications involving high-frequency pulse operation should be reviewed carefully with regard to corona and peak stresses. These two factors are very closely related to life expectancy of the capacitor. With the growth of pulse circuitry, users and manufacturers must begin to develop meaningful specifications, standards, and test procedures for pulse capacitors. Figure 4 shows typical examples of Sangamo Capacitors designed for pulse applications. The Type N-87 is a multiple-section Sangamo mica capacitor designed for packaging with other components in a hermetically sealed, oil-filled enclosure.

Fig. 4



Type N-38 Type N-87

Your inquiry for more complete information on special applications of Sangamo mica capacitors is invited.

SC60-5

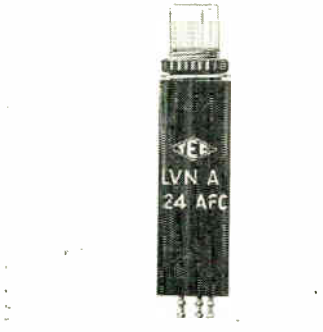
SANGAMO ELECTRIC COMPANY, Springfield, Illinois

—designing toward the promise of tomorrow

New Products . . . for the Electronic Industries

TRANSISTOR DRIVEN LIGHTS

Miniature neon transistor driven indicator lights operate on low supply voltages. Min. life is 25,000 hrs. (with NE-2H at 0.5 ma lamp current). A self-contained transistor oscillator

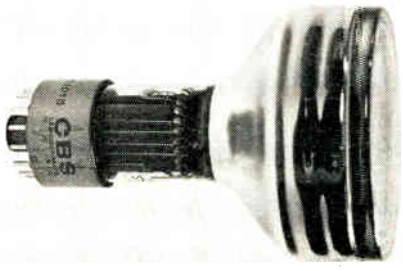


circuit converts low dc voltage to ac, stepped up to the supply required. Series includes 5 standard models (6 vdc to 24 vdc). Lamps have 2 terminals. 3-terminal unit available lights only on an input signal. Operating temp. is from −40° to 65°C. Power consumption 150 mw nominal. Body length is 1¾ in.; dia. 9/16 in. Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.

Circle 181 on Inquiry Card

PHOTOMULTIPLIER TUBE

A new 5-in. dia. 10-stage photomultiplier tube, CL-1015 withstands 40g shock of 11 msec duration and 10g vibration of 0-2000 cycles in each of 3 planes. It is interchangeable with



existing 5-in. 10-stage tubes. The faceplate is plano-concave with S-11 photocathode (visible response) deposited on a curved surface for excellent uniformity of response across the face of the tube, due to very high photoelectron collection efficiency. Linear output current is as high as 200 ma for 100- μsec pulses. Electron Tube Dept., CBS Laboratories, High Ridge Rd., Stamford, Conn.

Circle 183 on Inquiry Card

TONE GENERATOR

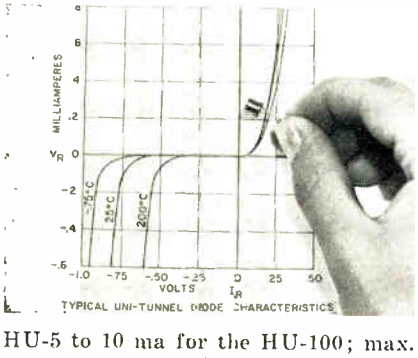
New tone generator, Model G-137 for missile environment includes 10 high stability tone oscillators in the 30 to 400 cps range and a mixing amplifier. Application of 1 or all remote

28 vdc gate signals turns on the tone oscillators connected to the amplifier. These produce a mixed composite signal at the output of the mixing amplifier which may then be fed to a transmission line or to a voltage controlled subcarrier oscillator. It indicates the precise occurrence and sequence of remote functions. Alto Scientific Co., Inc., 855 Commercial St., Palo Alto, Calif.

Circle 185 on Inquiry Card

SILICON DIODE

The "Uni-Tunnel" diode combines high efficiency at low voltage levels with extreme temp. stability over a wide temp. range. It utilizes the tunneling effect to provide high forward conductance at very low voltage levels. Biased in the reverse direction, the tunnel diode characteristic appears as a leakage current of micro-amp magnitude. Temp. range is −85°C to +200°C. Twelve types are offered from HU-5 and HU-5A to HU-100 and HU-100A. Min. forward currents at 0.25 v. range from 0.5 ma for the

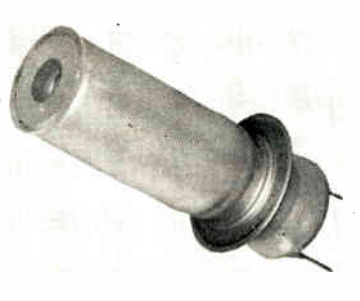


HU-5 to 10 ma for the HU-100; max. reverse currents (0-0.5 v) range from 5 μa to 100 μa. Hoffman Electronics Corp., 3761 S. Hill St., Los Angeles 7, Calif.

Circle 182 on Inquiry Card

INFRARED DETECTORS

Indium antimonide photoconductive infrared detectors, sensitive in the intermediate infrared spectrum. Detector cells have high sensitivity and fast response. For cooling to operating temp. of 77°K, the sensitive element is mounted on the end of a cooling well using either liquid nitrogen or a cryostat for operation with pressurized nitrogen gas. A wide range of cell resistances permits efficient coupling to either transistor or vacuum tube preamplifiers. Detectivity (D) measured at 77°K operating with a

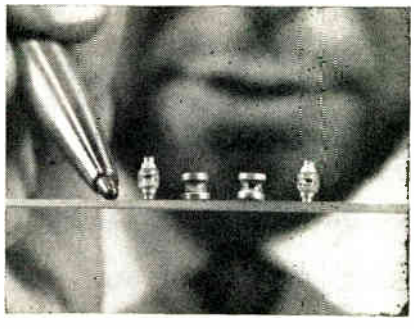


500°K black-body radiation source, a 900 cps chopping frequency, and a 1 cps bandwidth, is in excess of 4 x 10⁹. ITT Laboratories, 3700 E. Pontiac St., Ft. Wayne, Ind.

Circle 184 on Inquiry Card

MICROMINIATURE DIODES

Two series of microminiature silicon mesa varactor diodes, 1/18 in. in length and width, Series D-4140A to E and Series D-4141A to E, are electrically similar to the larger Series D-4075. The D-4141 types (center units) are 0.125 n. in dia. and 0.125 in. in length. They are designed with gold-plated flange-type and caps. The D-4140 series (end units) measure 0.105 in. in dia. x 0.235 in. in length and have gold-plated precision axial mounting studs. Both series can operate to 100°C with cut-off frequen-



cies up to 70 KMC. The D-4140 package is for traveling wave structure parametric amplifiers. Sylvania's Semiconductor Div., 100 Sylvan Rd., Woburn, Mass.

Circle 186 on Inquiry Card

INDICATOR LIGHTS

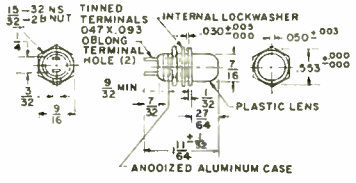
for every panel design by ELECTROSNAP HETHERINGTON CONTROL SWITCH DIVISION

CONTROLS COMPANY OF AMERICA
1426 Delmar Drive • Folcroft, Pennsylvania

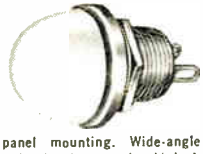
Shown below are only a few of the more than 50 basic standard types of indicator lights available from Control Switch Division. Actually, there are dozens of variations in color, mounting, appearance and circuitry possible for almost every basic style. For example, indicator lights are available for 6, 14, or 28 volt, D.C. and 110 V. A.C. circuits. So whatever your needs, there are ready-made, in-stock indicator lights to fit your panel.

SERIES L14005B

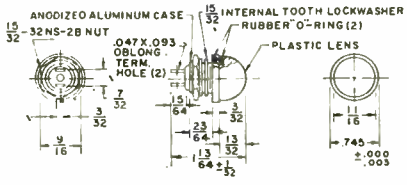
Conforms to MS-25256. Long plastic lens for 180° visibility. Front panel mounting (L14000) shown; also available for back mounting (L14200). Uses MS-25237 lamps



SERIES L5105



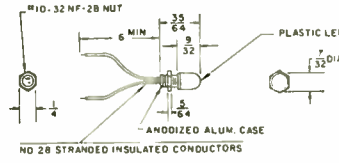
Watertight, front-of-panel mounting. Wide-angle visibility. 2-terminal circuit. Mounts in ½-inch hole. Uses MS-25237 lamps. Press-to-Test Model L16200 available.



SERIES L10000

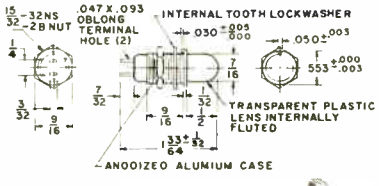
Supplied with 5V. Lamp

Sub-miniature, moisture-proof. Rated life of 60,000 continuous hours at 5 volts. Models available to mount flush with panel surface.



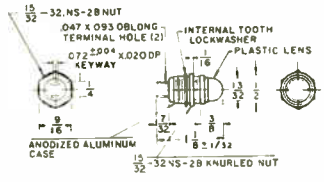
SERIES L15015B

Neon indicator with built-in 62,000 ohm resistor for 115V circuits. Conforms to MS-25257. Available for front or back panel mounting.



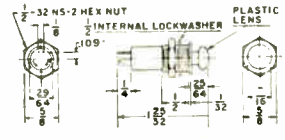
SERIES L14215

Special model for back-of-panel mounting on very compact panels. Mounting nut is tightened from front. Lens has knurled nut for easy removal of lens-lamp module. Uses MS-25237 lamps.



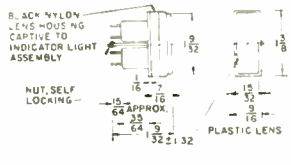
SERIES L3005

Moisture-proof push-to-test indicator light. Test lamp circuit by pushing plastic lens. Supplied with or without silicon rubber boot to seal panel. Lens has "O"-ring seal. Flange-type mounting in ½-inch hole. Uses MS-25237 lamps.



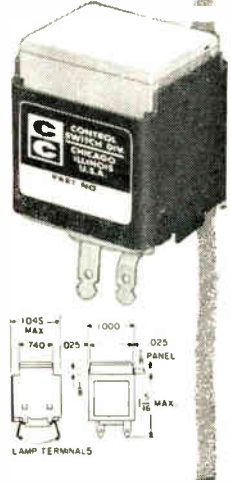
SERIES L5915

Miniature "bill board" placard contains two MS 25237 lamps. 2 color model shown (L5915), also available: 1-color (L5900) and Press-to-Test (L5200). All legends engraved (not hot stamped). Self indexing unit. Captive lens.



SERIES C6

TWINLITE modular indicator light assembly with identical panel appearance and mounting configuration to Series C6 lighted push-buttons. Mounts with barriers in rows, in matrix, or individually. Contains two lamps on individual or common circuits. Split or solid color buttons available. With 6 V or 28 V lamps.



ELECTROSNAP HETHERINGTON

CONTROL SWITCH DIVISION

CONTROLS COMPANY OF AMERICA

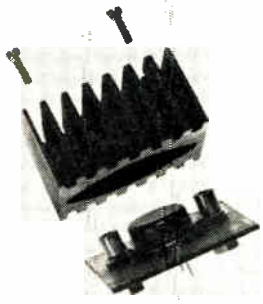
Factories at Folcroft, Pa.; Chicago, Ill.; El Segundo, Calif.

Circle 53 on Inquiry Card

New Products

TRANSISTOR HEAT SINK

Power transistor junction temperatures can be controlled below recommended maximums and yet maintain max. power output with this new heat sink. The unit, 1-55/64 in. square x

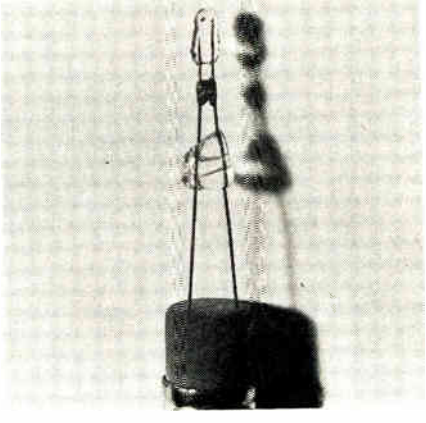


1-13/64 in. high, accommodates power transistors of the TO-3 and TO-36 outline. Radiator is anodized cast aluminum alloy with insulated aluminum base plate. Stainless steel mounting hardware and fibre insulators are supplied. Augat Bros., Inc., 33 Perry Ave., Attleboro, Mass.

Circle 211 on Inquiry Card

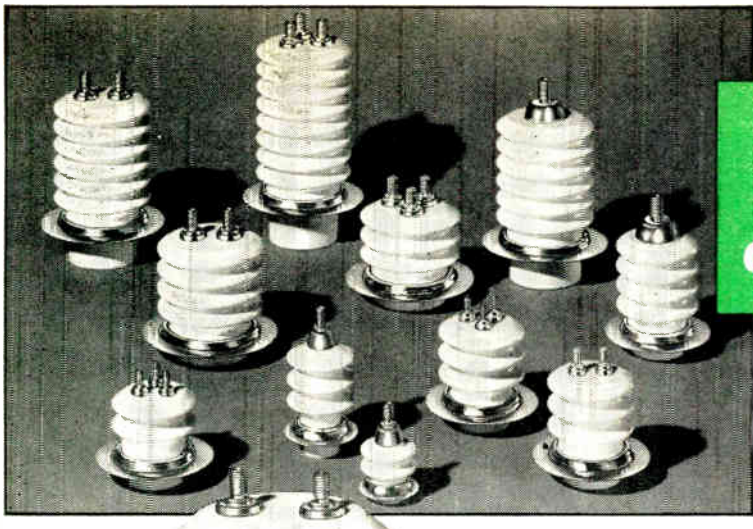
VAPOR DETECTOR

The Humistor is a device for detecting and measuring vapor or gases which exhibit an electric dipole moment, e.g. water vapor, Ozone, etc. It detects minute H^2O vapor concentrations in air. Classification of mixed ambients may be accomplished through use of selectivity transparent



coatings. Temperature sensitivity: Insensitive from 0°C to 100°C; Instrumentation: Readout may be accomplished on a conventional Megohmmeter. Conrad-Carson, Inc., 3110 Goddard Way, San Diego 1, Calif.

Circle 212 on Inquiry Card



ALITE®

CERAMIC-TO-METAL SEALS

Standard Bushings or Special Designs

FROM ONE COMPLETELY INTEGRATED SOURCE

ALITE — with its completely equipped facilities for producing high quality, vacuum-tight, ceramic-to-metal seals — is geared to meet all your requirements for high alumina ceramic-metal components. From design to finished assembly, every manufacturing step — including formulating, firing, metalizing and testing—is carefully supervised in our own plant. Result: effective quality control and utmost reliability.

Hermetic seals and bushings made of high alumina Alite are recommended for electromechanical applications where service conditions are extremely severe or critical. Alite has high mechanical strength and thermal shock resistance. It maintains low-loss characteristics through a wide frequency and temperature range. It resists corrosion, abrasion and nuclear radiation. Its extra-smooth, hard, high-fired glaze assures high surface resistivity.

To simplify design problems and speed delivery, Alite high voltage terminals, feed-throughs and cable end seals are available in over 100 standard sizes. However, when specifications call for special units for unusual applications, you can rely on expert assistance from Alite engineers to help you take full advantage of Alite's superior properties.

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ALITE DIVISION

U. S. STONEWARE

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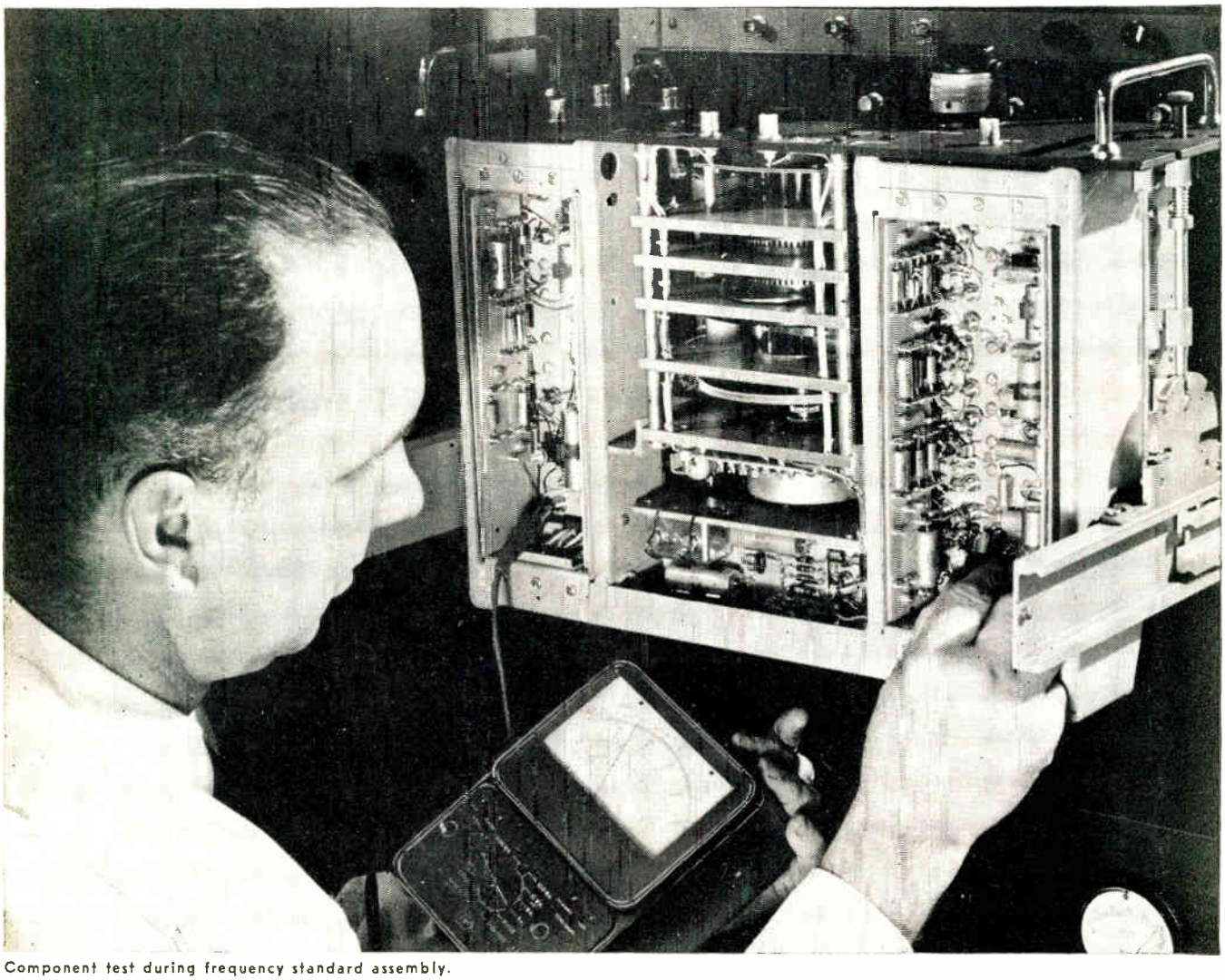
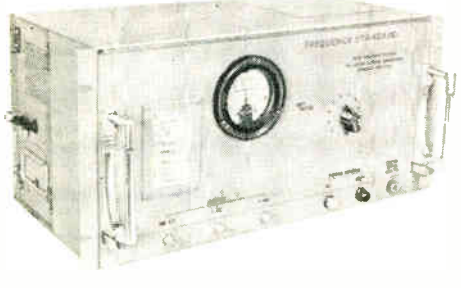
...another assurance of reliability from BORG



Component test during frequency standard assembly.

Frequency Standards with one part in a billion stability can't be mass-produced



Borg Frequency Standards are the world's most stable standards commercially available . . . one part in 10^9 for a twenty-four hour period. To achieve this kind of stability, every standard must be *hand assembled* and tested during each phase of production. Frequency is adjustable over a range of ± 5 parts in 10^8 with a setting accuracy of one part in 10^{10} . . . in temperatures from + 32 F to + 122 F . . . withstanding shocks of up to 15 g's. Stationary or mobile models available. *Write for complete data.*

BORG EQUIPMENT DIVISION
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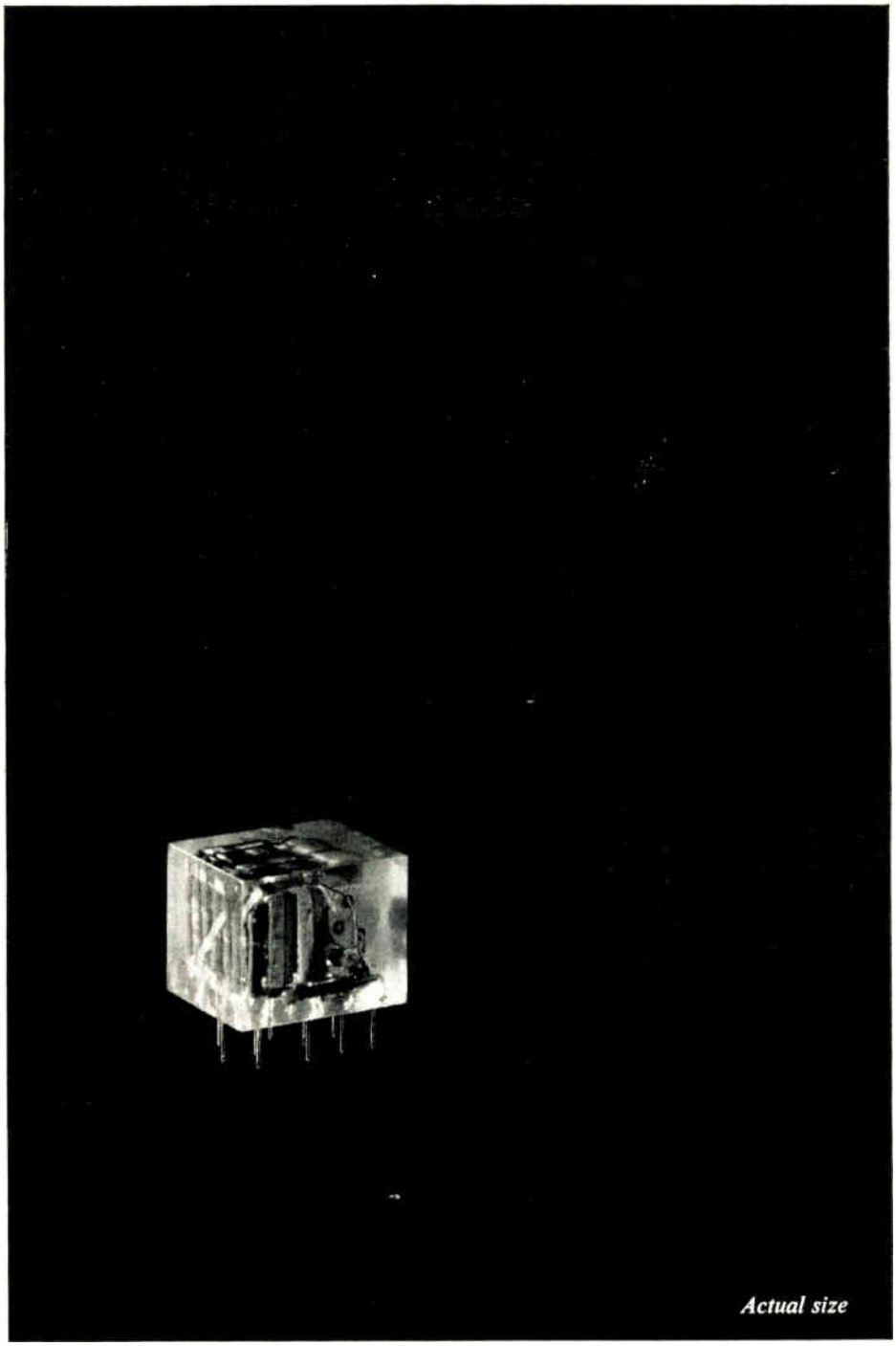
JANESVILLE, WISCONSIN

Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards



FROM DELCO RADIO NEW IDEAS FOR DEFENSE

MINIATURE MODULES WITH STANDARD COMPONENTS

They are *building block modules.* They are a product of Delco Radio's newly developed, three-dimensional packaging technique. They are used to build light, compact, reliable airborne and special purpose digital computers for missile control. Each module, vacuum encapsulated with epoxy resin, contains up to 35 standard components per cubic inch—averaging more than 50,000 per cubic foot. The modules perform all the standard logic functions. They meet or exceed all MIL-E-5272D (ASG) environmental requirements and will operate over a temperature range of −55°C to +71°C. They can be assembled in groups on printed circuit boards. There are 10 basic types and 15 variations of Delco Building Block Modules. With them, Delco Radio can quickly and easily build a compact, reliable computer for airborne guidance or any other military application. For complete details, write to our Sales Department. *Physicists and electronic engineers: Join Delco Radio's search for new and better products through Solid State Physics.*

PIONEERING PRECISION PRODUCTS THROUGH SOLID STATE PHYSICS

DELCO RADIO

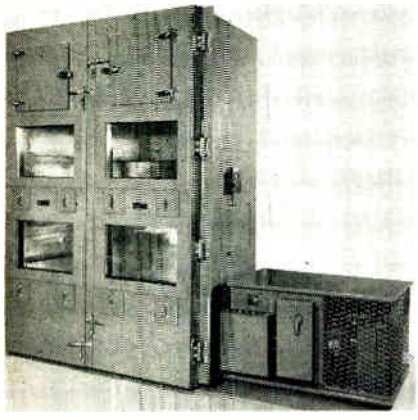
Division of General Motors • Kokomo, Indiana

Circle 57 on Inquiry Card

New Products . . . for the Electronic Industries

HOT-COLD CHAMBER

New type testing chamber for laboratory R&D work accommodates both large and small equipment. The 120 ft³ chamber is constructed with removable shelves spaced 12 in. apart.

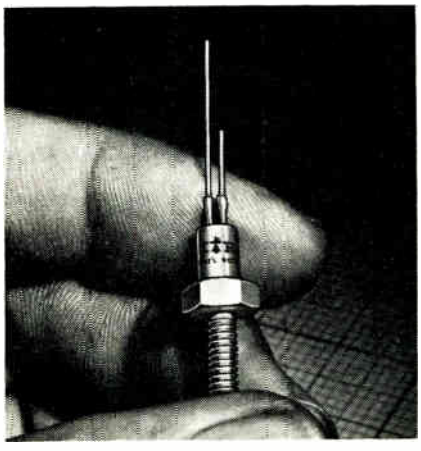


Two full-opening front doors are each provided with one 20 in. square access door and four 6 in. square hand holes for adjustment of equipment within the chamber, and two 16 x 24 in. multipane observation windows. Chamber temp. adjustable from +300° to −150°F. Two fin coil blower assemblies with 2500 watt heaters provide both heat and air circulation. Cincinnati Sub Zero Products, 3930 Reading Rd., Cincinnati 29, Ohio.

Circle 187 on Inquiry Card

CONTROLLED RECTIFIER

Miniature "Thyrode" silicon controlled rectifiers weighing as little as 1/10 oz. can replace mechanical relays where load currents of 1 a are required. Types X1RC2 through

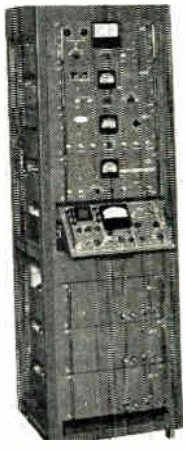


X1RC20, these 7 units have peak reverse voltage ratings of 20, 30, 50, 70, 100, 150 and 200 v. Applications include computer circuitry, temp. control, servo-mechanisms, ac and dc motor control, airborne printed circuitry, etc. Units feature hermetically-sealed, all-welded construction, and measure approx. 15/16 in., excluding leads. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 189 on Inquiry Card

HIGH POWER SSB

Through Class "C" amplification, Exciter/Driver systems, SSB-58-1A, achieve peak envelope powers of 10 kw to 4 mw. with undesired sideband rejections of 35 to 40 db, including all

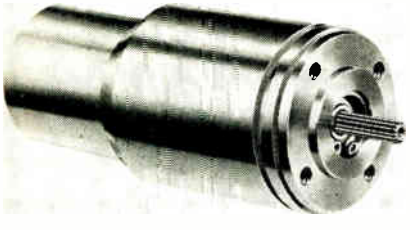


odd order intermodulation products. Either single or 2 independent 6 KC sidebands operating over a range of 1 to 30 MC are provided. Improved undesired sideband rejection at higher power levels, reduced size and weight, lower tube costs and relative insensitivity to varying antenna loads and tuning errors are other major advantages of Class C SSB operation. Kahn Research Laboratories, Inc., 81 S. Bergen Place, Freeport, N.Y.

Circle 191 on Inquiry Card

DAMPED SERVO MOTOR

New Size 11 hi temp inertially damped servo motor, Type 5752-03, for high speed and/or high gain servo systems. Inertial damping eliminates need for generator amplifier. No load speed is 5800 RPM. Torque at stall is 0.60 oz.-in., rated voltage is 115 RMS, 400 CPS for fixed phase and 70 for control phase. Flywheel magnet inertia is 2.0 gm-cm.² Flywheel mag-

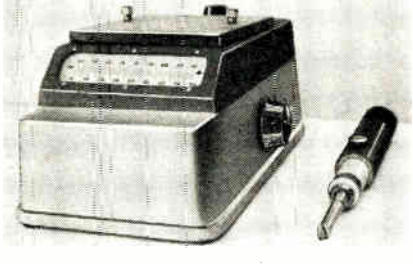


net damping factor 80 Dyne cm/rad/sec. Corner freq. are: 2.3 CPS — F_1; 6.4 CPS — F_2; and 23.3 CPS — F_3. John Oster Mfg. Co., Avionic Div., Racine, Wis.

Circle 188 on Inquiry Card

THERMOELECTRIC PROBE

Thermoelectric Probe, Model TE-1, is for type testing of all semiconductors and metals, detection of P-N junctions and measurement of relative TE power. It consists of a sensitive galvanometer, a cold base, a hot point and a variable dc attenuator. Base can be removed and an additional cold point can be added. Sensitivity is adequate even for metals

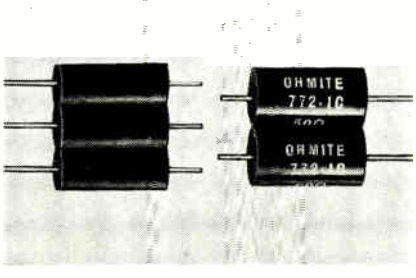


with low thermoelectric power, and is adjustable. Limits can be set for production testing or for comparison. Electro Impulse Lab. Inc., 208 River St., Red Bank, N. J.

Circle 190 on Inquiry Card

METAL FILM RESISTORS

A flat-sided version of cylindrical, axial-lead, metal film precision resistor. Three of these units can fit into an area which would accommodate only 2 of the full cylindrical type. Line consists of 8 different sizes and a total of 3 styles—full cylindrical, semi-cylindrical, and rectangular. The rectangular type has radial leads convenient for assembly into printed



circuits. A number of sizes in the line meet the physical styles of MIL-R-10509 and MIL-R-19074B (Ships). Ohmite Mfg. Co., 3645 W. Howard St., Skokie, Ill.

Circle 192 on Inquiry Card

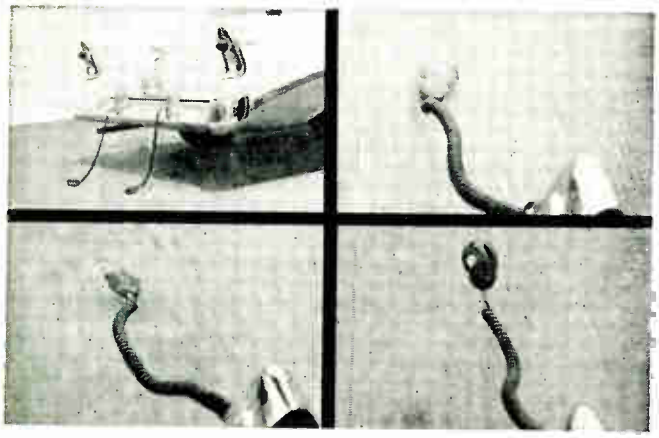
35,000 SMASHING, BATTERING IMPACTS—

and still working perfectly!

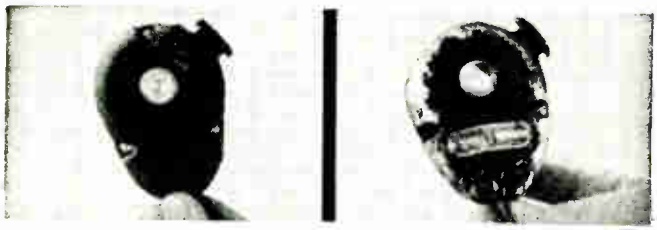
SHURE "TEN-FOUR"

COMMUNICATIONS MICROPHONE

proves its incredible durability in this gruelling destruction test!



New SHURE "TEN-FOUR" MICROPHONE, with exclusive Armo-Dur housing, and another microphone with standard die-cast metal housing were dragged for miles on a test drive over all kinds of pavements at speeds to 30 mph. In a matter of minutes, it was subjected to greater punishment than a lifetime of severest mishandling *and here's the result:*



Ten-Four with Armo-Dur Housing virtually unmarked—*still performed perfectly!*

Standard microphone with die-cast metal housing — cracked, broken, abraded—microphone inoperable.

For the microphone that stands up under severe operating conditions with no loss of high speech intelligibility, be sure to specify the Shure "Ten-Four" when you order your new communications equipment or replacements.

(Can be furnished with "Controlled Magnetic" or carbon cartridge.)

SHURE BROTHERS, INCORPORATED
222 Hartrey Avenue, Evanston, Illinois
HIGHEST QUALITY MICROPHONES — FIXED-STATION AND MOBILE

Circle 58 on Inquiry Card

TIMES

DATACABLE

A COMPLETE SERIES OF DATA-PROCESSING AND TRANSMISSION CABLE

TIMES' Datacable is the first full line of engineered cable to meet every data-system requirement, and includes—

- Miniature low-capacitance coaxial cables.
- Low mutual capacitance twisted and multi-pair cables.
- Miniature low attenuation 95 ohm system cables.
- U/L approved Teflon® insulated backpanel wire.
- Wide-band matched impedance coaxial cables.
- Large multi-conductor cables incorporating any or all of the above types.

Datacable is the result of TIMES' years of experience in cable application and design engineering for the computer industry. Select the cable for your application from the many "standard" Datacables, or let our engineers assist you in developing or adopting a cable to your special requirements.

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TIMES WIRE & CABLE DIVISION
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WALLINGFORD, CONNECTICUT, U.S.A.

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Please rush FREE literature on:

- ☐ Coaxial Cables
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- ☐ Multi-Conductors & Hook-up Wire
- ☐ For Info. Only ☐ Have Rep. Call

Circle 59 on Inquiry Card

Circle 60 on Inquiry Card

New Products

HARMONIC MIXERS

Harmonic mixtures for frequency measurements up to 18 KMC. Model P932A fixed tuned harmonic mixer, 12.4 to 18 KMC P-Band, mounts in a waveguide system and operates with

a H-P Model 540A or 540B transfer oscillator. Oscillator output is applied directly to the mixer, which generates harmonics and mixes them with an applied unknown waveguide frequency. Mixer's beat frequency output is applied to the scope the oscillator tuned for zero beat scope indication, and oscillator setting noted. Multiplication of dial frequency by harmonic number yields unknown frequency to within 0.5%. Hewlett Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 213 on Inquiry Card

RADIATION MEASUREMENTS

Wide-Field Radiometer, Model R-4K1, for making radiation measurements of small, remote, fast-moving targets against a variety of day and night backgrounds. It is suited for ground-to-air and air-to-air measurements of the radiation from high-speed missiles and aircraft. It can be mounted on a high-speed pedestal, radar antenna, infrared tracker or optical tracker for use with other in-

strumentation. A reticle-chopper package employs space-filter chopping to reject uniform background signals by a ratio of approx. 10,000 to 1. Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Circle 214 on Inquiry Card

New Products . . . for the Electronic Industries

ORIENTING TABLE

New orienting table for the Fitchburg Semiconductor Slicing Machine simplifies the orienting of semiconductor crystals prior to slicing, and is accurate to 1' of arc. The orienting

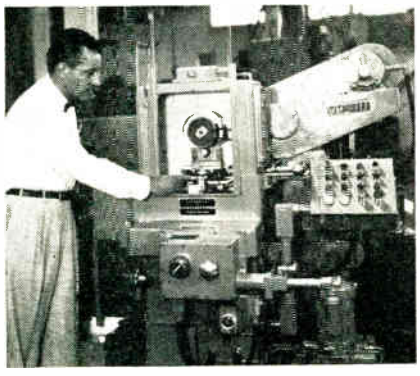


table can be installed on machines now in operation, or as optional equipment on new machines. These are fully automatic slicing machines, and produce wafers with a thickness from 0.025 to 0.007 ±0.0005 in. An automatic back-off mechanism minimizes surface imperfections. Speed of the spindle is controlled up to 9,200 rpm by a Variac. Electronic Div., Fitchburg Engineering Corp., Fitchburg, Mass.

Circle 193 on Inquiry Card

TRANSISTOR TRANSFORMERS

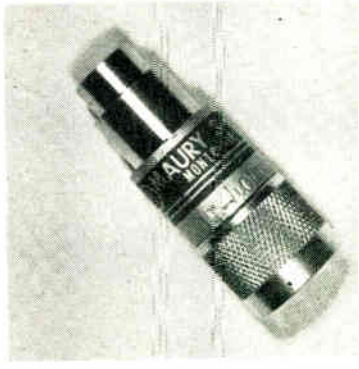
Line of miniaturized transistor transformers (Type TT) consists of 47 standard values. Transformers are molded for conformance with MIL-T-27A, Grade 5, Class R for altitudes

up to 50,000 ft. ATTom units have excellent response load distortion and high power capabilities for volume. One in. long hard drawn copper-tinned leads allow for direct printed circuit mounting. Applications: Interstage, output, input, single or push-pull output, reactors, line to base, collector to base or line, collector to speaker, and reversible-input to secondary. Arco Electronics, Inc., 64 White St., New York 13, N. Y.

Circle 195 on Inquiry Card

MATCHED LOADS

New line of micro-wave coaxial terminations. Two models available cover from dc to 4000 MC. Type ML-2000 features low VSWR of 1.03 max. from 1000 to 2000 MC and is usable to dc

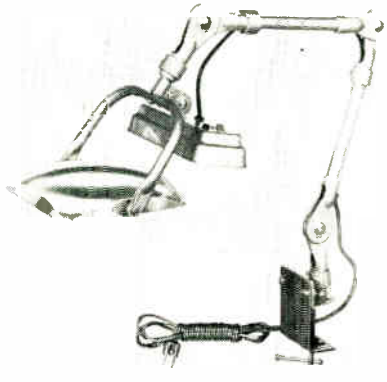


with a VSWR of 1.05 max. Type ML-4000 features low VSWR of 1.03 max. from 2000 to 4000 MC and is usable to 1000 MC with a VSWR of 1.05 max. Both have a nom. impedance of 50 ohms, handle 1 WCW of power and are supplied with either type N or O connectors. These matched loads are designed for use where an extremely low reflection termination is required. Maury & Assoc., 10373 Mills Ave., Pomona, Calif.

Circle 197 on Inquiry Card

MAGNIFYING VIEWER

Illuminated magnifying viewer for table or work bench mounting features a 6 x 6 in. acrylic lens that provides full 3-dimensional perception plus independent adjustment of lens and light. Full-vision lens eliminates eyestrain and posture fatigue. Model A is for the assembly of small parts. A 4½ in. universal mounting base

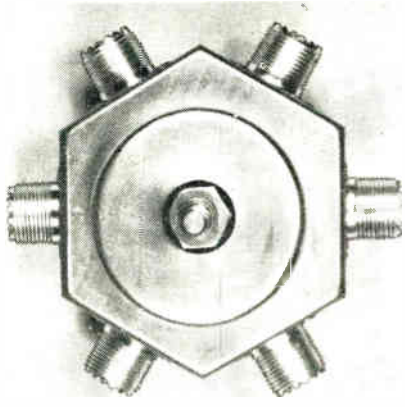


permits attachment to any table or work bench. Viewer can be swung back away from the working area with a 360° swivel collar. Fostoria Corp., Dept. 35, Fostoria, Ohio.

Circle 194 on Inquiry Card

COAXIAL SWITCHES

Multi-position coaxial switches for frequencies to 30 MC. Model 550A selects any one of 5 transmitters, antennas, exciters or other equipment and handles up to 1 kw of modulated power with a max. crosstalk of — 45 db. Model 551A is a 2-pole, 2-position unit for switching equipment rapidly in or out of series connection, and for

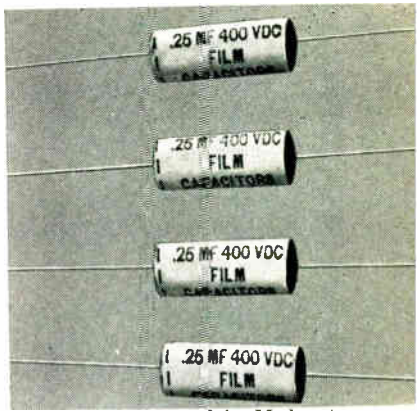


switching devices such as r-f power amplifiers in or out of circuit. Both are to be used with 52 or 75 ohm coaxial lines. Barker & Williamson, Inc., Bristol, Pa.

Circle 196 on Inquiry Card

METALLIZED CAPACITORS

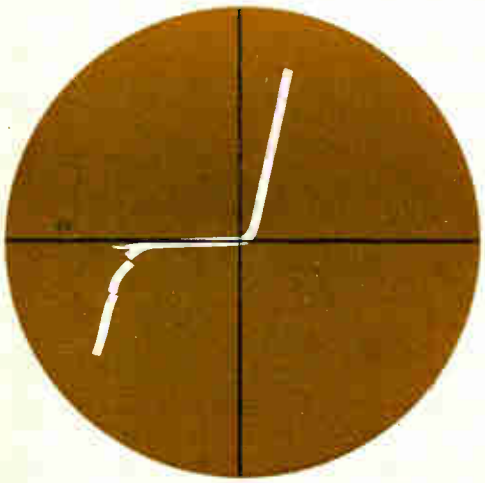
New "Flat Wrap" metallized Mylar® capacitors for miniaturization and reliability. Usable temp. range is up to 125 C without derating and self-healing characteristics extend life of the capacitors. Low dielectric absorption and high insulation resistance are other features. Capacitory tolerance of 1% and better available



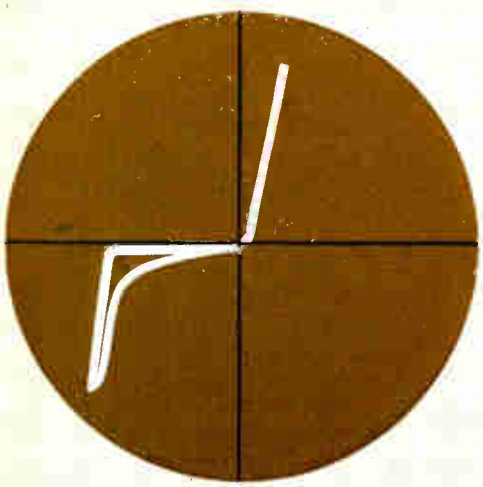
Units are wrapped in Mylar tape and the ends filled with epoxy resin for excellent resistance to humidity. Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y.

Circle 198 on Inquiry Card

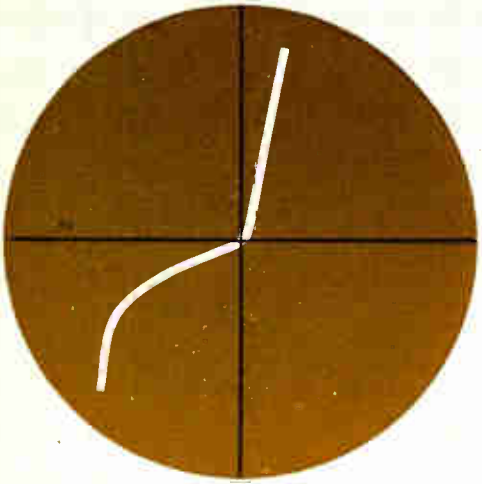
ALL PSI ZENER DIODES ARE 100% SCOPE-CHECKED



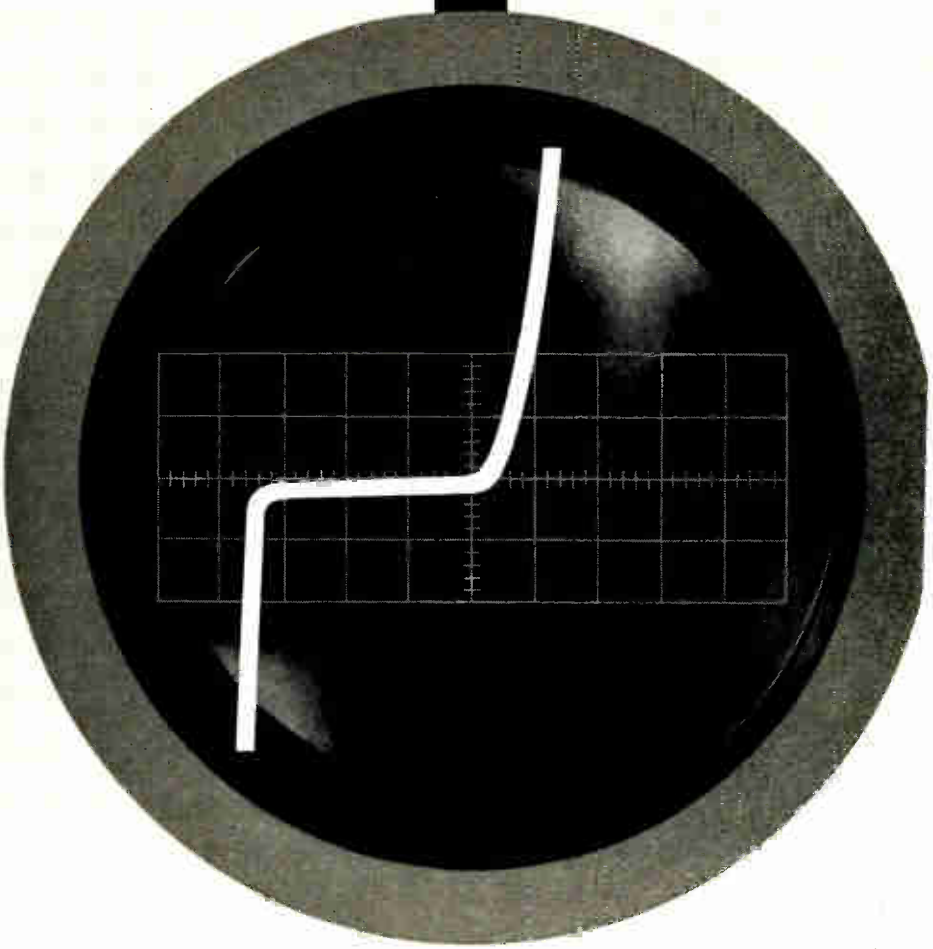
NO MULTIPLE BREAKS OR DISCONTINUITIES



NO HYSTERESIS



NO ROUND KNEES



IMMEDIATE DELIVERY! MILITARY TYPE 1N746A thru 1N759A

HE PSI POLICY OF 100% OSCILLOSCOPE TESTING OF ALL ZENER diodes nd assemblies is your protection against circuit instability due to double eak, soft knee, hysteresis and the many other "ailments" commonly found less carefully screened zener diodes. Reliability and electrical performance *us substantially higher power dissipation of 500 mW* make this broad line zener diodes well worth your early investigation. Tight leakage at 75% or % of zener voltage may be specified when ordering.

