First Details on SAC Control System

page 36

electronics

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