EW! LOW VOLTAGE REGULATING DIODES...1.5 TO 3.0 VOLTS. These w types are characterized by extremely low dynamic impedance and exnded operating temperature range. Available in ±5% and ±2% types. gged and compact, the units measure 3 8" diameter by .53" long and are nished with wire leads for easy mounting on printed circuit boards.

W VOLTAGE REGULATORS—PSI offers the highest surge, power and rrent rating of any subminiature regulator available.

OLTAGE REFERENCE DIODES—These six types, with nominal voltage nging from 6.8 to 40.8 volts, provide a temperature coefficient of less than 05%/°C and by specifying version "A" can be supplied at less than .0025%/°C.

All types available now in production quantities

Pacific Semiconductors, Inc.

SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.
12955 Chadron Avenue, Hawthorne, California

s Offices in: NEWARK · BOSTON · DE WITT, N.Y. · OTTAWA · BALTIMORE · CHICAGO (Oak Park) LADELPHIA (Rockledge) · ST. PETERSBURG · DALLAS · DETROIT · LOS ANGELES · PALO ALTO

Authorized distributors coast-to-coast

Circle 65 on Inquiry Card

500mW POWER DISSIPATION

PSI Type Number	Elect. Equiv.	Zener Voltage @5mA @25°C E_Z Min. (v)	E_Z Max. (v)	Maximum Dynamic Resistance (ohms) 1	Maximum Inverse Current I_b @25°C (μA)	I_b @100°C (μA)	At Inverse Voltage (v)
PS6465	1N465	2.0	3.2	60	75	100	1
PS6466	1N466	3.0	3.9	55	50	100	1
PS6467	1N467	3.7	4.5	45	5	100	1
PS6468	1N468	4.3	5.4	35	5	100	1.5
PS6469	1N469	5.2	6.4	20	5	100	1.5
PS6470	1N470	6.2	8.0	10	5	50	3.5

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed. Also available PS6313-6318 covering 7.5v to 27v Zener Voltages.

EIA Type	Zener (Breakdown) Voltage @5mA E_Z Min. (v)	E_Z Max. (v)	Maximum Inverse Current I_b @25°C (μA)	I_b @100°C (μA)	At Inverse Voltage (v)	Maximum Dynamic Resistance (ohms) 1
1N702	2.0	3.2	75	100	−1	60
1N703	3.0	3.9	50	100	−1	55
1N704	3.7	4.5	5	100	−1	45
1N705	4.3	5.4	5	100	−1.5	35
1N706	5.2	6.4	5	100	−1.5	20
1N707	6.2	8.0	5	50	−3.5	10

1. Measured at 10mA DC Zener current with 1mA RMS signal superposed. Also available 1N708-1N723 covering 5.6v to 27v Zener Voltages.

PSI Type Number	Elect. Equiv.	Zener Voltage @200 μA @25°C E_Z Min. (v)	E_Z Max. (v)	Maximum Inverse Current I_b @25°C (μA)	I_b @100°C (μA)	At Inverse Voltage (v)
PS6313	1N1313	7.5	10	.5	5	6.8
PS6314	1N1314	9	12	.5	5	8.2
PS6315	1N1315	11	14.5	.5	5	10.0
PS6316	1N1316	13.5	18	.5	5	12.0
PS6317	1N1317	17	21	.5	5	15.0
PS6318	1N1318	20	27	.1	10	18.0

EIA Type[1]	Zener Voltage E_Z (Volts)[2]	Max. Inverse Current E_R = −1V μa 25°C	150°C	Max. Dynamic Resistance I_Z=20mA I_{AC}=1mA Ohms (Max.)
1N746	3.3	10	30	28
1N747	3.6	10	30	24
1N748	3.9	10	30	23
1N749	4.3	2	30	22
1N750	4.7	2	30	19
1N751	5.1	1	20	17
1N752	5.6	1	20	11
1N753	6.2	0.1	20	7
1N754	6.8	0.1	20	5
1N755	7.5	0.1	20	6
1N756	8.2	0.1	20	8
1N757	9.1	0.1	20	10
1N758	10.0	0.1	20	17
1N759	12.0	0.1	20	30

1. ±10% Zener Voltage Tolerance. 2. E_Z measured at Test Current I_Z=20mA. All of the above types can be supplied in ±5% Tolerance. Add "A" suffix to indicate units with ±5% Tolerance of center Zener Voltage Value.

LOW VOLTAGE REGULATORS

PSI Type	E_f + 1mA (volts)	I+1 min. (mA)	Max. Dyn. Res. @1mA (ohm)	I_b @25°C (μA) Max.
1N912	0.62 ± 10%	100	60	1.0 @ −5v
1N913	0.62 ± 10%	250	60	5.0 @ −5v

VOLTAGE REFERENCE DIODES

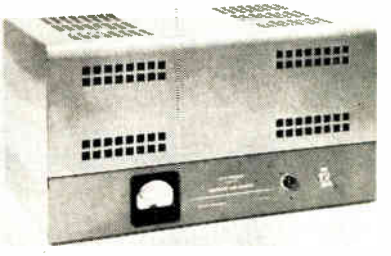
EIA Type Number	REFERENCE VOLTAGE @7.5mA @25°C (volts) Min.	Avg.	Max.	Max. Voltage change from 25°C Reference Voltage (volts) −55°C to +100°C	Max. Dynamic[1] Resistance (ohms)
1N2765	6.46	6.80	7.14	±0.050	20
1N2766	12.92	13.60	14.28	±0.100	40
1N2767	19.38	20.40	21.42	±0.150	60
1N2768	25.84	27.40	28.56	±0.200	80
1N2769	32.30	34.00	35.70	±0.250	100
1N2770	38.76	40.80	42.84	±0.300	120

1. Measured with 1mA AC superimposed on 7.5mA DC. Max. Operating Temp. @ I_Z = 7.5mA: −65°C to +175°C. Also available in "A" version—.0025%/°C.

New Products

STATIC GENERATOR

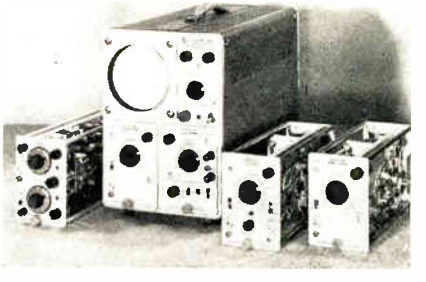
Compact static generator provides high voltage static electricity for a max. of 10,000 CFM air flow for use in the Statronic® system of dirt and dust control. Static voltage meter with red and green zones indicates operating conditions at the screens through which air flows in an air conditioning system. Generator supplies the screens with energy necessary to bombard dirt and dust particles in air, exploding them into bits well below 0.1 micron —particles remain suspended. Electrical input is 115 v. 60 CPS 1 phase from a source providing 75 w. CRS Industries, Inc., 1405 Locust St., Phila. 2. Pa.



Circle 215 on Inquiry Card

OSCILLOSCOPE

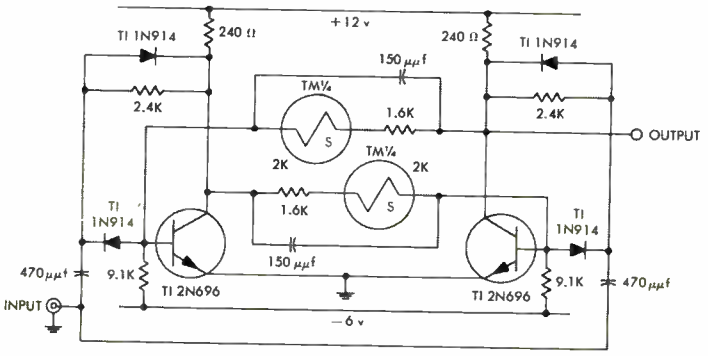
Basically an indicator unit, the Type 561 contains a 5-in. CRT with 3.5 kv accelerating potential, an 8 x 10 cm viewing area, an amplitude and sweep-time calibrator, and a power supply which can handle additional plug-in modules. The indicator unit powers any two of the five presently available modules — which drive the CRT deflection plates directly. Dimensions are about 13½ x 9¾ x 19 in. Weight is less than 27 lbs. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.



Circle 216 on Inquiry Card

How to compensate for temperature variation in a transistorized flip-flop

FLIP-FLOP CIRCUIT



sensistor® SILICON RESISTORS

Positive TC of +0.7%/°C for temperature compensation and sensing.

Standard available resistances ±10% @ 25°C:
68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 500, 560, 680, 820, 1000, 1200, 1500, and 1800 ohms.

Additional resistance values and tolerances available on special order.

Type No.	Wattage Rating	Body Dimensions	
	W	Length	Diameter
TM ¼	¼	0.585″	0.200″
TM ⅛	⅛	0.406″	0.140″
TC ⅛	⅛	TO—5 Transistor Package	
P-100†	—	0.500″	0.078″

† Hermetically sealed glass package for instrumentation and temperature control available in resistances of 100 ohms, 500 ohms and 1000 ohms ±10% measured at 25°C

This flip-flop circuit, designed by Texas Instruments, uses *sensistor*® silicon resistors in the cross-coupling network to compensate for increases in h_{FE} with temperature. At 125°C, it resolves 100 mμsec input pulses arriving at a 5 mc rate whereas a fixed resistor version was limited to 3.6 mc. In addition, at +125°C the circuit will operate at a resolution rate greater than 5 mc if the input pulse can be greater than 10 volts when the pulse width is decreased from 100 mμsec.

Another advantage of *sensistor* silicon resistors in a flip-flop using high h_{FE} transistors is the reduction in input voltage required to trigger at high temperatures. For instance, the *sensistor* silicon resistor circuit requires only 10 volts to trigger whereas the fixed resistor circuit required 14 volts.

Sensistor silicon resistors are temperature-sensitive devices that feature a positive temperature coefficient of +0.7% per °C. This predictable rate of resistance change makes *sensistor* resistors ideal for temperature compensation from —50°C to +200°C at frequencies up to 20 Kmc.

The *sensistor* silicon resistor, developed by TI, provides circuit design engineers with a lightweight temperature compensating and sensing device. Commercially available for over two years, the devices have been used successfully for bias stabilization in a-c coupled stages and in the first stages of d-c amplifiers; and have found wide application in amplifiers, power supplies, servos, telemetry, magnetic amplifiers, computer switching, and thermometry.

In addition, specify from this complete line of TI precision film resistors.

MOLDED

±1% tol

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDM⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDM¼	¼	RN65B	10 Ohm-1 Meg	500
CDM½	½	RN70B	10 Ohm-5 Meg	750
COM 1	1	RN75B	10 Ohm-10 Meg	1000
COM 2	2	RN80B	50 Ohm-50 Meg	2000

MIL-LINE

±1% tol

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CD⅛R	⅛	—	10 Ohm-1 Meg	350
CD¼R	¼	RN10X	10 Ohm-1 Meg	500
CD½PR	½	RN15X	10 Ohm-3 Meg	650
CD½MR	½	RN20X	10 Ohm-5 Meg	750
CD½SR	½	—	50 Ohm-10 Meg	850
CO1R	1	RN25X	10 Ohm-10 Meg	1000
CO2R	2	RN30X	50 Ohm-50 Meg	2000

HERMETICALLY SEALED LINE

±1% tol

TI type number	wattage rating watts	MIL designation	standard resistance ranges	max. recommended voltage volts
CDH⅛M	⅛	—	10 Ohm-500K	250
CDH⅛	⅛	RN60B	10 Ohm-1 Meg	350
CDH¼	¼	RN65B	10 Ohm-1 Meg	500
CDH½P	½	—	10 Ohm-3 Meg	650
CDH½A	½	RN65B	10 Ohm-3 Meg	650
CDH½M	½	RN70B	10 Ohm-5 Meg	750
CDH½S	½	—	50 Ohm-10 Meg	850
CDH 1	1	RN75B	10 Ohm-10 Meg	1000
COH 2	2	RN80B	50 Ohm-50 Meg	2000

Write on company letterhead for your copy of "Transistor Bias Compensation with *sensistor*® Silicon Resistors."

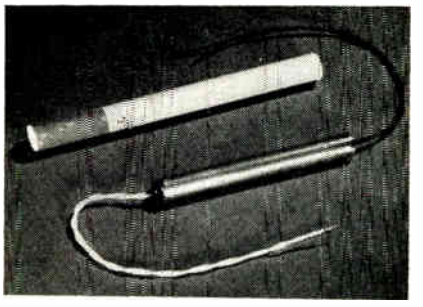
TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 · DALLAS, TEXAS

Circle 67 on Inquiry Card

New Products

ELECTRO-OPTICAL RELAY

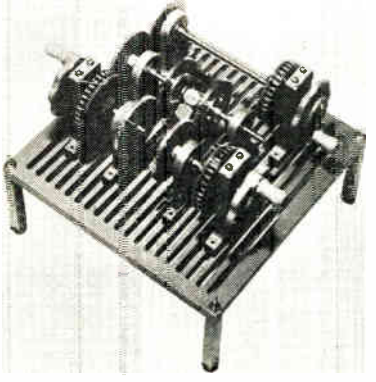
Electro-optical relay, the Raysistor, has a conductance on-off ratio of 1 million to 1; speeds to 100 operations/sec. A light source in the control and, when excited, actuates a photoconductor in the signal end, allowing either ac or dc information to pass. "On" life is 2500 hrs, irrespective of switching operations. It is non-polar and input is isolated from output. It may be applied to logic circuits and matrices for telemetering or signal commutation. A characteristic is its ability to switch without introducing transients in the signal circuit. When used as a potentiometer it is free of contact noise. Industrial Components Div., Raytheon Co., Newton 58, Mass.



Circle 217 on Inquiry Card

GEARS-SHAFTS-BEARINGS

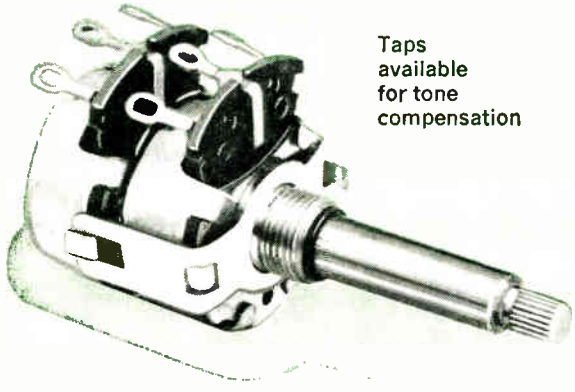
Redesigned line of miniature precision components for application embodying space and weight limitations. Components available in precision 1, 2, and 3 tolerances. Conforming to mil. specs, the new line, in 5/64, 3/32, and 1/8 in. shaft sizes, includes gears, shafts, differentials, ball bearings, couplings, collars, spacers, gear plates and other components needed for prototype or production use. PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.



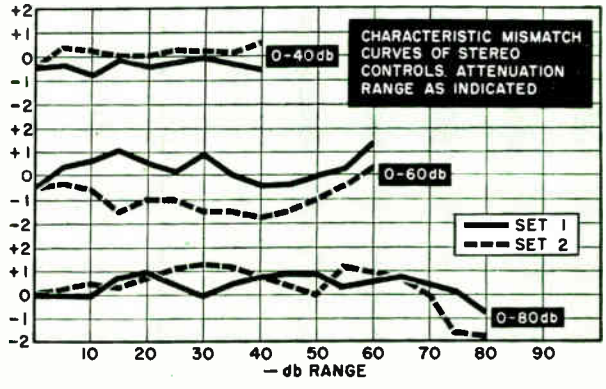
Circle 218 on Inquiry Card

±2db TRACKING with CLAROSTAT MATCHED ELEMENT CONTROLS

Now, a degree of accuracy in gain control for two audio channels equaling the accuracy of the associated circuitry. Clarostat now offers the stereo industry matched element controls with tracking in the order of ±2 db with a range of 80 db. For less precise tolerance requirements, Clarostat offers matched element controls in ±4 db or ±6 db tracking in 40, 60 and 80 db ranges. Clarostat matched element controls are available in both the famous Clarostat 37 (1-1/8" dia.) or 47 (15/16" dia.) series.

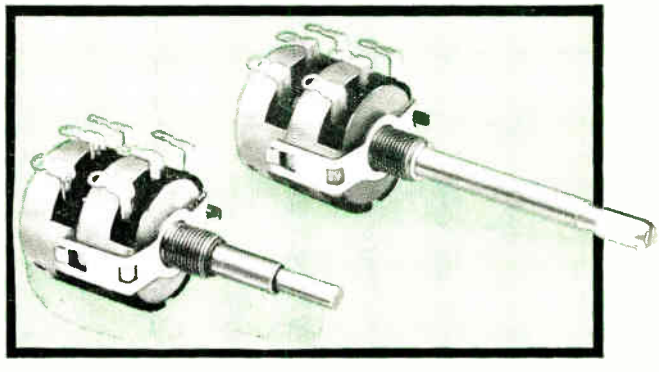


Taps available for tone compensation



THE COMPLETE HIGH FIDELITY CONTROL LINE

- Single units in both wire-wound and carbon for single channel gain, tone, or balance.
- Dual controls with concentric shafts for individual control of two functions.
- Friction-type dual concentrics with both shafts turning simultaneously, but permitting individual adjustment by holding one and turning other.
- Clutch-type dual concentrics allowing optional operation as dual unit, or by disengaging clutch, individual adjustment.



WRITE FOR MANUAL ON STEREO CONTROL —

CLAROSTAT MFG. COMPANY, INC.,

DOVER, NEW HAMPSHIRE

Circle 69 on Inquiry Card

New Products

CAPACITORS

New ME and WE Series, subminiature, metallized paper capacitors. Series ME, for dc circuitry, are vacuum epoxy-impregnated and sealed in epoxy cases. Operating temp. is −55°

to +125°C. Capacitance values are from 0.001 to 2.0 mfd. Series WE, for ac or dc circuits, are vacuum wax-impregnated and have an operating temp. range of −55° to +85°C. Capacitance values are from 0.001 to 1.5 mfd. Both series available in 100, 200, 400 and 600 vdcw ratings. Standard tolerance is ±20% with tighter tolerances to order. Electron Products Div., Marshall Industries, 430 N. Halstead St., Pasadena, Calif.

Circle 219 on Inquiry Card

SILVERED MICA CAPACITOR

New sub-miniature DM-10, a dipped silvered mica capacitor, is approx. 5/16 x ¼ x ⅛ in. At a working voltage of 100 wvdc, capacity range is 1 mmf through 360 mmf; at 300 wvdc, capacity range is 1 mmf through 300 mmf; at 500 wvdc, capacity range is 1 mmf through 250 mmf. Operating

temp. is up to 150°C. Characteristics include C, D, E and F, depending on capacitance value. Leads are of No. 26 AWG (0.159 in.) Copperweld Wire. Electro-Motive Mfg. Co., Inc., Willimantic, Conn.

Circle 220 on Inquiry Card

New Products . . . for the Electronic Industries

CHOPPER AMPLIFIER

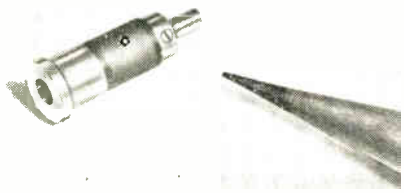
Chopper amplifier Model 1801-0100 converts a low level dc signal to a proportionate 400 CPS signal at a high power level. Signal can be used to operate a transistor amplifier (MTB

Model 1800-0300). Dc supply voltage is 28 vdc at 2 ma. Ac reference voltage is 115 v., 400 CPS 3 ma. Unit has a nom. input impedance of 5000 ohms. Linear range is 0 to ± 1 vdc and the allowable range is 0 to ± 30 vdc. Output frequency is 380 to 420 CPS and output voltage is 600 mv RMS max. into a 10,000 ohm load. Meets military requirements in temp. range −55°C to +71°C. M. Ten Bosch, Inc., 80 Wheeler Ave., Pleasantville, N. Y.

Circle 199 on Inquiry Card

CRYSTAL RESISTORS

Crystal type resistors plug into any component normally using the equivalent crystal type. Crystal mounts and mixers can be checked and standardized independently or

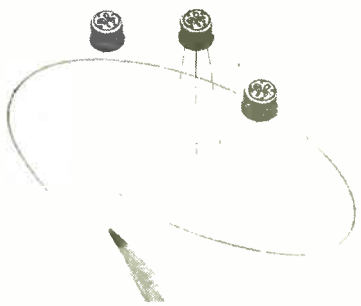


crystal impedance. These resistors on 1N21 or 1N23 crystal bodies are supplied in any resistance value from 25 to 400 ohms with standard 2% or 5% tolerance. Made by vacuum depositing a pure metal resistance film on ceramic and immediately sealed by an impervious protective coating, the resistors are very stable and reliable. Power rating is lw ave. at 100°C. Filmohm Corp., 48 W. 25th St., New York 10, N. Y.

Circle 201 on Inquiry Card

TRANSISTORS

Silicon unijunction transistors Type 2N1671 is for general purpose industrial use where circuit economy is important. Type 2N1671A is for firing circuits for silicon controlled



rectifiers and where a pulse amplitude is required. Type 2N1671B for use where a low emitter leakage current and a low trigger current are required. All have a max. intrinsic standoff ratio of 0.62. Interbase resistance characteristics are a min. of 4.7-kilohms and a max. of 9.1-kilohms at 25°C. Min. valley point currents of all the transistors is 8 ma. General Electric Co., Semiconductor Products Dept., Liverpool, N. Y.

Circle 203 on Inquiry Card

KEY BOARD SWITCH—LIGHT

New panel mounted, switch-light combination for switching low currents from ¼ mil to 50 mils. The unit can be supplied in SPST or SPDT, double-break, positive action, either with momentary contacts or push-on push-off mechanism. The plunger can be made to remain in and require pressing again to release. The plunger is light action and can operate below 1

lb. pressure. The push-buttons have a snap-in feature for re-bulbing from the front of the panel. It uses any size or shape lens, also any color lens. Pendar, Inc., Switch Div., 11741 Arminta St., Van Nuys, Calif.

Circle 200 on Inquiry Card

MICROWAVE RADIO

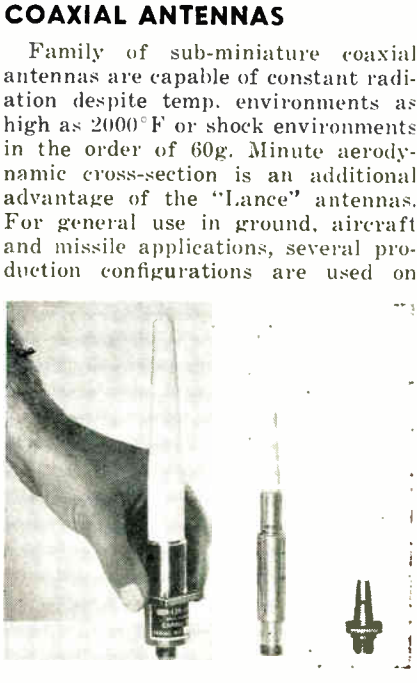
New line of microwave radio equipment in the 11,000-15,000 MC range. The new system, MW-601, features a new temp. control chamber for the klystron, which uses no electrical power for temp. regulation. Chamber temp. is automatically controlled by a spring operated mechanical device, with the klystron used as a heat source. Specs of the chamber are:

normal chamber temp.: 117 ±13 C over an amb. range of −30 to +60°C. Normal operating temp. of 117° may be varied by ±20 . Collins Radio Co., P. O. Box 1891, Dallas 21, Tex.

Circle 202 on Inquiry Card

COAXIAL ANTENNAS

Family of sub-miniature coaxial antennas are capable of constant radiation despite temp. environments as high as 2000°F or shock environments in the order of 60g. Minute aerodynamic cross-section is an additional advantage of the "Lance" antennas. For general use in ground, aircraft and missile applications, several production configurations are used on



missiles. The r-f characteristics allow the units to be supplied with linear or eliptical polarization over a frequency range of 1300 to 11,000 MC. Don-Lan Electronics, Inc., 1131 Olympic Blvd., Santa Monica, Calif.

Circle 204 on Inquiry Card

New Products

MICROWAVE COMPONENT

A new and useful device for assisting in the testing of Beacon Magnetrons, the coaxial line-to-waveguide transition. These transitions present a maximum VSWR of 1.10 over the specified band, and can be used to excellent advantage in circuits where usually available units present excessive reflections. These four transitions are available in six models, with frequencies ranging from 5.2 to 9.5 KMC. Bomac Laboratories, Inc., Salem Rd., Beverly, Mass.

Circle 221 on Inquiry Card

POWER TRANSISTORS

New series of 34 industrial power transistors include the 2N1529A-32A, 2N1534A-37A, 2N1539A-47A (5 a), the 2N1549A-60A (15 a) and the 2N1162A-67A (25 a) devices. Designed for continuous operation at junction temp. of 100°C, they are housed in the TO-3 (diamond) package and feature 0.8°C per w max. thermal resistance and 90 w power dissipation. Motorola Semiconductor Products, Inc., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 222 on Inquiry Card

New Products . . . for the Electronic Industries

DC TAUT-BAND METERS

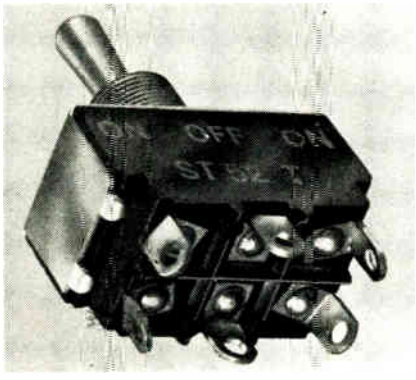
New 100° indicating instruments (KX-251) for measuring dc volts and amps uses both taut-band suspension and core magnets. The ammeter measures from 20 μa to 50 a and the volt-

meter measures from 35 mv to 800 v. Instruments can be used in magnetic fields up to 500 gausses. The main advantages of the new instruments are the frictionless bearing system and the high degree of magnetic shielding available with the core magnet design. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 205 on Inquiry Card

TOGGLE SWITCHES

Complete line of toggle switches meeting MIL-S-3950A and MIL-S-6745 specs and incorporating a barrier configuration between terminals. Barrier design between the terminals in-

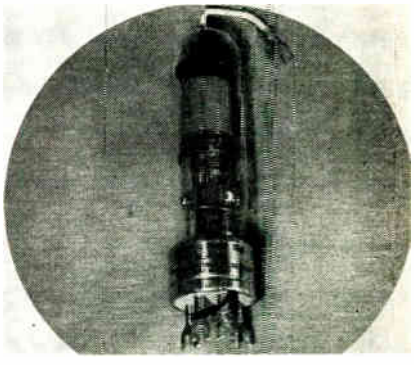


creases leakage paths and at the same time provides a safety factor in event of a loose connection. Toggle-switches include models for all common circuit characteristics based on double-pole, double-throw or single-throw configurations, including momentary close or open functions. Kulka Electric Corp., 633-643 So. Fulton Ave., Mt. Vernon, N. Y.

Circle 207 on Inquiry Card

HIGH CURRENT RECTIFIER

Inert gas and mercury vapor high current half-wave rectifier, 10 a, 1000 peak voltage, added to line of industrial tubes. The NL-664L is for control applications requiring a high cur-



rent half-wave rectifier. It uses the lug base as a standard feature. Also available with bracket base and flying leads for panel mounting under the type designation NL-664P. Other ratings are: filament v. — 2.5; filament current — 25 a; peak anode current — 120 a and condensed mercury temp. limits of −40 to +100°C. National Electronics, Inc., Geneva, Ill.

Circle 209 on Inquiry Card

DIRECTIONAL COUPLERS

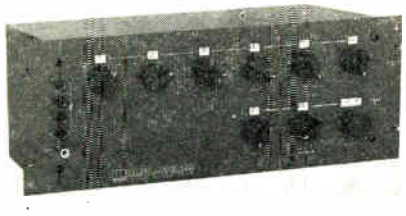
New and improved line of high directivity broad band coaxial directional couplers provide flat coupling over a full octave frequency range with low VSWR. Directivity exceeds 30 db. Coupling values of 10, 20, and 30 db are within 1 db of nominal value over the specified range, with calibration provided to an accuracy of ±0.2 db at 5 frequencies. Couplers may be

used at lower frequencies. Coupling increases below specified range at approx. 6 db/octave. Narda Microwave Corp., 118-160 Herricks Rd. Mineola, N. Y.

Circle 206 on Inquiry Card

RESISTANCE STANDARD

Model RS-925 is a decade resistance standard covering from 10 milliohms to 1.2 megohms continuously. Last dial controls a 105-division slide wire rheostat with a resistance of 100 microhms per dial div. To eliminate "zero" correction, the 10 milliohm per step decade stops at a min. setting of 10 milliohms. To avoid lead and contact resistance variations, provision

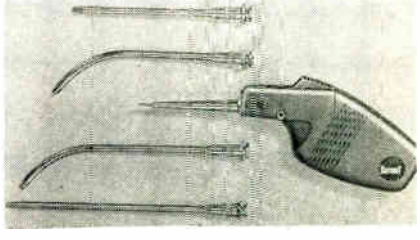


has been made for making 4 terminal measurements. Dimensions: 7 x 19 x 7 in. Electro Scientific Industries, Inc., 7524 SW Macadam Ave., Portland 19, Ore.

Circle 208 on Inquiry Card

SOLDER DISPENSER

Accessories to the line of precision wire solder dispensing tools augmented by an assortment of straight and curved probe tips. Probes are bayonet type inserted or removed by a 90° turn. Solder feed is smooth and positive and can be regulated accurately by knurled feed control. Probe tip provides back-up pressure at the point of soldering and speeds melting



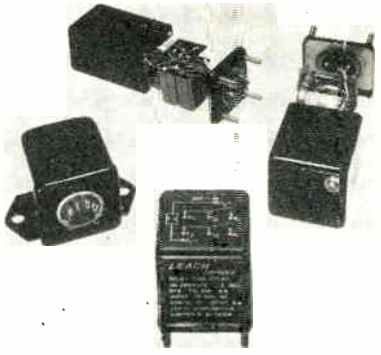
process. A supply of wire solder is in the handle. Commercial Products Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 210 on Inquiry Card

New Products

TIME DELAY RELAY

Printed circuit time delay relay. Cutput operated by transistorized gate energized from an R-C timing net. Standard line consists of time delays on release and time delays on operate

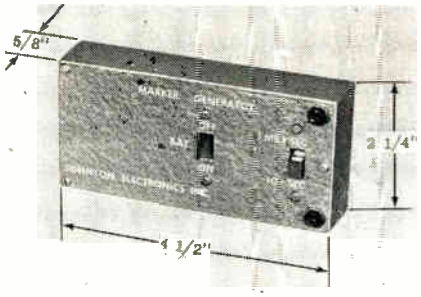


with timing range of 100 msec. to 60 sec. Specs are: Input voltage range, 21-30 vde; operating current, 130 ma max.; accuracy ±10%; recycle time, 50 msec.; contacts, 2 PDT delay on operate—1 PDT delay on release; contact rating, 2 a resistive—1 a inductive; life, 100,000 cycles min.; vibration, 15 g's through 2000 CPS; shock, 50 g's; and transients, 70 v. for 50 msec. Leach Corp., Controls Div., 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle 223 on Inquiry Card

MARKER GENERATOR

This "Pocket Pipper" uses crystal control to provide a 10 μsec. and a 1 msec pulse to accurately calibrate the sweep of an oscilloscope. Transistorized, it weighs 8 oz. the Model 100 MG 1 operates on self-contained 9 v. battery for 1 year of normal use. No



warm up time necessary. Switch provides instant change from 10 μsec. to 1 msec. pulse. Johnson Electronics, Inc., Electronics Div., P. O. Box 1675, Casselberry, Fla.

Circle 224 on Inquiry Card

A GOOD RESOLUTION ON TAPE—

Tape high frequencies, whip the dropout problem with "SCOTCH" BRAND High Resolution Tapes

RIGHT HANDS UP, GENTLEMEN? Then repeat this phrase: "We resolve to get the tape that gets all the high frequencies—'SCOTCH' BRAND High Resolution Tape."

All levity aside, there's no need to settle for second-best. With "SCOTCH" BRAND Tapes 158 and 159 you get sharp resolution in high frequencies, good low frequency response—plus the consistent performance of a uniform tape.

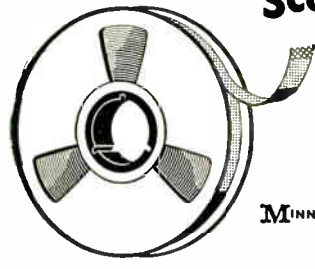
Since "SCOTCH" BRAND high potency oxides are more efficient than ordinary oxides, a thinner coating can be applied to the polyester backing, and the sensitivity at short (1 mil) wave lengths is still about 3½ db greater than that of ordinary oxides. This thinner coating means a more flexible tape, permitting the intimate tape-to-head contact so necessary to sharp resolution in the higher frequencies. Thanks to "SCOTCH" BRAND silicone-lubricated binder system, backing and oxide are locked together as a *system*. Tape passes over heads friction-free, with even motion, minimizing phase and frequency shift distortion.

You can pack more pulses per inch, and get either standard or extra playing time with "SCOTCH" BRAND High Resolution Tapes. Your dropout count is lower because uniformity is higher. Only "SCOTCH" BRAND can draw on 3M's more than 50 years of experience in precision coating techniques. The result is a consistent tape with a uniform coating you can depend on for reliable performance.

"SCOTCH" BRAND High Resolution Tapes meet your need for top high-frequency response even in pulse code modulation (PCM) and pre-detection (video) applications; so switch now from tapes that may well be made obsolete by new instruments.

Whatever your application—data acquisition, reduction, or control programming—experienced "SCOTCH" BRAND technology has a dependable tape for the job. Sandwich Tapes 188 and 189 cut head-wear, eliminate oxide rub-off, last 10 times longer than ordinary tapes. New Heavy Duty Tapes 198 and 199 give long wear, minimize static charge build-up. High Output Tape 128 gives top output in low frequencies, even at temperature extremes. And "SCOTCH" BRAND Standard Tapes 108 and 109 remain the standard for instrumentation.

Your nearby 3M Representative serves as a convenient source in all major cities. For details consult him or write Magnetic Products Div., 3M Company, Dept. MBR-90, St. Paul 6, Minn.



SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

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

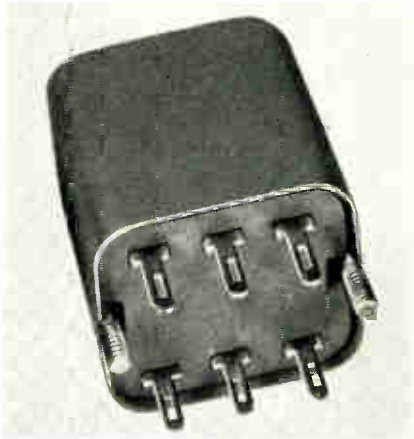
3M COMPANY

Circle 75 on Inquiry Card

New Products

ULTRASONIC TRANSFORMER

New transformer covers 20 KC to 10 MC; impedance, 75 ohms unbalanced to 600 balanced. Unit will handle 1 w. Type 121°C, is epoxy encapsulated in an aluminum shield can



and is mounted by 2 #632 spade bolts. The case is ½ in.³ It is for low insertion loss and good matching characteristics over wide frequency ranges. Balanced windings feature low unbalanced voltage. Bandwidth ratings are conservative. It can be used for antenna matching. Interstage coupling, impedance matching, computer drive circuits, pulse applications, voltage step-up and dc isolation. North Hills Electronics, Inc., Glen Cove, L. I., N. Y.

Circle 225 on Inquiry Card

GANGABLE POTENTIOMETERS

The 319 Series, miniature wirewound gangable potentiometers, are ⅞ in. dia. and less than ¼ in. high per ganged section. They are gangable within a resistance range of 100 ohms

to 200K ohms. An adjustment method positions each wiper independently throughout a full 360°. Daystrom, Inc., Pacific Division, 9320 Lincoln Boulevard, Los Angeles 45, Calif.

Circle 226 on Inquiry Card

Transitron

introduces

an exciting new device for simpler, more reliable, more economical switching circuitry

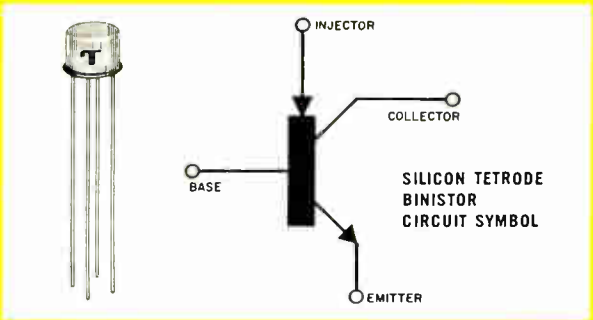
BINISTOR

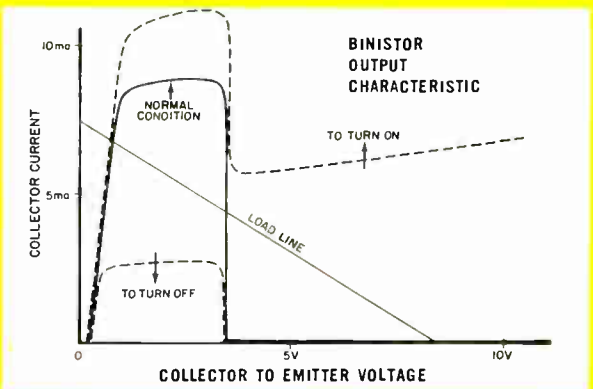
(BY-NIS-TOR)

The Silicon NPN Tetrode binistor is a new component and a new concept for the circuit designer!

The key parameters of this bi-stable, negative resistance device are determined by external circuitry in contrast to existing devices. The significant reduction of peripheral circuitry results in outstanding savings in cost, space, weight and solder connections. For example, a typical flip-flop requires at least 13 components versus only 4 in an equivalent binistor stage. Very large current and voltage gains are realized in both on and off directions. Inputs and output are compatible in level with typical transistor and diode circuits. The tetrode binistor can operate from $-80°C$ to $+200°C$.

To learn more of this important new development — THE BINISTOR — and how it works — write for Bulletin No. TE-1360.





CONDENSED SPECIFICATIONS TRANSITRON BINISTOR

Typical Turn-off Current Gain	50 @ 15ma Collector Current
Operating Collector Current Range	50μa to 15ma
I_j critical	0.5ma @ 5ma Collector Current
Operating Temperature Range without Temperature Compensation	−65°C to 150°C

Circle 77 on Inquiry Card

Transitron electronic corporation

wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE • CABLE ADDRESS: TRELCO

a new look in counters

AND NEW RELIABILITY, TOO

CMC was first to introduce the all-transistor 10 megacycle counter. Now CMC scores another important first with its complete new line of vacuum tube counting, timing and frequency measuring equipment. Note the clean, functional lines of these tastefully styled instruments . . . user engineered to eliminate costly "cockpit trouble". These instruments are the most reliable vacuum tube counters ever built. In the counter-timer below, for example, nine tubes have been eliminated. New modular circuitry simplifies maintenance and reduces weight. Unitized construction is exceptionally rugged. And to further simplify matters, all models have three key components in common—input amplifiers, power supplies, and shaping circuits. In short, these instruments will give you long, trouble-free operation.

BUT SEEING IS BELIEVING—Your nearby CMC engineering representative will be happy to arrange a demonstration and provide complete technical data. Or you can write us direct at Dept. 44.

CMC's Model 226B Universal Counter-Timer (1 mc) leads a complete new line which includes a 220 kc universal counter-timer, a time interval meter and a frequency-period meter.

PRICES:
Model 226B, $1175; Model 226BN, illustrated, $1445 with Nixies; Model 225C, $900; Model 203B, $995; Model 251B, $915. Rack mount $10 extra. F.O.B. Sylmar, California.

CMC 9 8 7 6 5 4 3 2 1 0 32

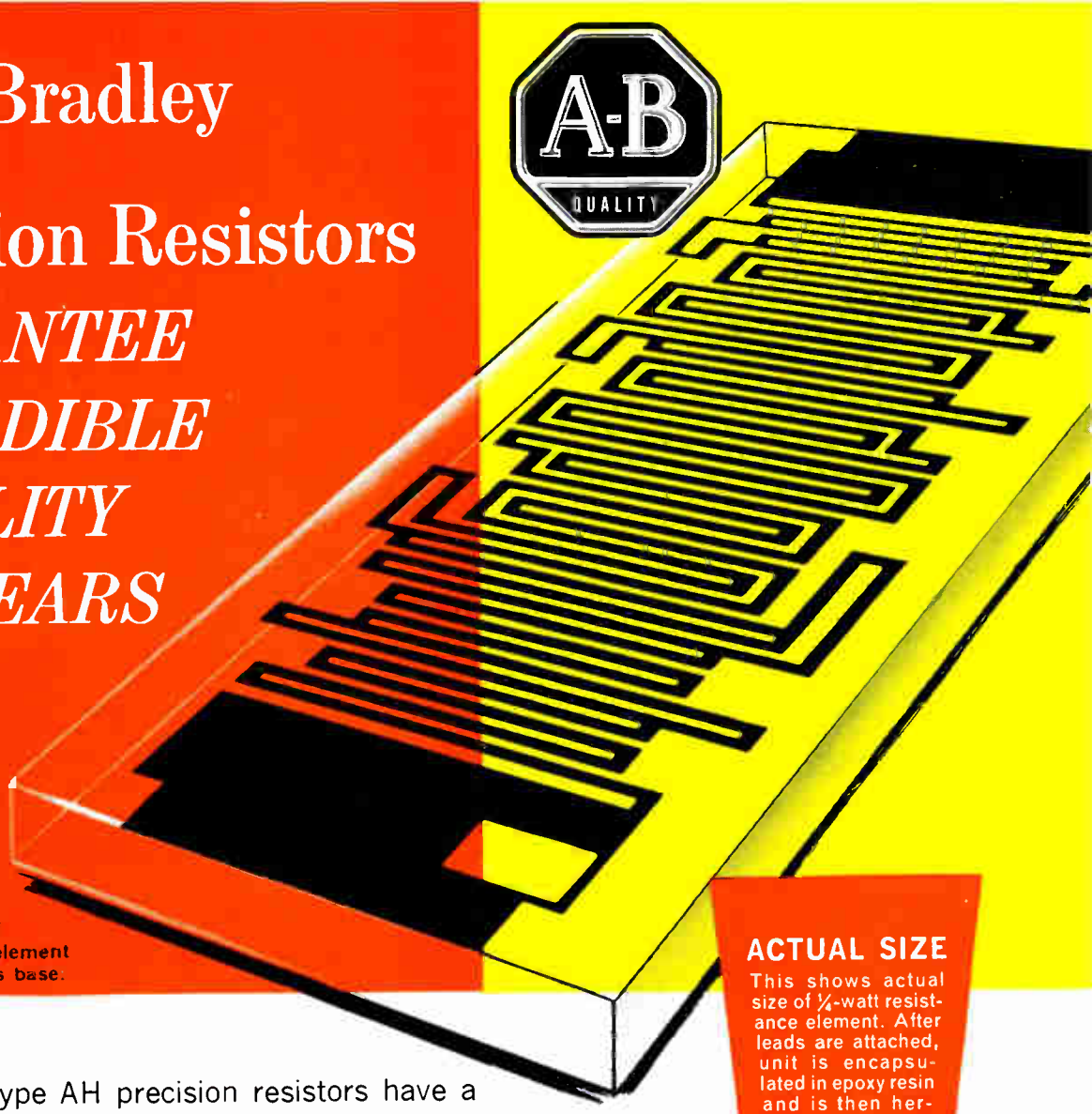
Computer Measurements Co.
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

Circle 78 on Inquiry Card

Circle 79 on Inquiry Card

Allen-Bradley
Type AH
Precision Resistors

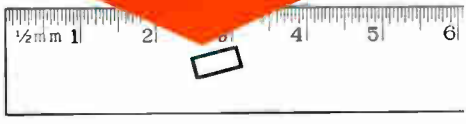
GUARANTEE
INCREDIBLE
STABILITY
FOR YEARS



Enlarged illustration of metal grid resistance element mounted on clear glass base.

ACTUAL SIZE

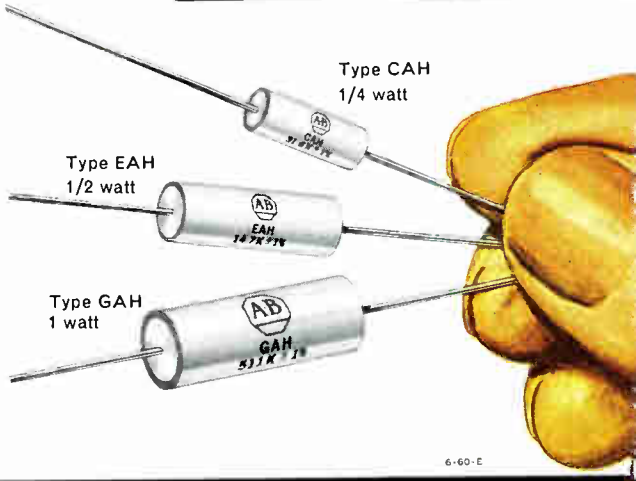
This shows actual size of ¼-watt resistance element. After leads are attached, unit is encapsulated in epoxy resin and is then hermetically sealed in a ceramic tube



Allen-Bradley Type AH precision resistors have a temperature coefficient of ± 25 PPM or less

Allen-Bradley hermetically sealed precision resistors have an assured long-term resistance stability that is unsurpassed. In addition, *all* characteristics exceed MIL Specs for film and wire-wound precision resistors. The unique design of the metal grid is noninductive, providing excellent high frequency performance. The noise level is of the same low order of magnitude as wire-wound resistance units. With the metal grid deposited on a clear glass substrate, the resistance element is given a visual inspection under extreme magnification, to make certain that it is completely free of possible defects. Unlike conventional metal film resistors, these units are calibrated *without* disturbing the actual current path in the grid.

Allen-Bradley Type AH precision metal grid resistors are available in 1%, 0.5%, 0.25%, and 0.1% tolerances, and with temperature coefficients of 25 PPM or less. Considering the meticulous care with which they are produced, the Type AH resistor could not be cheap. However, where accuracy and reliability are essential—there isn't a resistor on the market which is equal to the Allen-Bradley Type AH precision resistor. Please write for more detailed information.



6-60-E

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

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

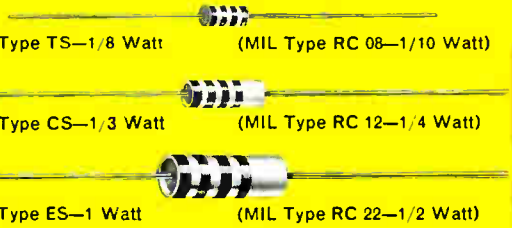
A-B QUALITY

Radioactive Tracers ASSURE Positive Seal OF ALLEN-BRADLEY TYPE S CERAMIC ENCASED RESISTORS

Detecting leaks so microscopic that *less than 1 cc of air* (approximately 1/16 of a cubic inch) *would require 30 years to pass through* . . . this ultra-scientific radioactive test is your assurance that the hermetic seal of the resistance unit is virtually perfect. In the test, resistors go into a tank where the air is evacuated and radioactive Krypton 85 is introduced under pressure. After the resistors have been allowed to "soak" in this atmosphere for several hours, they are removed and individually placed in a shielded chamber equipped with a scintillation counter. If any radioactivity is detected, it indicates a leak in the seal, and the resistor is rejected. You can depend on the Allen-Bradley hermetically sealed resistors—they *are* what they are *claimed to be!*

A-B TYPE S HOT MOLDED HERMETICALLY SEALED RESISTORS

Ceramic Encased



Type TS—1/8 Watt (MIL Type RC 08—1/10 Watt)

Type CS—1/3 Watt (MIL Type RC 12—1/4 Watt)

Type ES—1 Watt (MIL Type RC 22—1/2 Watt)

ACTUAL SIZE

This superior testing technique, which employs radioactive tracers, provides positive proof that the hermetic seal of each and every Allen-Bradley Type S ceramic encased resistor is virtually *perfect*—it guarantees that the unit is completely protected against moisture and humidity.

These Type S resistors have a special carbon composition resistance element and an insulating jacket which are hot molded into one integral unit by an *exclusive* A-B process. The unit is then encased in a ceramic tube with metal seals.

Combining freedom from catastrophic failure with positive protection against humidity, these ceramic encased resistors assure unparalleled performance and absolute reliability. Made in 2% and 5% tolerances in standard EIA values up to 22 megohms and higher, on special order.

For continuous reliability, specify A-B Type S ceramic encased resistors. Send for Technical Bulletin 5003, today.

DESIGN WITH ARNOLD 6T CORES . . .

SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply *your* requirements. Full data (Bulletin TC-101A and Supplements) on request. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

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BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES • *Find them FAST in the YELLOW PAGES*

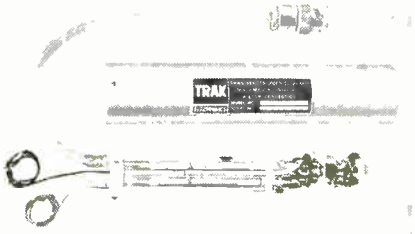
1539

READY TO ROLL! RIGHT FROM STOCK

New Products

L-BAND OSCILLATOR

Miniature Type 9127-L oscillator is end-tuned over ±25 MC at 1090 MC. Design available in 900-1200 MC. Specs include: Pulse Service Power Out, greater than 250 w min. (0.003



duty cycle, 1 μsec. pulse at 1000 v. at approx. 1.0 a.; CW Service Power Out, greater than 20 mw with a plate voltage of 60 vdc at 15 ma.; Temp., ±250 KC over + 20°C. to + 100°C.; Shock, 100g for 3 msec results in less than 0.25 MC FM; Vibration, 10g from 50 to 2000 CPS in each of 3 axes results in less than ±1 MC FM. Output Impedance, 50 ohms.; Output Connector, UG-88C. Microwave Components Dept., Trak Electronics Co., 48 Danbury Rd., Wilton, Conn.

Circle 227 on Inquiry Card

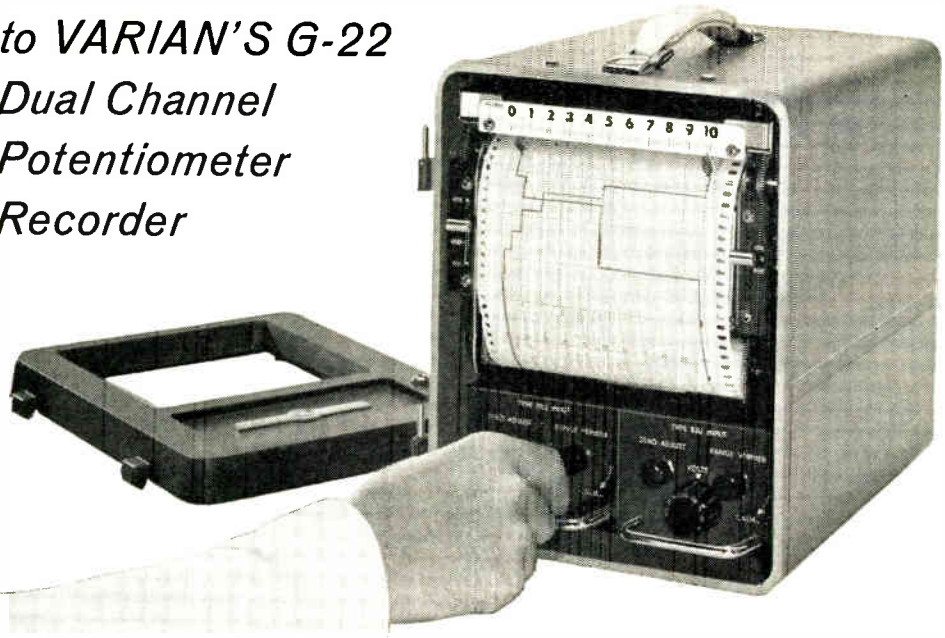
FIXED COAX ATTENUATORS

Series 180 fixed coaxial attenuators have exceptional stability and withstand appreciable overloads and peak powers with no change of characteristics. Shock and vibration resistance is high and a negligible change of attenuation occurs under humidity and temp. cycling. Nom. attenuation is 3, 6, 10 and 20 db. Principle specs are: Frequency range: 1 to 12.4 KMC for

3, 6, and 10 db and 2 to 12.4 KMC for 20 db.; impedance 50 ohms: Temp. coefficient of attenuation: 0.00043/db/°F, from 32°F to 125°F. Insertion length approx. 7¾ in. FXR, Inc., 25-26 50th St., Woodside 77, N. Y.

Circle 228 on Inquiry Card

A new addition to VARIAN'S G-22 Dual Channel Potentiometer Recorder

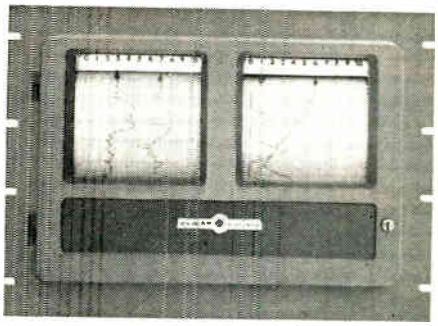


ADJUSTABLE SPAN

0-10 MV TO 0-500 VOLTS

More versatile than ever, the Varian G-22 will now record from sources of almost any likely signal voltage. A newly available plug-in input chassis, the B-22 attenuator type, is easily set as needed from spans as little as 10 millivolts full scale to as high as 500 volts. Front-panel adjustment is continuous in between for optimizing use of the chart's full width in any recording situation.

The G-22 can be your best all-purpose recorder in other ways too. Two channels in themselves also mean versatility—they make the recorder a correlator of simultaneous variables (any two you choose). Two plug-in input chassis mean that each channel's recording characteristics can be quickly changed. And zero can be reset anywhere across the chart from left to right—each channel separately. Last but not least don't underestimate the value of the handle on top. This recorder goes wherever there is recording to be done.*



*Varian offers rack mounted versions too—either singles or twins. The latter is pictured, showing how four channels of recording can be fitted within the 19-inch width of a standard rack.

SPECIFICATIONS, OPTIONS, AND ACCESSORIES

One second full-scale balancing time • Accuracy 1% of full scale • Sensitivity 0.25% of full scale • Two chart speeds standard, four speeds optional • Wide selection of chart speeds from ⅛" per hour to 16" per minute • Weight 33 pounds • Available accessories include retransmitting slide wires, alarm contacts, event markers, etc.

For full specifications, write the Instrument Division.

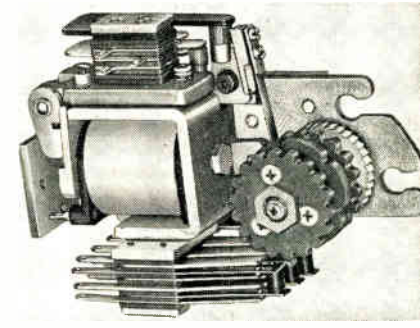
VARIAN associates
PALO ALTO 19, CALIFORNIA

NMR & EPR SPECTROMETERS, MAGNETS, FLUXMETERS, GRAPHIC RECORDERS, MAGNETOMETERS, MICROWAVE TUBES, MICROWAVE SYSTEM COMPONENTS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, RESEARCH AND DEVELOPMENT SERVICES

New Products

STEPPING SWITCH

New stepping switch, the cam-operated Type 200, makes an ideal memory device as but a single impulse is required to switch and no power is required to hold it operated. Position



of the switch remains unchanged by equipment or power shutdowns. Available in models with up to 8 cams providing 30, 32, or 36 tooth ratchets. Operating speed is up to 60 sps self-interrupted, 30 sps remote-impulsed. Can be used as a replacement for interlock relays or for use where control of a sequence of operations is necessary. C. P. Clare & Co., 3101 Pratt Blvd., Chicago 11, Ill.

Circle 231 on Inquiry Card

PRESSURE TRANSDUCER

New Type 4-383 Potentiometer Pressure Transducer, combines high vibration resistance with superior linearity. Max. deviation due to the effects of linearity, hysteresis, repeatability, and friction is less than ± 1%. It withstands up to 35 g's acceleration at 2000 CPS and withstands 2500 psi.

Gage and absolute models of the instrument measure pressure from 600 to 3500 psi. Operating temp. is −65 to +200°F. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 232 on Inquiry Card

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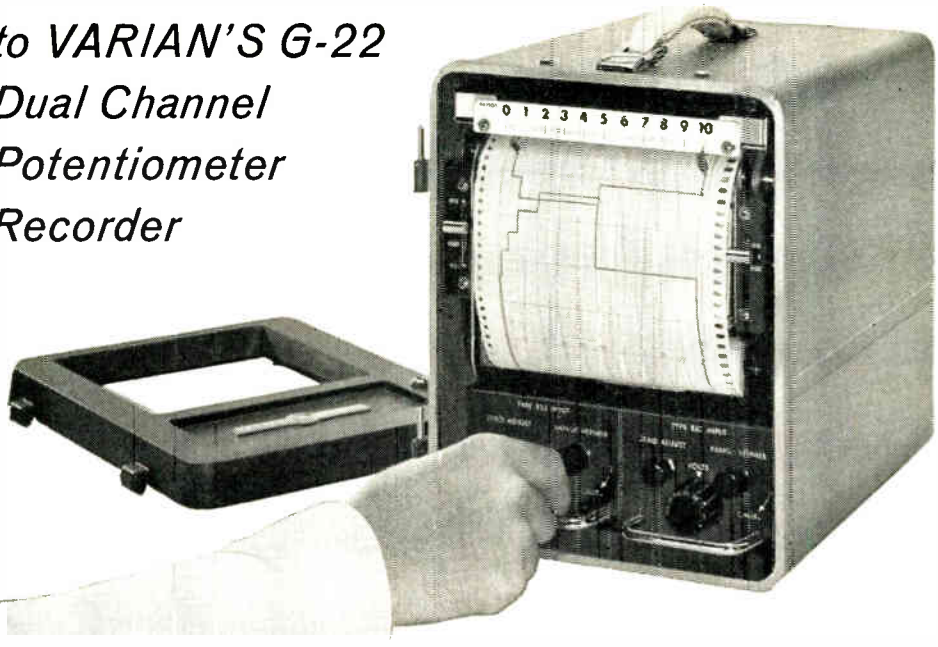

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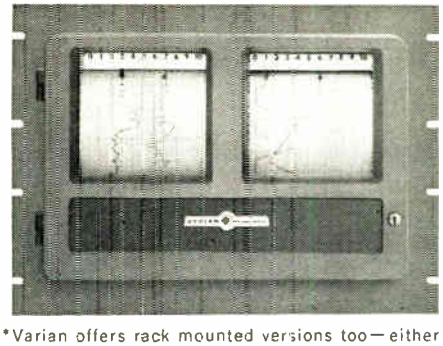

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VARIAN associates
PALO ALTO 19, CALIFORNIA

NMR & EPR SPECTROMETERS, MAGNETS FLUXMETERS, GRAPHIC RECORDERS, MAGNETOMETERS, MICROWAVE TUBES, MICROWAVE SYSTEM COMPONENTS, HIGH VACUUM EQUIPMENT, LINEAR ACCELERATORS, RESEARCH AND DEVELOPMENT SERVICES

New Products

DIGITAL MICRODIAL

New 1330 Series direct-reading digital microdial. Turns-counting dial combines digital counting system with internal illumination for improved readability. It counts from 000 through 999 in exactly 10 turns. Ro-

tation is continuous for standard models. Numbers are displayed through a sealed, one-piece lens featuring 1.5 magnification. Curved design permits wide-angle viewing. Internal Illumination is in white or red light. Adjustment knob is machined aluminum with a fluted rim for sure grip. Snap-on design permits access for lamp replacement. Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wis.

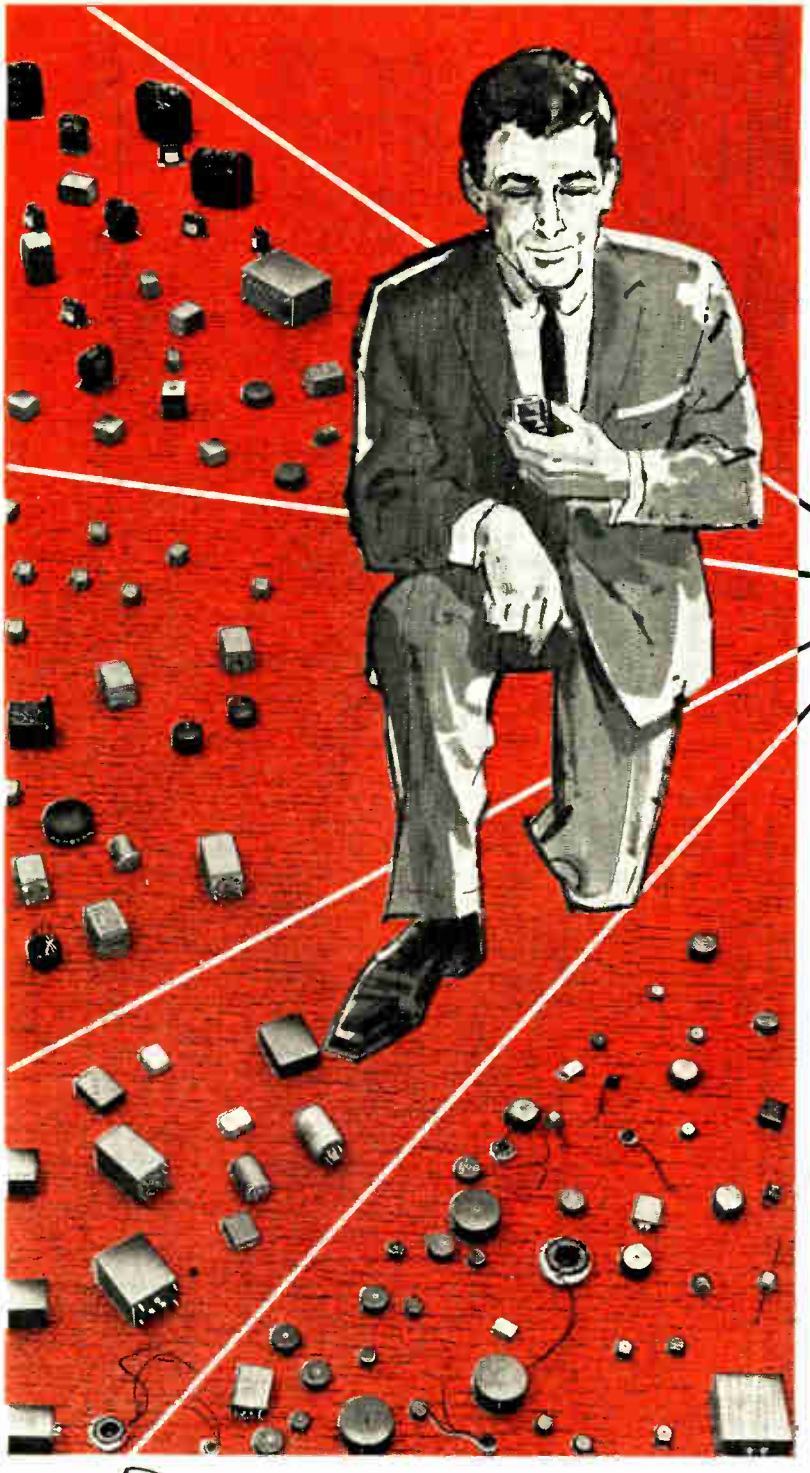
Circle 229 on Inquiry Card

CLOSED ENTRY TEST JACK

New test jack, provides closed entry and stud terminal. The Press-Fit SKT-35 test jack is for use with 0.032 in. dia. x 0.200 max. probe, and uses a Teflon body. The closed entry assures perfect alignment of the test probe with the beryllium copper contacts.

Test jack body is 0.148 in. dia. for through-chassis installation, with a 0.172 in. dia. dimension above the chassis. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 230 on Inquiry Card



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Testco
Boeing Field—Room 105

315

New Products

STEPPING SWITCH

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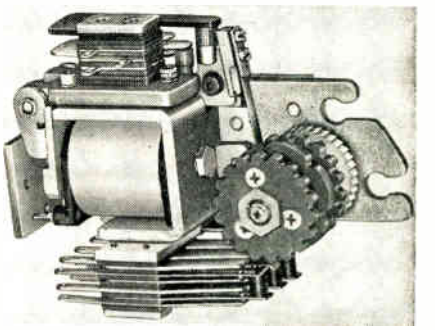

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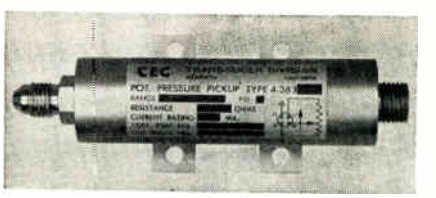


Gage and absolute models of the instrument measure pressure from 600 to 3500 psi. Operating temp. is —65 to +200°F. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 232 on Inquiry Card

SEND FOR A COPY OF 28-PAGE CATALOG 66SR WHICH PROVIDES OPERATING DATA ON BREEZE CUSTOM UNITS AND DRAWINGS AND SPECIFICATIONS OF ALL STANDARD SLIP RING ASSEMBLIES.

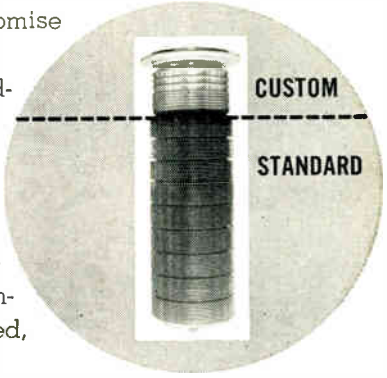
COMBINING CUSTOM AND STANDARD SLIP RING ASSEMBLIES

FOR LOWER COSTS—FASTER DELIVERY

This slip ring assembly controls, powers and monitors the centrifuge arm of a motion simulator. Its production required the combination of highly creative engineering skills, well-equipped manufacturing facilities and diversified production methods available to you at Breeze.

The unit, having a duty cycle of 2000 amps, is only 48" high, yet contains 425 slip rings. These include both standard rings and rings engineered for this application. There are rings of flat and cylindrical design, electroplated rings and rings of fabricated construction in the assembly.

Whatever your slip ring requirement, it can be met without compromise at Breeze.



For general applications, Breeze offers a line of field-proven standards with ring envelope diameters from 1" through 10½". These are flat, fabricated assemblies built from off-the-shelf components to insure rapid delivery at reduced costs.

For custom applications including general purpose control and power, radio frequency and video, high voltage, high speed instrumentation and switching, Breeze produces flat, cylindrical or concentric assemblies using all standard construction methods, fabricated, electroplated and plastic molded.

BREEZE MARK

BREEZE CORPORATIONS, INC.

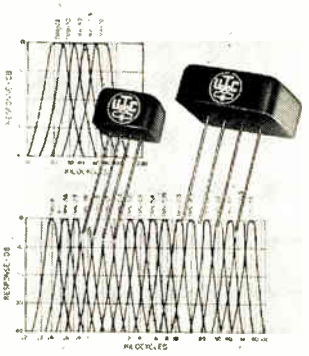
700 Liberty Avenue, Union, New Jersey • Telephone: MUrdock 6-4000

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

New Products

BAND PASS FILTERS

New line of ultra miniature telemetering band pass filters (Minifilters) for transistor and printed circuit applications. The MNF and MWF filters have input and output impedances of 10,000 ohms with the low

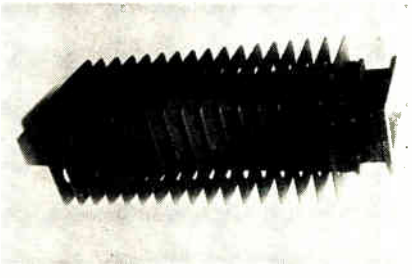


connection brought out to individual terminals so that the input and output may be used at different dc potentials. The MNF filters are down less than 3db at ± 7.5% of center frequency while the MWF filters are down less than 3 db at ± 15% of center frequency. Attenuation of greater than 40 db is afforded in the stop bands. United Transformer Corp., 150 Varick St., New York 13, N. Y.

Circle 233 on Inquiry Card

DUMMY LOAD

New dummy load for L-band radar, dissipates 8 kw of ave. power and 2200 kw of peak power without liquid cooling. Model 890374 can be used from 1120 to 1700 MC. Size of the new model is 32⅞ in. x 8⅞ x 11 7/16 in. Weight is approx. 80 lbs. It is com-



patible with the RG-103/U waveguide, and is designed for rugged environmental conditions. A liquid-cooled version also is available for use with significantly higher powers. Airtron-Pacific, 5873 Rodeo Rd., Los Angeles 16, Calif.

Circle 234 on Inquiry Card

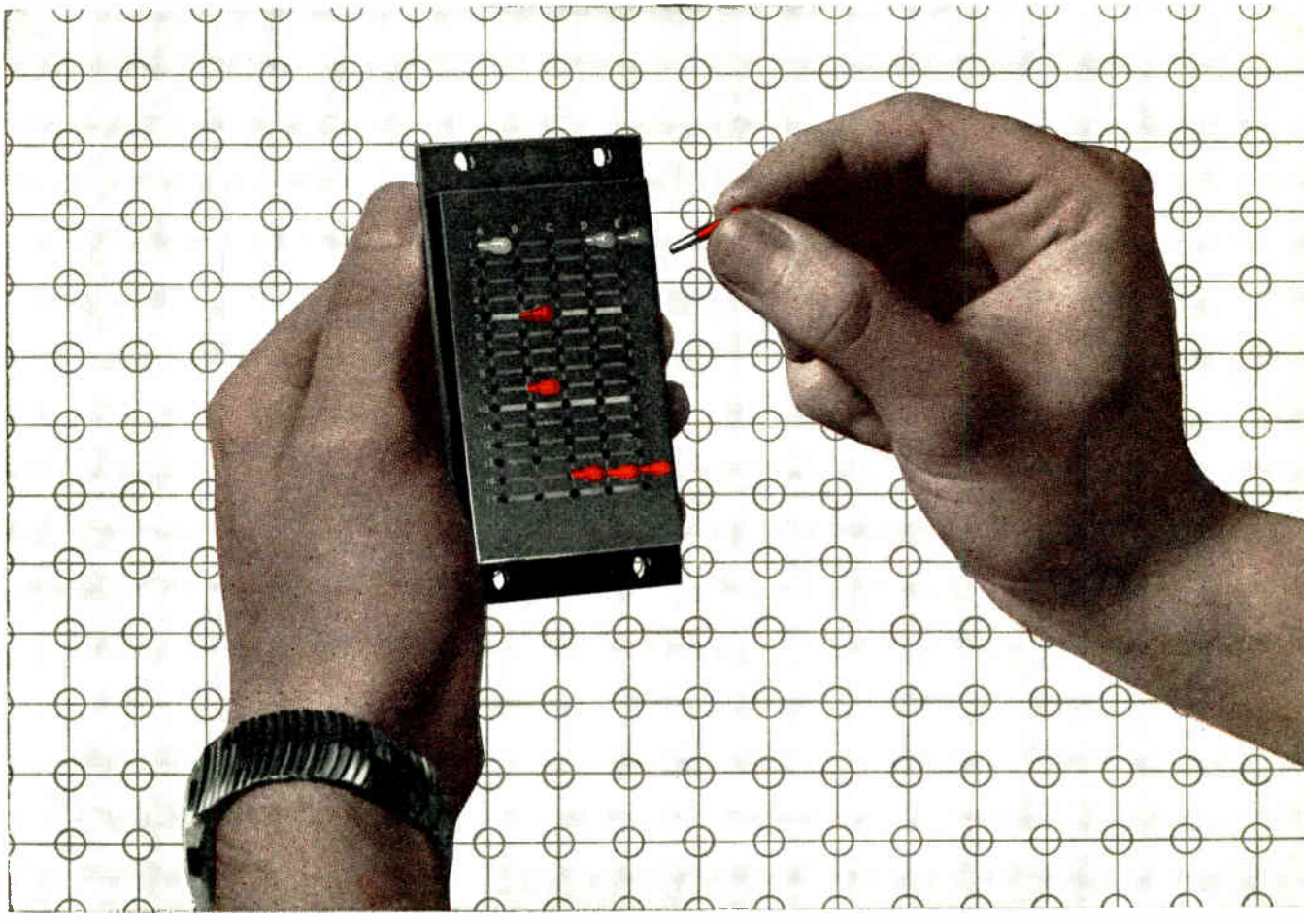
PIN POINT PROGRAMMING

AMP PINBOARDS can do a host of dry circuit switching or commoning functions . . . permit numerous matrixes in one assembly. Complicated switching functions can be accomplished by simply inserting or removing a pin.

You can use these PINBOARDS as modular building blocks for instrumentation applications, automated tooling, test equipment, data processing . . . any variety of size and grid arrangements in multiples of a basic 15 x 5 hole pattern. Contact springs can be bussed in any combination desired. And for safety, there are no exposed conducting surfaces on the rear side of the board. The conducting area of the pin is safely inside board before contact is made with mating springs.

AMP PINBOARDS are factory pre-wired to your specifications . . . with standard or special silk screen legends. Designed for simplicity . . . flexibility . . . reliability . . . with three amperes continuous current rating.

Write for complete specifications.



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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • West Germany

New Products

HEATING WIRE

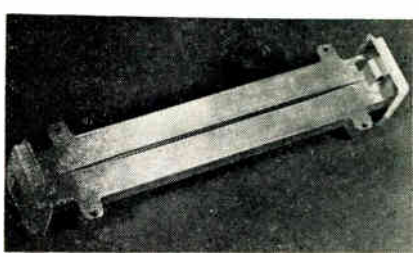
New Thermocoax high temp. heating wire is extremely flexible and has good heat transfer and heat dissipation ratings. It is useful where commercially available ovens cannot be readily adapted to special situations

and conditions. Nuclear, industrial and research applications are foreseen, such as heating objects in a vacuum or under pressure, and maintaining such elements as sodium in a liquid state. In use, the highly flexible Thermocoax heating wire is simply coiled around the object to be heated and brought out through the oven. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 235 on Inquiry Card

SLOTTED SECTION

New line of special test equipment and components to be known as Half-X Components. A slotted section in Half-X waveguide is designed to mate commercially available carriages. It permits accurate measurement of impedance and VSWR in 0.900 x 0.200 in. ID waveguide. Slope and distortion



are minimized through close tolerance construction. Residual VSWR of the section is less than 1.03:1. Flanging consists of modified UG-39/U configuration. Turbo Machine Co., Lansdale, Pa.

Circle 236 on Inquiry Card

NOW! WESTINGHOUSE IN FULL PRODUCTION ON FAMILY OF TUNABLE X-BAND MAGNETRONS

Westinghouse announces a family of tunable X-Band Magnetrons available now for airborne radar service—and new production facilities to meet your requirements at all times. These high-performance magnetrons feature improved stability, minimum frequency drift, excellent spectrums, high efficiency and low voltage operation. The new family not only features Type WL-7008, but also includes Types 7110, 7111, 7112 and 6865A. Some of their typical performance characteristics are as follows:

- **Frequency range: 8500 to 9600mc**
- **Peak power output: 220 Kilowatts**
- **Pulse widths: up to 2.8 microseconds**
- **Heater voltage: 13.75 volts**
- **Frequency range excursion: 7 seconds at 1500 rpm shaft speed**

For full information, contact your nearest Westinghouse industrial tube representative, or write: Westinghouse Electric Corporation, Electronic Tube Division, Elmira, N.Y.

YOU CAN BE SURE...IF IT'S Westinghouse

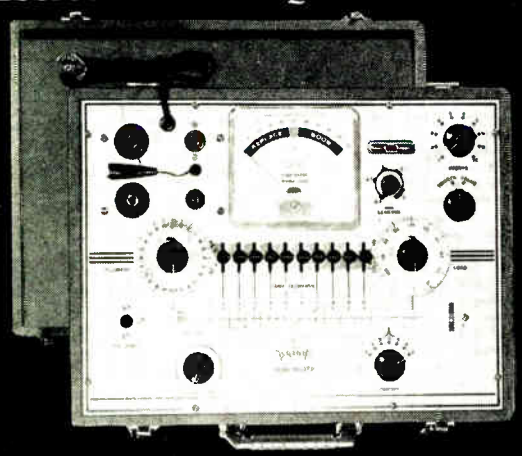
Electronic Tube Division Elmira, N.Y.

Circle 90 on Inquiry Card

it takes two . . . to test

TRIPLETT

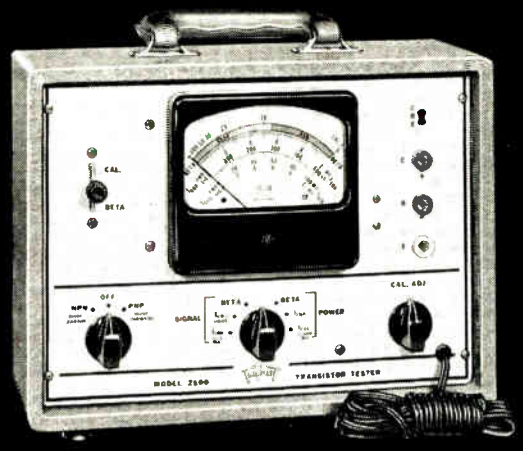
PROFESSIONAL TEST EQUIPMENT



Model 3414 TUBE TESTER

Fast and extremely flexible. Provides easy, accurate testing. All switch settings can be made before the tube warms up . . . you're ready to test before the filaments have heated to the proper temperature. Rejects burned out tubes instantly without waiting for the filaments to heat. Neon indicator shorts test, new fast and accurate. Full range filament Voltages—0.65 to 117 in 23 steps. Improved lever switching for complete control of each tube element. Quick-change roll chart. TV picture tube test by means of BV adapter (available at extra cost of $5.40) without removing tube from receiver. Large, clear-view meter has three-color GOOD-?-BAD scale.

Counter–Portable Type case. Ultra-professional appearance in dark gray leatherette covered wood: 15¾" x 11½" x 6½". Hinged removable cover. Chrome hardware and feet. Model 3414..... **$79.50**



Model 2590 TRANSISTOR TESTER

Test Power Type Transistors and Signal Type Transistors under SIMULATED OPERATING CONDITIONS. Tests for shorts and leakage. Provides for testing ICEO (at 9.5 volts), ICBO (at 9.5 volts), and BETA (at 3 volts) on both NPN and PNP transistors. Checks leakage and forward currents of Diodes. EXTREMELY SIMPLE TO OPERATE. No roll charts or special technical data required. The only information needed to make a test is the transistor type. A transistor socket and a set of external leads permits use with any basing arrangement. Power-115 volts. 50-60 cycles AC. No batteries are required. The recessed panel is of etched heavy-gauge aluminum. It has a natural finish with black and red markings and trim.

Counter–Portable Type case in gray leatherette-covered wood: 11⅜" x 8⅜" x 5⅛". Case has rubber feet. Model 2590..... **$49.50**

Model 690-A TRANSISTOR TESTER

Light and extra-portable. Provides leakage and gain tests for all low and medium power PNP and NPN type transistors. Measures DC BETA (current gain from base to collector with grounded emitter) from 5 to infinity. The long GOOD scale provides a better indication of the degree of quality. Affords an exact test for shorts and leakage . . . checks forward and reverse leakage of diodes. Prevents drain on batteries in case of accidental shorting of leads. Battery operation eliminates need for external power supply. Error-proof controls. Transistor socket and external leads for any basing layout. The panel has black and red markings etched on aluminum. The black molded case is 2½" x 5½" x 6". Model 690-A..... **$29.50**

TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

PANEL METERS

All Triplett testers and instruments are available nationally through authorized Triplett distributors. A list of the distributors in your area is available on request.

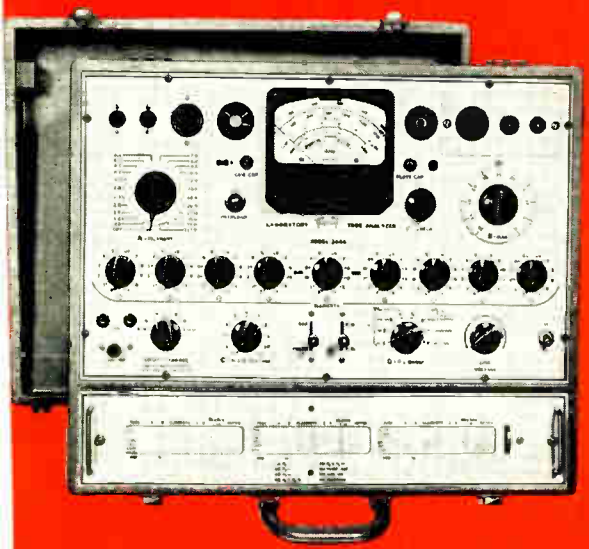
TRIPLETT

both tubes and transistors

HAS THE ANSWER!

Among these five outstanding Triplett testers you will find those that are perfectly suited to your particular requirements for tube and transistor analysis. Whether they be efficient lightweight models for quick readings on service calls . . . or industrial models to solve the most perplexing analysis problems, Triplett testers will give you dependable service and accurate measurements.

LABORATORY ANALYZERS / **Model 3444 TUBE ANALYZER**



The finest instrument of its type available today. It speedily and accurately solves the most puzzling tube analysis problems in any field: Laboratory, Research, Industrial, Radio, Television, etc. This model measures true Gm without any extra compensating factors. **The first** Portable Gm Tube Tester with signal levels the same as those used in the large competitive units considered standards for tube testing.

The first Portable Tube Tester with self calibrating Mutual Conductance System.

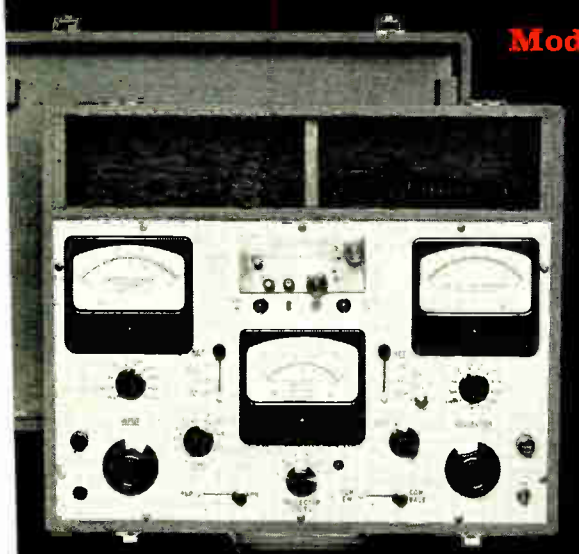
The first Portable Tube Tester reading directly in volts, milliamperes and microhms the conditions of tube measurement.

The first Portable Tube Tester equipped for plotting or developing characteristic curves. (Dual triode sections for example, may be compared at bogie and cut off *plate current in volts* and *milliamperes*, not arbitrary numbers.)

THE FIRST portable analyzer able to test the new Nuvistor tubes used in computer work. CHECKS PLATE current cutoff. CHECKS GAS under actual operating condition (measures to a fraction of one UA of gas current). CHECKS RECTIFIERS under load. CHECKS THYRATRON firing voltage and grid current. CHECKS DUAL section tubes with only one lever movement. PROVIDES SHORTS and leakage measurements from 0-10 megohms using a filtered DC supply of 85 volts.

Counter–Portable Type Case in gray leatherette-covered wood: 15 3/16" x 18 13/16" x 7 3/4". Hinged removable lid, sloping panel, compartment for line cord, leads, acorn adapter and removable roll chart. Chrome hardware and feet.

Model 3444 ..... $249.5



Model 3490 TRANSISTOR ANALYZER

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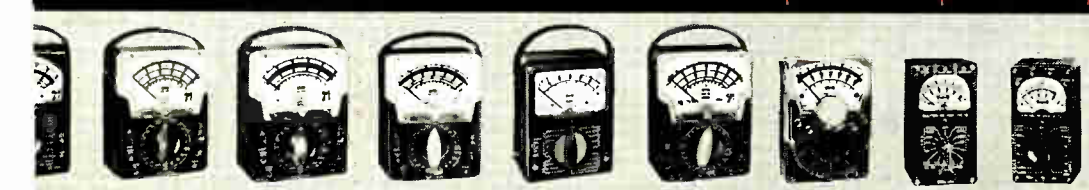
RANGES:

INPUT CURRENT (Emitter or Base)	COLLECTOR CURRENT	ICEO, ICO (ICBO)	COLLECTOR VOLTAGE	EMITTER OR BASE VOLTAGE	TETRODE
0-1 Amp, 0-300 Ma, 0-100 Ma, 0-30 Ma, 0-10 Ma, 0-3 Ma, 0-1 Ma, 0-300 Ua.	0-10 Amp, 0-3 Amp, 0-1 Amp, 0-300 Ma, 0-100 Ma, 0-30 Ma, 0-10 Ma, 0-3 Ma, 0-1 Ma, 0-300 Ua.	0-60 Ma, 0-6 Ma, 0-600 Ua, 0-60 Ua.	0-120V, 0-60V, 0-30V, 0-12V, 0-6V, 0-3V	0-12V, 0-1.2V	0-10V Calibrated Contr

nter-Portable Type Case in gray leatherette-covered d: 15 3/16" x 18 13/16" x 7¾". Hinged removable cover accessory compartment and sloping panel. Chrome dware and feet. Model 3490 ..... $399.50



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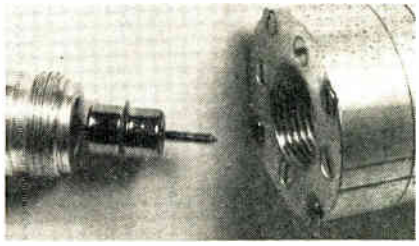

Storage temp., 100°C; Total device dissipation, at 25°C, 80 mw; (electrical characteristics at 25°C)—Collector cutoff current, ICBO at VCB = −15 v. IE = 0, 10 μa; Collector cutoff current, ICBO, at VCB = −20 v. IE = 0, −25 μa; Collector cutoff current, ICES at VCE = −20 v., VBE = 0, −50 μa; Emitter cutoff current, IEBO at VEB = −0.4 v., IC = 0, −1 ma; Collector Capacitance, C_c at VCB = −15 v., IE = 0, 0.8 μμf; Base resistance collector at VCB = −15 v., IE = 2 ma, 30 μμ sec.; Capacitance product, $r_b' C_c$ at f = 46 MC. Philco Corp., Lansdale Div., Church Rd., Lansdale, Pa.

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Two additions to series of matched microwave mixer-preamplifier assemblies cover octave frequency bands from 1 to 2 KMC (MML-2) and from 2-4 KMC (MMS-2). I-f outputs of 30

or 60 MC are standard. Output bandwidth is 8 MC, noise figure 7.5 db, and gain 25 db. Typical LO power required is 1 milliwatt. LEL Inc., 380 Oak St., Copiague, L. I., N. Y.

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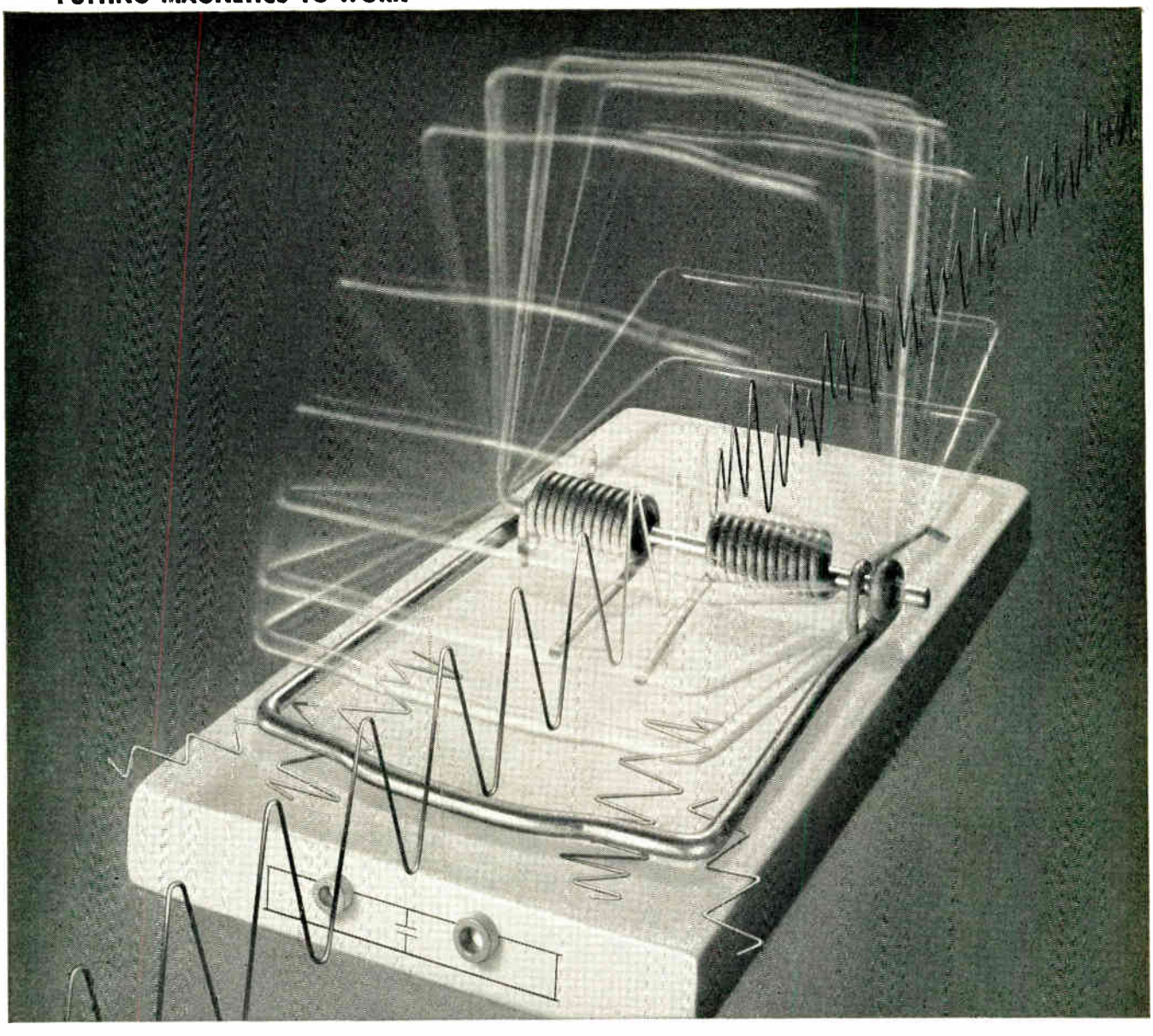

How to build a better (audio signal) trap!

Magnetics Inc. permalloy powder cores give filter designers new attenuation and stability standards—and miniaturization to boot!

The art of trapping unwanted frequencies has been advanced during the past year with a succession of improvements in molybdenum permalloy powder cores by Magnetics Inc. Most audio filter designers now work with smaller cores, more stable cores and cores whose attenuation characteristics are ultra-sharp. Do you?

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Why not write for complete information? Like all of our components, molybdenum permalloy powder cores are *performance-guaranteed* to standards unsurpassed in the industry. *Magnetics Inc., Dept. EL-82, Butler, Pa.*

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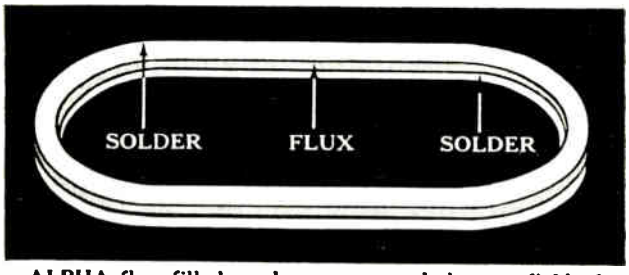
NEW solder development!



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ALPHA makes a wide range of flux-filled and solid preforms *Request information today!*

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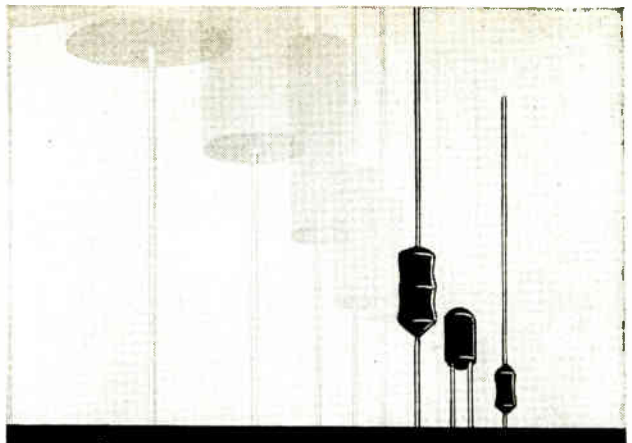

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This free folder contains complete specs on 24 models of the miniature AGASTAT Time Delay Relay for missile, aircraft, computer, electronic and industrial applications. They're small as 1-13/16" x 4-7/16" x 1½", with adjustable timing ranges starting at .030 and as high as 120 seconds.

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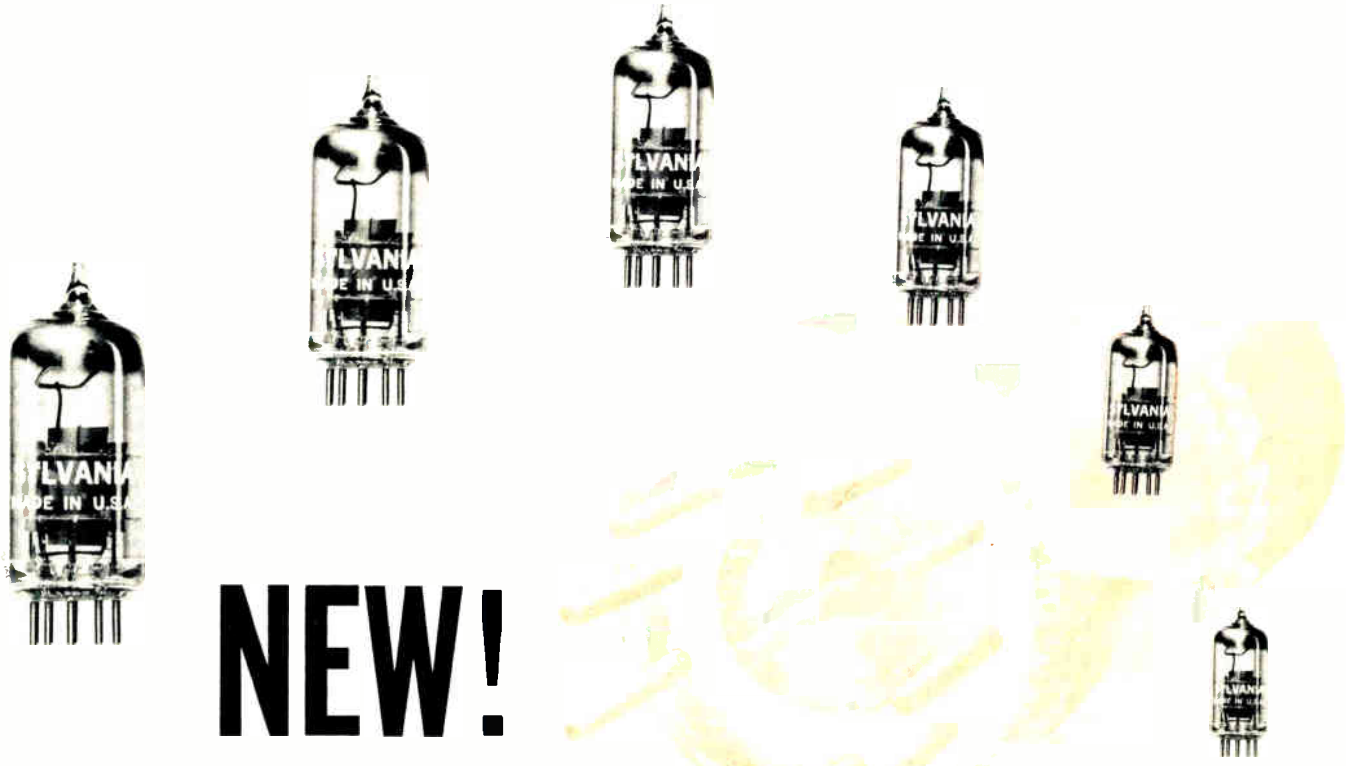
ELECTRON TUBE NEWS ...from SYLVANIA



NEW!

10-PIN TUBES in T-6½ envelope offer

• CIRCUIT ECONOMIES • IMPROVED PERFORMANCE • NEW MULTI-UNIT COMBINATIONS

Sylvania adds a 10th pin to the center of the standard 9-pin miniature circle of the T-6½ envelope . . . offering dramatic circuit advantages with a minimum of circuit redesign.

Now, with Sylvania 10-PIN TUBES, new multi-unit combinations can be contained efficiently in one envelope . . . offering potential savings in circuitry, reducing space requirements. Tube elements can be tied separately . . . improving interelement isolation. The 10th pin provides sturdy support for improved shielding between tube units. Now, 10-PIN design can offer tubes with inherently low input capacitance-high gain. Note, too, that sockets designed for 10-PIN TUBES can accept conventional 9-pin miniature tubes.

Specific examples of 10-PIN TUBES include a new medium-mu triple-triode designed to provide the combined function of rf amplifier, oscillator and mixer for VHF. This unique triple-triode features separately terminated cathodes and heater. Cathodes, therefore, can be connected to "ground" without grounding heaters—enabling better tube placement in series string arrangement.

Design around SYLVANIA 10-PIN TUBES

A further 10-PIN TUBE development is a new high-performance double tetrode in a T-6½ bulb. It provides small size, big performance as a combination rf amplifier, oscillator-mixer. Additional types will include a dual-pentode, triode-pentode and a new sextuple-triode.

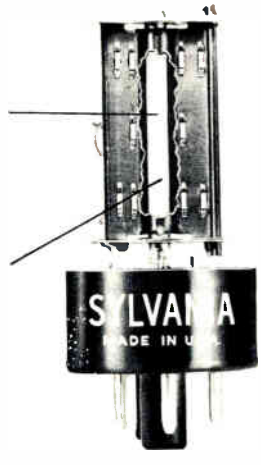
Contact your Sylvania Sales Engineer for complete information. He will gladly work with you on the individual tube requirements of your design.

NOW! SYLVANIA-6146
SYLVANIA-6883
SYLVANIA-6159

All three beam power pentodes are manufactured and tested to exacting Sylvania standards for highest quality. They are designed for reliable service as an af power amplifier and modulator, rf power amplifier and oscillator. Maximum plate dissipation is 25 watts (ICAS). They are identical in electrical characteristics except for heater ratings: Sylvania-6146 has a 6.3V heater; Sylvania-6883 – 12.6V; Sylvania-6159 – 26.5V. Ask your Sylvania Sales Engineer for complete data and delivery information.

Sarong Cathode significantly minimizes plate-to-cathode arcing. Surface of *Sarong* is virtually free of "peaks and valleys," provides uniform spacing between cathode and plate.

Sarong Cathode eliminates "hot spots." Control of density of *Sarong* coating assures uniform temperature and emission over the entire cathode surface.



NEW! SARONG CATHODE
extends life, improves reliability of
SYLVANIA-6AU4-GTA, 6AX4-GTA

Sylvania *Sarong Cathode* prolongs service, increases performance of two highly popular TV damper tubes. *Sarong Cathode* minimizes plate-to-cathode arcing. *Sarong* eliminates "hot spots," increases stability. This vital development plus individual tube-type improvements such as—the use of "pigtail" heater welded firmly to the stem lead in the 6AU4-GTA, the use of laminated plate material for strength and heat dissipation in the 6AX4-GTA—combine to minimize possibility of early-hour field failures. Your Sylvania Sales Engineer will gladly give you complete information.

For further information, contact the Sylvania Field Office nearest you. Or for data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. I, 1100 Main Street, Buffalo 9, N.Y.

SYLVANIA

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TOTALLY NEW!

New expanded polystyrene case offers advantages never before found in "C.P." Acid containers!

Lighter! Stronger! Safer! Exclusive new expanded polystyrene case for B&A® "C. P." Acids!

An exclusive development of General Chemical, this new "one-way" case holds four 5-pint "C.P." acid bottles in contoured pockets formed of shock-resistant low density expanded polystyrene. Here is still another packaging "break-through" from America's leading producer of laboratory and scientific chemicals . . . another example of continuing B&A leadership in reagent packaging.

Smaller! Lighter! The new case is substantially smaller than old-fashioned containers and is far easier to store and handle. Tare weight with empty bottles is less than 1.1 pounds. This saves you money on freight.

Easier to handle! Convenient finger grips make case easy to lift and carry. Top and bottom specially designed with interlocking feature for safe stacking.

Safer! The new polystyrene case is chemically resistant, and it is weather-resistant, too. Withstands outdoor storage. Bottles are "cradle cushioned," fully protected in form-fitted polystyrene pockets.

Stronger! The new case is far stronger than other "one-way" cases now in use for "C.P." acids. In thorough and extensive testing, it has met the most stringent ICC drop test requirements . . . bottles remained unharmed after 16 separate drops from a 4-foot height!

Order Now! These new units are now ready for shipment from General Chemical's B&A distributing points coast to coast. They have had more than a year of intensive research and testing and are *proved* superior to any other type of "shipper" now available! For further information, phone or write your nearest B&A office.

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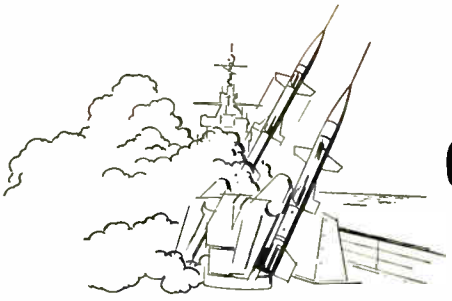

HANDY & HARMAN SILVER FLAKE

Coats Lighter, More Effective Plastic Lens For Long Range Missile Control System

An exciting new application in the missile control field is the development by the Surface Armament Division at Sperry Gyroscope Company of a silver-coated plastic lens for use with the Navy's Talos missile. As compared to earlier metal versions, the new lens weighs substantially less and provides twice the signal gain at the same production cost! The Talos delivers, with extreme accuracy, a high explosive or nuclear warhead to any altitude at which airplanes now fly, as well as far beyond the range of human visibility.

The silver coat imparts RF reflectivity and electrical conductivity to the lens and is applied in paint form. As the silver base for this paint, Sperry uses Handy & Harman's Silver Flake. An important quality of this flake is that its waferlike particles are asymmetrical and overlap on the surface of the lens, affording up to 35% of the conductivity of an equivalent weight and shape of fine silver.

Handy & Harman Silver Flake finds use throughout the electronic and electrical industries...it is ideal for pigments to make conductive coatings on such non-conductors as ceramics, glass, mica, plastic and paper, as in the manufacture of capacitors, thermistors, carbon resistors, printed circuity and electrostatic shields.

Handy & Harman has available every form of silver useful to manufacturers and fabricators—flake, powder, paint, paste, sheet, strip, wire bimetals, silver oxide, divalent oxide, etc. Our Research and Engineering Department is always available to assist you in the selection or use of any silver form for any application from brazing to conduction coating. **Below are listed six of our Technical Bulletins. Please indicate their numbers for prompt attention.**

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Silver-Copper Alloys	Bulletin A-2
Silver-Magnesium-Nickel	Bulletin A-3
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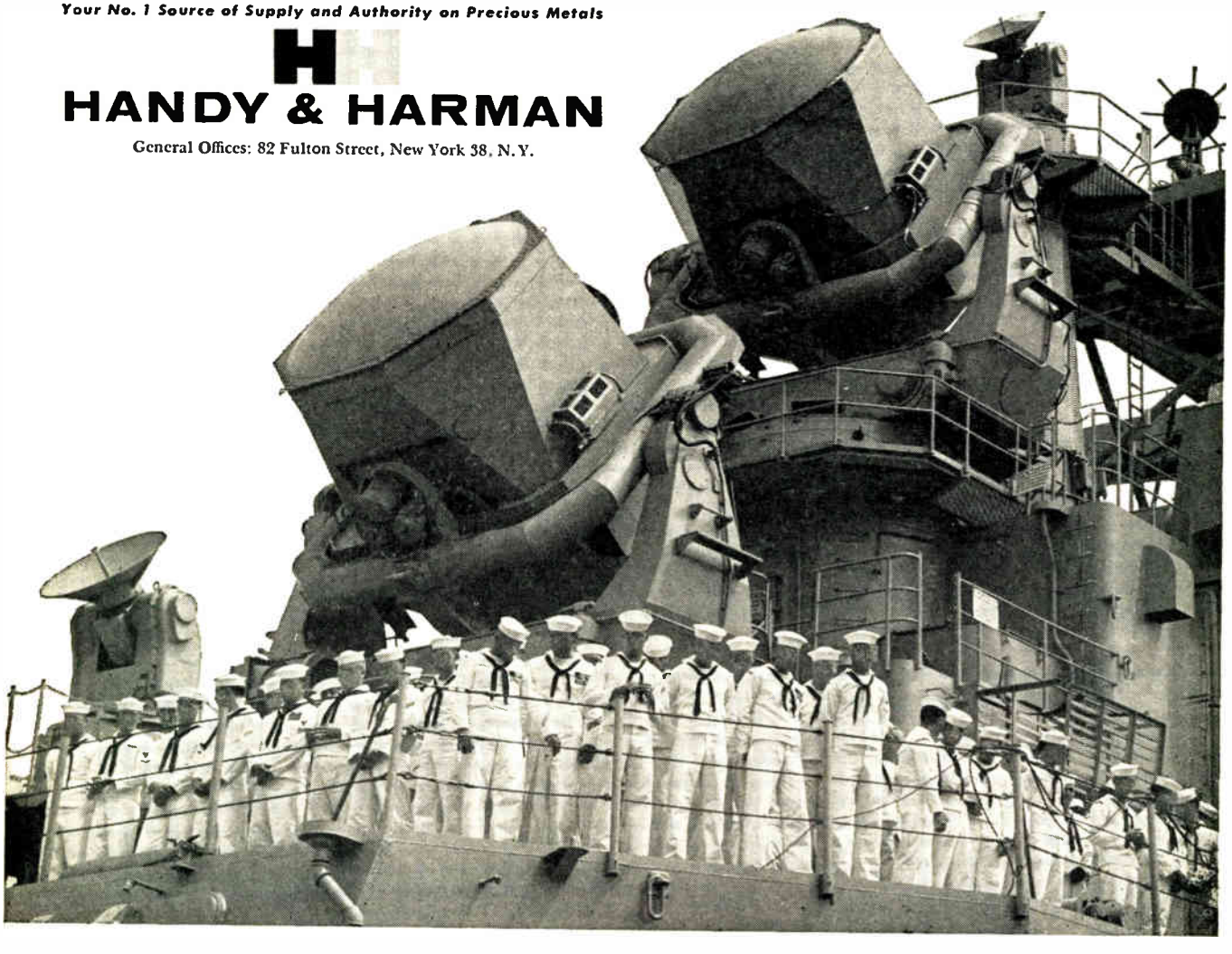

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ANTENNAS, PROPAGATION

Reflection of a Longitudinally Polarized Wave From a Rectangularly Corrugated Conductor Surface, L. N. Deryugin. "Radiotek," 15, No. 5, 1960. 8 pp. Examined is the diffraction on a rectangularly corrugated conductor surface of a plane wave, polarized parallel to the ridges of the surface. Equations for calculations of reflection coefficients are derived on the basis of a rigorous treatment of an electrodynamic surface problem. Coefficients of reflection are computed and plotted, and the diffraction of parallel and perpendicularly polarized incident waves are compared and discussed. (U.S.S.R.)

A Method to Evaluate the Intensity of Radio Signals, Reflected from the Surface of the Moon, M. P. Dolukhanov. "Radiotek," 15, No. 5, 1960. 4 pp. Until the present time propagation losses of radio signals reflected from the moon's surface, were determined by the so-called "Radar Equation." It is shown that the same expression for losses can be obtained by assuming that the reflected wave is formed within the boundaries of the first Fresnel half-zone and, in addition, compensating for the curvature of the reflecting surface. The offered method permits to interpret physically more correctly the effects produced from moon-surface reflections. (U.S.S.R.)

Antenna Arrays with Attenuated Side Lobes, K. Baur. "El. Rund." June 1960. 6 pp. The author presents basic properties of radiation diagrams of homogeneous antenna arrays and describes modern methods of arranging antenna arrays with attenuated side lobes. (Germany.)

AUDIO

The Difference in the Contours of Equal Loudness for Plane Waves and Diffuse Sound Fields. G. Jahn. "Hochfreq." April 1960. 7 pp. The influence of the type of the sound field on subjective loudness measurements was determined through the use of objective measurements. The sound levels in a plane wave and in a diffuse sound field are determined that are needed to produce equal loudness. Below 5.5 KC the level of the plane wave has to exceed the level of the diffuse sound field by =3 db, while at 10 KC this difference increases to 10 db. The results compare favorably with results from earlier subjective measurements. (Germany.)

Reverberation Time in Subjective Perception, T. Tarnoczy, et al. "El. Rund." June 1960. 4 pp. The results of new investigations shed light on the human perception of the reverbation time and on the relation between the latter and the time in music. (Germany.)

New Technique for Hearing Aids, R. Jouve. "El. & Auto." May 1960. 3 pp. A new method relies on what is called the audibility curve. This curve can be used as a starting point to determine the characteristics of an equipment specially adapted to the patient. (France.)

CIRCUITS

Three-Branch Reactive Sections for Ladder Filters with One or Two Cut-Off Frequencies, J. Bimont. "Cab. & Trans." Apr. 1960. 27 pp. The author proposes a diagram method for the synthesis of every possible three-branch structure consisting of reactances without mutual inductive couplings for a ladder filter having one or two cut-off frequencies (as defined on the image impedances). (France.)

A 60 kc/s-12.5 Mc/s Amplifier for 2.6/9.5 mm Coaxial Links, J. Paquet. "Cab. & Trans." Apr. 1960. 17 pp. The paper describes the general layout of a wideband amplifier for coaxial systems, consisting of a preamplifier and an output amplifier interconnected through a temperature compensating network. (France.)

A General Study of Multiple Balanced Circuit Cables, J. Dufresnoy. "Cab. & Trans." Apr. 1960. 9 pp. This paper was written as an introduction to the theory of cross-talk between balanced circuits. (France.)

Some Theorems Concerning Passive Linear Networks, F. Gasparini. "Alta Freq." Feb. 1960. 6 pp. A simple demonstration of Cohn's theorem for passive linear dipoles is reported. An extension of this theorem is following by which it is possible to get some energetical properties of such dipoles, at this time known in a general way by means of a different procedure. (Italy.)

Mutual Decoupling in Telephone Cables with Dieselhorst-Martin Quads, L. Sansone and R. Monelli. "Alta Freq." Feb. 1960. 31 pp. The general manufacturing principles of ordinary multipair telephone cables and the well-known theory of decoupling by properly choosing the lays, which theory applies to the case of single-group (pair or star-quads) cables, are first remembered. (Italy.)

Junction Transistor Circuits, J. J. Ward. "El. Tech." Apr. 1960. 3 pp. (England.)

Pilot Production of Printed Wiring Boards, W. Moore. "ATE J." July 1959. 6 pp. The factors that contributed to the adoption of the printed wiring technique are first outlined and the dequence of manufacturing operation in use at A.T.E. is then described. Production experience to date is briefly reviewed and a description is given of the method of replacing components on printed wiring boards. (England.)

The Reliability of Printed Wiring. "ATE J." July 1959. 14 pp. Three authors deal with this subject in three sections covering the physical properties of laminates, their processing, and radioactive tracer studies on them. (England.)

Ammonia Maser Oscillator, A. M. J. Mitchell. "El. Tech." Apr. 1960. 8 pp. Constructional details of an ammonia maser are described. Four important parameters affecting the frequency of oscillation have been investigated; viz., ammonia flow, separator voltage, magnetic fields and cavity tuning. The difference frequency between two ammonia masers running at 23,870 Mc/s was found to

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Ann. de Radio. Annales de Radioelectricite
Bull. Fr. El. Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electreakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechniczne

USSR

Avto. i Tel Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

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be stable to within 12 c/s over 4 hrs. Over shorter periods the stability was higher and there have been occasions where a stability of 1 c/s over an hr. was observed. The possibilities of improving stability further are discussed together with potential applications of the maser. (England.)

Recent Advances in Low-Noise U.H.F. and Microwave Amplifiers, G. O. Chalk. "Brit. C&E." Apr. 1960. 8 pp. The conventional u.h.f. and microwave low-noise amplifier are the triode and the traveling-wave tube. In recent years considerable advances have been made in improving the noise performance of these tubes and at present the best noise figures achieved with triodes vary from about 2 dB at 200 Mc/s to 6 dB at 1,000 Mc/s. (England.)

Rectifier Modulators Analysis by Successive Approximations, D. P. Howson. "El. Tech." Apr. 1960. 5 pp. A general set of equations for the series rectifier modulator having been obtained, a method of reducing the complexity of these equations without undue loss of accuracy is postulated. (England.)

COMMUNICATIONS

A Summary of the Present Position of Stereophonic Broadcasting, D. E. L. Shorter & G. J. Phillips. "BBC Mono." No. 29. 20 pp. The various methods by which stereophonic programmes can be produced for sound recording or broadcasting are discussed with particular reference to stereophonic reproduction under domestic conditions. (England.)

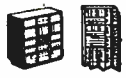
Aspects of Potential Signal-to-Noise Ratio in the Presence of Fading Signals, D. D. Klovsky. "Radiotek," 15, No. 5, 1960. 9 pp. Individual coherent and incoherent reception criteria are obtained for an ideal receiver of discrete communication with fluctuating noise and with smooth and rapid fading of the signal. The probability density of the incoming to the receiver signal envelope is assumed to be distributed according to the general law of Rayleigh. Circuit application of the derived criteria is illustrated. The lowest probability of erroneous reception is calculated for certain types of systems. (U.S.S.R.)

The Effectiveness of Various Methods to Raise the Dynamic Range of a Panoramic Radio Receiver, N. N. Svetlov. "Radiotek," 15, No. 5, 1960. 4 pp. In this article certain considerations of comparative evaluations of the effectiveness of various methods to raise the dynamic range of a panoramic radio receiver are presented. Experimental data, plots and results are also included. The evaluated methods are applied on one of the several cascaded stages of a wideband channel using tubes with identical parameters. (U.S.S.R.)

Addition of Telegraph Signals on a Common Impedance, V. M. Rozov. "Radiotek," 15, No. 5, 1960. 6 pp. For duplexed reception of telegraph signals, aimed to reduce noise, an adding device must be added no matter which type of separation is used (spacial frequency or time). Analyzed in this article is the case of uncalibrated telegraph signals added on a common impedance. (U.S.S.R.)

High-Frequency Pulse Transmission Through Linear Systems With Lagging Feedback, A. N. Nedeshev. "Radiotek," 15, No. 5, 1960. 3 pp. The change in the high-frequency content of a rectangular pulse resulted from its passage through a closed system with a detuned linear amplifier and lagging feedback is analyzed. It is shown how the change of the high-frequency content is dependent on the inherent detuned state and the pass-band of the systems. (U.S.S.R.)

Investigation of the Deviation from the Uniform Speed in Magnetic Taperecorders Through the Use of Electromechanical Analogies, W. Wolf. "Hochfreq." April 1960. 11 pp. The effects of the changes in tape length due to elasticity and the inertia of the drive components are investigated using analogous electrical networks. The synchronous motor of the tape drive is treated in a similar manner. The changes in tape length between the reproducing head and the spool are determined and methods for their elimination are discussed. When the results obtained using the method of electrical analogies are compared with the results obtained from the mathematical method, the accuracy and economy of the electrical analogy is evident. (Germany.)



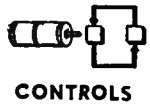
COMPUTERS

Error Accumulation in Calculation on Digital Computers, V. A. Brick. "Avto. i Tel." May 1960. 6 pp. The statistical method of error estimate of computing devices used in automatic control systems and of specialized and general-purpose computers is described. The method is based on the theory of random diffusion. Errors of such computing processes are analyzed in which sequential simple errors can be considered as independent random values distribution densities of which approach normal. (U.S.S.R.)

Transistorized Functional Logic Blocks, P. Logadec. "El. & Auto." May 1960. 7 pp. The elementary blocks described in this paper have a number of advantages. They are fully transistorized and need only low voltage supplies. (France.)

Simple Relay Computer Handles B.C. Tunnel Traffic Problems with Ease, Karl Haselsteiner. "El. & Comm." July 1960. 2 pp. Contrary to general belief computers need not be "exotic" nor expensive to fulfill functional tasks. (Canada.)

Mechanized Stores Transaction Data Handling, P. Huggins. "Brit. C&E." July 1960. 5 pp. In this article an account is given of an experimental stores-transaction system which was designed to replace the conventional "pencil and paper" methods of documentation normally used in a manufacturing company's stores. (England.)



CONTROLS

Something About Terminology, Purpose, Methods and Auxiliaries of Open Loop Control Techniques, H. Kaltenecker. "rt." Mar. 1960. 6 pp. The present contribution is intended to give a general survey of open loop control techniques, an introduction into the relative terminology and an idea of the problems involved. (Germany.)

The Ripple of Compensated Recorders. H. Frenk. "rt." Mar. 1960. 4 pp. The influence of time constants at various places in the control loop is shown and the possibility of a pronounced decrease of the ripple without increase of the sluggishness is discussed. (Germany.)

Logical Transistorized Functional Units for Industrial Open Loop Control Systems, W. Weitbrecht & G. Sinn. "rt." Mar. 1960. 6 pp. The typical basic networks recurrently used in the industrial control technique are systemized into logic functional units, each forming as it were a building block. (Germany.)

Electrical Open Loop Control Systems and Components for Industrial Actuators, K. Buhring. "rt." Mar. 1960. 8 pp. A methodical survey of all open loop control systems which are available nowadays for industrial actuators is followed by a discussion of the working principles of the various units which make up these control loops. (Germany.)

Open Loop Systems in Control Engineering, Th. Kosbahn. "rt." Mar. 1960. 6 pp. Two examples of systems actually operating satisfactorily, demonstrate the application of open loop techniques in the chemical industry. (Germany.)

How to Increase the Range of Operation of Tirrill Controllers, Part 2, W. Leonhard. "rt." Mar. 1960. 5 pp. (Germany.)

A Remote Control System Using Electro Mechanical Techniques, S. Lechowicz. "Proc. AIRE." Jan. 1960. 9 pp. A remote control system based upon one-way digital signaling by means of relays and uniselectors is used to operate the transmitters and receivers of a vhf communications system. (Australia.)

Manual Control Circuits for Data Processing Systems, P. M. Hall. "ATE J." Apr. 1959. 14 pp. Various input/output devices, such as punched cards, paper tape, and so on, are available for use with data processing systems. The choice depending on the application. This article describes techniques for inserting data by means of manually-operated keys and for controlling the system. Brief notes are included on methods of presenting stored data in the form of a visible display on lamps and indicators. (England.)

Effect of Stationary Random Processes on Automatic Control Systems Containing Essentially Non-Linear Elements, G. I. Pyatnitsky. "Avto. i Tel." Apr. 1960. 7 pp. A method of calculation of non-linear control systems effected by stationary random processes is proposed. The method proposed is a generalization of the method of statistical linearization and it permits to take into account distortion of the spectrum of the random process by a non-linear element. (U.S.S.R.)

Steady States in Automatic Control Systems, B. V. Shirokorad. "Avto. i Tel." Apr. 1960 9 pp. Some conceptions and methods of the automatic control theory which are connected with existence of the steady states in autonomous systems with coexistence of some independent frequencies are discussed. (U.S.S.R.)

Dynamics of an Electromagnetic Control Element, I. E. Dekabrun, et al. "Avto. i Tel." Apr. 1960. 7 pp. An equation for motion of an electromagnetic control element of a turning type is deduced. The theoretical results are compared with the experimental ones. (U.S.S.R.)

Interpolated Analysis of Accuracy of Automatic Control Systems with Random Disturbances, V. I. Chernetsky. "Avto. i Tel." Apr. 1960. 8 pp. An approximate method of finding solutions of the systems of common differential equations containing random functions and random values. Formulae to calculate moments are deduced. The method develops some Chebyshev's ideas. (U.S.S.R.)

Analytical Design of Controllers, A. M. Letov. "Avto. i Tel. Apr. 1960. 6 pp. The solution of a problem of analytical design of controllers according to the given optimizing functional is described. The solution is applicable to the open area of determining differential equations of the system. The cases of the closed area are analyzed in the second and third parts of the paper. (U.S.S.R.)

Utilization of Resistances to Stabilize Current and Voltage, V. S. Popov. "Avto. i Tel." Apr. 1960. 3 pp. (U.S.S.R.)

Stabilization of Thermoresistance Temperature, G. K. Nechaev. "Avto. i Tel." Apr. 1960. 7 pp. (U.S.S.R.)

Theory of Ideal Model of Extremum Controller, V. V. Kazekevich. "Avto. i Tel." Apr. 1960. 17 pp. Using the theory of point transformation one of the extremum control circuits is analyzed. Periodic solutions and transient processes are determined. (U.S.S.R.)

Interdependent Uncoupled Control Loops Made Autonomic, R. Starkermann. "rt." Apr. 1960. 5 pp. This contribution is an attempt to throw more light on the behavior of multiple loop

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International ELECTRONIC SOURCES—

control systems of which very little has been known up to now. (Germany.)

Voltage Control of a Self-Excited DC-Generator with Additional External Excitation, H. Boddeker. "rt." Apr. 1960. 3 pp. Continous and stable voltage regulation of a self-excited dc-generator in a control system can be achieved by applying a small amount of additional external excitation. (Germany.)

Methods of Grid Control of Mercury Rectifiers, H. Dornheim. "El. Rund." Apr. 1960. 3 pp. Operation and properties of different proved control methods of mercury rectifiers are described. (Germany.)

Stress Presented to Low Power DC Motors Fed from Rectifiers, Magnetic Amplifiers and Thyratron Control Devices, G. Haar. "El. Rund." Apr. 1960. 3 pp. The author describes excessive copper losses, difficulties in the commutator action and armature voltages in detail and indicates they should be taken into account by motor manufacturers, buyers and operators to ensure safe operation and satisfactory life. (Germany.)

Effect of Rate Feedback on Dynamics of Relay Servosystem with Load, N. S. Gorskaya. "Avto. i Tel." May 1960. 14 pp. The effect of the rate feedback on free oscillations of the relay servosystem with load is analyzed. The linear part of the servosystem is described by the complete second-order equation. Accurate methods and the theory of point transformation are used for the analysis. (U.S.S.R.)

Transient Processes in Automatic Control Systems, Z. Sh. Blokh. "Avto. i Tel." June 1960. 10 pp. The method of determining a transient process in delay control systems is described. The delay system transfer functions which take into account main circuit delay, delay in main loop of the feedback and in additional loops of the feedbacks are found. (U.S.S.R.)

The Calculation of Pulse Systems for Different Input Signals, J. Tschauner. "Nach. Z." June 1960. 4 pp. The performance of a pulse system (step control) depends to a large extent on the manner in which the signal is fed in. The present investigation relates to the calculation of pulse systems with an input of a general form. (Germany.)

Observations on the Theory and Literature of Linear Impulse Control Systems, L. Prouza. "rt." May 1960. 6 pp. In this article a systematic survey is given of the various terms and definitions commonly used in the technical literature dealing with linear impulse filters with a view to facilitate the study and digest of the available information. It should be noted, however, that the so-called inverse formulae and statistical signals are beyond the scope of this contribution. (Germany.)

Stability Analysis by Means of the Frequency Responses of Controller and Controlled Plant, H. Cremer and F. Kolberg. "rt." June 1960. 5 pp. A criterion for stability investigations is derived from the locus curves of controller and controlled plant. (Germany.)

Programme Control of Amplifiers, A. Sethy. "rt." June 1960. 3 pp. A problem which frequently presents itself in telecommunications is the necessity to vary the action of an electronic amplifier according to a pre-determined time programme. The principal methods for dealing with this problem are discussed and practical means for their realization are considered. (Germany.)

GENERAL

Design Principles of Reading Machines, A. A. Kharkevich. "Radiotek," 15, No. 2 (1960). 14 pp. The author understands by the term reading machines, devices which automatically recognize letters, and other printed, typed or hand-written signs. He analyzes in a general theoretical manner the existing methods and notes the desirable and possible lines of development. The reading process is divided into three stages, the presentation and inspection of signs, making their description and finally comparing it with a standard. Various methods of scanning including straight scanning, slope and curvature recognition and topological scanning are analyzed. The requirement for descriptions are brevity and a minimum distance between any two descriptions. The author considers that the possible methods for achieving this are not as yet clear. The problems of text preparation and self-instruction of reading machines are also discussed. Existing machines are too complicated in the author's opinion due to the lack of a proper theoretical analysis of the problem, which should eventually lead to the simplification of these machines and the possible partial abandonment of the arithmetic computer technique in their design. (U.S.S.R.)

Statistical Theory of Gradient Systems of Automatic Optimization with Quadratic Characteristic of Object, A. A. Feldbaum. "Avto i Tel." Feb. 1960. 13 pp. The problem of analyzing gradient systems of automatic optimization with random factors is formulated. The methods of determining errors in the steady-state operation and the estimate of time of the transient process in the gradient system with many input variables are given. To illustrate the results the one-variable system and the two-variable system are considered. (U.S.S.R.)

Processes of Finite Duration in Pulse-Width Systems, I. V. Pyshkin. "Avto i Tel." Feb. 1960. 8 pp. For pulse-width systems equations are deduced describing transient processes which come to an end at finite time. Different ways of realization of such processes are described for the second order systems. Complete non-linearities necessary to realize the process are proposed to be replaced by linear elements. Data of the experiments confirm possibility of the said replacing. (U.S.S.R.)

The Human Memory as an Information Storing Device, E. Schaefer. "El. Rund." Mar. 1960. 6 pp. The limited capacity of the human memory is estimated on the basis of stored knowledge; information that can be stored during lifetime when the flow of information is constant; and the number of neutrons forming storage cells. Finally, the existing memory hypotheses are discussed and the conclusions for the development of information stores are derived. (Germany.)

Infrared Detection, R. Tomasi. "el. & auto." Mar. 1960. 5 pp. Fundamental properties of infrared radiation are stated, as well as its propogation characteristics with particular attention to atmospheric propagation. Certain imitations in usefulness are established in some detail and its applications are outlined. (France.)

Radiation Detection and Counting, A. Magnan. "el. & auto." Mar. 1960. 11 pp. Two devices are commonly used for radiation detection: The Geiger-Muller tube and the scintillator. Both are summarily described. For both devices, several complete diagrams of ordinary or professional equipments are given. Thus five units using G-M tubes and three professional units using a scintillator and a photomultiplier tube are described. Most of these units are entirely transistorized and as such put to good use the advantages inherent to semiconductors. (France.)

Current Developments in Neutron Detectors, F. Gardner. "Brit. C&E." Mar. 1960. 5 pp. This article discussed generally the properties of neutron detectors and the factors influencing their design and construction. Some detectors which have recently been designed for particular applications and environment are described. (England.)

Integrated Electro-Mechanical Design as Applied to Electronic Equipment, D. L. Swale. "Brit. C&E." Mar. 1960. 7 pp. In the design of complex electronic equipments, the three basic requirements that have to be kept con-

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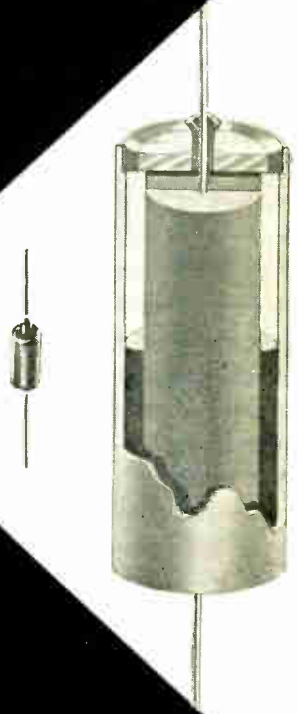

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stantly in mind are: reliability, simplicity of operation and ease of maintenance. In this article, these closely related requirements are discussed as seen from the point of view of the electro-mechanical designer. (England.)

Determination of Optimum Weight Function of Pulse System Providing Extremum of Certain Functions, N. I. Andreev. "Avto. i Tel." Apr. 1960. 9 pp. A method of determining optimum pulse system providing extremum of a general enough criterium is described. (U.S.S.R.)

Cesium Frequency Standard of the National Physical Laboratory in Britain, L. Essen. "Radiotek" 15, No. 3 (1960). 4 pp. This is an account of the paper read by the author in Moscow in June 1959. briefly describing the cesium frequency standard developed by the NPL: The standard can be used for determining units of frequency and time with respect to the spectral line of cesium with an accuracy of the order of $\pm 10^{-10}$ and for continuous use in controlling radio broadcasts of standard frequencies. Measurements of the highest precision should be based on this atomic resonance. The astronomical and atomic units should be compared with the greatest possible accuracy and then a unit of time adopted by international agreement and possibly based on atomic transition. (U.S.S.R.)

Application of Krylov-Bogolubov Method of Asymptotic Approximations to Investigation of Delay Systems, V. S. Kislyakov. "Avto. i Tel." Apr. 1960. 14 pp. Application of Krylov-Bogolubov method of asymptotic approximations to investigation of the delay linear and non-linear systems is considered. Efficiency of the application of the method is illustrated with two examples. (U.S.S.R.)

The Stability of Sampled Data Systems, J. Tschauner. "rt." Feb. 1960. 5 pp. This contribution deals with a simple, easily understandable derivation of stability criteria for sampled data systems of any order, employing root locus methods. (Germany.)

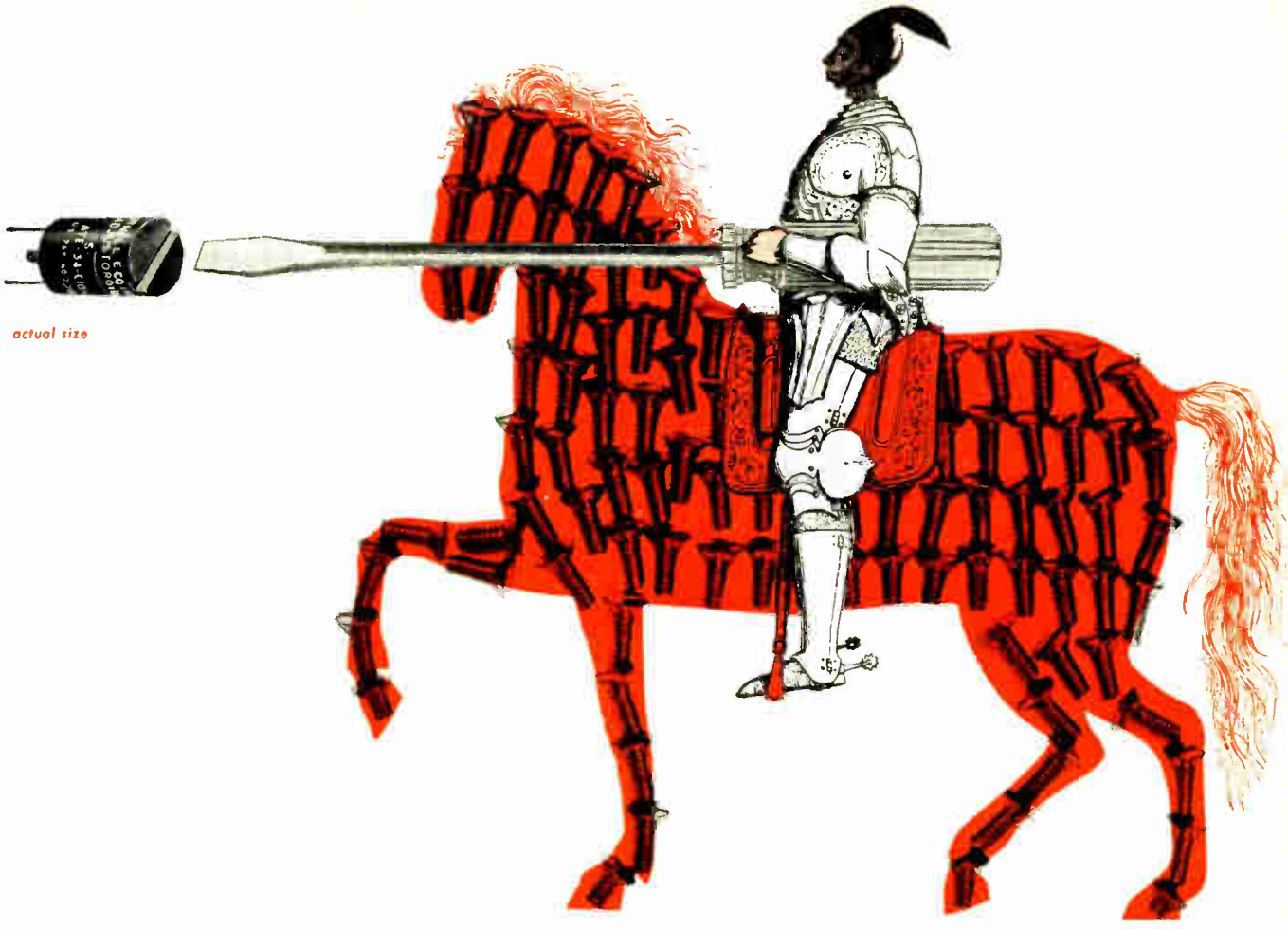
Numerical Operators' Method, S. Bellert. "Roz. Elek." Vol. 5, No. 4. 69 pp. The present paper shows a mathematical method of its practical applications. The discussed method is the algebra whose elements (numerical operators) constitute a generalization of the concept of complex number. There exists a great similarity between the algebra of numerical operators and the algebra of complex numbers. (Poland.)

The Orientation of Diamonds for Tools by Means of an X-ray Image Intensifier, J. F. H. Custers & A. J. van der Wagt. "Phil. Tech." No. 6, 1960. 2 pp. Since the wear resistance of diamond is markedly anisotropic, diamonds in tools should be given a specific orientation with respect to the direction in which they are subjected to wear. The outward form of a diamond is not always a sufficient guide to its proper setting in a tool; the orientation must then be determined from the X-ray diffraction pattern (Laue diagram). (Netherlands, in English.)

Ruby Maser Amplifier Extends Range of Electronic Systems Tenfold, Dr. Theodore H. Maiman & Col. Harold McD. Brown. "El. & Comm." May 1960. 3 pp. Pound-for-pound the ruby maser is described as the most sensitive listening device in the history of science. (Canada.)

Italian Language Entropy and Its Evaluation, R. Manfrino. "Alta Freq." Feb. 1969. 26 pp. The paper deals in a systematic way with the subject of the entropy of the Italian language. To this purpose, exhaustive statistic analyses and computations have been effected on the frequency of letters, diagrams, trigrams and words in Italian texts of various subjects (historic, scientific and journalistic) in order to derive the asymptotic behavior of the entropy, or average information contents of the symbols (letters) for the language to be examined. (Italy.)

The Origin and Nature of the Moon, H. C.



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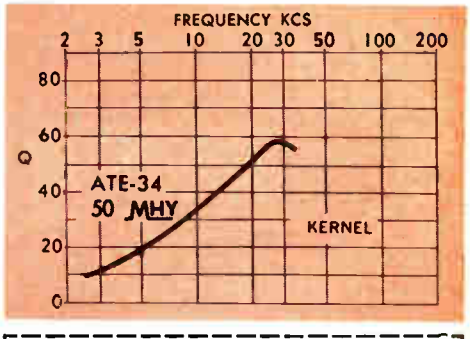

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International ELECTRONIC SOURCES

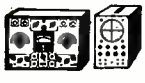
Urey. "Endeavour." Apr. 1960. 13 pp. The photographs of the far side of the Moon that were sent back from the Russian satellite have stimulated interest in the origin and nature of the Moon. The author of this article discusses the present theories, and suggests inferences concerning lunar structure that may be drawn from the photographs. Other artificial satellites of the Moon will be launched, and the contributions to our knowledge that may be made by these are also considered. (England.)

The Stellarator and other Thermonuclear Projects in the United States, M. B. Gottlieb. "Endeavour." Apr. 1960. 10 pp. The preliminary work towards the harnessing of thermonuclear power has already been described in Endeavour. There are a number of possible approaches to the problem of heating and containing a totally ionized gas, and this article describes current American research on the fundamental physical processes, with special reference to the stellarator. (England.)

Instrumentation for a Subcritical Homogeneous Suspension Reactor, IIIA. The Monitoring of Low Neutron Flux by Means of Fast Pulse-Counting Channels, J. J. van Zolingen. "Phil. Tech." No. 4/5, 1960. 11 pp. Description of the pulse-counting channels used for monitoring the neutron flux in the KEMA subcritical suspension reactor. The components developed in the KEMA laboratory include a "millivolt discriminator" for pulses from as low as 12 mV at up to several million pulses per second. (Netherlands, in English.)

Instrumentation for a Subcritical Honogeneous Suspension Reactor, IIIB. The Monitoring of High Neutron Flux with the Aid of an Electrometer. "Phil. Tech." No. 4/5, 1960. 4 pp. Description of the monitoring system used in the KEMA subcritical suspension reactor for measuring the neutron flux in the range 2×10^3 to 2×10^6 neutrons per cm^2 per second. (Netherlands, in English.)

Instrumentation for a Subcritical Honogeneous Suspension Reactor, IV. The Safety Circuits, F. J. Schijff. "Phil. Tech." No. 4/5, 1960. 5 pp. The KEMA subcritical suspension reactor contains three safety rods of boron carbide, which are suspended from electromagnets, the energizing current for which flows through a number of relay contacts in series. If one of the relays cuts out, the rods drop and the reactor is stopped. (Netherlands, in English.)



MEASURE & TESTING

A New Portable Dial Tester, J. L. Ingram. "ATE J." Oct. 1959. 3 pp. The operating principles are dealt with, followed by a description of the testing procedure. The article concludes with particulars of the battery and a brief description of the general construction. (England.)

A Transistorized Crystal Chronometer, N. F. Blackburne & R. A. Spears. "ATE J." Oct. 1959. 10 pp. A form of transistorized crystal chronometer has been evolved by A.T.E. from the original circuitry designed by B.T.R. This article describes the standard form and discusses some of the more recent modifications and facilities. (England.)

A Survey of Sweep Generators, R. Brown. "Brit. C&E." Apr. 1960. 8 pp. (England.)

TELEVISION

Monochrome Reproduction of Color TV Signal, R. D. A. Maurice. "El Tech." Mar. 1960. 4 pp. It is shown that in a color-television system, using the standard N.T.S.C. method of gamma correction the deterioration in orthochromatism of the monochrome compatible picture can be reduced by the presence of the dot pattern due to the chrominance subcarrier. A "notch" or sub-carrier elimination filter is thus undesirable in monochrome receivers. (England.)

A Short Presentation of the Additional Requirements for Monochrome TV Transmitters used for the Transmission of Color TV, G. Coldewey. "Nach. Z." Apr. 1960. 4 pp. The international discussions attempting the achievement of European Standards for color TV have not yet been concluded. Additional requirements have to be met by existing TV transmitters when color TV is to be transmitted. The paper contains proposals for these additional requirements in the form of values which should be included in the specifications for transmitters. (Germany.)

The Spectral Composition of the Statistical Fluctuations of Present-Day Television-Camera, H. Fix and A. Kaufmann. "Rundfunk." Apr. 1960. 6 pp. The authors examine, using a search-tone method, the spectral composition of the statistical fluctuations occurring with known television-camera installations, in the case of a straight amplifier frequency characteristic and of a phase-corrected accentuation of high frequencies, for the purpose of optimum correction of the resolution loss in the picture tube. (Germany.)

The Visual Interference Effect of Horizontal Picture Instability in Television, Ulrich Messerschmid. "Rundfunk." Apr. 1960. 6 pp. When transmitting video tape recordings and also in the case of live transmissions using a wave-form generator synchronized with the supply mains, there can occur horizontal oscillatory movement of the picture that may considerably impair the subjective impression of the picture. In this connection questions regarding the subject effect of these oscillations have been raised repeatedly, and this article constitutes a reply to them. (Germany.)

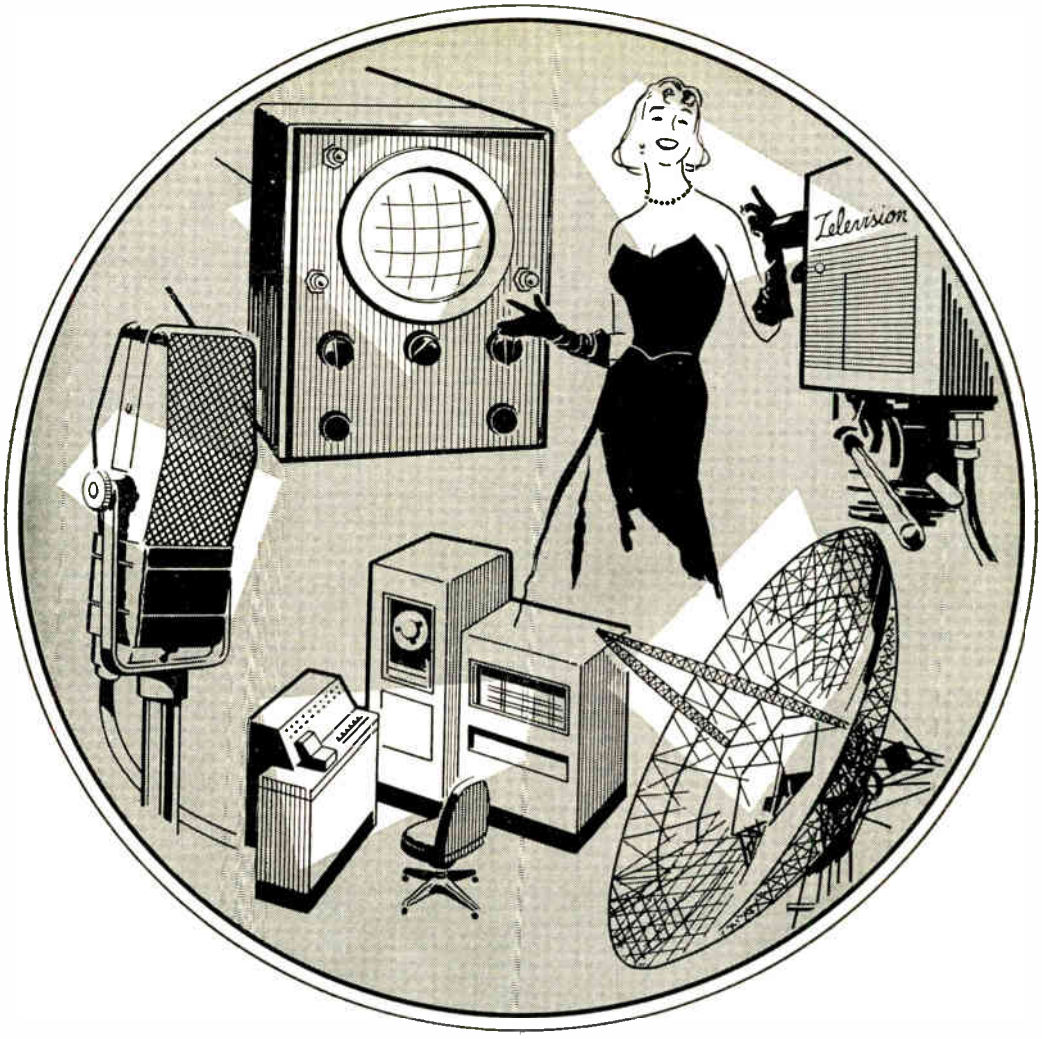
TRANSMISSION

A Method for Determining the Inner Dimensions of a Waveguide, J. Bachel. "Freq." Apr. 1960. 4 pp. A measuring method is devised that allows a continuous determination of the inner dimensions of long waveguides to within ± 1 micrometer. The inner dimensions are measured as the capacitances of an inner wall with respect to a metal plate that is supported by the opposite wall in a mechanically exact and insulated manner. The measuring method lends itself for metallic tubing or tubing whose inside is metallized at least at the points of measurement. (Germany.)

Transmission Characteristics of H_{01} Waveguides with Randomly Distributed Irregularities, H. Larsen. "Freq." Apr. 1960. 7 pp. Randomly distributed deformations of cross sections and axial curvatures of circular waveguides are described in general terms by autocorrelation functions. This is followed by the derivation of formulas for the distortion of the propagation coefficient of the H_{01} mode and the formation of secondary flux of undesired modes. Numerical examples for the calculation of deformation tolerances are discussed, using a Gaussian bell-shaped distribution curve as the autocorrelation function. (Germany.)

The Three DB Coupler, W. Stoesser. "Freq." Apr. 1960. 4 pp. Starting from the general case of the short slot coupler, a vectorial and mathematical explanation is given of the characteristics of the 3 db coupler. A new method for reducing the physical length is introduced. The phase errors are analyzed and some explanations are given as to the possibility of practical realization of this coupler. (Germany.)

How the Plane of Polarization Follows a Twist in a Square Waveguide, K. Schnetzler.



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

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

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

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

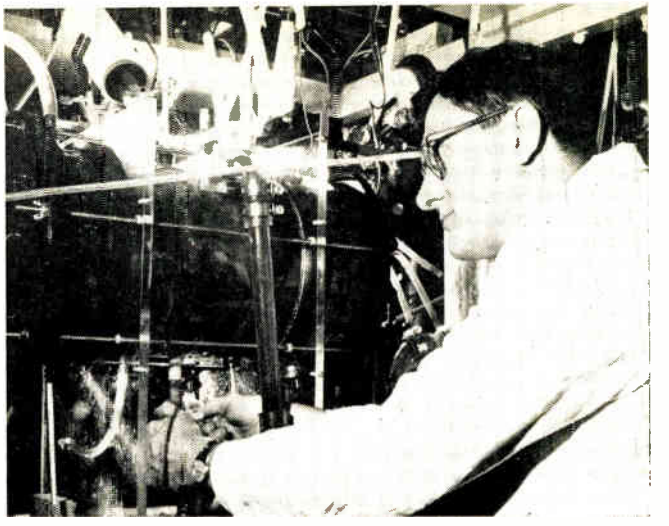
†Manufactured under U.S. patents

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

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



Sealed in a plastic tank, fast-growing algae is studied by Dr. R. J. Benoit of Electric Boat's chemical engineering section. Algae may be used for air revitalization and food on nuclear submarines.

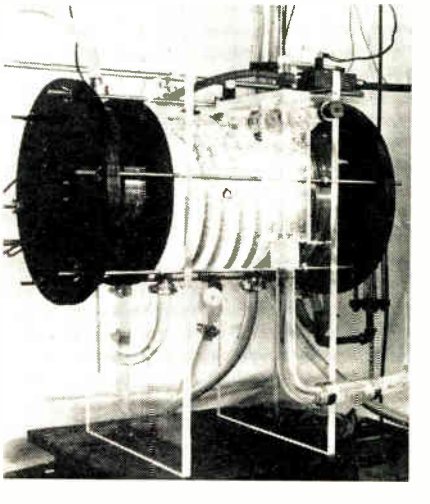
Plastics in Design

WALK into the pattern shop at General Dynamics Corp.'s Electric Boat Div. in Groton, Conn., or stop down the street at the plant's four story building devoted solely to research and development, and chances are you won't enter a room that doesn't have plastics of one kind or another in use in design or experimental work.

Their earliest adoption of plastics was primarily for pattern and model-making, and most of the plastics purchased by the firm were supplied by Commercial Plastics & Supply Corp. of New York City. As the firm's highly skilled craftsmen became familiar with the new materials, Richard J. Porter, superintendent of the Pattern Shop, experimented with plastics as a substitute for more conventional materials. Many such experiments are still classified, but several may be mentioned.

For some time now, the firm has operated plastic algae tanks in experiments to determine the simplest, most direct and least expensive methods for supporting life for long periods underwater and in spacecraft. Current experiments attempt to learn the

(*Continued on page* 192)



Close-up of tank shows the variety of plastics used in the unique air revitalization system. Nylon, teflon, lucite, plexiglas, and similar materials were used.

WHICH DO YOU NEED?

HIGH IMPEDANCE

HIGH GAIN

LOW DRAIN

LONG LIFE

You Get Them All With The Raytheon CK6611 and CK6612

There's no need to compromise when you design Raytheon CK6611 or CK6612 into your RF stages. These fully shielded, subminiature pentodes are specially designed for battery-operated communication applications where high input impedance and maximum gain along with low filament drain are required.

Military specification approval and Raytheon's intensive quality control program assure the ability of both types to meet and surpass vibration, shock, fatigue, and life test requirements. Average life expectancy, for example, is in excess of 5,000 hours. Excellent uniformity of characteristics and availability are the result of Raytheon's special production facilities and long experience in manufacturing these types.

For technical data on the CK6611 and CK6612 please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

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CHARACTERISTICS AND TYPICAL OPERATION — CLASS A_1 AMPLIFIER

	Filament Voltage (dc)	Filament Current	Plate Voltage	Grid #2 Voltage	Grid #1 Voltage	Transconductance
CK6611	1.25 volts	20 mA	30 volts	30 volts	0*	1,000 μmhos
CK6612	1.25 volts	80 mA	30 volts	30 volts	0**	3,000 μmhos

*Grid Resistor = 5 megohms **Grid Resistor = 2 megohms

RAYTHEON

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

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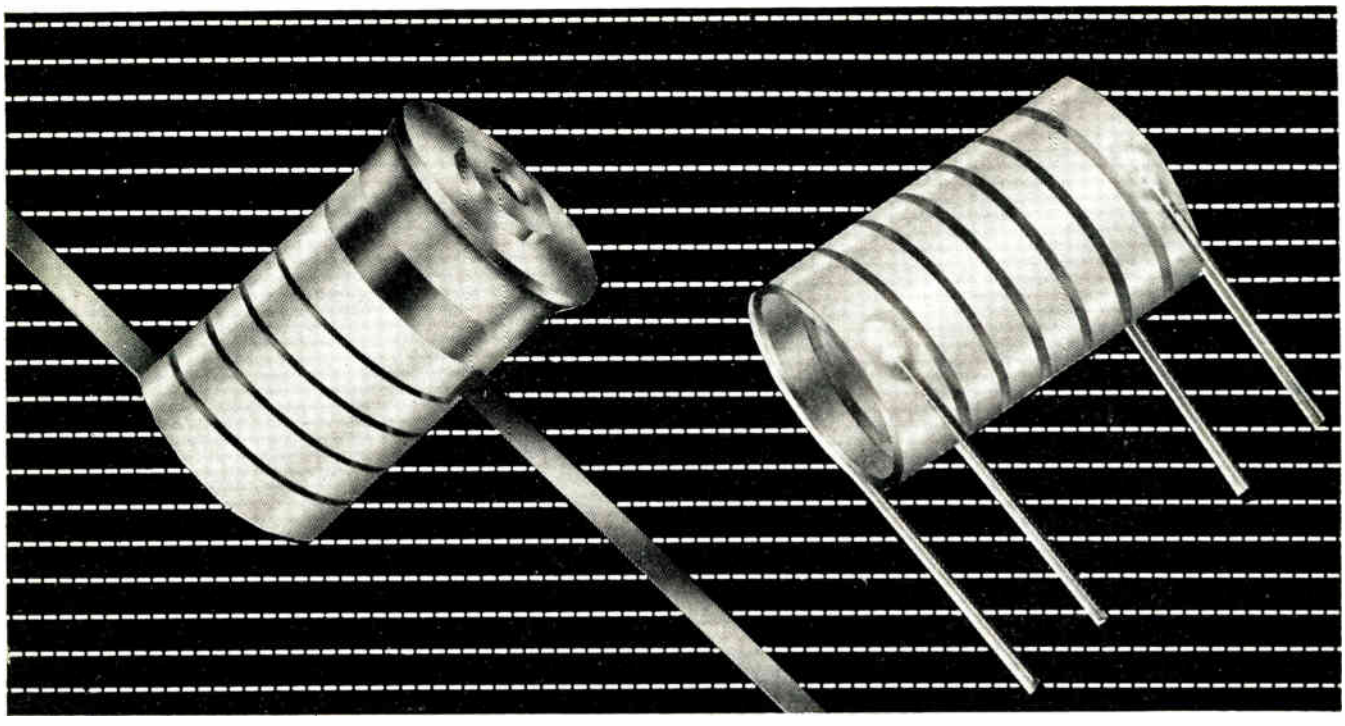
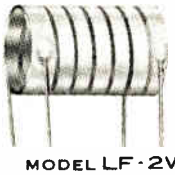


NEW FROM JFD FIXED MINIATURE METALIZED INDUCTORS

JFD now offers a complete line of fixed-value miniature Metalized Inductors in inductances to cover a wide variety of circuit application requirements

MODEL LF-1P010
ACTUAL SIZE



MODEL LF-2W008
ACTUAL SIZE

TYPICAL PANEL MOUNT JFD METALIZED INDUCTORS

Model	Inductance μh (± 5%)	Q Min.
LF-1P010	0.10	145
LF-1P025	0.25	135
LF-1P040	0.40	105
LF-1P070	0.70	120
LF-1P100	1.00	135
LF-1P200	2.00	180

Listed above are only six of 23 standard JFD Metalized Inductors available in panel mount and printed circuit types from .05 μh to 2.00 μh.

The new JFD Inductor series employs silver film permanently fused to a low loss dielectric glass cylinder. This lightweight monolithic construction achieves a new high in stability, durability and economy; a new low in temperature coefficient of inductance and distributed capacitance. Assures you of utmost reliability for critical circuit operation in severe environment.

JFD Metalized Inductors can also be designed to help solve any development, design, or production problem. The number of turns, types of windings, size and distributed capacitance, Q and other parameters can be designed to suit individual circuit requirements. Write for bulletin 223 for full specifications.

Features

1. Rugged construction affords unusually high stability under conditions of severe shock and vibration.
2. Use of glass dielectric assures low temperature coefficient of inductance and operation without derating over a wide range of extreme environmental conditions.
3. Low distributed capacity.
4. Special alloy plating protects metal parts from corrosion.
5. A high Q over a broad frequency range.
6. Silver plated copper leads.
7. Available in panel mount and printed circuit mount types.

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72 ADC Incorporated — Miniature transformers
55 Alite Division, U. S. Stoneware—Ceramic-to-metal seals
135 Allegheny Ludlum Steel Corporation—A-L electrical steels
79 Allen-Bradley Co.—Hermetically sealed precision resistors
299 Allen-Bradley Co.—Ceramic encased resistors
95 Allied Chemical, General Chemical Div.—Chemical packaging unit
61 Alpha Metals, Inc.—Flux-filled solder washers
180 American Electrical Heater Company—Melting-type wire stripper
20 American Rectifier Corporation — Variable speed drives
43 American Time Products, Inc. — Frequency standards and fork oscillator units
88 AMP Incorporated — Modular programming boards
149 Amperite—Delay relays and ballast regulators
41 Amphenol-Borg Electronics Corp., R F Products Div.—Product distribution
100 Andrew Corporation—Multi-V type FM antenna
80 Arnold Engineering Company, The—Tape cores
154 Associated Research, Incorporated—Test instruments
139 Avnet—Transistor distribution

36 Babcock Relays, Inc.—Multi-pole miniature relay
34 Ballantine Laboratories, Inc.—Calibrator
152 Beckman/Berkeley Division—Digital frequency-measuring system
60 Beckman/Helipot Division — Miniature potentiometers
42 Bendix Corp., The, M. C. Jones Electronics Co., Inc.—RF load resistors
19 Bendix Corp., The, Red Bank Div., Semiconductor Products — Military power transistors
37 Bendix Corp., The, Scintilla Div.—Distribution network
174 Biwax Corporation—Industrial sealing waxes
23 Boonton Electronics Corp.—Capacitance bridges
56 Borg Equipment Div., Amphenol-Borg Electronics Corp.—Frequency standards
86 Breeze Corporations, Inc.—Custom and standard slip ring assemblies
140 Bruno-New York Industries Corp.—Pigtailoring machine
47 Brush Instruments Div. of Clevite Corp.—Operations monitors
48 Brush Instruments Div. of Clevite Corp.—Transistor switch
104 Burnell & Co., Inc.—Adjustable toroids
94 Burroughs Corporation—Beam-switching tube
73 Bussmann Mfg. Div., McGraw Edison Co.—Fuses and fuseholders

107 CBS Electronics, Semiconductor Operations—Switching transistors
26 Centralab, The Electronics Div. of Globe-Union, Inc.—Linear motion variable resistors
113 Century Electronics & Instruments, Inc.—Strain gauges
49 Cinch Manufacturing Corporation—Mil-type connectors
98 Clare & Co., C. P.—Stepping switch
99 Clare & Co., C. P.—Stepping switch
69 Clarostat Mfg. Company, Inc.—Audio controls
8 Clevite Transistors — Semiconductor device
171 Cobehn, Inc.—Spray-clean equipment
84 Communication Accessories Company—Laminated transformers, magnetic amplifiers, networks, and toroidal coils
78 Computer Measurements Co.—All-transistor counters
176 Conforming Matrix Corporation—Spray-coating machine
92 Conrac, Inc.—Video monitor
14 Consolidated Vacuum Corporation—Vacuum pumping system
300 Continental Electronics—Video recording tubes, and monitor tubes
53 Controls Company of America, Control Switch Div.—Indicator lights
22 Curtiss Wright Corporation, Electronics Div.—Time delay relays, digital motors, and ultrasonic delay lines

155 Dade County Development Department—Industrial development opportunities
31 Dale Products, Inc.—Resistors
62 Daven Co., The — Miniature precision wire wound resistors
70 DeJUR-Amsco Corporation, Electronics Div.—Panel meters
57 Delco Radio, Div. of General Motors—Miniature modules
175 Delco Radio, Div. of General Motors—High-power transistors

103 Efcon, Incorporated—Tantalum electrolytic capacitors
63 Elastic Stop Nut Corporation of America—Time/delay/relays
30 Electrical Industries—Multi-lead headers, condenser seals, and individual terminals
116 Electro Contacts, Div. Electro Switch Corp.—Slip-ring assemblies and rotary switches
133 Electronic Components, Div. of Telecomputing Corp.—Encapsulating and stripping compounds
145 Electronic Instruments Co., EICO—Electronics catalog
156 Elgin National Watch Company—Hermetically sealed relays
101 ESC Electronics Corp.—Miniature variable delay networks

81 Fairchild Controls Corporation, Components Div.—Sub-miniature rate gyros
163 Fairchild Semiconductor Corporation—Silicon transistors and diodes
12 Fansteel Metallurgical Corporation — Silicon power rectifiers
11 Fansteel Metallurgical Corporation — Tantalum capacitors
39 Formica Corporation, A Subsidiary of American Cyanamid—Designer's fact book
177 Freed Transformer Co., Inc.—Constant voltage transformers and magnetic amplifiers
147 Fresno County—Electronic plant locations

13 General Electric, Power Tube Dept.—Microwave triodes
165 General Products Corporation — Solid-block terminal boards
126 Gertsch Products, Inc.—Frequency meter
172 G-L Electronics—Nickel Alloy Magnetic laminations
173 Globe Industries, Inc.—Venezxial blowers
151 Graphic Systems—Visual control board
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50 G-V Controls, Inc.—Thermal relay

71 Handy & Harman—Silver flake
21 Hewlett-Packard Company — Microwave measuring instruments
33 Hewlett-Packard Company — HF signal generator
68 Hill Electronics, Inc.—Electronic filters
161 Hoffman Electronics Corporation, Semiconductor Div.—Silicon tunnel diodes
124 Howard Industries, Inc.—Fractional h.p. gear motor
4 Hughes Aircraft Company, Semiconductor Div.—P-N-P silicon alloy transistors

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150 Industrial Electronic Engineers, Inc.—In-line digital displays
168 Industrial Test Equipment Co.—Impedance comparators

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505 Cannon Electric Co.
502 General Electric, Defense Systems Dept.
504 Motorola, Inc.
503 National Cash Register Company, The

96 International Electronic Research Corporation — Transistor heat dissipator IERC
44 ITT Industrial Products Division—Power systems

87 Jennings Radio Manufacturing Corporation—Vacuum coaxial relays
137 Jettron Products, Inc.—Magnetron connectors
110 JFD Electronics Corporation — Fixed miniature metalized inductors
153 Johnson Company, E. F.—Nylon connectors
122 Jones Division, Howard B., Cinch Mfg. Co.—Plugs and sockets

170 Kay Electric Company—Audio, video, vhf sweeping oscillator
102 Kearfott Division, General Precision, Inc.—Ferrite isolator
143 Keithley Instruments, Inc. — Micro-microammeter
120 Kemet Company, Division of Union Carbide Corp.—Tantalum capacitors
179 Kester Solder Company — Resin-core solder
83 Klein & Sons, Mathias—Pliers
158 Knights Company, The James—Crystal-controlled transistorized oscillator

123 Lel, Inc.—Broadband receiving systems
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93 Magnetics, Inc.—Powder cores
46 Microwave Associates, Inc.—Magnetrons
119 Midwest Foam Products Company—All types of polyether or polyester foams
75 Minnesota Mining and Manufacturing Company, Magnetic Products Div.—Instrumentation high resolution tapes
35 Minnesota Mining and Manufacturing Company, Mincom Division—Magnetic tape instrumentation recorder/reproducer

64 National Ultrasonic Corp. — Ultrasonic cleaning equipment
111 New Departure Division, General Motors Corp.—Miniature ball bearings
117 Newman Corporation, M. M.—Miniature soldering iron
24 Non-Linear Systems, Inc. — Electronic digital voltmeter
38 Nothelfer Winding Laboratories, Inc.—Pulse transformer
144 Nuclear Measurements Corp. — Nuclear instrumentation catalog

29 Ogilvie Press, Inc.—"Engineered" drawing and tracing paper, cloth, forms

Employment—Use the handy card below to get more information on the engineering positions described in the "Professional Opportunities" Section which begins on page 240 of this issue.

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115 Philbrick Researches, Inc., George A.—DC amplifier
8 Philco, Lansdale Div.—Switching transistor
17 Polarad Electronics Corporation—Microwave analyzers
18 Polarad Electronics Corporation—Servo analyzer
186 Powertron Ultrasonics Corporation — Cleaning equipment
1 Radio Materials Company—Subminiature ceramic capacitors
108 Raytheon Company, Industrial Components Div.—Wide band noise source
109 Raytheon Company, Industrial Components Div.—Subminiature pentodes
9 Raytheon Company, Microwave and Power Tube Div.—1,000,000-watt magnetron
167 Reeves-Hoffman — Precision crystal oscillator
40 Reeves Instrument Corporation—Miniature floated gyros
32 Revere Corporation of America—Custom designed molded harnesses
162 Rohn Manufacturing Co. — Communication tower
76 Rotron Mfg. Co., Inc.—Vane axial fan
159 Sarkes Tarzian, Inc.—Silicon voltage regulator zener diodes
160 Sarkes Tarzian, Inc.—Silicon Zener Voltage Regulators
52 Sangamo Electric Company—Mica capacitors
51 Scientific-Atlanta, Inc. — Remote tuned signal sources
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54 Sonotone, Electronic Applications Div.—Miniature and subminiature tubes
128 Spectrol Electronics Corporation—Precision potentiometers
10 Speer Carbon Company, Jeffers Electronics Div.—Miniature stable inductors
105 Sprague Electric Company—RF interference locator
2 Sprague Electric Company — Deposited carbon resistors
7 Sprague Electric Company—Germanium transistors
25 Stackpole Carbon Company, Electronic Components Div.—Slide switches
166 Stainless, Inc.—Tower engineering
74 Stanpat Co.—Adhesive-backed drafting aid
6 Stevens Manufacturing Company, Inc.—Thermostats
141 Stromberg-Carlson, Div. of General Dynamics—Telephone quality relays
28 Struthers-Dunn, Inc.—Relays
106 Superior Tube Company—Cathode alloy
127 Sylvania Electric Products, Inc., Semiconductor Div.—Microwave diodes
112 Sylvania Electric Products, Inc., Mountain View Div.—Traveling-wave tubes
114 Sylvania Electric Products, Inc., Semiconductor Div.—Switching transistor
148 TA Mfg. Corporation—Instrument cases
45 Telechrome Manufacturing Corporation—Special effects generator
134 Telectro Industries Corp.—Modular magnetic tape systems
15 Texas Instruments, Incorporated (Semiconductor-Components Div.) — Silicon mesa transistors
67 Texas Instruments, Incorporated (Semiconductor-Components Div.) — Silicon resistor
118 Theta Instrument Corporation — Servo systems
188 Thomas & Betts Co., The—Cable ties and straps
59 Times Wire & Cable Div., The International Silver Co. — Data-processing and transmission cable
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130 Trak Electronics Company, Microwave Components Dept.—Miniature oscillator cavities
77 Transitron Electronic Corporation — Switching transistors
91 Triplett Electrical Instrument Company —Test equipment
164 Tru-Ohm Products, Div. Model Engineering & Mfg., Inc.—Power rheostat
66 Union Switch & Signal—Miniature relay
169 United Transformer Corp.—Transformers
121 Vapor Heating Corporation — Mercury tube thermostats
82 Varian Associates—Dual channel potentiometer recorder
131 Varian Associates—Recording paper
27 Victoreen—Electronic tubes
89 Waveline, Inc.—Microwave test equipment
90 Westinghouse Electric Corporation, Electronic Tube Div. — Tunable x-band magnetrons
129 Westinghouse Electric Corporation, Semiconductor Dept. — Silicon high-voltage rectifier stacks
85 White Industrial Div., S. S.—Air abrasive equipment
97 Wilmad Glass Co., Inc.—Precision glass tubing
125 X-Acto, Inc.—Precision knives

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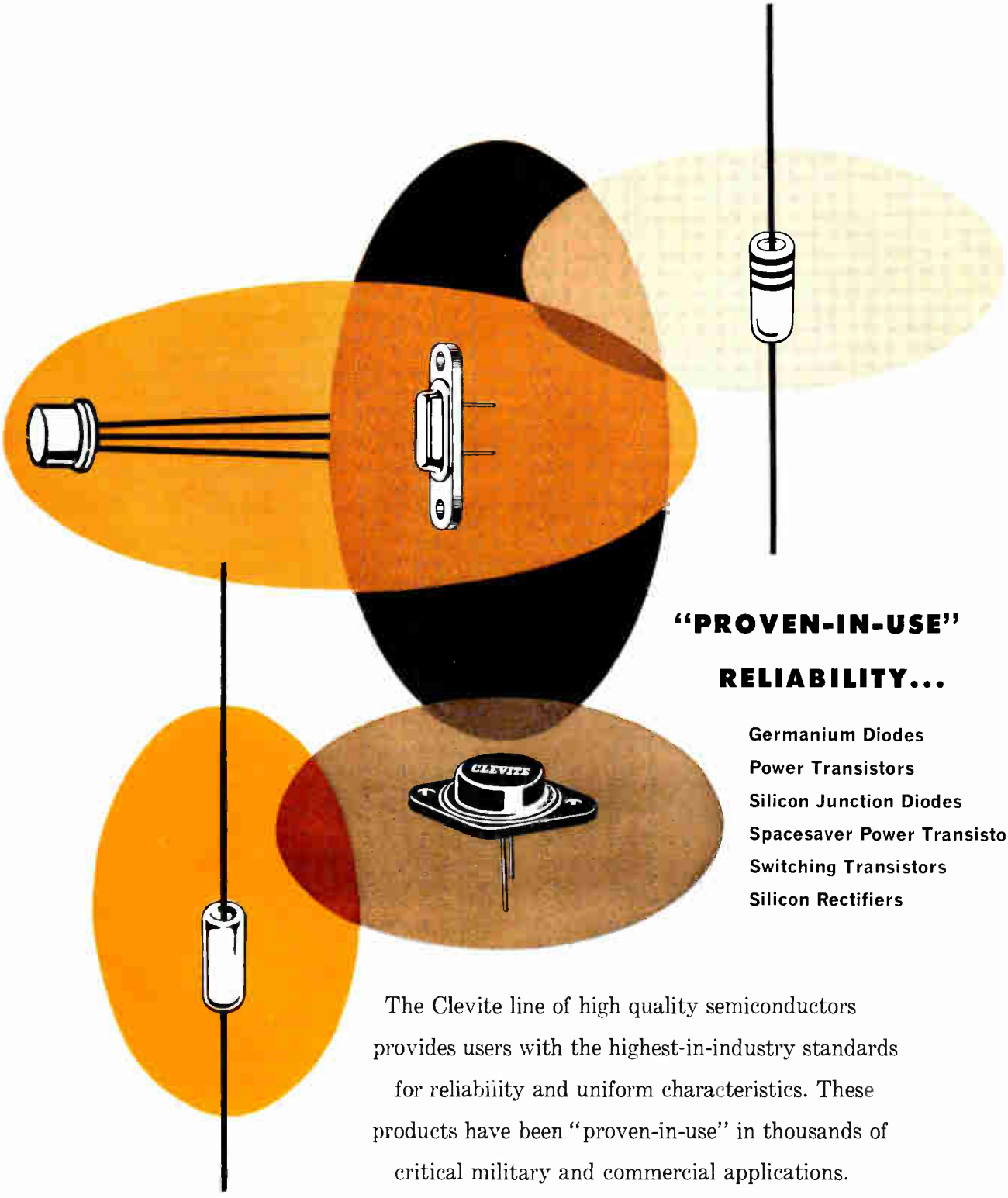

"PROVEN-IN-USE" RELIABILITY...

- Germanium Diodes
- Power Transistors
- Silicon Junction Diodes
- Spacesaver Power Transistors
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- Silicon Rectifiers

The Clevite line of high quality semiconductors provides users with the highest-in-industry standards for reliability and uniform characteristics. These products have been "proven-in-use" in thousands of critical military and commercial applications.

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N/D's Unique "White Rooms" Improve Miniature Ball Bearing Reliability!

In these rooms infinitesimal air-borne contaminants are scientifically whisked from the air . . . away from super-precision miniature ball bearing parts. New Departure's White Rooms date back nearly twenty years. And today, they're a major factor in N D s growing recognition as a leader in M/I ball bearing reliability.

At N D, miniature ball bearings are completely assembled in properly humidified, temperature controlled atmospheres. Advanced air filter systems completely change the air in these spotless rooms every few minutes. In addition, pressurized access air locks and individual counter-top pressurized chambers are used by N/D's skilled technicians during final assembly and statistical inspections.

These methods and equipment are only a few of the reasons why more and more major missile contractors, today, rely on New Departure Miniature and Instrument ball bearings.

If you are working on a new miniature ball bearing application where reliability is critical, include an N/D Sales Engineer in your design discussions. Call or write Department L.S., New Departure Division, General Motors Corporation, Bristol, Connecticut.

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INSTRUMENT SOCIETY OF AMERICA EXHIBIT

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

Plastics

(*Continued from page* 182)

feasibility of supporting life for infinitely longer periods, and under conditions of almost complete self-regeneration.

For that reason, the plastic tanks containing experimental equipment are subjected to extreme conditions of duress, high-level light rays, extreme agitation and turbulence in the tank itself—in short, simulating the most adverse conditions under which life might need to be sustained.

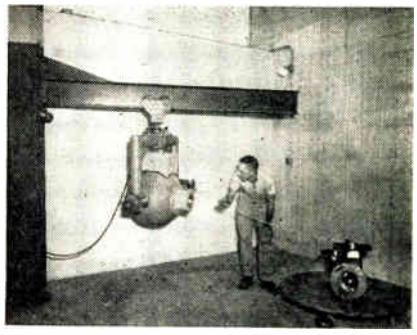
Models made wholly in plastic are used because more conventional materials in combination have cracked up due to unequal expansion. Plastics, on the other hand, are dimensionally stable. They are easy to cement, and the joints will hold under extraordinary impacts and stress. Plastics are also strong in thin sections.

Models constructed preparatory to making the equipment itself include a full-size non-regenerative heat exchanger made of plexiglas and vinylite; models of atomic waste disposal barges made wholly in plastic; ships' insignias for each of the atomic subs the firm has launched; lucite lenses comparable to those used in the newer ships as port-holes; and similar pre-production items.

Altogether, the New England firm consumes substantial amounts of plastics materials each year, primarily in vinyls, acrylics, the acetates and fluorocarbons (Teflon, Kel-F, *et al.*).

GAMMATRON INSTALLED

Radionics, Inc., Norristown, Pa. recently installed its largest cobalt 60 gamma radiography facility containing 1,430 curies of cobalt 60, (over $40 million in radium) in a specially designed room at the Quaker Alloy Casting Co., Myerstown, Penna.



Microwave Component News from SYLVANIA

NOW...LOW COST TEST EQUIPMENT PM-FOCUSED TWT's

Lighter, smaller than solenoid focused versions

For microwave test equipment and other commercial applications, Sylvania now has two S-band PM focused traveling-wave tubes which offer these advantages:

Low Cost Significant price reductions from the level of other PM focused tubes make these units competitive with the price of solenoid, tube, and power supply.

Light Weight These tubes weigh only 3 pounds, compared to the 15 to 35 pounds of a solenoid package.

Small Size The 2¼" maximum diameter of these tubes means that they have about half the size, a quarter the volume of solenoids.

Simple Installation Since PM tubes are factory focused, they do not have the installation problems associated with solenoid tubes.

High Performance No electrical performance is sacrificed in attaining the advantages these long-life tubes have over solenoid types: TW-4260 delivers a minimum of 1 watt over the full 2-4 kmc octave, and the TW-4261 achieves 10 mw minimum power and 37 db minimum gain over the same range.

For more information on these or other units in Sylvania's extensive line of TWT's, contact your nearest Sylvania tube sales office or write, wire or phone Sylvania Special Tube Operations, 500 Evelyn Avenue, Mountain View, California.

SYLVANIA

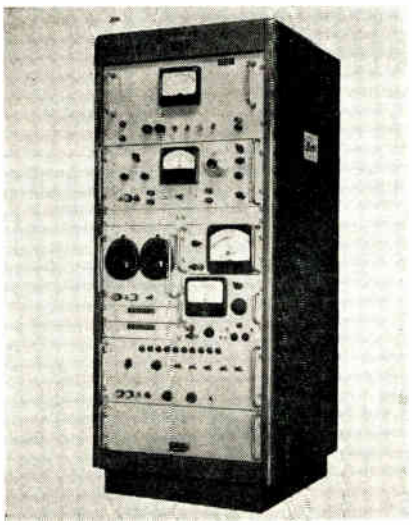
Subsidiary of GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

New Products

TEST CONSOLE

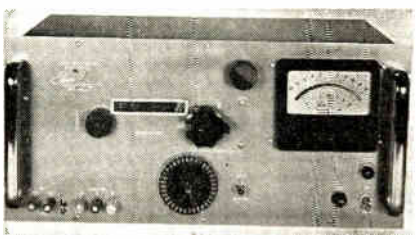
Semi-automatic console performs tests on 400 cycle resolvers, synchro transmitters, differentials, and control transformers. Tests performed and accuracy are: Input voltage (2%);



Input current (2% ±1 ma); Transformation ratio (0.2%); RMS null (2% ±1 mv); Fundamental null (2% ±1 mv); and Composite error from E.Z. (±30 seconds using Kearfott index stand). Overall size of the unit is 50 9/16 x 21 9/16 x 22 in. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.
Circle 285 on Inquiry Card

INPUT SIMULATOR

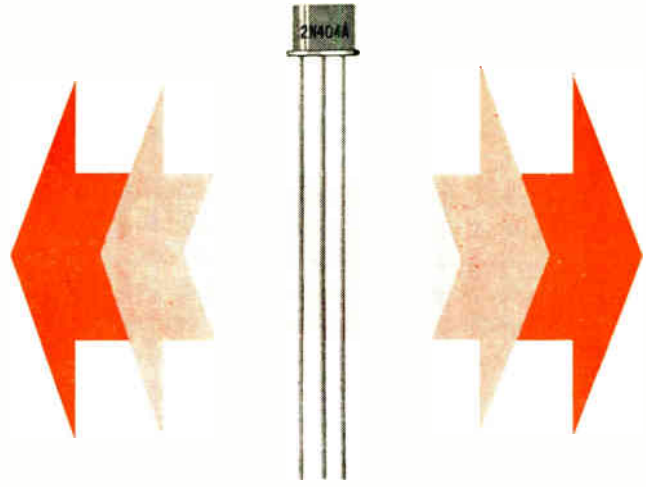
Flight control systems which receive their input signals from synchros or resolvers may be tested for steady-state accuracy with this System Error Bridge. Angular inputs,



accurate within 20 sec. of arc may be dialed in. Specs: Range, 0° through 360° continuous; Resolution, 4 sec of arc; Absolute accuracy, 20 sec of arc; Size, 19 x 10½ x 8 in. For testing, it replaces such transducers as the vertical gyroscope and magnetic compass. Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.
Circle 287 on Inquiry Card

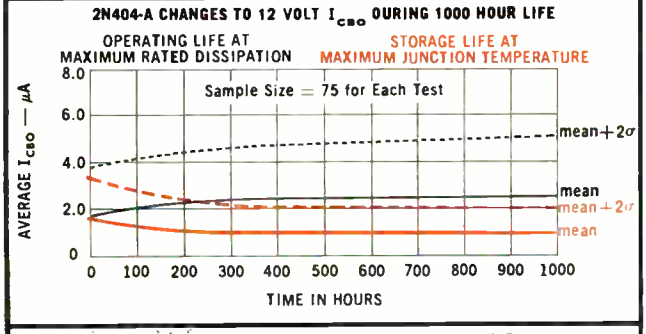
New! Switching Transistor

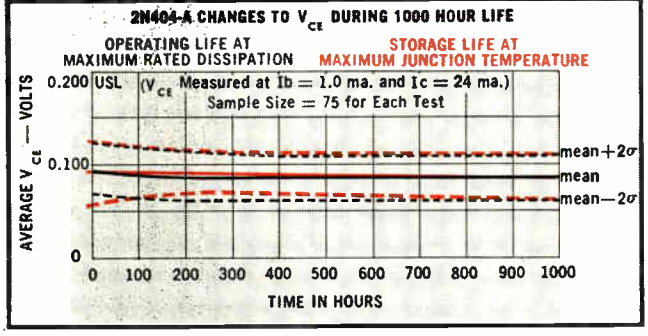
SYLVANIA 2N404A



features improved

ABSOLUTE MAX RATINGS AT 25°C	2N404	2N404A
Collector to Base Voltage	−25V	−40V
Emitter to Base Voltage	−12V	−25V
Collector to Emitter Voltage	−24V	−35V
Collector Current	100mA	150mA
Power Dissipation at 25°C	150mW	150mW
Power Dissipation at 55°C	90mW	90mW
Power Dissipation at 70°C	60mW	60mW
Junction Temperature	−65°C to +100°C	−65°C to +100°C





- **ELECTRICAL STABILITY ASSURED BY TIGHT AQLs**
- **POWER DISSIPATION OF 150mW**
- **VOLTAGE RATINGS OF −40V**
- **OPERATING TEMPERATURE CAPABILITIES OF 100°C**

Sylvania introduces the 2N404A, PNP germanium-alloy switching transistor—unilaterally interchangeable with the popular 2N404. A medium-speed switching transistor, Sylvania-2N404A is recommended for service where high reliability, electrical stability and resultant long-life expectancy are prime performance considerations. Reliability is assured by a tighter AQL. Sylvania-2N404A must meet a 1% combined AQL for the following parameters: collector cutoff current at 25°C and 80°C; emitter cutoff current; emitter floating potential; saturation voltage at 12mA and 24mA; input voltage at 12mA and 24mA; and stored base charge.

Designing now? Sylvania-2N404A is available now! Contact your Sylvania Field Office *or* your local franchised Sylvania Semiconductor Distributor for price and delivery information. For technical data, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 199, Woburn, Massachusetts.

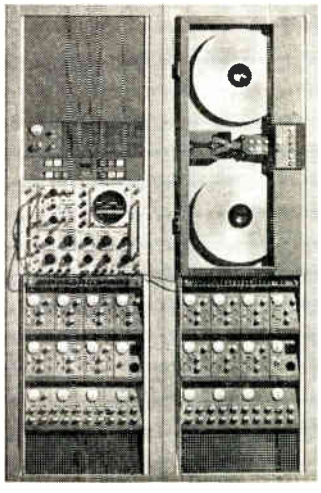
SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

New Products

RECORDER/REPRODUCER

Model CM-114 video band Recorder/Reproducer handles 14 tracks of both analog and pulse signals with frequency response from 400 CPS to 1.0 MC at 120 ips. It has a selection of 6 tape speeds ranging from 7½



to 120 ips, and features higher frequency response at lower tape speeds. At 60 ips, for example, freq. response is up to 500 KC. Constant phase equalization at all speeds provides fidelity of pulse response. Playback speeds can be reduced by a ratio of 16 to 1. Mincom Div., Minnesota Mining & Manufacturing Co., 2049 S. Barrington Ave., Los Angeles 25, Calif.

Circle 288 on Inquiry Card

STATIC INVERTER

The Airborne PI Series dc-ac static inverter supplies 28 v., single phase, 400 cycle sq.-wave output from a 28 vdc source. Unit is less than 11½ in.³, transistorized, and hermetically sealed. Regulation is better than 8% from full load to no-load. Freq. stab.

is ±5%. Under constant load, output voltage is directly proportional to input voltage. Electrodynamic Instrument Corp., 1841 Old Spanish Trail, Houston 25, Tex.

Circle 289 on Inquiry Card

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Instruments
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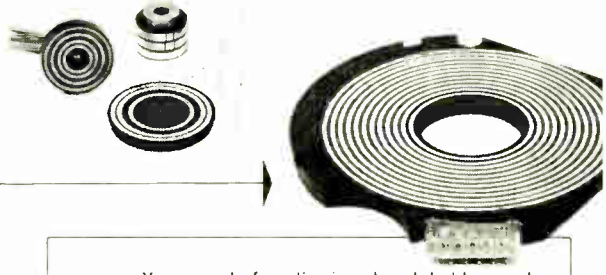
Programming
Sampling
Stepping
Sequence Selecting

SLIP-RING ASSEMBLIES
•
ROTARY SWITCHES



Your needs for slip-ring, brush-holder, and rotary-switch assemblies designed, manufactured, and tested to your performance specifications can now be met by the enlarged facilities available through the Electro Contacts Division of Electro Switch Corp.

Bulletin 60-01 shows typical products and contains a check list to help you specify. This bulletin is available through all Electro Switch sales representatives or on request to

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The Best Miniature Soldering Iron In The World . . .

Precision
MINIATURE SOLDERING IRON

110-115 volts
No Transformer
Weighs 1 ounce
6½ inches long

$4.35 EACH IN LOTS OF 6
Tips extra

Precision . . . the best low wattage soldering iron made . . . has sealed element to maintain constant temperature around 626°F.

- Ultra-flexible 3-wire cord . . . grounded . . . 50 megohms between element and tip protects components and operator.
- Bright "safety" yellow handle stands more than 1000°F . . . stays cool.
- Easy slide-on tips . . . stay hot under production speeds . . . made of tungsten-copper alloy; nickel or iron plated; diameters from 3/32" to 3/16"; spade or chisel ends.

Irons furnished less plugs: heavy-duty 2 or 3-pronged plugs available.

Write:
M. M. NEWMAN CORPORATION, Dept. F
79 Clifton Avenue, Marblehead, Massachusetts

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A SINGLE INSTRUMENT TO

SIMULATE INPUTS
MEASURE OUTPUT ANGLES
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SERVO SYSTEMS

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SYSTEM ERROR BRIDGE TESTS

- Inertial Platforms
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- Vertical Gyros
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- Antenna Pedestals

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THETA'S PRECISION ANGULAR DIVIDER

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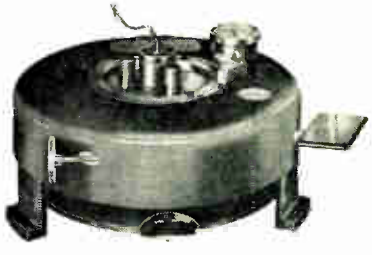


Certified accuracy of less than 20 sec.-of-arc composite error at the point of contact with your shaft.
Ready to use — no fixturing required.
Approved and used throughout the world.

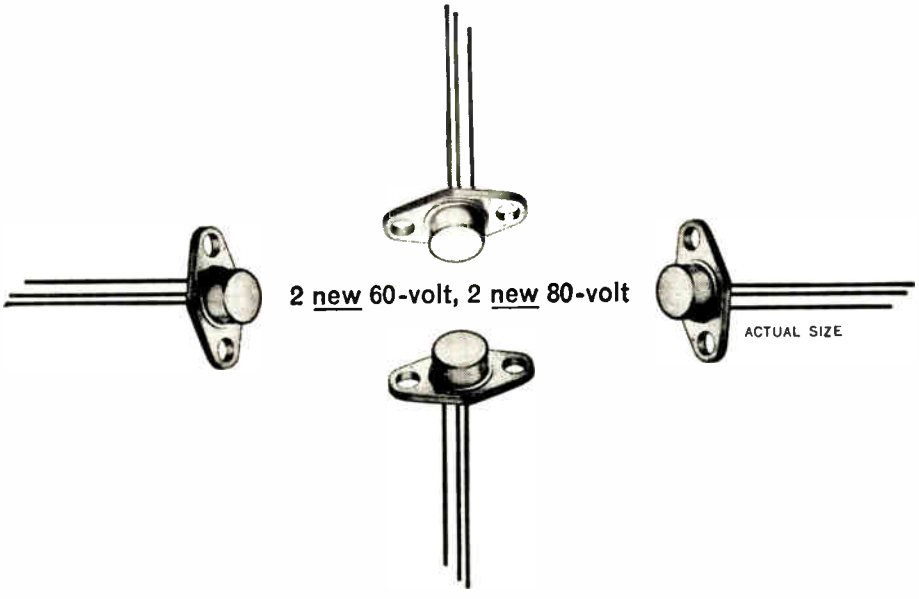
Write today for detailed technical bulletin.

MANUFACTURER OF PRECISE TEST EQUIPMENT FOR SERVO SYSTEMS.

Theta INSTRUMENT CORPORATION
520 Victor Street • Saddle Brook, New Jersey
Hubbard 7-3508 • TWX: HKK 952-U

Circle 118 on Inquiry Card

4 new miniature DELCO POWER TRANSISTORS



NOW, FROM DELCO RADIO, A COMPLETE LINE OF SMALL, HIGH-POWER TRANSISTORS!

	2N1172	2N1611	2N1612	2N1609	2N1610
V_{CB}	40	60	60	80	80
V_{EBO}	20	20	20	40	40
V_{CEO}	30	40	40	60	60
I_C	1.5 A	1.5 A	1.5 A	1.5 A	1.5 A
I_{CO}	200 μ a	100 μ a	100 μ a	100 μ a	100 μ a
H_{FE}	30/90	30/75	50/125	30/75	50/125
$V_{/Sat}$	1.0 V	1.0 V	0.6 V	1.0 V	0.6 V

These four new Delco transistors, plus the 2N1172 40-volt model, offer highly reliable operation in a new range of applications where space and weight are restricting factors.

Designed primarily for driver applications, Delco's versatile new transistors are also excellent for amplifiers, voltage regulators, servo amplifiers, miniature power supplies, ultra-low frequency communications, citizens' radio equipment and other uses where substantial power output in a small package (TO 37) is required.

Special Features of Delco's Four New Transistors: Two gain ranges. Can be used on systems up to 24 volts. Can be mounted with the leads up or down with the same low thermal resistance of 10° C/W. Dissipation up to 2 watts at a mounting base temperature of 75° C.

Available in volume production. Write for full engineering data.

DELCO RADIO
DEPENDABILITY
RELIABILITY

Newark, New Jersey
1180 Raymond Blvd.
Mitchell 2-6165

Santa Monica, California
726 Santa Monica Blvd.
EXbrook 3-1465

Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

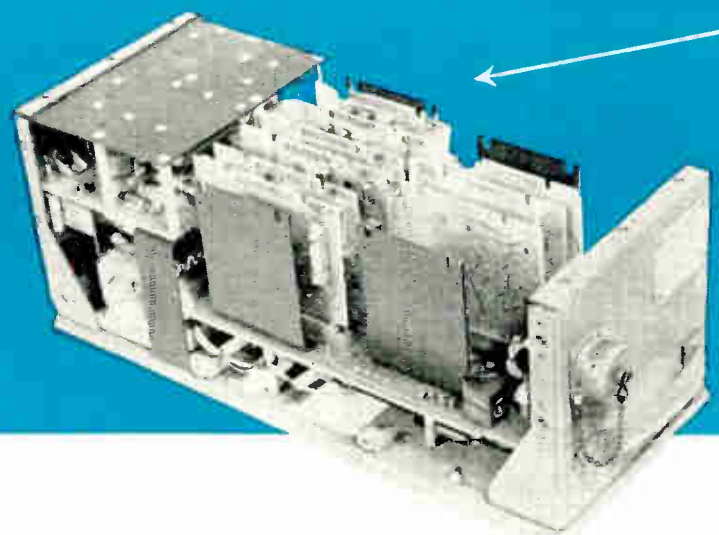
Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

Division of General Motors · Kokomo, Indiana

"KEMET" CAPACITORS HELP CONTRIBUTE TO THE PERFORMANCE AND RELIABILITY OF THE BOEING 707 ELECTRICAL CONTROL SYSTEM

Boeing 707 commercial jet transport.

A transistorized panel showing position of a "Kemet" solid tantalum capacitor.



Uncovered control panel with transistorized panels in position.

Westinghouse Electric Corporation engineers are using "Kemet" capacitors in the control for the electric power system used on the Boeing 707. This most modern a-c electrical power system — each system comprised of a generator, control panel, voltage regulator and current transformer—provides optimum performance . . . simplified control . . . and automatic protection so essential in jet transport operation.

Transistorized control panels utilize static components in place of conventional relay circuits to provide reliability equal to that of the equipment being protected. "Kemet" solid tantalum capacitors were specified to help achieve this purpose. These extremely rugged capacitors insure the reliability required to minimize maintenance and alterations . . . the small physical size needed to reduce power plant bulk . . . and the stability of operation demanded by the power supply to insure maximum efficiency and dependability from the associated equipment. These "Kemet" capacitors, along with the other components of this electrical system, help provide precise instrumentation data to the crew and offer increased safety and comfort to the passengers.

You can apply the proved reliability and performance of "Kemet" capacitors to your equipment. For details, write Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

"Kemet" and "Union Carbide" are registered trade-marks for products of

KEMET COMPANY

UNION CARBIDE

New Products

GRAPHIC RECORDING SYSTEM

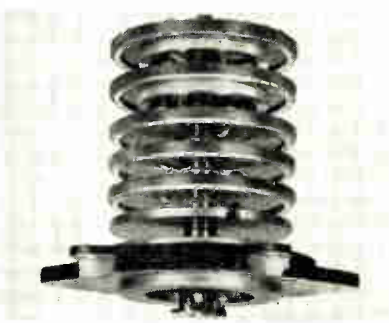
New modular, instant graphic recording system, Model 305, helix-type, provides high-resolution graphic recordings. Recording speed, paper feed rate, and input signal amplification most consistent can be selected. Basic

unit is "flying spot" helix recorder. Four synchronous helix drive assemblies provide a dynamic recording speed range of 60 rpm to 1800 rpm, corresponding to a helix sweep rate range of 1 sec. to 1/30 sec. Also, 4 paper feed drives provide a corresponding paper feed rate range of 0.6 in./min. to 18.0 in./min., for standard 100 lines to the in. resolution. Alden Electronic & Impulse Recording Equipment Co., Inc., Alden Research Center, Westboro, Mass.

Circle 239 on Inquiry Card

SLIP RING ASSEMBLIES

A slip ring assembly of concentric ring type construction for switching from positive to negative for sine and cosine functions in radar antenna mounts. Unit accomplishes switching within 0° 20′. Switching is either break-before-make or make-before-



break. Phasing accuracy is 0.20′ electrical and 0.005 in. mechanical. Slip ring assemblies operate in an amb. temp. range from −65 to 165°F. Breeze Corporations, Inc., 700 Liberty Ave., Union, N. J.

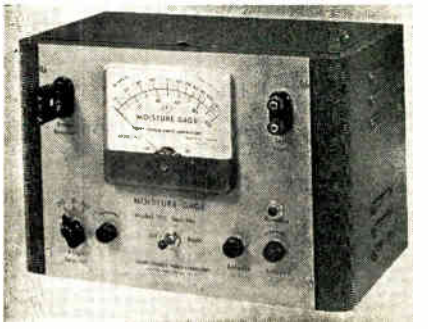
Circle 290 on Inquiry Card

Circle 172 on Inquiry Card

New Products

MOISTURE GAGE

Model 102 moisture gage, uses the ac conductance method employing 1 KC oscillator for 0-100% range; and oscillator and differential bridge for 0-10% range. Sensitivity is (0-100% range), 0-10^7 ohms; (0-10% range),



0-10^{12} ohms. Accuracy is: (0-100% range), 1% of full scale; (0-10%), 1% of full scale. Temp. effects: between 60° and 140°F—none; negligible above or below these limits. It includes an additional 0-100 empirical scale for special purposes. Henry Francis Parks Laboratory, P.O. Box 1665, Lake City Station, Seattle 55, Wash.

Circle 291 on Inquiry Card

FREQUENCY MARKER

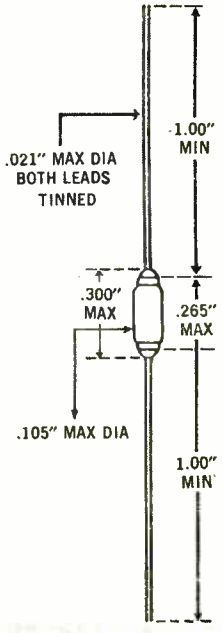
Vari-Marker Model H is a general purpose frequency marker, CW oscillator, and calibrator for continuously variable and "picket fence" harmonic signals from 1.5 to 230 MC. All signals available either as r-f output or as "birdie pip" audio frequency markers. Some specs: R-f level, 1.0 v RMS into 70 or 50 ohms, metered; Flatness, ±0.5 db, AGC'd; Attenuators, Switched 20, 10, 6, 3 db, continuous 6 db; Freq. dial, direct reading, ac-

curate to ±1%. (Harmonic Generator): Spacing, switched, 250 KC, 500 KC, 2.5 MC, other frequencies can be specified; Accuracy, ±0.005%. Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

Circle 292 on Inquiry Card

Sylvania Micro-Min Diodes shown actual size.

90% smaller in volume and weight...



SYLVANIA MICRO-MIN DIODES

offer microminiaturization in microwave circuitry

One-tenth the size, one-tenth the weight—*90% smaller than their prototypes*—Sylvania *Micro-Min* Diodes extend design possibilities where microminiaturization and reliability are essential to microwave equipment.

Sylvania *Micro-Min* mixer and detector diodes feature true hermetic seals . . . withstand temperatures of −55°C to +150°C . . . meet MIL-S-19500B environmental specs for shock, vibration, lead fatigue, acceleration, moisture resistance, soldering and temperature cycling.

New packages—*even smaller than Micro-Min Diodes*—are now under development at Sylvania! Our engineers can work with you in developing new microminiaturized equipment. Contact them.

If your present design requirements are for exceptionally small size, extremely lightweight *and* maximum reliability, specify Sylvania Microwave *Micro-Min* Diodes. For price and delivery information, contact your Sylvania Field Office or your local franchised Sylvania Semiconductor Distributor. For technical data on specific Sylvania *Micro-Min* Diodes, write Semiconductor Division, Sylvania Electric Products Inc., Dept. 199, Woburn, Massachusetts.

MICRO-MIN TYPE	APPLICATION	PROTOTYPE
1N830	UHF Detector	—
1N830A	UHF Detector	—
1N831*	S Band Mixer	1N21C*
1N831A*	S Band Mixer	1N21E*
1N832*	X Band Mixer	1N23C*
1N833	X Band Video Detector	1N358
1N918	Ku Band Mixer	1N78

*Available in Matched Pairs

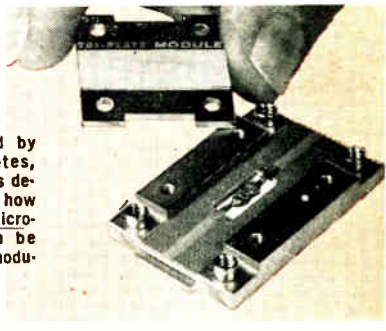


Photo shows Sylvania Micro-Min Diode as used in TRI-PLATE® detector module designed by Sanders Associates, Nashua, N. H. This device illustrates how easily Sylvania Micro-Min Diodes can be integrated into a modular construction.

SYLVANIA

Subsidiary of GENERAL TELEPHONE & ELECTRONICS

Circle 127 on Inquiry Card

Total Redesign

(*Continued from page* 80)

changes, introducing five color variations and increasing visibility of the entire line of dials. The new design cuts die castings to a minimum. Only the mounting plate is now die cast and is not plated.

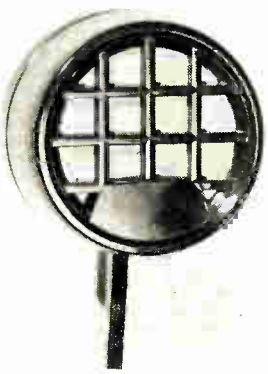
The new line is made of Implex plastic. Using the twin injection principle, numerals and calibrations are actually molded of a separate colored plastic. The result is no blurring or washing out of characters. Color does not wear off after heavy usage.

Under the new manufacturing process, the cap and cantilever arm are now molded in Cycolac, with a window to show the small dial. The cap is snapped on to the cantilever arm. Color variations of cap, dials and cantilever arm permit a wide choice of combinations for easy visual distinction, and for color keying controls.

Borg engineers say the new Microdials harmonize with the design of the most modern electronic equipment, yet retain all the basic quality features of the old line. Even better, the new design has improved saleability and eliminated the necessity of a price increase.

In approaching the "total redesign" of a component systematically, six facets of the problem are explored thoroughly: Function, the market, materials, manufacturing, appearance, and merchandising.

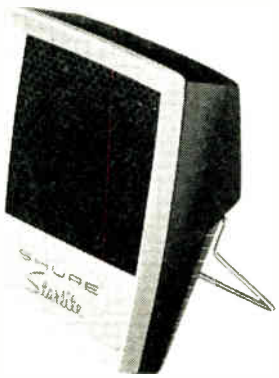
This old microphone, marketed by Shure Bros. Inc. was a candidate for face-lifting.



Of course, good design is of great importance when the appearance and utility of the component helps or hinders the sale of the product of which it is a part.

In the past, manufacturer approach to design has centered around the concepts of a better corporate image; improved styling and planned obsolescence. These now entering the picture are additional concepts of "total redesign." These concentrate on increased ratio of utility to price and basic devotion to one goal: Increased net profits.

Re-designed, the Shure Starlite, cost no more than its less attractive predecessor.



Electronic Teaching Device

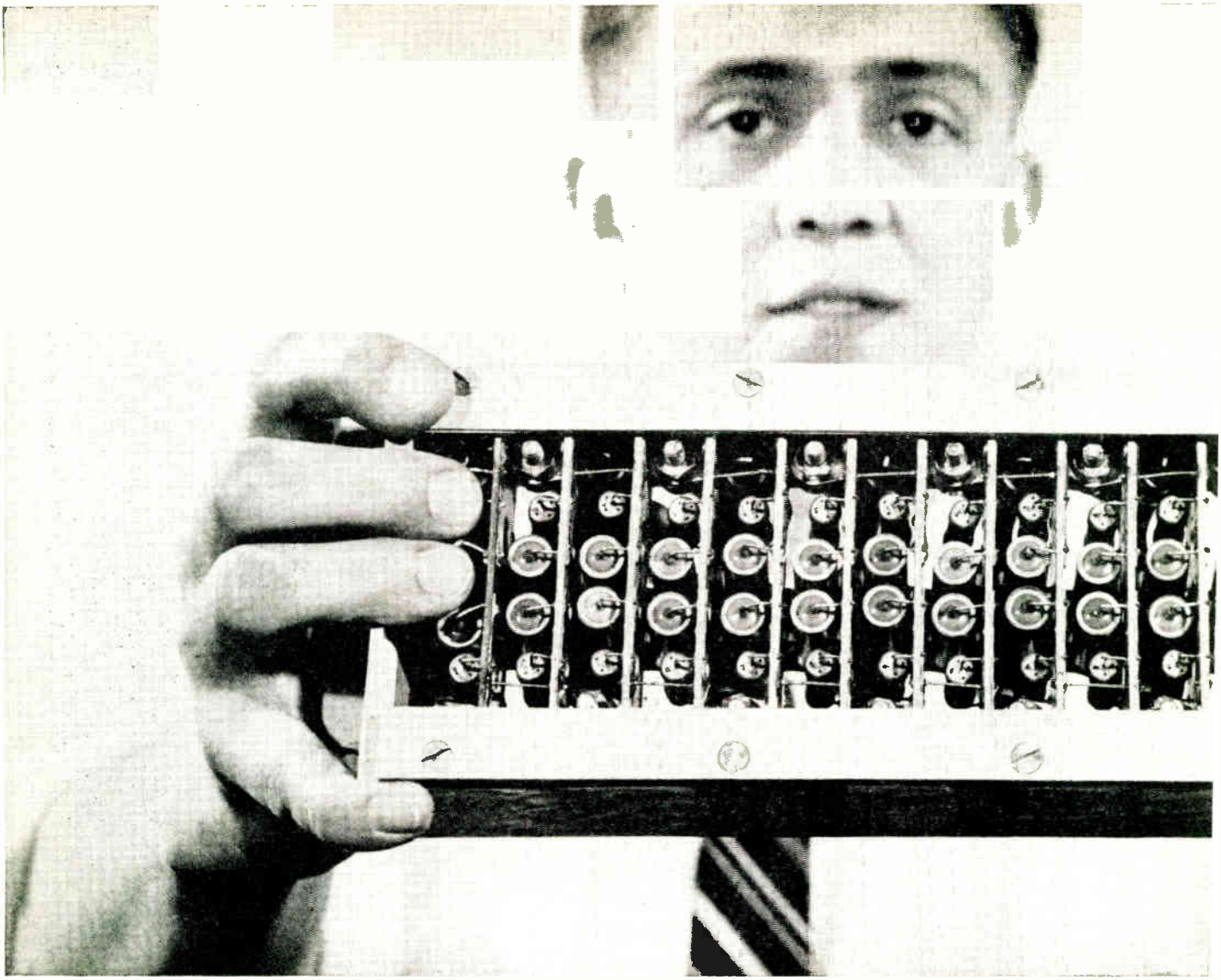
An "Electronic Dynamic Demonstrator," built by Transvision Electronics, Inc., 460 North Ave., New Rochelle, N. Y., is designed to teach the basic principles of electronics, from the fundamental electronic circuits through radio, TV, and Radar.

It is a 3 x 5 ft breadboard which assembles (circuit by circuit): Filament Circuit, Power Supply, Audio Amplifier, and TV Circuits.

Ford Foundation Grant

The Ford Foundation has granted $700,000 to Polytechnic Institute of Brooklyn to establish an honors program in science and engineering. Under the new program exceptional students will earn a doctorate in 6 years of full time study. It generally takes from 8 to 10 or more years to earn doctorates.

Thirty-three students have been selected for the program. There will be no strict dividing line between undergraduate and graduate work, but students in the program will be awarded bachelor of science degrees when they have completed the undergraduate part of their studies.



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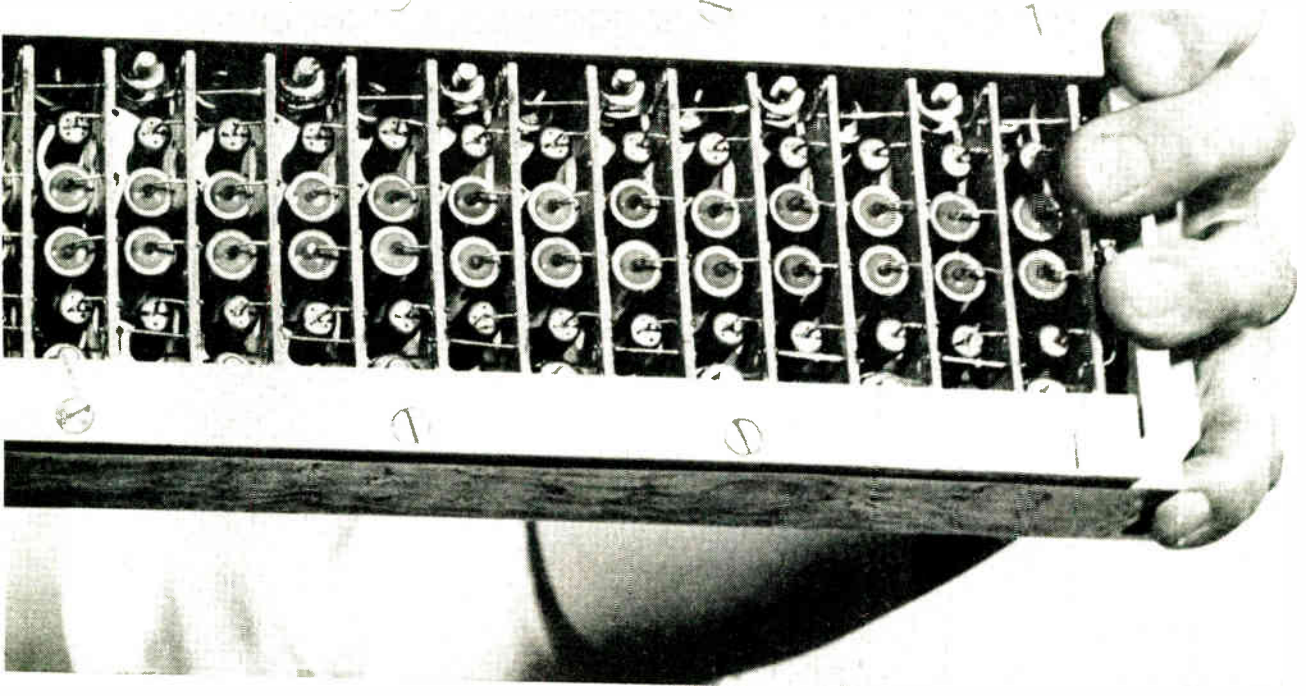
RELIABILITY PROVEN BY 14,000 KW IN FIELD APPLICATIONS

WESTINGHOUSE SILICON HIGH-VOLTAGE RECTIFIER STACKS



Westinghouse silicon rectifier stacks offer the most reliable source of high-voltage rectified power available today. In precipitator applications alone, more than ten million stack-hours have been achieved without a single stack failure. Exclusive Westinghouse design features guarantee uniform division of reverse voltage, provide optimum transient, steady state, and overload characteristics. Stacks assembled in compact, unitized packages take less space, require minimum maintenance, operate in ambient temperatures as high as 110°C. Stacks are available in current ratings from 1.2 Amps to 18 Amps, and in PRV ratings from 9.6 KV to 35 KV. For extremely high voltage requirements, stacks may be connected in series (up to three stacks without additional capacitance compensation).

For full information, or engineering assistance in your installation, contact your local Westinghouse representative, or write: Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pennsylvania.

MIL TYPE COMPONENTS

Unique Westinghouse modular inserts feature MIL Type shunting resistors, capacitors, and mounting boards. All components are 100% tested before and after assembly.

APPLICATIONS

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- Radio broadcasting transmitters
- Radar transmitters
- Ultrasonic transducers
- Radar pulse forming networks

You can be sure...if it's **Westinghouse**

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Industry News

Dr. Harry Letaw, Jr. . . . becomes Marketing Manager, Surface Radar and Navigation Operations, Raytheon Co., Waltham, Mass.

J. Harold Moore . . . to General Manager, Defense Projects, Defense Activities., Western Electric Co., New York, N. Y.

Bernard Krieger . . . Manager of Marketing, Manson Labs., Inc., Stamford, Conn.

James O'Donnell . . . new Sales Administrator, Efcon, Inc., Garden City, L. I., N. Y.

Ralph V. Barnett . . . new Vice President and Eastern Branch Manager, Librascope Div., General Precision, Inc., Glendale, Calif.

R. V. Barnett

B. R. Cohn

Burton R. Cohn . . . General Manager, Systematics Div., General Transistor Corp., Redondo Beach, Calif.

R. David Miner . . . Assistant to Sales Manager, Sprague Electric Co., Los Angeles, Calif.

George R. Lawrence . . . Sales Manager, Electronic Tube Div., Sperry Gyroscope Co., Great Neck, N. Y.

F. Robert Walker . . . new Manager of Marketing, Gulton Industries, Inc., Metuchen, N. J.

William D. Jameson . . . Manager, Buffalo District Sales Office, I-T-E Circuit Breaker Co., Philadelphia, Pa.

Edward Bachorik . . . to Vice President in Charge of Sales, Allied Control Co., New York, N. Y.

John N. Albaugh . . . now Manager of Planning, Gov't Products Group, American Machine and Foundry Co., New York, N. Y.

J. D. Brandfas . . . to Sales Manager, Dale Products, Inc., Burbank, Calif., branch.

Austin F. Marx . . . Sales Manager, Computer-Measurements Co., Sylmar, Calif.

Industry News

Jack R. King . . . Sales Manager; **Lloyd Buchanan** . . . Field Engineering Manager; **Dr. Edgar L. Eichhorn** . . . Professional Services Manager, Data Processing Systems Group, Burroughs Corp., Detroit, Mich.

Ben L. Allgood . . . Regional Sales Manager, Los Angeles; **Ben Roberts** . . . Central Regional Sales Manager (Illinois, Indiana, Michigan, Iowa), Eitel-McCullough, Inc., San Carlos, Calif.

Earl J. Shelton . . . new Manager, High-Power Tube Div., Eitel-McCullough, Inc., San Carlos, Calif.

Thomas C. Clark . . . to Vice President, Houston Fearless Corp., Los Angeles, Calif.

T. C. Clark

J. R. Welty

John R. Welty . . . Products Manager for Diodes and Rectifiers, Motorola, Semiconductor Products, Motorola, Inc.

Ralph B. Knapp, Jr. . . . new Manager of Operations, Distributor Products Div., Raytheon Co., Westwood, Mass.

Walter L. Schott . . . Manager, Distributor Sales Div., International Rectifier Corp., El Segundo, Calif.

John D. Vickrey . . . Sales Manager, Selenium Products Div., International Rectifier Corp., El Segundo, Calif.

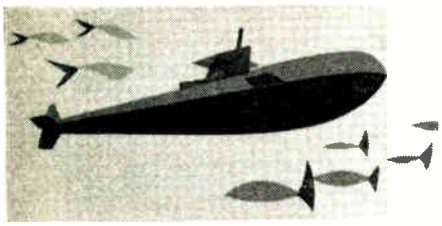
George D. Butler . . . to Vice President, International Resistance Co., Philadelphia, Pa.

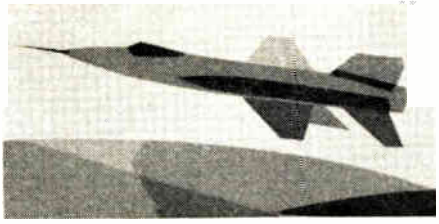
Donald P. Vaughan . . . new Marketing Manager of Spectrol Electronics Corp., San Gabriel, Calif.

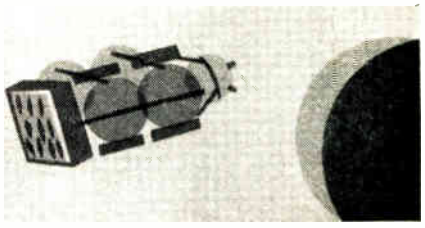
John T. Jackson . . . named Vice President-Management Planning, Remington Rand Div., Sperry Rand Corp., New York, N. Y.

Moses Shapiro . . . new President; **Monte Cohen** . . . Vice-Chairman of the Board, at General Instrument Corp., Newark, N. J.

from under the seas . . . to the edges of space . . . and beyond







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Vāp-Air Mercs have many uses, widespread acceptance

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Used for:
Temperature control of electronic compartments, reference ovens, crystal ovens; nose-cone devices; gyroscopes; inertial guidance system; accelerometers; air compressors; turbines; cabins, cockpits, capsules; windshields; de-icing equipment; oil, fuel, hydraulic systems; for telemetering of temperatures; for control systems, and as warning devices in ground support vans and equipment; and many other uses.

have proved outstandingly accurate and dependable for the most critical thermal sensing and control applications in missiles, aircraft, ground support and undersea equipment.

The Army Ballistic Missile Agency has for two years accepted Merc thermostats as standard temperature control items on all their missiles.

Time after time, Vap-Air mercury tube thermostats have proved their exceptional ability to meet the most exacting specifications for thermal sensing and control. Small, lightweight, they are unaffected by altitude or moisture, can't arc or burn, can withstand 100-G shocks and 30-G vibration without loss of accuracy. They have fast response, close limit tolerances, wide operating ranges, and undeviating accuracy to provide millions of cycles of reliable operation. Mercs need only simple circuits, are adaptable to virtually any need.

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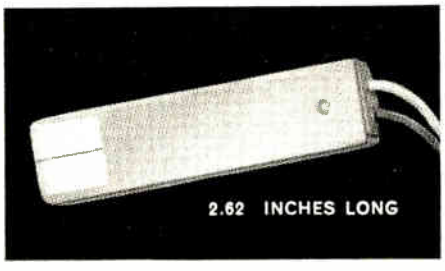

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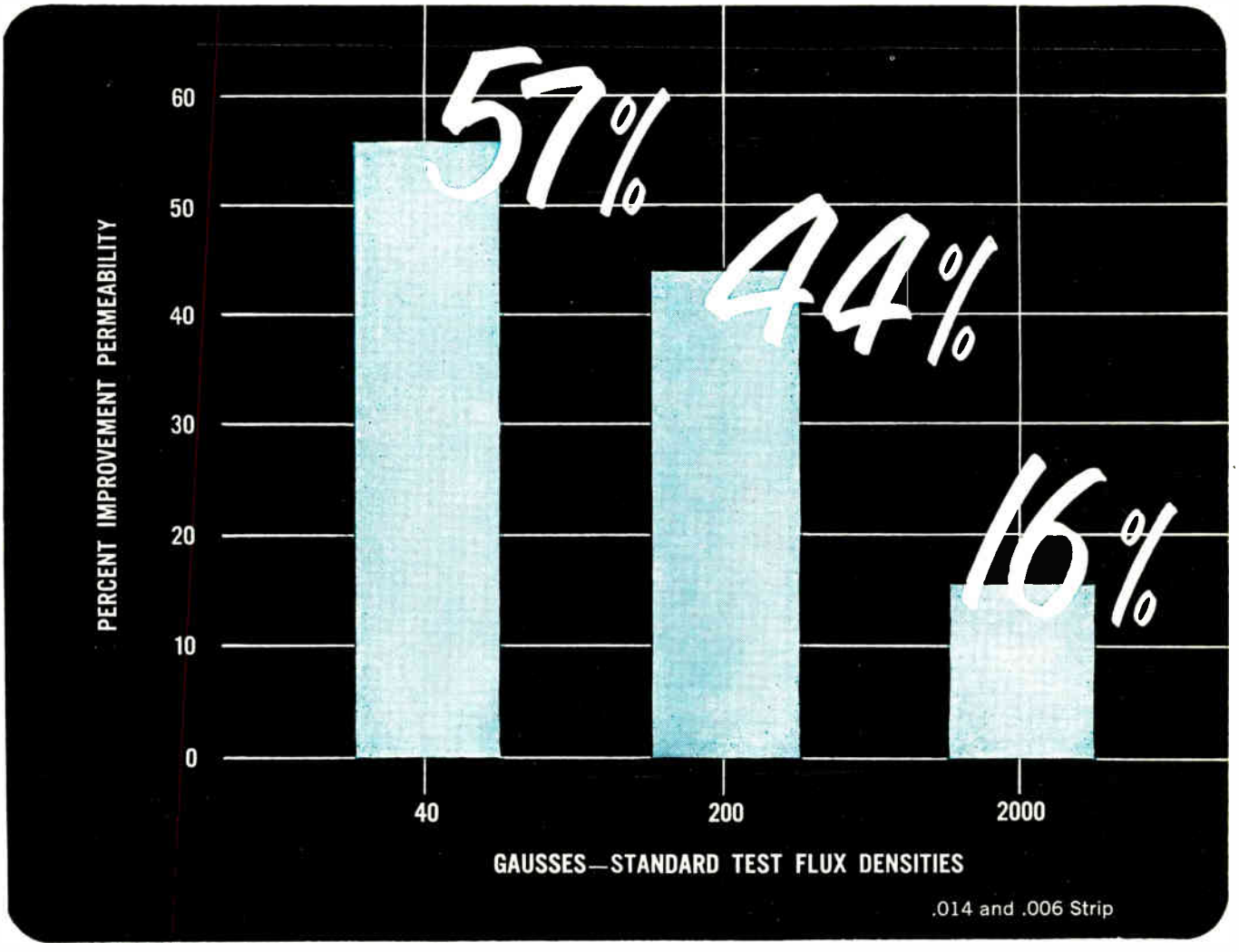

Greater permeability for Allegheny Ludlum's AL-4750...and it's *guaranteed*

promises more consistency, higher predictability for magnetic cores

AL-4750 nickel-iron strip now has higher *guaranteed* permeability values than ever before. For example, at 40 induction gausses AL-4750 now has 57% higher permeability than in the past, using the standard flux density test.

This greater permeability means better consistency and predictability for magnetic core users . . . and allows careful, high performance design.

This improvement in AL-4750 is the result of Allegheny Ludlum's continuing research on electrical alloys and nickel-bearing steels. Moly Permalloy has been similarly improved in permeability. A-L constantly researches silicon steels, including A-L's well-known grain-oriented silicon, Silectron, and other magnetic alloys.

Complete facilities for the fabrication and heat treatment of laminations are available at Allegheny Ludlum. And A-L's technical know-how guarantees you close gage tolerance, uniformity of gage throughout the coil and minimum spread of gage across the coil-width.

If you have a problem on electrical steels, laminations or magnetic material, call A-L for prompt technical assistance. Write for blue sheet EM-16 for complete data on AL-4750. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept.*** EI-9.

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Industry News

Raymond D. Griffiths . . . Manager of Field Marketing, Sylvania Electronic Systems, Waltham, Mass.

John N. Glover . . . District Manager, Stromberg Carlson, Div. of General Dynamics Corp., Colorado Springs, Colo.

Robert I. Neel . . . to Manager, Transmission and Components, Telecommunications Div. Stromberg-Carlson, Div. of General Dynamics Corp., Rochester, N. Y.

Robert C. Boe . . . new Marketing Manager, Buffalo Operations, Sylvania Electronic Systems, Buffalo, N. Y.

Raymond W. Delcamp . . . Head, Microwave Test Equipment Sales, FXR, Inc., Woodside, N. Y.

R. W. Delcamp

Dr. R. P. Johnson

Dr. Ralph P. Johnson . . . Vice President, Electronics Div., Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

Harvey Miller . . . Sales Manager; **Julian Lobenstein** . . . Director of Market Research, Selenium Div., Radio Receptor Co., Subsidiary of General Instrument Corp.

Leonard D. Sullivan . . . new Sr. Corporate Representative, Raytheon Co., Washington, D. C.

Boyd B. Barrick . . . General Sales Manager, Distribution Products Div., Raytheon Co., Westwood, Mass.

Thomas S. Hurley . . . new Supervisor of Merchandising and Advertising, Semiconductor Operations, CBS Electronics Div., Columbia Broadcasting Systems, Inc., Lowell, Mass.

Howard P. Munday . . . Training and Communications Coordinator, CBS Electronics Div., Columbia Broadcasting System, Inc., Danvers, Mass.

Clarence E. Watson . . . to Director of Industry Marketing, Remington Rand Univac Div., Sperry Rand Corp., New York, N. Y.

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in May, 1960.

Accelerators, ion	170,335
Accelerometers	47,350
Amplifiers	119,068
Amplifiers, d-c	53,750
Amplifiers, servo	58,582
Analyzers, spectrum	125,775
Antennas	59,817
Antennas, transmitting	84,296
Attenuators, waveguide	112,919
Batteries, dry	817,539
Batteries, storage	188,617
Beacon, radar	78,832
Cable, telephone	101,708
Computers, control data	700,000
Computers, satellite	33,500
Components, servo	52,260
Connectors	62,776
Connectors, antenna	29,992
Connector, receptacle	61,030
Converters	168,912
Converters, SSB	215,206
Cruisers, video-tape	125,000
Data Processors	446,448
Direction Finders	196,845
Drying chambers, vacuum	46,608
ECM components	10,636,400
Radar Pulse analyzers	34,779
Filters, band-pass	32,607
Gyroscopes	167,894
Headsets, microphone	346,864
Height sets, cloud	457,150
Klystrons	92,750
Magnetrons	206,305
Measuring sets, humidity	221,289
Meters, field strength	95,820
Meters, solar radiation	85,637
Microphone, carbon	43,870
Microwave components	57,088
Modulator systems, telemetry	28,604
Multimeters	215,934
Navigation systems, radar	44,036
Oscillators, AM	27,023
Oscillators, BW	39,044
Oscillators, UHF	26,150
Potentiometer assemblies	36,393
Processors, flight test data	229,000
Radar, doppler	92,992
Radar systems	48,177
Receiver-amplifiers	66,945
Receiver, Loran	1,690,000
Receivers, radio	173,878
Reconnaissance sets, components	1,900,000
Recorders/reproducers	385,391
Recording systems, airborne	31,412
Regulators, voltage	32,538
Relays	51,153
Relays, solenoid	52,477
Relays, thermal	33,099
Resistor assemblies	2,204,498
Resistors, variable	267,487
Signal generators	95,580
Sources, r-f, modulated	54,570
Standards, ac, voltage	90,865
Switchboard equipment	366,148
Switches	170.362
Switches, pressure	34,500
Targets, radar reflective	189,803
Telemetry equipment	53,029
Teleprinters	63,647
Teletypwriter sets	1,225,500
Test equipment	67,242
Test sets, electron tube	211,232
Test sets, guided missile launcher	91,014
Test sets, high frequency vibration	119,225
Test sets, r-f power	68,751
Transducers	361,613
Transistors	36,321
Transmitters, radiobeacon	53,122
Tubes, electron	1,738,662
Wire	85,899

"Management's Biggest Challenge"

(*Continued from page* 1)

nomic aid to other countries and the United Nations would lead all peoples together down a path of eternal peace and prosperity. Korea gave us something of a nightmare in these dreams and this was indeed fortunate. But again during the past year or two we have been searching for some simple formula, some panacea to make these problems disappear. There has been widespread belief that peaceful coexistence is possible—that disarmament is a realistic solution—that if we can only ban nuclear testing, war will be impossible or that if only the leaders would meet at the summit—the way would suddenly appear to them and we could then live happily ever after.

In these troubled times we as a nation have been fatefully unrealistic on the three most important issues.

1. We have failed to understand the true nature of communism and its chief advocate, Russia. We do not properly evaluate her strengths and her weaknesses and we won't believe her intentions.

2. We have failed to fully appreciate and take advantage of our own strengths and capabilities, both our military capability and the importance of our own traditions and ideas and the good will they generate.

3. We do not seem to understand the extent or importance of the growing tide of independence and economic development occurring among the majority of the peoples of the world. These pressures are so great and so widespread that they are bound to influence the course of history for centuries in the future and they will not be stopped or diverted by transitory remedies nor are they likely to be much influenced by other current problems. I do not know that our industry can or will have much to do with these great underlying pressures but as to our ability to meet the Russian problem and as to setting an example of true leadership for the world to see, I believe we can have a part.

On the first of these issues—that we have failed to understand the true nature of our chief adversary, Russia—I would like to make a few comments. Not that I can claim to set you all straight on this matter in a few minutes, nor that I have all the answers at hand by any means, but in many ways this is a very important key to the situation.

Just a year ago this week I was in Russia and although one does not learn much in a short visit, I think a few impressions might be helpful. The one impression I came back with, and which I did not have before my visit, is that there is a vast difference between what the Russians say about their country and what actually exists there. While one can see some very impressive accomplishments and they certainly do their best to show you the impressive things they have, one is appalled at what they lack. Many things we take for granted simply do not exist in their country. They have, for example, virtually no road system and as a result no system of highway transport of freight. Lack of highways seems understandable when one realizes they produce only about 200,000 automobiles per year as compared to our 6 or 7 million, but all the trucks we saw were what we would call typical open-bed Army trucks. They use these to haul people to work and to carry freight. Their roads and their trucking are about what we might consider typical in this country in the 1920's right after World War I.

They are working hard at new construction, building many apartment buildings, which incidentally are located in strategic spots so the tourists can see all of the new buildings, or perhaps they route all the tourists that way, and on the face they look fairly impressive, but if you looked a little more closely you realized for example they had no wheelbarrows in use anywhere. Much of the building was of bricks and mortar but both were carried in a two-foot-square box with handles and a woman on each end.

All of these brand new apartments were wired with what I estimated to be No. 16 wire with one single light bulb hanging from the ceiling in each room and no outlets for appliances anywhere. Remember that, when you next read their statistics about the number of appliances they produce.

. . . I saw a good many electronic products in Russia. I do not know whether the things I saw represented their most recent developments or not. I had no reason to believe otherwise, as it certainly seemed to be their nature to show us the best they had. I did not see one single electronic device in Russia which represented an advance over what we have in this country and most of their electronic products look like devices which have been out of date for several years in America. I do not intend to categorically imply that they copy all of our equipment, but I did see a number of their products which were strangely familiar and I assure you I know enough about some of these devices to know that we did not copy theirs.

We have heard a great deal about the excellence of the Russian schools and certainly education has more to do with the eventual strength and character of a nation than almost any other activity. We become greatly concerned when we learn that every student there is required to take four years of physics before he can graduate from the equivalent of our high school. I visited one of these schools in Leningrad and it was good. I felt much better about the relative quality of our own schools as I learned something of the details of theirs. For example, when I asked the question of the fourth year class in physics at this school, not a single student knew Ohm's law.

Perhaps the most important impression I have from a brief visit to their country is that the Russians are masters at showmanship and facade and that in their total strength they are not nearly as strong as they would like to—and unfortunately I think have been able to—make us believe.

On returning from this visit I developed an interest in reading what other people had to say about Russia and so that you need not have to rely solely upon my word, I would like to read to you a few quotations from others who have visited that country.

Here is one quotation: "Do you know what it is to travel in Russia? For the superficial mind, it is to be

fed on illusions—but for one who has his eyes open and, added to a little power of observation, an independent turn of mind, it is continuous and obstinate work, which consists in laboriously distinguishing at every turn between two nations in conflict. These two nations are Russia as it is and Russia as it would like to show itself to Europe."

And again a quotation: "Actually, this country lends itself marvelously to all kinds of fraud. Russia is always governed by deceit. Here admitted tyranny would be a step forward. On this point as on many others, foreigners who have described Russia have united with the Russians to deceive the world. Either Russia has as yet been described only by men whose position or character would not permit independence or the most honest minds lose their freedom of judgment from the moment they enter Russia."

And another: "Up to now I believed that man could do more without truth for the spirit than air and sun for the body. My journey to Russia disabuses me. Here, to lie is to protect the social order. To speak the truth is to destroy the State."

And finally, another quotation: "Russian despotism not only counts ideas and sentiments for nothing. but remakes facts. It wages war on evidence and triumphs in the battle, for evidence has no defender, no more than justice when they embarras the power."

Ladies and gentlemen, these quotations I have given you were made in 1839 by a Frenchman, the Marquis de Custine, who traveled in Russia at that time—and I submit to you that reading this gentleman's account of the character of the Russians, one would swear there has been not the slightest change in the basic character of the Russian people in the last 120 years.

. . . I am sure we in this country do not yet understand the true nature of Russia and Communism. We overestimate her strength and perhaps misjudge her weakness. Above all, we must understand that we cannot deal with Russia and the Russian Communist in the same way we can deal with nations and people who have been under the influence of Western Civilization for centuries as have most of our friends and allies.

. . . As for intentions of the Communists, just read what they have to say—read Lenin, Stalin and Khrushchev and believe them. We did not believe Hitler meant what he said when he wrote *Mein Kampf*—that was an expensive lesson then—it will be infinitely more expensive if we have not learned it by now.

If we have failed to understand and have underestimated the nature of our chief adversary, I think also we have failed to understand the great strength, both physical and moral, which is America. In this regard, I think it is useful to review some of the characteristics of our own industry which have given it strength and which make it an outstanding example of the operation of our free enterprise system.

The vast majority of firms showing their products here this week were started as independent business ventures by one or a few individuals who felt that working on their own or for a small independent firm would give them the opportunity to do a better job. This week's show presents a magnificent display of the ingenious ideas which come from a dynamic free

(*Continued on page* 216)

Challenge

(*Continued from page* 215)

enterprise industry. One notes as he goes through the exhibits that very large and also very small firms are represented. A close examination of the products of each reveals that some of the best products and some of the most ingenious ideas come from the smallest firms. In other words, although the large enterprises are doing an outstanding job in our industry, great size and financial strength are not a prerequisite to top quality performance in the American electronic industry and I hope they never will be.

WESCON gives testimony to another important characteristic of our industry. It is built on a free exchange of ideas. This exchange on a technical level between engineers and scientists has, of course, been one of the main objectives of our Institute of Radio Engineers and I think the Institute has been quite successful in assisting this important spread of knowledge among its professional ranks and as a result throughout the industry.

It is my impression that the free exchange of ideas on business methods and problems, as well as in the technical area, has been an important factor in the management success of many of the firms here this week. I am quite certain that there has been a much freer exchange of both management and technical know-how between electronic firms on the West Coast than elsewhere in the country. I like to think this has been an important contributing factor to the fabulous growth of our industry in the West.

Being inhabited by young, well-trained, enthusiastic and ambitious people, the electronic industry holds examples of the best thinking in professional management and evidence of the highest ethics in business practice. We not only provide employment in our industry for about two million men and women, but we provide the best of jobs and working conditions for them. We understand, I think quite fully, that people are more important than money in the electronic business.

The utilization of long range planning, and great emphasis on forward-looking research and development, have been the cornerstone of our growth, and with this growth has come unusually good stability.

This electronic industry of ours has virtually none of the characteristics of the capitalistic system which Marx used as the model against which to direct his proposed system of communism. It is time more people understood this fact, both here at home and throughout the world. We have in our electronic industry not only the great productive capability which has contributed so much to our national defense strength, but we have an example of free enterprise at its best, an example which we should at once hold up for the world to see—and also defend with all the vigor at our command.

I think we have a serious problem to preserve these important strengths of our industry. There is a growing trend toward mergers and acquisitions—spurred by the attraction of the exhorbitant price-to-earnings ratios which the investment community has generated out of their enthusiasm for our performance. There is no evidence which will stand critical examination to indicate our industry is any stronger as a result of these mergers and acquisitions, I have seen many cases where, when the pride of ownership and the opportunity for truly free individual decision was lost, the enterprise which was acquired, lost, rather than gained, in true productive capability.

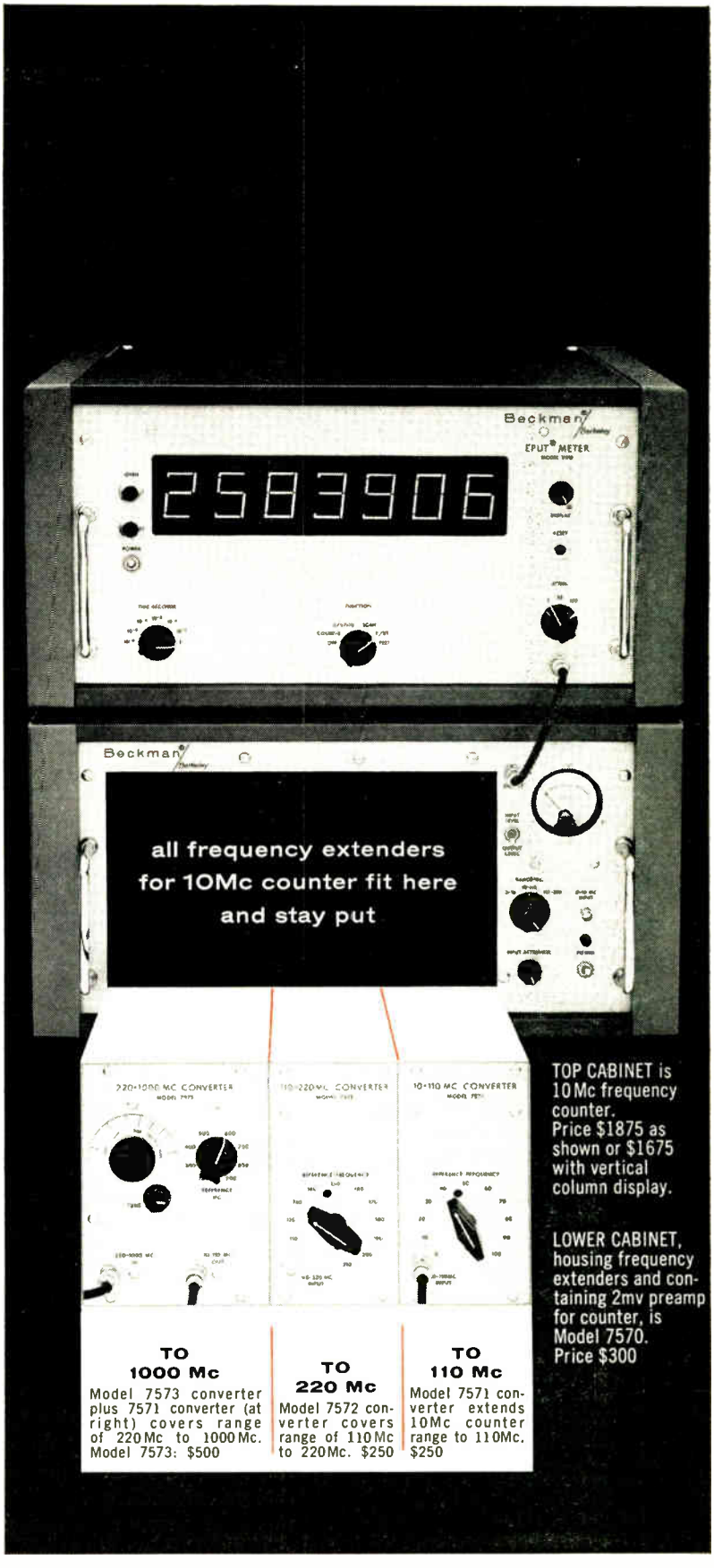
I think, too, we must as an industry resist the pressures of governmental control with all our might. This is an especially difficult task when we depend on the Government for such a large proportion of our business. It should be abundantly clear, however, that arbitrary rules generated by governmental bureaucracy are not necessarily going to bring about better reliability in our product nor progress in any other area of our affairs. If we follow the lead of those in Government who say that it is more important to limit profits than it is to produce an economical product of highest quality, we will find ourselves heading straight

(*Continued on page* 220)

measure rf to 1000 mc without replacing plug-ins

It's all here in two easily-movable cabinets — a digital frequency-measuring system of wider range and lower price than any comparable equipment on the market. The counter in the top cabinet measures all frequencies from 10 cps to 10Mc. Heterodyne converters—added to the bottom cabinet as you need them—extend range to 110Mc, 220Mc or 1000Mc. ● This provision for expanding the system simply and economically makes the equipment a wise long-term investment. Buy only the range you need now, rest assured that you can cover higher frequencies whenever need arises. ● Accuracy is .00001% or better from 1Mc to 1000Mc. Sensitivity is unequalled: 2mv from 10Kc to 10 Mc, 10mv to 110Mc, 20mv to 220Mc and 1mw to 1000Mc.

WRITE FOR DETAILED TECHNICAL BULLETINS ON MODEL 7570 SERIES



Beckman® | *Berkeley Division*
Richmond, California

25 YEARS INSTRUMENTAL

T27

Challenge

(*Continued from page* 217)

down the socialist road to the camp of communism. A case actually came to my attention recently in which the Government rejected the lowest bid because the cost breakdown showed what the Government agent considered to be too high a profit and the contract was awarded to a higher bidder only because they thought his expected profit margin was not exorbitant.

Thus, while it is unrealistic to expect less Government business in our industry, because we in fact have a great responsibility to provide our defense effort with the best of electronic devices, we must exert every means at our command to see that this objective will be achieved in the best and most efficient manner from a truly free and independent electronic industry.

There are some other things we can do in our industry to add our strength against the task ahead. Our industry employs at least 150,000 scientists and engineers. It is imperative that we exert every effort to make the work of these people as productive as possible. We must continue to find ways to keep scientific talent on scientific work and not make executive and administrative positions in our industry so attractive in money and prestige that these will be filled by people who by training and capability are better fitted to scientific assignments.

We must put more effort into improving the educational system in this country. This is an area of very great opportunity for each of you in the electronic industry to help. The need ranges from people to participate on local school boards —to people who will teach adult education courses in the plant and outside. As to you who are executives, there is more your company can do in the financial support of the private colleges and universities—for private education is the special responsibility of private business. We must improve the quantity and quality of the educated people coming to our ranks and we must do everything possible to encourage them to continue their education all during their profes-

sional careers. Our industry derives its great strength from the large numbers of capable, highly educated people we employ. We must give commensurate support to the source of this strength.

We can do a great deal also to encourage a better understanding of these problems in our own communities. In this year of presidential election—we can encourage our employees to register—to become better acquainted with the issues and candidates. Above all we must encourage a better understanding of the importance of the great issues which confront our nation—so that leaders who understand the importance of freedom will be chosen and so that issues will be adopted which will preserve our democratic system. If we yield to those who want to improve the world by spreading the wealth, instead of improving the world by enabling each person to do a better and more efficient job in his own work, we will eventually find, as have the Russian people, that total dependence on the Government is inevitably a form of slavery. We must elect people who understand that human dignity can survive only in freedom and independence in each institution within our society. Let's encourage our people to select candidates who understand the hard, cold facts of the situation we face. We all dream of lasting world-wide peace, but any candidate who holds out to the American people that this can be achieved by his personal formula and without long years of hard work and sacrifice is talking sheer hypocrisy and does not deserve a place in our Government.

I think then in this brief review of the characteristics and problems of the electronic industry—we can get an indication of the possibility that we have greater strength both physical and moral than we have heretofore been willing to admit. We have the problem of maintaining this strength. Some of the things I suggested that we can do here in our own industry will, I think, help in further strengthening our country. As we face the problems of foreign competition, as we establish branch operations in foreign countries, and

(*Continued on page* 222)

as we look at the larger opportunities which are available to us in the further development of our individual businesses, I feel sure there will be many opportunities wherein we can at once advance the interests of our companies and at the same time be of great service to our nation, across the seas as well as here at home.

So as we continue the work of this conference, we will be discussing the myriad of problems technical and otherwise which confront us in the day-to-day pursuit of our business or profession. I suggest that we also take stock in our own accomplishments and renew our resolve that the task we face can and will be done.

The United States has for less than two decades held a position of undisputed leadership in the world. This leadership has come not from any aggressive action, nor at the expense of other people, but as a result of the basic strengths which have been generated within our unique system of freedom and democracy. Never in the history of the world has such leadership been achieved with such selfless and humanitarian motives.

In these same two decades our electronic industry has grown from a small, insignificant factor in our economy to one of the greatest industries of our nation, and we have had a very important part in helping our country achieve this world leadership.

Will history record that the American dream of equality of opportunity, of justice for all and of the supreme importance of the individual has been permanently established for all future mankind? Or will history record that these American ideas and concepts have been rolled back by the ruthless communist totalitarianism expressed in Nikita Khrushchev's statement, "We will bury you." The answer to this question cannot come—in our democracy—from the President alone, nor from the Congress nor from any other part of the Government. This question must be answered in the right way by each of us as individuals. It must be the conviction of the majority of all the people. We must give the right answer—nothing can be more important.

* * *

SARKES TARZIAN
SILICON ZENER VOLTAGE REGULATORS

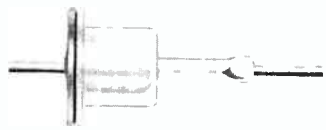
Tarzian silicon voltage regulators, commonly called zener diodes, are constant voltage devices used to control output voltage of power sources and as voltage reference elements capable of operating over a wide temperature range. Hermetic sealing and mechanical ruggedness provide long term reliability even under the most adverse conditions.

Three power classifications cover a wide range of applications.

¼ Watt Zener Regulators

Specifications 25°C.

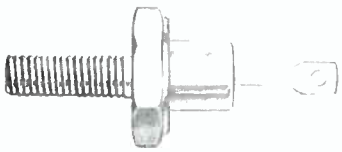
Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
.25T5.6	5.6	25	3.6	1N708
.25T6.2	6.2	25	4.1	1N709
.25T6.8	6.8	25	4.7	1N710
.25T7.5	7.5	25	5.3	1N711
.25T8.2	8.2	25	6.0	1N712
.25T9.1	9.1	12	7.0	1N713
.25T10	10	12	8.0	1N714
.25T11	11	12	9.0	1N715
.25T12	12	12	10	1N716
.25T13	13	12	11	1N717
.25T15	15	12	13	1N718
.25T16	16	12	15	1N719
.25T18	18	12	17	1N720
.25T20	20	4	20	1N721
.25T22	22	4	24	1N722
.25T24	24	4	28	1N723
.25T27	27	4	35	1N724
.25T30	30	4	42	1N725
.25T33	33	4	50	1N726
.25T36	36	4	60	1N727
.25T39	39	4	70	1N728
.25T43	43	4	84	1N729
.25T47	47	4	98	1N730
.25T51	51	4	115	1N731
.25T56	56	4	140	1N732
.25T62	62	2	170	1N733
.25T68	68	2	200	1N734
.25T75	75	2	240	1N735
.25T82	82	2	280	1N736
.25T91	91	1	340	1N737
.25T100	100	1	400	1N738



1 Watt Zener Regulators

Specifications 25°C.

Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)
1T5.6	5.6	100	1.2
1T6.2	6.2	100	1.5
1T6.8	6.8	100	1.7
1T7.5	7.5	100	2.1
1T8.2	8.2	100	2.4
1T9.1	9.1	50	3.0
1T10	10	50	3.5
1T11	11	50	4.2
1T12	12	50	5.0
1T13	13	50	5.8
1T15	15	50	7.6
1T16	16	50	8.6
1T18	18	50	11
1T20	20	15	13
1T22	22	15	16
1T24	24	15	18
1T27	27	15	23
1T30	30	15	28
1T33	33	15	33
1T36	36	15	39
1T39	39	15	45
1T43	43	15	54
1T47	47	15	64
1T51	51	15	74
1T56	56	15	88
1T62	62	5	105
1T68	68	5	125
1T75	75	5	150
1T82	82	5	175
1T91	91	5	220
1T100	100	5	260



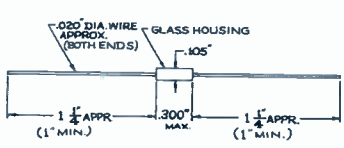
10 Watt Zener Regulators

Specifications 25°C.

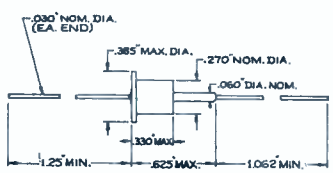
Tarzian Type	Zener Volt. (V)	Test Cur. (Ma)	Dyn. Imp. (Ohms)	Jedec Type
10T5.6	5.6	1000	1	1N1803
10T6.2	6.2	1000	1	1N1804
10T6.8	6.8	1000	1	1N1805
10T7.5	7.5	1000	1	1N1806
10T8.2	8.2	1000	1	1N1807
10T9.1	9.1	500	1	1N1808
10T10	10	500	2	1N1351
10T11	11	500	2	1N1352
10T12	12	500	2	1N1353
10T13	13	500	2	1N1354
10T15	15	500	2	1N1355
10T16	16	500	3	1N1356
10T18	18	150	3	1N1357
10T20	20	150	3	1N1358
10T22	22	150	3	1N1359
10T24	24	150	3	1N1360
10T27	27	150	3	1N1361
10T30	30	150	4	1N1362
10T33	33	150	4	1N1363
10T36	36	150	5	1N1364
10T39	39	150	5	1N1365
10T43	43	150	6	1N1366
10T47	47	150	7	1N1367
10T51	51	150	8	1N1368
10T56	56	150	9	1N1369
10T62	62	50	12	1N1370
10T68	68	50	14	1N1371
10T75	75	50	20	1N1372
10T82	82	50	22	1N1373
10T91	91	50	35	1N1374
10T100	100	50	40	1N1375

NOTES: Standard tolerance is ± 10% however, closer or wider tolerances are available on request.
Also available on request:
(a) Special voltage ratings.
(b) Symmetrical double anode types (for clippers).

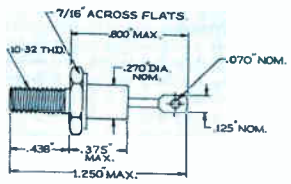
DIMENSIONS



DIMENSIONS



DIMENSIONS

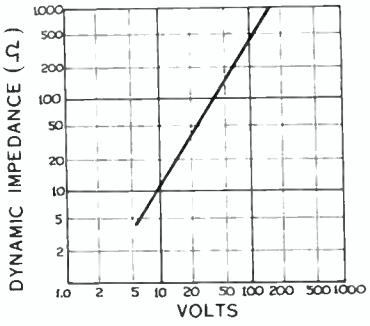


SARKES TARZIAN SILICON VOLTAGE REGULATOR ZENER DIODES
Characteristics and Application

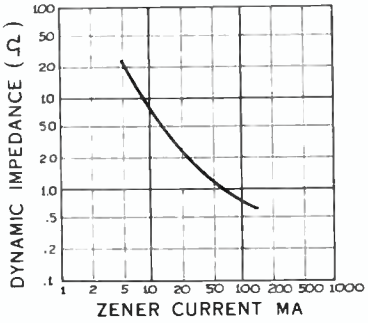
Dynamic Impedance

Dynamic impedance is a measure of voltage change effects on operating current and provides a practical measure of regulating performance. Dynamic impedance is measured by superimposing a small AC current upon the DC test current and measuring the resultant voltage across the diode.

The following curves show the effects of voltage and current on dynamic impedance.

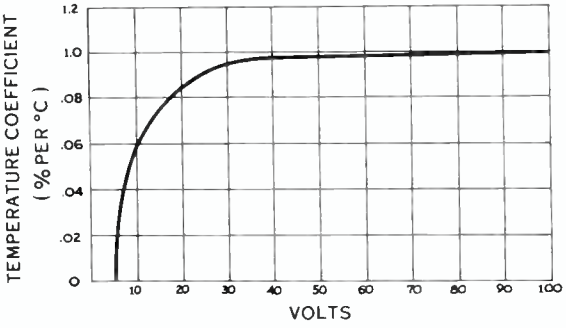


TYPICAL CURVE FOR 1T7.5



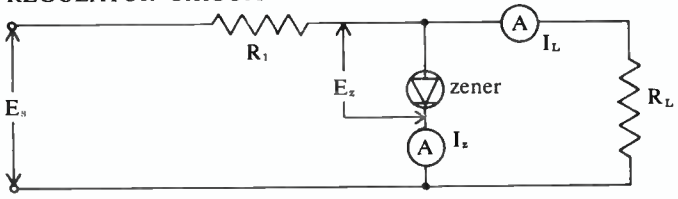
Temperature Coefficient

The operating voltage of a silicon regulator changes with operating temperature. This characteristic must be considered in design. The following curve shows temperature—voltage relationships typical in silicon zener diodes.



Typical Application

REGULATOR CIRCUIT



As the input voltage increases the inverse bias across the zener diode will increase and cause a large current to flow. This increase will cause more current to flow through R_1 and increase the drop thereby adjusting the load voltage. Load variations have a similar effect. The result is a substantially constant output voltage.

Determination of R_1 is as follows:

$$R_1 = \frac{E_s - E_z}{I_z + I_L}$$

$$I_z = \left(\frac{E_s - E_z}{R_1}\right) - I_L$$

$$P_z = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

Where:

R_1 is the series resistor
E_s is the source voltage
E_z is the zener diode voltage
I_z is the zener diode current
I_L is the load current
P_z is the zener diode power dissipation

Where the load current and input voltage are variable:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I\,(\text{max.}) + .1 I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\,(\text{min.})\right) E_z$$

For constant load current but variable input voltage:

$$R_1 = \frac{E_s\,(\text{min.}) - E_z}{I_L + .1 I_L}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s\,(\text{max.}) - E_z}{R_1} - I_L\right) E_z$$

For constant input voltage but variable load current:

$$R_1 = \frac{E_s - E_z}{I_L\,(\text{max.}) + .1\, I_L\,(\text{max.})}$$

$$P_z\,(\text{max.}) = \left(\frac{E_s - E_z}{R_1} - I_L\right) E_z$$

NOTES: The above equations allow a tolerance of 10% to compensate for load regulation.
If dynamic impedance is a significant percentage of the value of R_1, this must be taken into consideration.
A high impedance source presents additional problems and must be considered if it is significant compared to R_1.

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WASHINGTON News Letter

VITAL TO INDUSTRY—Automation has been vital to the development and expansion of electronics, "the fastest-growing industry in the nation." This statement by Don G. Mitchell, President, General Telephone & Electronics Corp., former Sylvania Electric Products head before its merger with GT&E, was made in a statement filed with the Joint Congressional Economic Committee's subcommittee on automation and energy resources. Employment in the electronics manufacturing industry in contrast to claims about the effects on jobs of automation, he cited, has increased substantially in the past five years. For all segments of the industry; manufacturing, and its related elements of engineering and research, total employment in 1960 is about 1 million compared with 700,000 five years ago.

AUTOMATION KEY TO GROWTH—Defense electronics has increased 85% since 1955, from $2.8 billion to $5.9 billion, Mr. Mitchell stated. However, the most rapid relative growth has been in the field of industrial and commercial electronics. The GT&E President pointed out, "Here you have a highly unusual phenomenon to consider. Industry, which owes much of its growth and development over the years to automation, is in turn itself inventing and producing devices and equipment. This will further automation in all spheres of American industry and commerce."

NEW FCC COMMISSIONER—Under a recess appointment by President Eisenhower, Charles H. Kind, on leave as Dean of the Detroit College of Law, has taken office as an FCC Commissioner. This appointment fills out the full complement of the FCC with seven Commissioners. Mr. Kind is to serve, if confirmed by the Senate after Congress reconvenes in its regular session, until June 30, 1961, in the remainder of the term of Chairman John C. Doerfer who resigned March 21.

"THIN ROUTE" TROPO—A new electronic "transmission concept that reduces telegraph and data transmission costs 60%" was disclosed by the General Electric Co. at IRE's Global Communications Symposium in Washington. The new development, called "Thin Route Tropo," is being tested, GE announced, over a 152-mile hop between Arlington and Lynchburg, Va. Chief use for the immediate future of the new system will be for teletype-data transmission by federal government agencies and the military services. However, GE anticipates speedy use by commercial organizations, particularly law enforcement agencies, toll roads, park and forestry services, pipelines, mining companies, banks, manufacturers, airlines and railroads.

SPACE COMMUNICATIONS NETWORK—The Bell System has evolved a plan for a space communications network to carry telephone calls and television programs throughout the world. The plan was recently presented to the FCC in the Commission's reopened 1959 microwave policy decision proceedings. The network, the Bell System outlined, would be established via a system based on around 50 satellites in random polar orbits at a height of about 3000 miles. The cost of the system, including provision for transoceanic TV channels between each pair of ground stations, would cost an estimated $170 million with $65 million for the ground installations.

CANNOT SHARE FREQUENCIES?—Dr. James B. Fisk, President of the Bell Telephone Labs, told the FCC that it would be impracticable for satellite systems to share frequencies with ground microwave systems. Ground receivers in the satellite system, he said, can function only if they are well beyond the horizon from any ground microwave transmitters on the same frequency. He foresaw for the operation of a worldwide commercial satellite communication system an initial requirement of approximately 2000 megacycles of frequency space, with the "most favorable frequencies lying between 1000 and 10,000 MC."

However, the EIA, after studying the frequency requirements for space communications in the bands above 890 MC, contends differently. They find that space satellite communications systems may operate on the same frequencies as point-to-point systems on earth without interfering with each other.

Therefore, the FCC may use its present frequency allocation system, says EIA.

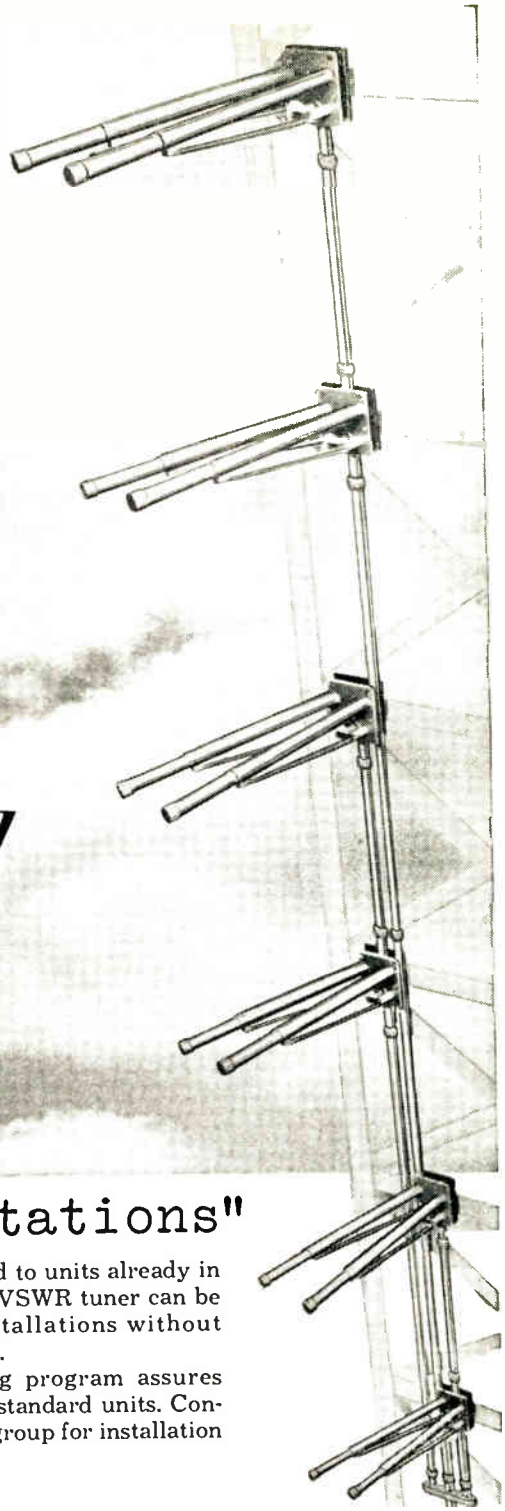
National Press Building
Washington 4

ROLAND C. DAVIES

WHAT DEFENSE SURPLUS MEANS—The DOD is disposing of excess and surplus property worldwide this year that originally cost the Government $8 billion. Military items are still carried at their original price, without depreciation, despite age, wear, condition or obsolescence. Under normal business accounting methods such items would have been depreciated or written off during the years and the return from their sale shown as a profit, but under Government accounting methods the difference between the original, new cost, and final return price years later is shown as a loss. However, $2 billion (or 25%) of the excess and surplus property will have further utility, other than military, in Federal agencies, Civil Defense, and Health and Educational programs which have been authorized by Congress.

ANDREW MULTI-V* FM ANTENNA

For Multiplex or Standard Service



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"Boston's Music Stations"
WCRB
AM 1330 / FM 102.5

January 22, 1960

Andrew Corporation
P.O. Box 296
Westwood, Massachusetts

Attention: Mr. John Wyman

Gentlemen:

As you know we recently purchased one of your six-bay Multi-V FM broadcast antennas, and over 1000 feet of your H-1 Heliax for use on our new FM installation on the WBZ-TV tower.

Our choice of the antenna was based on our previous experience with antennas of this type, which have always performed very well. We are happy to say that our new antenna and co-ax are exceeding our best expectations, and giving excellent coverage for both our main channel and our multiplex transmissions.

We do not hesitate to recommend highly this Multi-V Antenna to any broadcaster proposing new or improved FM facilities.

Yours truly,
Richard L. Kaye
Richard L. Kaye
Station Manager

RLK:chn

Also Special Background Music Via WCRB Music Service Inc.

"exceeding our best expectations"

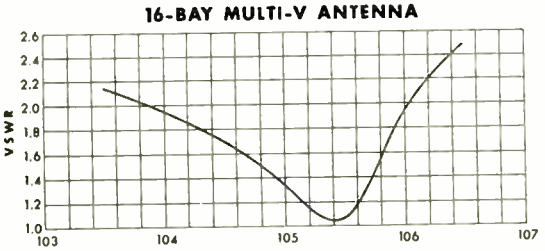
The ANDREW Multi-V is the standard of the industry. Over 353 Multi-V units have been installed to date, accounting for more than 50% of the stations presently licensed. Installations have been made in all climates and service is uniformly acclaimed both for standard and multiplex operation. De-icers are available for use when icing conditions occur and can be added to units already in service. Similarly, the VSWR tuner can be added to existing installations without modifying the antenna.

A new warehousing program assures quick deliveries of all standard units. Consult our Field Service group for installation quotations.

*U.S. PATENT 2,637,533 — Exclusive ANDREW design

Measured VSWR on a 16-bay production unit. Note bandwidth. VSWR tuner, Type 19893, is available for tuning out tower effect, thus, assuring optimum performance and eliminating need for field tuning individual bays.

16-BAY MULTI-V ANTENNA



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HELIAX is the preferred cable for FM. Low VSWR, greater mechanical strength and flexibility have made it the favorite of broadcasters. Available in continuous lengths in diameters up to 3⅛ inches.

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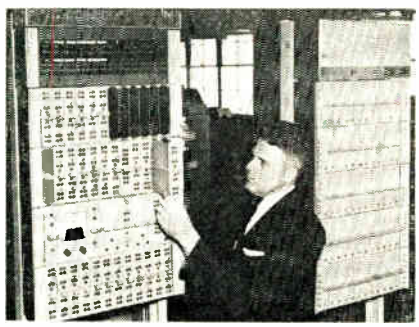
The Systems Engineering Section of ELECTRONIC INDUSTRIES • SEPTEMBER 1960

SYSTEMS—WISE . . .

MICROWAVE NETWORK



Clinton DeGabrielle, GE microwave representative checks first unit of TCS-600 transistorized multiplex-carrier equipment to be delivered by GE for use in Western Union's new 3,700 mile microwave communications network. More than $1 million worth of these units will be built to W.U. specs by GE—1960-61.

▸ General Precision Inc.'s Librascope Div. has developed a two-address electronic, advance process control digital computer system—the Libratrol-1000—that accepts data directly from analog instrumentation and also provides for closed loop operation. Completely transistorized, it operates in the serial, binary mode and offers data-handling capabilities because of its 8000 word memory and a new concept in data placement and recovery.

▸ The Registered Publication System Dept. of the U. S. Naval Security Station in Washington, D. C., is now exercising control of its store of vital military publications through a new Remington Rand Univac Solid State 80 Magnetic Tape System, core of the Department's Closed Integrated Data Process System.

▸ A completely integrated computer control system combining instrumentation from primary elements to final controls has been introduced by Minneapolis-Honeywell Regulator Co. for large-scale industrial processes. Nucleus of the system is the Honeywell 290 digital computer, a general-purpose all-solid-state device specifically designed for process applications.

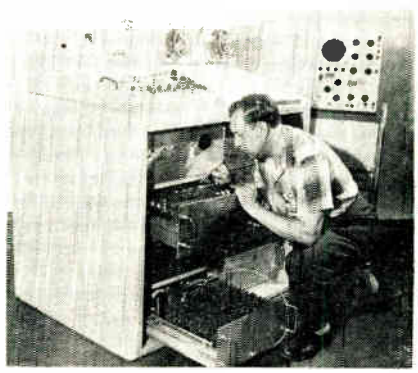
▸ A completely new automatic Elapsed Time Computer, designed and engineered by the Calculagraph Co., Harrison, N. J., automatically computes and simultaneously prints elapsed time—the difference between "start time" and "finish time" of a given operation.

▸ The FCC will send representatives into areas served by unlicensed TV booster stations to explain to their operators how they may obtain authority to continue present operations pending conversion to the newly authorized low-power VHF translator stations. On July 28 last the Commission announced the following schedule for licensing VHF boosters which were constructed on or before July 7, 1960: (1) On or before October 31, 1960, application should be made for temporary operating authority. (2) On or before February 1, 1961, application for license indicating compliance with the VHF translator rules should be filed. (3) On or before October 31, 1961, the facility must be in complete compliance with the VHF translator rules. Operation thereafter will be permitted only under a license granted by the Commission.

▸ Bell Lab engineers have reduced power requirements and size of apparatus by using transistorized amplifiers in the repeater and terminal equipments of an experimental closed loop TV transmission system operating between Holmdel, N. J. and headquarters. Local power supply is eliminated; operating power is transmitted over coaxial cable.

▸ A modern solid-state memory designed by Daystrom's Military Electronics Div. has increased storage capability of the Naval Ordnance Research Calculator (NORC) from 132,000 to 1,320,000 bits of information.

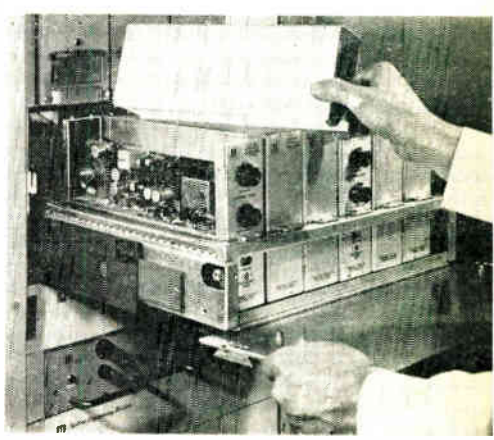
ELECTRONIC LABORATORY



Lightweight electronic checkout system developed by Goodyear Aircraft Corp. for use at any level from subassemblies in the factories to complete weapons in the field, is given a final assembly check by an electronics technician. A "Central Programmer," the unit weighs less than 1000 pounds.

▸ An automatic internal communications switchboard which can be easily expanded with plug-in units has been developed by Dictograph Products Inc., Jamaica, N. Y. to provide any number of stations up to 240 and as many as 32 links. Also, the number of stations in any installation can be increased by about an additional 20 to 25% by adding selective ring common talk stations. The system comprises a basic 60 line-8 link switchboard and power supply, extension frames, and group selector frames.

CONTROL AMPLIFIER

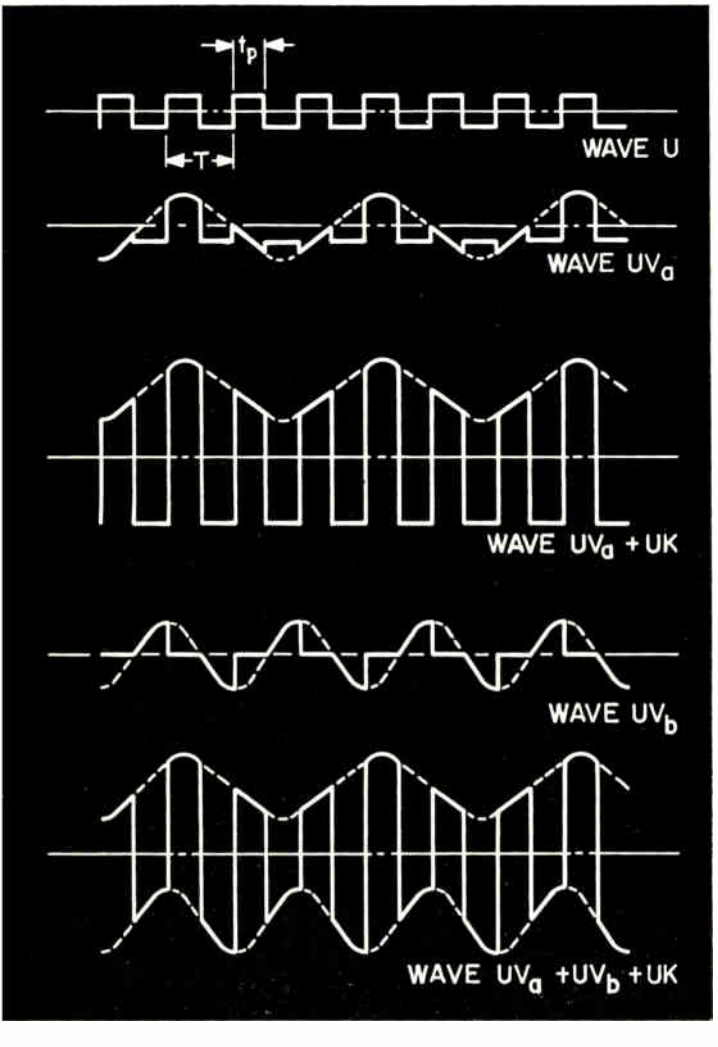


Compact Solid-State and Frequency Control System developed by Minneapolis-Honeywell's Brown Instrument Div. has no moving parts—as evidenced by these 6 amplifiers—two control and four alarm units for two generators—which fit into pullout drawers in standard 19" relay rack. Phila. Electric Co. will be system's first user.

The stereo trend is prompting development of dual channel transmission techniques by broadcasters. Several proposed systems have been developed around time division. This article presents a theoretical analysis of the system spectrum . . . with experimental verification.

Spectrum Analysis

Figs. 1 to 5 (top to bottom): (1) The sampling function, wave U; (2) the audio signal multiplied by the sampling function, wave UV_a; (3) the pulse train formed into single polarity pulses, wave $UV_a + UK$; (4) audio function of the second channel starts one pulse width after first channel, wave UV_b; and (5) the total wave, $UV_a + UV_b + UK$.



TIME division stereo is a modulation scheme in which a two channel stereo audio program shares time in the signal transmission. The dual-channel transmission is accomplished by sampling at a rate above the audible frequency range of either channel. The sampling means is a switch in which each channel will share equally on a time basis. At the receiver, the switching or sampling rate is detected and the channels separated by switching on or off each channel amplifier at the appropriate time.

The analysis which follows indicates that the time division stereo means is essentially a modulation system for producing a sum $(A+B)$ modulation of the main carrier, and a difference $(A-B)$ modulation of a subcarrier frequency; the subcarrier frequency being the fundamental switching rate.

Spectrum Analysis

The time division of the two audio channels, f_a and f_b, is to be accomplished by a sampling function at a repetition rate with a base frequency of f_r.

The sampling function, Fig. 1, is expressed by the following:

(assuming $t_a = 0$ at the start)

$$U = k \sum_{m=-\infty}^{\infty} \frac{\sin mk\pi}{mk\pi} \cos m\omega_r t. \qquad (1)$$

where $k = t_p/T$

t_p = pulse duration

T = pulse spacing

For equal time sharing $t_p = 1/2T$ and k is equal to 1/2, then

$$U = 1/2 \sum_{m=-\infty}^{\infty} \frac{\sin \frac{m\pi}{2}}{\frac{m\pi}{2}} \cos m\omega_r t. \qquad (2)$$

The function for the f_a audio channel is

$$V(t) = A_a \cos (\omega_a t + \theta_a) \qquad (3)$$

By BARTON C. COFFMAN

Assistant Director
Research and Engineering
Crosby-Teletronics Corp.
299 Robbins Lane
Syosset, New York

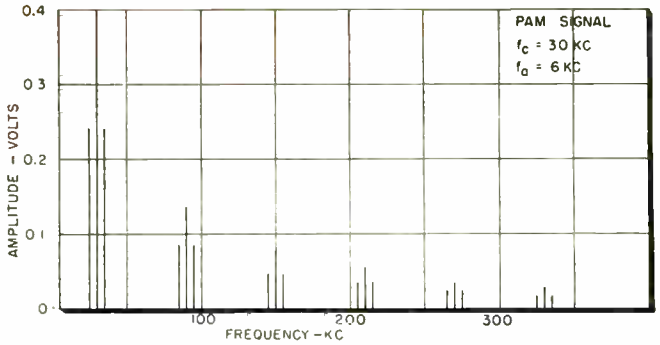


Fig. 6: Measured spectrum analysis of the PAM signal of Fig. 3.

# of Time Division Stereo

and the expression for the total wave of the f_a audio signal switched on and off at rate $1/T$ can be obtained by multiplying the audio signal $V(t)$ by the sampling function U, Fig. 2:

$$M_a(t) = U\,V_a = 1/2\,A_a \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c + \omega_a)\,t + \theta_a\right] \quad (4)$$

This expression may be reduced since it can be shown that:

$$\sum_{m=-\infty}^{\infty} mk = \sum_{m=0} mk + \sum_{m=-\infty}^{-1} mk + \sum_{m=1}^{\infty} mk \quad (5)$$

Substituting Eq. (4) in (5):

$$M_a(t) = 1\,2\,A_a \sum_{m=0} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c + \omega_a)\,t + \theta_a\right]$$

$$+ 1\,2\,A_a \sum_{m=-\infty}^{-1} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c + \omega_a)\,t + \theta_a\right] \quad (6)$$

$$+ 1\,2\,A_a \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c + \omega_a)\,t + \theta_a\right]$$

The first part of this expression readily reduces to:

$$1/2\,A_a \cos(\omega_a t + \theta_a) \quad (7)$$

Double Polarity Pulses

The second and third part of the expression can be shown to be similar if like numbers of opposite sign are substituted in the expressions, i.e., -1, -2, etc., in the second, and $+1$, $+2$, etc., in the third. Then the expressions become for $m = -1$ and $m = +1$:

$$1\,2\,A_a \frac{\sin\frac{\pi}{2}}{\frac{\pi}{2}} \cos\left[(\omega_c + \omega_a)\,t + \theta_a\right] \quad (8a)$$

$$\text{and } 1/2\,A_a \frac{\sin\frac{-\pi}{2}}{\frac{-\pi}{2}} \cos\left[(-\omega_c + \omega_a)\,t + \theta_a\right] \quad (8b)$$

or Eq. (8b) can be re-written:

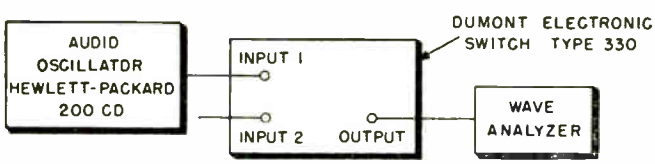
$$1/2\,A_a \frac{-\sin\frac{\pi}{2}}{\frac{\pi}{2}} \cos\left[(\omega_c - \omega_a)\,t - \theta_a\right]$$

The total expression Eq. (4) can then be re-written as:

$$M_a(t) = 1/2\,A_a \cos(\omega_a t + \theta_a) + 1\,2\,A_a \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c \pm \omega_a)\,t \pm \theta_a\right] \quad (9)$$

The above expression is for a double polarity amplitude modulated pulse. This produces a suppressed carrier type of modulation, in that the expression accounts for only the upper and lower sidebands.

Fig. 7: System used to experimentally generate signal in Fig. 3.



Spectrum Analysis *(Continued)*

Single Polarity Pulses

Single polarity pulses can be formed by adding UK, Fig. 3, where K is some factor, to the pulse train of Fig. 2. With this addition, Eq. (9) then becomes:

$$M_a(t) = 1/2\,A_a \cos(\omega_a t + \theta_a) \quad (10)$$

$$+ 1/2\,A_a \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c \pm \omega_a) \pm \theta_a\right]$$

$$+ 1/2\,K \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos m\,\omega_c t.$$

This is the expression for a wave consisting of: (1) an audio frequency f_a; (2) a carrier frequency at f_c, with upper and lower sidebands of f_a; and (3) odd multiples of f_c with upper and lower sidebands of f_a. Fig. 6 is a plot of the measurements. The audio frequency f_a was 6 KC, the switching rate fundamental frequency f_c was 30 KC.

The above signal was generated experimentally by the system shown in Fig. 7. A spectrum analysis of the ouput signal was measured using a General Radio Wave Analyzer, Type 736A and a Sierra Wave Analyzer, Model 121A.

The second channel f_b audio function is expressed

$$V(t) = A_b \cos(\omega_b t + \theta_b) \quad (11)$$

The audio function is operated on by the same sampling function as channel A, but with $t_o = t_p$ at start, that is, the sampling function starts one pulse width, t_p, after the start of the sampling function in A. This function is expressed by

$$U_b = K \sum_{m=-\infty}^{\infty} \frac{\sin mk\pi}{mk\pi} \cos(m\omega_c + m\pi)t \quad (12)$$

for $k = 1, 2$

$$U = 1, 2 \sum_{m=-\infty}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos(m\omega_c + m\pi)t \quad (13)$$

Following the same procedure as in Channel A the total wave expression reduces to

$$M_b(t) = 1/2\,A_b \cos(\omega_b t + \theta_b) \quad (14)$$

$$- 1/2\,A_b \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c \pm \omega_b)t \pm \theta_b\right]$$

Where m is odd, even values of m reduce the expression to zero. The minus sign is brought about due to the $m\pi$ expression in the cosine function. This wave is shown in Fig. 4.

By adding Eq. (14) to the expression for channel A, Eq. (10), we arrive at the total wave shown in Fig. 5.

$$M(t) = 1\ 2\,A_a \cos(\omega_a t + \theta_a) + 1\ 2\,A_b \cos(\omega_b t + \theta_b) \quad (15)$$

$$+ 1\ 2\,A_a \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c \pm \omega_a)t \pm \theta_a\right]$$

$$- 1\ 2\,A_b \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos\left[(m\omega_c \pm \omega_b)t \pm \theta_b\right]$$

$$+ 1\ 2\,K \sum_{m=1}^{\infty} \frac{\sin\frac{m\pi}{2}}{\frac{m\pi}{2}} \cos m\,\omega_c t$$

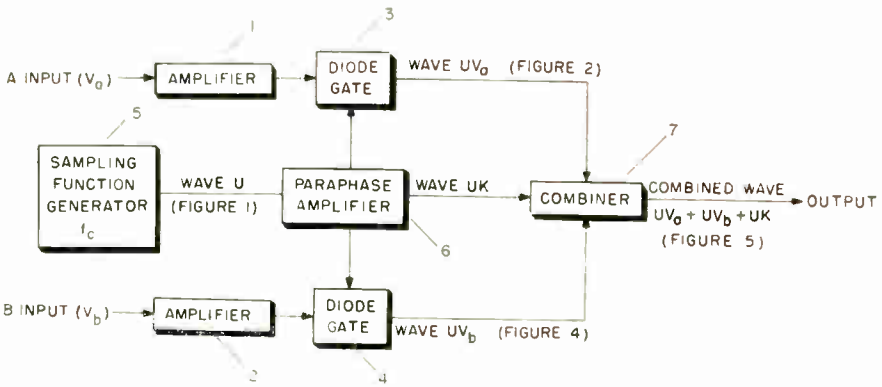
m is odd.

The expression thus represents an audio message $(A+B)$ and the upper and lower sidebands of $(A-B)$ about a carrier frequency of f_c and all odd harmonics of f_c.

Transmission System

Equipment for generating the time division stereo wave is shown in Fig. 8. The two audio input waves, V_a and V_b, are fed into identical Amplifiers, 1 and 2, and thence to Diode Gates, 3 and 4. The sampling function, wave U, is generated by a Square Wave Generator, 5, and fed to a Paraphase Am-

Fig. 8: System used to generate the time division stereo wave shown in Fig. 5. Operation is described in text under the subhead "Transmission System."



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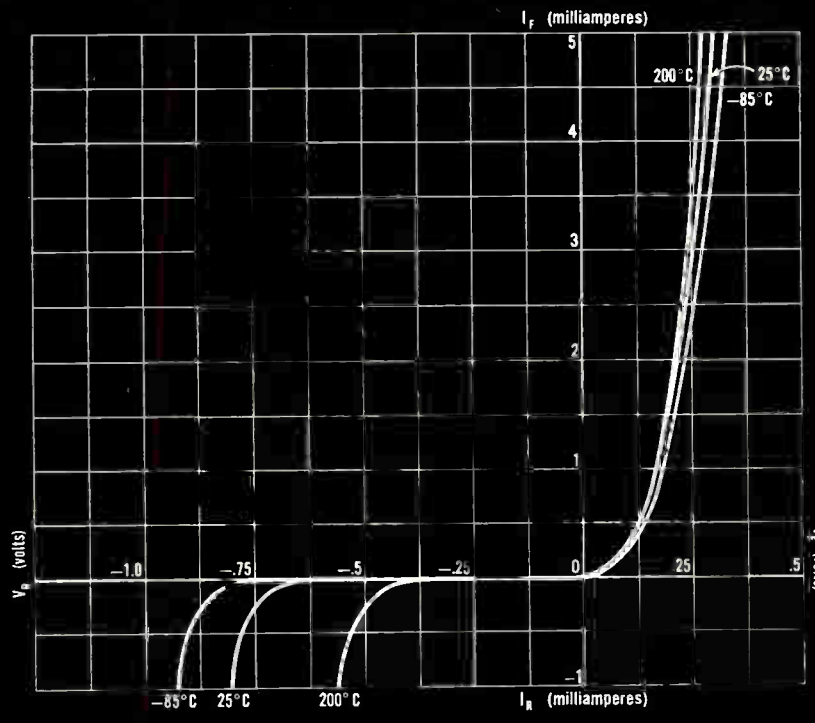
TO-18 Case

For unprecedented efficiency at low signal levels plus extreme temperature stability...

HOFFMAN NOW OFFERS YOU SILICON UNI-TUNNEL* DIODES



TYPICAL UNI-TUNNEL DIODE CHARACTERISTICS

These unique devices, sometimes referred to as "backward" diodes, utilize the tunneling effect to achieve high forward conductance at very low voltage levels. When they are biased in the reverse direction, the familiar tunnel diode current characteristic appears as a leakage current measurable in microamperes.

TYPICAL APPLICATIONS

Ability of the Uni-Tunnel diode to operate efficiently at low voltage levels eliminates the complex circuitry previously required for low-level operations, resulting in lower cost, greater reliability and decreased space requirements (see modulator circuit at left). Benefits like these also make Hoffman Uni-Tunnel diodes ideal in:

- computer logic
- detectors
- choppers
- clampers
- tunnel diode circuitry

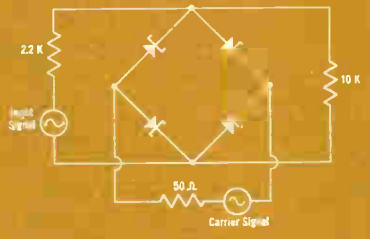
SPECIFICATIONS

Twelve types available with minimum forward currents as high as 10 mA (at .25V) and maximum reverse currents as low as 5.0 μA (at 0 to 0.5V). Operating and storage temperature range is −85°C to +200°C.

STANDARD AND CUSTOM-ENGINEERED UNITS AVAILABLE IMMEDIATELY IN QUANTITY

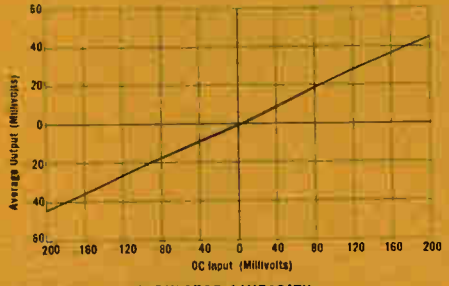
Contact factory, El Monte, California, or your local Hoffman sales office for further information. Ask for Technical Data Sheet 131-760 UTD.

HOW HOFFMAN UNI-TUNNEL DIODES SIMPLIFY AND IMPROVE MODULATOR CIRCUITRY DESIGN

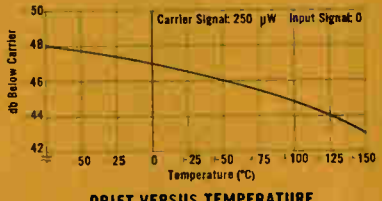


BRIDGE MODULATOR CIRCUIT UTILIZING FOUR HOFFMAN UNI-TUNNEL DIODES

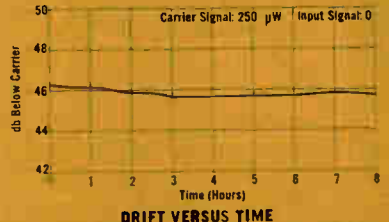
These Graphs Illustrate Typical Operating Characteristics of the Modulator Circuit Above



MODULATOR LINEARITY
Average Output Voltage Versus DC Input Voltage



DRIFT VERSUS TEMPERATURE
Change of Output Power (db) Versus Temperature



DRIFT VERSUS TIME
Change of Output Power (db) Versus Time (25°C)

Write for details in Hoffman Application Notes - Volume II, Number 1

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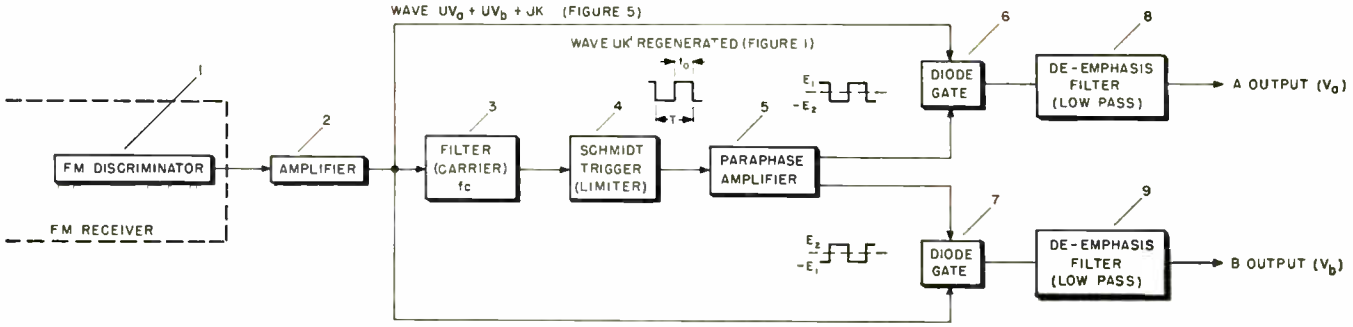


Fig. 9: This receiver uses identical waves of reverse polarity to operate diode gates. Thus, the gates permit only their respective signals to pass.

plifier, 6, which develops two gating waves of opposite polarity to alternately gate the diodes on and off at the repetition rate $1/T$.

This rate is chosen to be at a fundamental frequency, f_c, above the audible range. For minimum amplitude distortion on each channel, the sampling rate should be twice the highest audio frequency to be transmitted. The output of Diode Gate, 3, will be the wave $U\,V_a$ in Fig. 2. The output of Diode Gate, 4, will be the wave $U\,V_b$ in Fig. 4

The two waves, $U\,V_a$ and $U\,V_b$, are combined with the sampling wave UK in Combiner, 7, and fed to the FM transmitter. The output is the combined wave $U\,V_a + U\,V_b + UK$ in Fig. 5. This wave occupies an audio band from the lowest transmitted audio frequency up to at least five times the fundamental sampling frequency, or 5 f_c, plus the highest transmitted audio frequency. However, as will be shown later, the spectrum can be limited to the fundamental frequency plus the highest audio frequency without affecting the transmission.

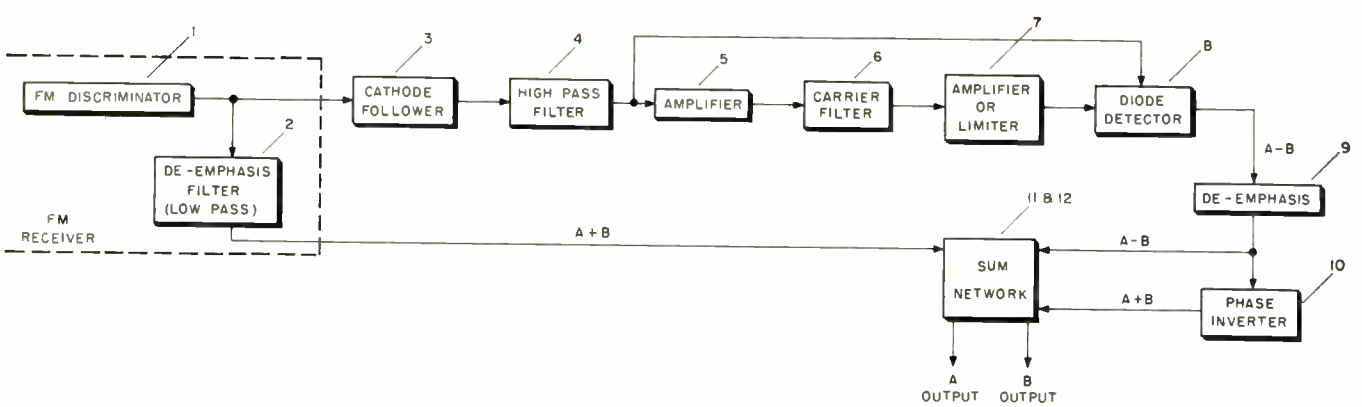
Receiving System

A block diagram of the means for receiving the time division stereo wave is shown in Fig. 9. The recovered audio spectrum of Fig. 5 is obtained at the output of the Discriminator of the standard FM receiver, 1. This wave is amplified by Amplifier, 2, fed to two Diode Gates, 6 and 7, and a Narrow-Band Filter, 3. The latter passes only the fundamental frequency, f_c, of the sampling function, wave U. The selected fundamental frequency f_c operates a Schmitt Trigger circuit, 4, (Limiter) to produce a square wave identical to the original sampling function. But, exalted (amplified) by a factor K', the wave's peak amplitude is much larger than the peak amplitude of the combined input wave.

This wave UK' is fed through a Paraphase Amplifier, 5, to produce two identical waves, but with reverse polarity, Fig. 9. The wave is then fed to Diode Gates, 6 and 7, and alternately turns each on and off to allow only the V_a wave to pass through Gate 6 and De-Emphasis Filter 8. In a like manner, it allows only the V_b wave to pass through Gate 7 and de-Emphasis Filter 9.

The actual electrical mechanism which takes place in the separation of the signals is one of exalted carrier amplitude modulation detection and simple audio addition. Referring to the section on Spectrum Analysis, we see that the transmitted wave consisted of a spectrum of: (1) a sum $(A+B)$ of the two audio signals; (2) a high frequency signal, (f_c, the fundamental frequency of the sampling rate) which is amplitude modulated by a difference $(A-B)$ of the two audio signals; and (3) odd harmonics of f_c with sidebands $(A-B)$ of the audio signals. The receiver block diagram in Fig. 9 now represents an exalted carrier AM receiving system. The carrier frequency f_c is selected and amplified (exalted) to be many times stronger than the $A-B$ sidebands. The detection process takes place in the Diode, 6, where the exalted carrier from the Paraphase Amplifier, 5, is reintroduced with the $A-B$ sidebands. At this same time, the $A+B$ audio signals are passed

Fig. 10: Another form of the exalted carrier reception method. Operating details are described in the text.



through the Diode, 6, and are added to the detected $A-B$ audio to produce $(A+B) + (A-B)$ or $2A$.

In a like manner, Diode 7, receives an exalted carrier reversed in phase 180° from the Paraphase Amplifier, 5, which is mixed with the $A-B$ sidebands. This results in an audio signal of $(-A+B)$ which when added with the $A+B$ audio signal producing $(A+B) + (-A+B)$ or $2B$. Thus the separation is completed.

Alternate Receiver

A second form of the exalted carrier reception method is shown in Fig. 10. The detected stereo signal at the FM Discriminator, 1, is fed through a Cathode Follower, 3, to a High-Pass Filter, 4. This filter passes all the upper frequencies which contain the fundamental sampling frequency f_c and the upper and lower $(A-B)$ sidebands. The signal is amplified by amplifier, 5, passed through a narrow Carrier Filter, 6, which passes only the fundamental frequency f_c. This is exalted (amplified) by Amplifier, 7, and mixed with the $A-B$ sidebands in Diode Detector, 8. The detected $A-B$ signal is then fed through a De-Emphasis Circuit, 9, and to a Paraphase Amplifier, 10. The two audio output signals $(A-B)$ and $(-A+B)$ from Amplifier, 10, are fed to Summation Circuits, 11 and 12, where the $(A+B)$ audio, recovered through the Low-Pass Filter (De-Emphasis Circuit), 2, is added to result in $(A-B) + (A+B)$ or $2A$ and $(-A+B)+(A+B)$ or $2B$.

Study Re-entry Problems

Raytheon Co., Waltham 54, Mass., is studying how to bring space men and their vehicles in for safe landings. Working for the Air Force's Research and Development Command, they will study and plan instrumentation for a Recovery Control Center to be established at the Air Force Flight Test Center, Edwards Air Force Base, Calif.

Right now the facility is working on the X-15 manned space flight program. Recovery of such vehicles as Dyna-Soar is scheduled for control from the center flight, and medical specialists expect to make reentering the earth's atmosphere as safe and as normal as landing at major air terminals.

Delay Lines

(Continued from page 117)

acoustic wavelength of the signal that is put into the line.

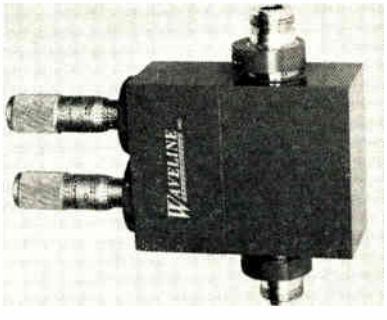
Continuous variation of time delay is achieved by adjusting the slit position vertically. Fixed tapped delay lines can be designed to use light-conducting tubes, positioned at various delay times, which feed to a single photocell.

Variability and multiple tapping are not the only advantages gained by use of the photoelastic technique. Exceptional second time signal suppression is achieved by use of absorbing terminations and third time signals are non-detectable. It should be noted that tapping in no way attenuates the acoustic signal.

Photoelastic lines having delays up to 150 microseconds have been built and operated successfully at frequencies up to 30 MC by the Electronic Components Department of Corning Glass Works. Higher frequencies and longer delay times are feasible under certain circumstances. Development work is continuing.

COAXIAL FILTER

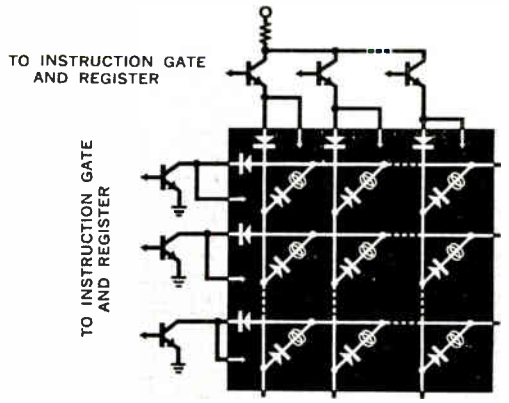
Two section coaxial filter for operation from 3.5 to 4.0 KMC is individually tuned by micrometer drive to provide a 3 db bandwidth of 14 MC nom. Unit has input VSWR of 1.25 max. and an insertion loss of 1.3 db max. Rejection at $F_o \pm 30$ MC is 22 db min.



It is intended for lab use but can be modified for military missile applications. Unit can be furnished with either Type N or TNC fittings. Waveline, Inc., Caldwell, N. J.

Circle 286 on Inquiry Card

NEW



Typical n-junction matrix for n-stage matrix configuration. Fairchild 2N1613 transistors and FD200 diodes, used throughout, guarantee acceptable leakage, switching speed and conductance values up to 125°C.

ANSWER

TO COMPUTER MATRIX PROBLEMS

LOW LEAKAGE TRANSISTORS AND FAST RECOVERY, LOW CAPACITANCE DIODES FROM FAIRCHILD

Approach to the ideal matrix. 2N1613 silicon transistors and FD200 silicon diodes from Fairchild are unique in making feasible the ideal matrix. They give you low leakage and low capacitance with high conductance and high speed, even at high ambient temperatures. These characteristics are combined only in Fairchild Planar devices. With them you can now largely ignore stray leakage or capacitance build-up across the matrix. Temperature effects and long-term performance decay are no longer critical. You can eliminate complex circuitry previously necessary in designing around these losses.

Fairchild's Planar structure for transistors and diodes features the industry's most advanced diffusion and surface passivation techniques. Current leakage is reduced to 10 mμA maximum (2N1613) and 0.1μA maximum (FD200) at 25°C. Maximum values at 150°C are 10μA and 100μA.

Surface passivation also prevents significant degeneration of parameters during circuit life which could introduce error or failure in the matrix. This technique also lends itself to precisely controlled manufacture, assuring excellent product uniformity.

2N1613 ELECTRICAL CHARACTERISTICS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
h_{FE}	D.C. Current Gain	40		120	I_C = 150 mA V_{CE} = 10V
$V_{BE(sat)}$	Base Saturation Voltage			1.3V	I_C = 150 mA I_B = 15 mA
$V_{CE(sat)}$	Collector Saturation Voltage			1.5V	I_C = 150 mA I_B = 15 mA
C_{ob}	Collector Capacitance		18	25μμf	I_E = 0 V_{CB} = 10V
I_{CBO}	Collector Cutoff Current		0.8mμ A 1.0μ A	10mμ A 10μ A	V_{CB}=60 T = 25°C V_{CB}=60 T = 150°C

FD200 ELECTRICAL SPECIFICATIONS (25°C except as noted)

Symbol	Characteristic	Min.	Typical	Max.	Test Conditions
V_F	Forward Voltage			1.0V	I_F = 100 mA
I_R	Reverse Current			0.1μA	V_R = −150V
I_R	Reverse Current (150°C)			100μA	V_R = −150V I_R = 100μA
B_V	Breakdown Voltage	200 V			
t_{rr}	Reverse Recovery Time			50.0 mμ sec	I_f = 30 mA R_L = 150Ω I_r = 30 mA
C_o	Capacitance			5.0μμf	V_R = 0V f = 1 mc
RE	Rectification Efficiency	35%			100 mc
	Forward Voltage Temperature Coefficient		−1.8 mV/oC		

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TOWER TIPS

TOWER ACCEPTANCE—Inspection

Most towers are very simple structures physically. Assuming that the tower was designed by a competent engineer to EIA standards and that the number and size of members called for by the manufacturer are adequate, the job of checking should not be too complicated.

The following is a suggested checkoff list:

1. Has the site been cleaned of all debris, paint cans, reels, and miscellaneous erection junk?
2. Is the tower plumb?
3. Is the tower painted properly—international orange and white—per construction permit?
4. Are the bolts pulled up tight?
5. Are all the nuts secured and locked as called for by the manufacturer?
6. Are the turnbuckles safety-wired to prevent back turning?
7. Is the service entrance cable or conduit attached securely?
8. Check anchor distances against tower drawing.
9. Were holes for the foundations dug deep enough as per drawing?
10. Are the anchor holes backfilled? If not, the first rain will make a sizable depression over the anchor.
11. Is the coaxial system tight?
12. Does the lighting system work?
13. Are all the junction boxes secured with watertight gaskets in them?
14. Look at the face of the tower. Is there any appreciable twist on one face?
15. On large towers, check the guy tensions by the method given to you by the manufacturer.
16. Look at all the members from the ground. Are any of them visibly damaged or bent during the course of construction?
17. Did the erector leave any unpaid bills around town that you know of?

Three chronic complaints about erectors are:

1. Shorting in the lighting system.
2. Sloppy paint job.
3. Leaks and dents in the coaxial system.

(Reprinted from NAB Engineering Handbook)

Walter L. Guzewicz

CUES

for Broadcasters

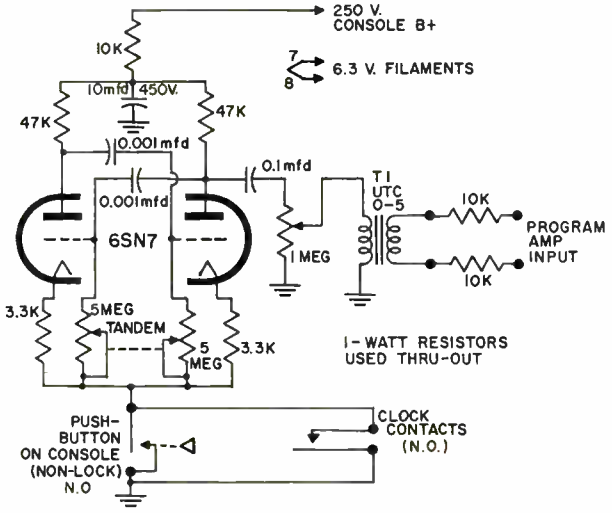
Automatic Time Tone

FREDDIE J. HEBERT, Ch. Eng.
KSIG, Crowley, La.

Here, at Radio Station KSIG, the manager, sales department, as well as the announcers on the board, wanted an accurate time signal tone burst on the air every hour, on the hour, without necessarily throwing switches, using mixers, or any other means of introducing the tone burst into the program channel, except by automatic means. Besides using the time signal each hour, it was found necessary to be able to use this tone at random, for other time signals as requested by individual sponsors.

A Multi-vibrator was built, using a 6SN7. This is used as our tone source, which can cover any audio frequency needed. Filament and plate supply is furnished by our Gates console power supply. The output of the oscillator is capacitively coupled to a one meg pot (used for level adjust), and a miniature UTC 0-5 interstage transformer, which is bridged directly across the input of the program amplifier.

The cathodes of the 6SN7 are grounded through a momentary push button, located in a convenient place on the console. A pair of wires are connected in parallel with this push-button, and our Western Union clock. This clock has a built-in set of normally-opened contacts used to flash a red light each time the clock



Time tone signal can be actuated automatically by studio clock.

resets itself on the hour. This light was disconnected from these contacts.

Now, each time the clock resets on the hour, the clock contacts are closed, which completes the ground circuit of the Multi-vibrator cathodes. This, in turn, introduces a 1000-cycle tone burst into the program amplifier at about 75 per cent modulation (more, if desired). A tone burst is also aired any time, by simply pressing the button on the board. This simple unit has been installed over a year ago, and not one case of trouble has developed . . . besides, it's a very handy gadget to use.

Some "Tips"

DONALD M. WHEATLEY, Ch. Eng.
WJOY, Burlington, Vt.

I am enclosing a few tips which might be of interest to other broadcasters.

Anyone having tried to change the filament rheostat on the Gates "Hi-Watter" transmitter alone will realize that the sloping panel makes it hard to do. A third hand can easily be made from a long TV antenna stand-off insulator of the kind that has the machine screw end. Push out the insulator which leaves a good finger loop. Take out one of the screws from the rheostat mount and insert the tool in its place. Take out the other screw and with the tool lower the

(*Continued on page* 238)

(*Continued from page 237*)

rheostat to where it can be worked on. When putting in the new control wire it up and then put in the tool from the front, draw into place, insert a regular mounting screw and tighten. The tool can then be removed and the other screw can be put in place.

A simple tool for holding nuts, washers and other small parts in cramped quarters can be made from a long TV stand-off insulator. Push out the insulation from the ring and on the other end fasten an alligator clip. It takes but a moment to make and is a great time saver.

Many times it is necessary to mark tubes with installation date, right or left in circuit etc. A red china marking pencil used when the tube is hot works very well and does not rub off as easily as when used on a cold tube.

In case any readers tap pilot bulbs that are out in hopes that they may relight, I would like to make this comment. DON'T. I learned my lesson the hard way after tapping the filament indicator on my transmitter. These lamps were 220-volt lamps in the primary. When I tapped one I blew us off the air—that is—the bulb exploded with a loud report (of course the control room mike switch would be open at that moment!). It took out the main fuses in the transmitter as well as spreading glass all around. It even ripped open the brass screw bases of the lamp.

Recorder Wheel Cleaning

SAM BEATTY, Ch. Eng.
KALM, Thayer, Mo.

The following suggestion is for Magnecorders, and probably will apply equally well to other makes.

To remove oil from the rubber idler wheels and shafts, wash with denatured alcohol. Carbon tet will work fine, except it tends to dissolve the rubber and causes a hard glaze to form, and the trouble shows up again in a week or two.

If the rubber surface is glazed, sand lightly with a medium grit paper (not common sand paper, as it will probably lose abrasive in the recorder) while recorder is running. Then wash thoroughly with the denatured alcohol. This will remove all traces of oil and will leave the rubber surface with a live feeling. One magnecord at KALM, treated with this method, is still working perfectly after more than a month of use.

▸ Five hundred mobile, single sideband "desk-top radio stations," weight 60 lbs. complete, with a several thousand mile range, are being built by Dynamics Corp. of America for use in worldwide Air Force communications network, MARS. They will provide link up of posts and provide secondary Air Force communications net in case of emergency.

▸ **The nation's first data communications networks for transmitting business, scientific, military, and industrial information over telephone lines at the highest speeds ever achieved with commercial-type equipment have gone into operation. Using either a Collins Radio Co. magnetic tape or punched card transmission system, the speed is 300 characters per second, equivalent to 3000 words per minute—double the rate of any other commercially available equipment.**

FIRST CHOICE FOR RELIABILITY

Designers of complex military and industrial equipment fully appreciate the need for extremely reliable components. For over a decade, UTC has been devoting constantly increasing manpower and dollars in the search for increased transformer and filter dependability. Investigation and analysis have been related to the life testing of large numbers of units to failure, plus thousands of wire-insulation-impregnant-potting and encapsulating systems. This program has resulted in proven materials, methods of structure and full quality controls which assure in UTC units an overall degree of reliability unequaled in our industry.

RELIABILITY UNDER ADVERSE ENVIRONMENT

As a leader in the production of extremely miniaturized components, UTC is a natural source for missile applications. Add to this the need for top reliability under adverse environmental conditions, and one can see why UTC units have been chosen for almost every missile from the Sidewinder to the Jupiter to the Atlas; our satellites, and project Mercury.

Special Units to Your Specifications

or 1000 Stock Items . . . with UTC High Reliability

General Catalog G Filter Catalog F

RELIABILITY TO DESTROY

A vital factor in second generation missiles is the sure ability to destroy the missile should something go wrong. UTC high reliability transformers were first choice for Ramo-Wooldridge in the design and production of their 4 pound AN/DRW-11 "command destruct" receiver which provides UHF FM signals to three command channels.

RELIABILITY TO NAVIGATE . . . CONTROL . . . COMMUNICATE

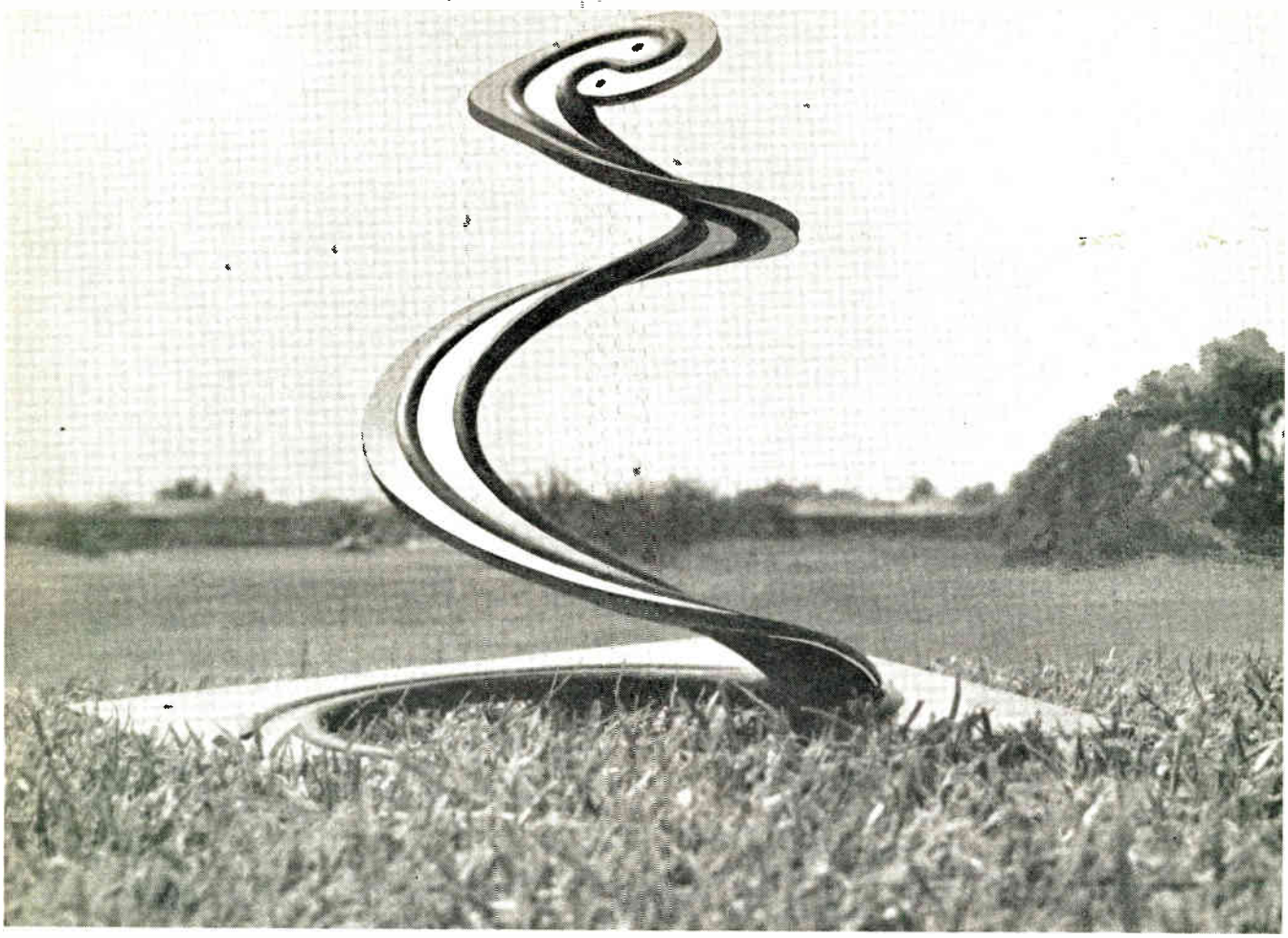
Manufacturers providing principal electronic gear for the B-58 chose UTC for optimum miniaturization with maximum reliability under adverse environment. In general aircraft use UTC high reliability units are found in virtually all applications such as Tacan, omnirange, intercommunication equipment, and fire control. The high inherent quality level of UTC airborne components is illustrated by over 19,000 units being shipped to one customer . . . then fully tested . . . with zero rejects.

UNITED TRANSFORMER CORP.

150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

Circle 169 on Inquiry Card



ARCHIMEDES SETTLES ON FARM IN KANSAS

Well, it's not exactly Archimedes himself, in person . . . but he's actively represented by one of his best ideas. And it isn't the kind of Kansas farm that grows wheat or milo . . . actually we grow *antennas*.

The Boeing/Wichita "antenna farm" turns out a very valuable crop — advanced communications systems and tools. The men responsible for this harvest, and many others at Boeing/Wichita are outstanding engineers. They are also *thinkers* . . . idea men . . . men who are quietly contributing big, new concepts to their field and to their age.

We need more just like them. If you are the kind of senior engineer who will be right at home in this dynamic company, we want to talk to you. Write in confidence to Mr. Melvin Vobach, Dept. OE9, Boeing Airplane Co., Wichita 1, Kansas.

BOEING/WICHITA

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers • Development Engineers • Administrative Engineers • Engineering Writers
Physicists • Mathematicians • Electronic Instructors • Field Engineers • Production Engineers

Need Computer Men

IBM President, Thomas J. Watson, Jr. says that the new class of computer professionals in the U. S. must be sharply increased. He cited a recent survey of 18 large industrial firms that employ about 1000 special systems people. Seven years ago only five of these firms had any systems men at all. One utility now has over 2000 people—many of them professional—working in data processing. Many more will be needed in the future.

To help solve the problem, IBM has announced a new IBM Systems Research Institute to be located on United Nations Plaza, New York City. Curriculum will include case studies in systems-design, workshops in systems planning, advanced programming, and business simulation techniques. Faculty will include senior IBM systems people and visiting lecturers from industry and leading universities. IBM Vice-Pres. John C. McPherson, will direct the Institute. Annual budget will be about $2 million.

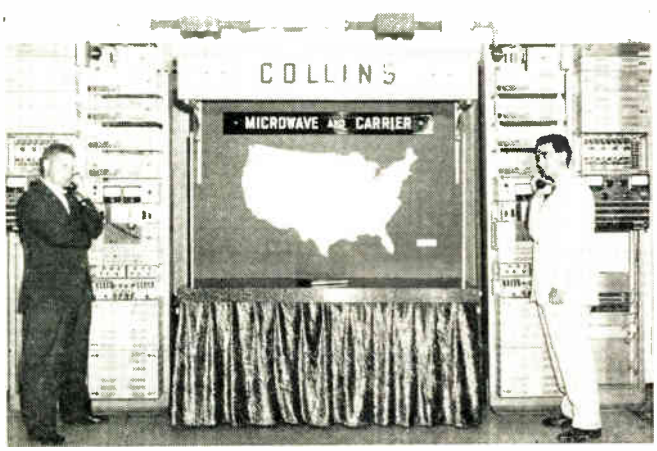
New Florida Firm

J. B. Moore Laboratories, Inc., a new firm specializing in audio devices and electronic instrumentation, has started operations in Opa-Locka, (P. O. Box 606) a suburb of Miami, Fla. John B. Moore is President. Ned S. Olney, Vice President, and P. L. Wiltfong is Secretary-Treasurer.

New A.I.E.E. Fellows

The American Institute of Electrical Engineers has elevated 19 members to the grade of Fellow.

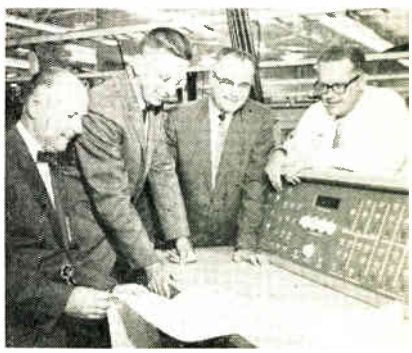
New fellows are: M. A. Baker, General Electric Co., Erie, Pa.; F. M. Clark, General Electric Co., Schenectady, N. Y.; W. J. Creamer, head of EE dept., Univ. of Maine, Orono, Me.; W. Criley, EE Prof., Vanderbilt Univ., Nashville, Tenn.; H. H. Davenport, Southwestern Bell Telephone Co., Little Rock, Ark.; H. F. Gidlund, Public Service Co. of Colorado, Denver, Co.; G. W. Heumann, General Electric Co., Schenectady, N. Y.; R. D. Jones, General Electric Co., Fort Wayne Lab., Fort Wayne, Ind.; J. H. Karr, Robbins & Myers, Inc., Springfield, Ohio; M. Lee, Burndy Corp., Norfolk, Conn.; S. B. Lent, Metropolitan Transit Authority, Boston, Mass.; M. R. Lory, Westinghouse Electric Corp., East Pittsburgh, Penna.; F. W. McCloska, Sargent & Lundy Engineers, Chicago, Ill.; H. J. Nevitt, Ericsson Telephone Sales Corp.; Rio de Janeiro, Brazil; J. W. Picking, Reliance Electric & Engineering Co., Cleveland, Ohio; I. E. Ross, General Electric Co., Fort Wayne, Inc.; C. F. Schwan, Reliance Electric & Engineering Co., Cleveland, Ohio; G. G. Somerville, General Electric Co., Pittsfield, Mass.; and C. R. Vail, Prof., Duke Univ., Durham, N. C.



MICROWAVE EXHIBIT

R. R. Reiland (L) talks to Frank Bencini through operating microwave and carrier communications equipment which Collins Radio Company, P.O.B. 1891, Dallas, Tex., will exhibit in 20 major U.S. cities.

UNIVERSITY GETS COMPUTER



Dr. T. B. Thompson, R. M. Shervem, Dr. G. D. Overman, and A. G. Newman (L to R) look over new high speed, general purpose digital computer, the GE-304, which General Electric Co. is planning to install in the Arizona State University's Computer Center.

Engineering Enrollments Still Declining. Why?

The Engineering Manpower Commission of Engineers Joint Council, 29 West 39th St., New York 18, has surveyed the causes for the decline in freshman engineering enrollment in the U. S. This is what they found:

1. Increased interest by qualified students in other fields of science, especially since "science and the space age" has been glamorized in public opinion.
2. Concern over the rigors and demands of engineering education.
3. A decrease in application from students lacking in genuine interest and motivation for engineering.

These same factors, the survey found, account for an increased attrition rate among engineering students.

On the positive side, the study revealed that the problem of accepted students not enrolling in the fall had decreased. It showed that the proportion of acceptable applicants had increased over that of

(*Continued on page* 253)

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 187.

Fig. 1: Carbon copy reproduction

How To . . .

Duplicate Technical Papers

The engineer, besides writing the technical paper, must often prepare it for publication or for duplication. To be sure of a "good job" he should know the possibilities and limitations of the different printing and duplicating processes.

By FRANCIS J. GALVIN

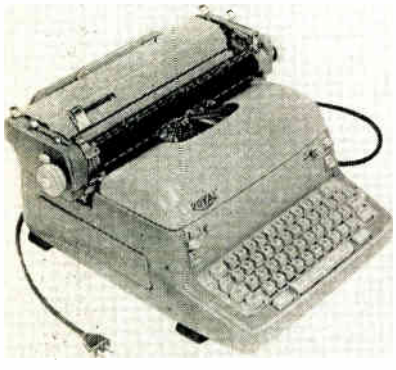
Advanced Development Staff
GPL Div., General Precision, Inc.
63 Bedford Rd.
Pleasantville, New York

THE engineer often must deliver finished material, and follow it through the process of either internal or external publication. He should know the mechanics of the operation, as his knowledge could mean the difference between "slip shod" or well presented material. This article discusses the duplication equipment at the engineer's disposal and provides a comparative cost analysis.

The Typewriter

The typewriter is the most basic and commonly used machine for duplication and a prospective user should learn the mechanical features of each type and the kind of work for which each is best suited. Features include automatic margins, key-set tabulation, interchangeable platens, half-spacing escapement, two-color ribbon, ribbon elimination in cutting stencils, type sizes and faces, carriage widths, machine finishes, attachments like those used in continuous form typing, and bearings in moving parts of the machine.

Fig. 2: The electric typewriter offers stroke-controlled operation.
Photo courtesy of Royal Electric Typewriter Co.



Carbon Copy Reproduction

The cheapest way to reproduce a maximum of six (6) copies is to use a typewriter with carbon paper (fig. 1). The number of copies which can be reproduced this way depends on the make of typewriter, the quality of carbon paper, the second sheet, the typist's touch (on mechanical typewriters) and the condition of the type face.

The Electric Typewriter

The electric typewriter (see fig. 2) offers stroke-controlled operation of the keyboard, spacing, shift, and carriage return. It is ideal for cutting stencils, and for producing multicopy work.

The operator's production is usually higher (25% more) than with ordinary machines, and fatigue is lessened.

The Automatic Typewriter

The automatic typewriter produces, in quantity, automatically typed or repetitively typed material.

It produces typed copy by using a perforated strip, similar to the perforated roll used on player-pianos. Some parts of the copy, such as the name and address, may be inserted manually. Operating speed is 100 to 120 words/min. It can also be used for manual operation.

The Vari-typer

The Vari-typer (see fig. 3) has interchangeable type, or "fonts." It is useful where a distinctive type face or font is required, such as in

c) If text or art are changed on a master, use a typewriter with a multilith ribbon for the text and a multilith pen or pencil for the art.

d) Use a non-reproducible pencil for proofreading.

e) Use a piece of tissue paper to cover the printed area after typing.

f) Never try to retype or redraw on a metal master. If necessary, alterations may be made using the negative of the metal master or by creating a new master.

Xerography

Xerography is a dry electrical copying process. Anything written, printed, typed, or drawn may be transferred onto pre-sensitized paper or metal offset plates, and then run off on an offset duplicator. Such plates do not require a photographic negative. Only a Xerox Trans-Positive Sheet which serves as an intermediate between the

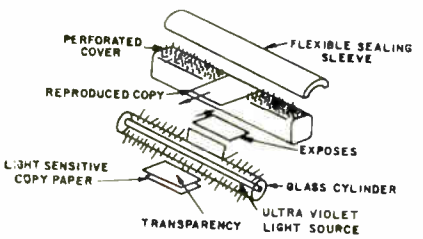


Fig. 13: The Diazo or White Print process.

original document and the completed master. Reductions to 50% and enlargements to 150% of original onto a 8½ x 13 in. Xerox plate are possible, the cost is low; reproduction rapid.

Fig. 9 shows Xerox copying equipment. Basic operation is given in fig. 10.

Stenofax

Stenofax is an electronic facsimile copying machine.

This machine prepares a coated offset paper master, or a duplicating stencil by scanning original copy and by punching tiny holes which correspond with the copy in a black stencil.

The Standard Register Co. has an electronic reproducer which can "print" an 8½ x 11 in. record from microfilm at the rate of 60 min. and copy at 0.2¢ each. A dye mist

(*Continued on page 252*)

Duplicating

(*Continued from page* 250)

is electronically deposited on ordinary paper.

Mist Printing

In mist printing, the image is magnetized upon a master which similarly magnetizes blank sheets. These sheets are run through a mist of ink, oppositely polarized. Ink mist sticks to the magnetized spots in the paper only.

Photocopy Devices

The two main types of photo copying machines used today are optical or projection and contact.

Fig. 14: Ozalid machine can make 200 copies an hour.

Projection Type

A projection copier is essentially a camera which produces a copy on photographic paper instead of film (figure 11). The Photostat machine made by the Photostat Co., is a familiar example of a projection copier. Similar machines are the Rectigraph (the Haloid Co.) and the Dexigraph (the Remington Rand Co.) Projection equipment will reproduce most types of material satisfactorily, including books and bound volumes of periodicals, and newspapers. They produce copies the same size as the original, enlarged, or reduced. For large quantities, these copies are the most economical. However, they are expensive, occupy much space, and require trained operators.

Contact Type

A contact copier is essentially a lensless photographic printer (figure 12), which holds photographic paper close to the original. A glass plate is laid over the material; a

light source shines on the paper and impresses the image whether typed or drawn. A contact copier is generally in the form of box and is often referred to as a "contact box." They reproduce copies the same size as the original. This type is relatively inexpensive, takes up little space, and requires less skill to use than the projection type.

The Diazo or White Print Process

This process, fig. 13, passes ultraviolet light through translucent paper masters to light-sensitive copy paper. The paper is passed through ammonia vapor or liquid alkali, and comes out as dry copy. One of the best known is the Ozalid process. In an hour, a small model machine, fig. 14, can make 200 copies 9 in. wide. A large model can make 1,000 copies 16 in. wide.

Cost Comparison

Table I gives a cost comparison of duplicating methods. The output speeds can vary considerably from the figures shown.

Enrollment

(*Continued from page* 241)

1958-59, and that 83% of the colleges anticipate maintaining or increasing the level of enrollment this fall.

Many Deans were critical of the job done by the Nation's high schools. Others considered the lack of maturity of many students as a "product of our times." All generally agreed that there was a need for the engineering profession to communicate the facts about engineering to young people.

Stand-in For Human Voice

The Army is using a dual purpose instrument, the Automatic Articulation Tester, as a stand-in for the Human Voice in the testing of communications equipment. It is being used to test equipment which must deliver messages sharply and clearly through noise, natural radio interference, and enemy jamming efforts. It also measures the effectiveness of devices and tactics for jamming an enemy's radio channels.

The instrument was developed by Auerback Electronics Corp., Narberth. Penn.

Give your Products

MORE RELIABILITY and BETTER PERFORMANCE with

FREED QUALITY

In stock for immediate delivery

CONSTANT VOLTAGE TRANSFORMERS.

Meets Military Specifications
No Tubes
No Moving Parts
Accurate Regulations
Fast Response
Fully Automatic

MIL Type

Commercial Type

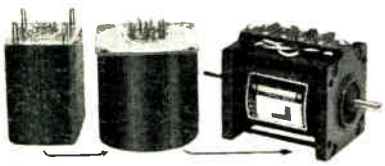
Here at last is a hermetically sealed magnetic voltage regulator that will provide constant output voltage regardless of line and/or load changes.

SUPPLIED EITHER MIL. OR COMMERCIAL				
CAT. #	INPUT VOLT.	LINE FREQ.	OUTPUT VOLT.	OUTPUT VA.
MCV- 620L	95-130 v	60 cps.	115	20
MCV- 670L	95-130 v	60 cps.	115	70
MCV-6130L	95-130 v	60 cps.	115	130
MCV- 670F	95-130 v	60 cps.	6.4	70
MCV-6130F	95-130 v	60 cps.	6.4	130
MCV- 420F	95-130 v	400 cps.	6.4	20

MAGNETIC AMPLIFIERS

- Hermetically Sealed To MIL Specifications
- No Tubes
- Direct Operation from Line Voltage
- Fast Response
- Long Life Trouble Free Operation
- Phase Reversible Output

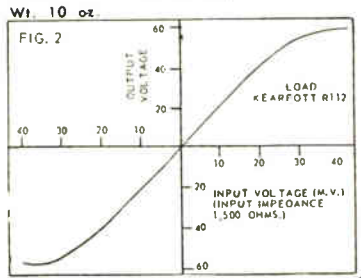
Power Gain 2×10^8



Transistor Preamp. MAT-1 Wt. 10 oz.

Mag. Amp. MAF-5 Wt. 18 oz.

Motor



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WRITE FOR FURTHER INFORMATION ON THESE UNITS OR SPECIAL DESIGNS

Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.

1726 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.

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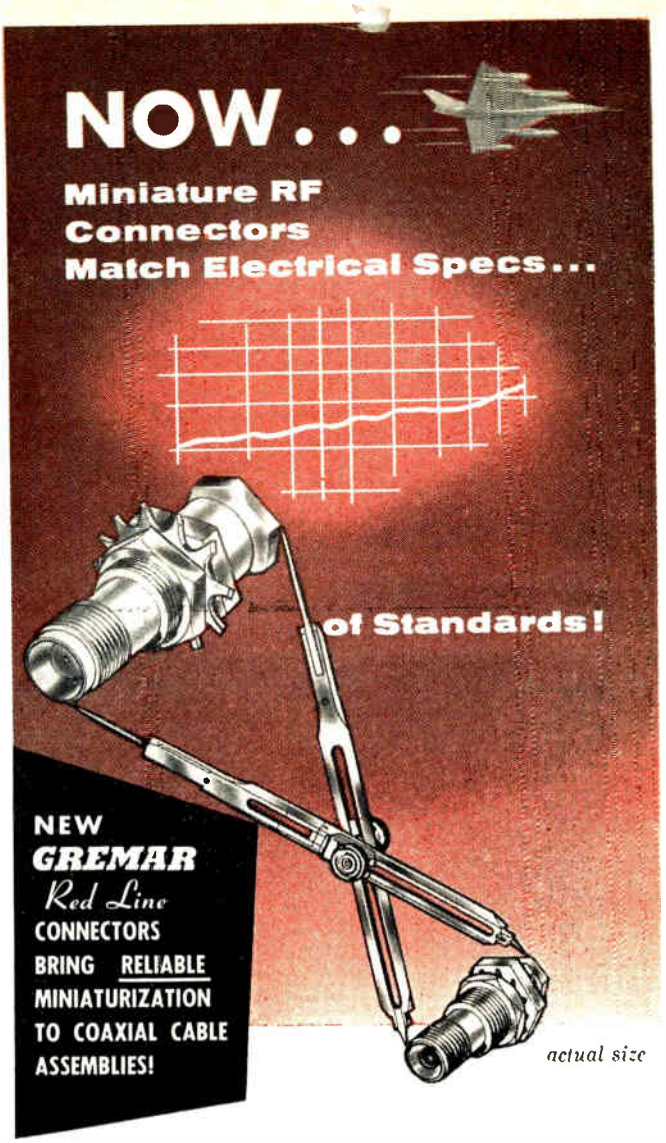


REPLACE STANDARDS WITH MINIATURES! Now, because of GREMAR CONNECTRONICS (T), it is possible to miniaturize your RF cable assemblies and still maintain rigid electrical specs.

Red Line Miniatures, identified by their red Teflon insulation, are half the size and weight of the reliability-proved GREMAR TNC Connectors.

DESIGNED FOR USE WITH MIL-TYPE SUBMINIATURE COAXIAL CABLES, Red Line Miniature Connectors and adapters feature:

- A new patented metal-to-metal cable clamping method which saves up to 80% of your cable assembly time while assuring a lower, more constant VSWR.
- Nominal 50 ohm characteristic impedance, 500 volts rms peak and 10,000 megacycles practical frequency limit.
- Operating temperature range: −65F to +350F.
- Meets or exceeds all applicable requirements of MIL-STD-202A and MIL-E-5272B.
- Configurations for all typical applications including adapters to BNC and TNC connectors.
- Metal parts are heavily silver plated for maximum corrosion-resistance . . . protected with Iridite to retard tarnishing. All contacts are gold-plated.
- Standard *Red Line* adapters and connectors are stocked for *immediate* delivery.

WRITE FOR BULLETIN 9 containing complete data on Gremar *Red Line* Ⓣ Miniatures. Literature on all other RF connectors is available for the asking.

GREMAR

MANUFACTURING COMPANY, INC.

RELIABILITY THROUGH QUALITY CONTROL

Dept. E, Wakefield, Mass., CRystal 9-4580

Circle 178 on Inquiry Card

ELECTRONIC INDUSTRIES Advertisers—September 1960

This index is published as a convenience. No liability is assumed for errors or omissions.

Wins Science Award

Robert A. Rubega, a physicist in the Underwater Acoustics Section of Stromberg Carlson's Research Div. has won the Company's first annual award for Science and Technology (a plaque and $2,000). His work (classified) was in submarine detection.

C. R. MacBride (R) Exec. V.P., General Dynamics Corp., presents award to Robert A. Rubega. Looking on are (from left): J. D. McLean, Pres., Stromberg-Carlson; Dr. N. A. Finkelstein, Dir. of Res., and Dr. R. Weller, Vp-Engineering.

Want Electronic Industry

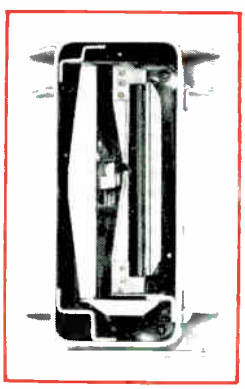
Minnesota has formed an advisory committee to encourage further development of the electronic industry in that state. Representatives from industry, business, finance, banking, and the Univ. of Minnesota will serve on the committee.

The most precise, sturdiest thermal relay ever built... best for missile applications

... from the leader in thermal relay design!

Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)
Setting Tolerance: ±5% (±¼ sec. min.)
Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)
Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.
Power Input: 4 watts. Rated for continuous energization at 125°C.
Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

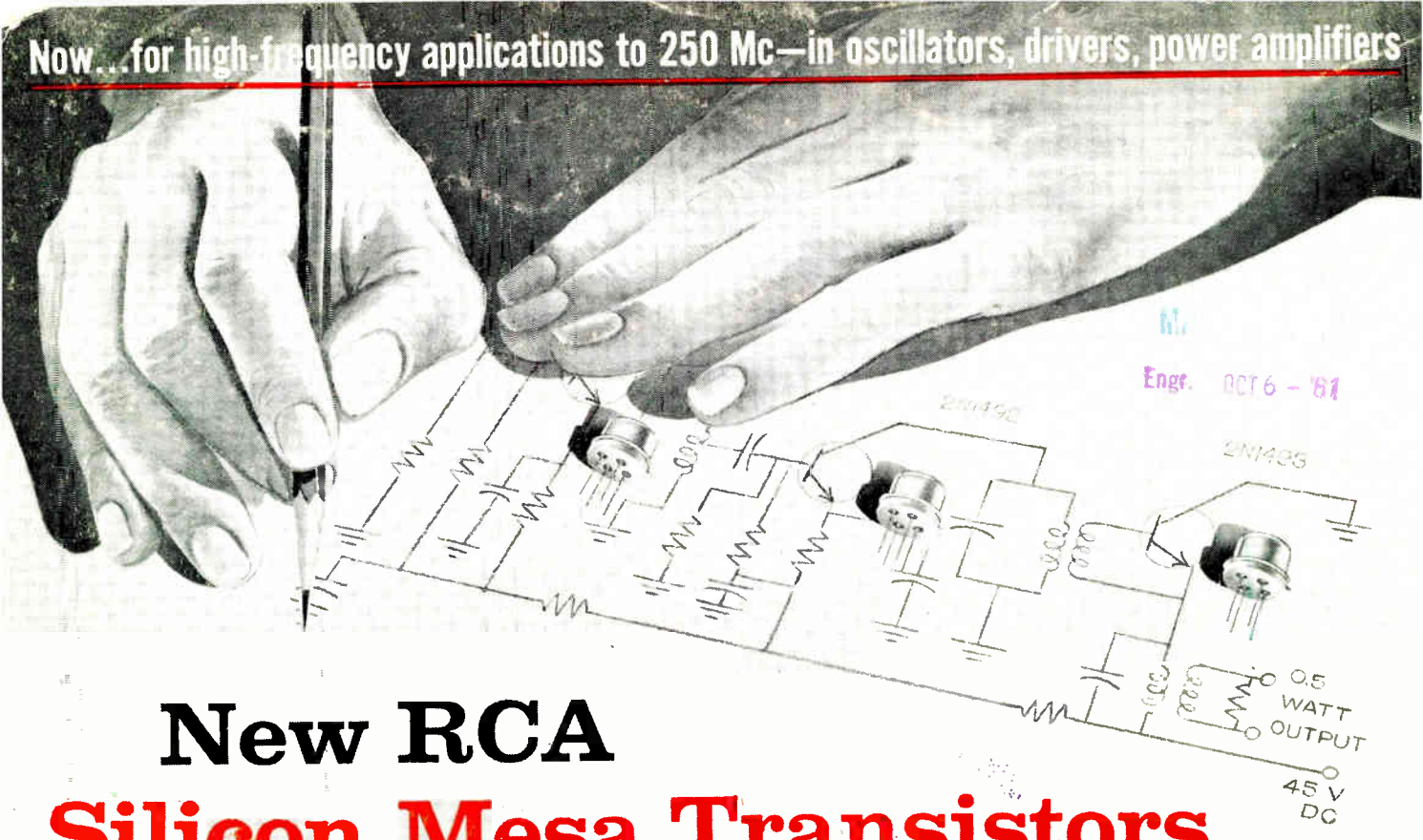
Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms
Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.
Vibration: Operating or non-operating, 20 g up to 2000 cps
Shock: Operating or non-operating, 50 g for 11 milliseconds
Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.
Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

G-V

Circle 50 on Inquiry Card



New RCA
Silicon Mesa Transistors

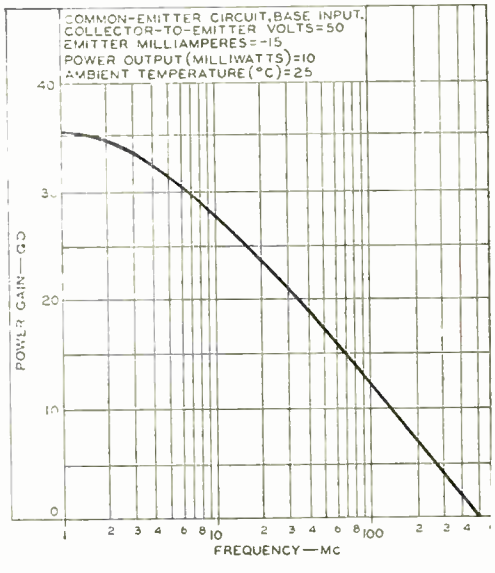
Three new RCA N-P-N high-frequency medium-power transistors, 2N1491, 2N1492 and 2N1493, designed specifically for industrial and military communications equipment in the 30-Mc to 250-Mc range

These three new RCA high-frequency silicon transistors can provide ½-watt minimum useful power output in a crystal-controlled transmitter at 70 Mc.

Each of the three new RCA types is controlled for power output and power gain to facilitate use in integrated circuit designs. For example, in a high-frequency circuit where the 2N1491 acts as an oscillator, the 2N1492 as a driver, and the 2N1493 as an rf power amplifier, each type delivers ample power to drive the following stage and provide output of 0.5 watt at 70 Mc. All three types, packaged in JEDEC TO-12 case with ½" leads, feature a dissipation rating of 1/5 watt at 100°C and a maximum junction temperature of 175°C.

RCA high-frequency silicon Mesa transistors were developed in cooperation with the U. S. Air Force, Wright Air Development Division, and initially produced in cooperation with the Air Material Command on an Industrial Preparedness Measure for Military Devices.

Call your RCA Field Representative today for details. For technical bulletins on these three types, write RCA Semiconductor and Materials Division, Commercial Engineering, Section I-50-NN, Somerville, N. J.



TYPICAL POWER GAIN—RCA 2N1492 and 2N1493

RATINGS AND CHARACTERISTICS				
Maximum Ratings, Absolute Values:	2N1491	2N1492	2N1493	
Collector-to-Base Voltage	30	60	100	max. volts
Emitter-to-Base Voltage	1	2	4.5	max. volts
Emitter Current	−50	−50	−50	max. ma
Junction Temperature	175	175	175	max. C
Characteristics at Ambient Temperature = 25 C:				
Max. Output Capacitance	5	5	5	uuf
Min. Power Gain at 70 Mc:				
with 10-milliwatt output	13	—	—	db
with 100-milliwatt output	—	13	—	db
with 500-milliwatt output	—	—	10	db

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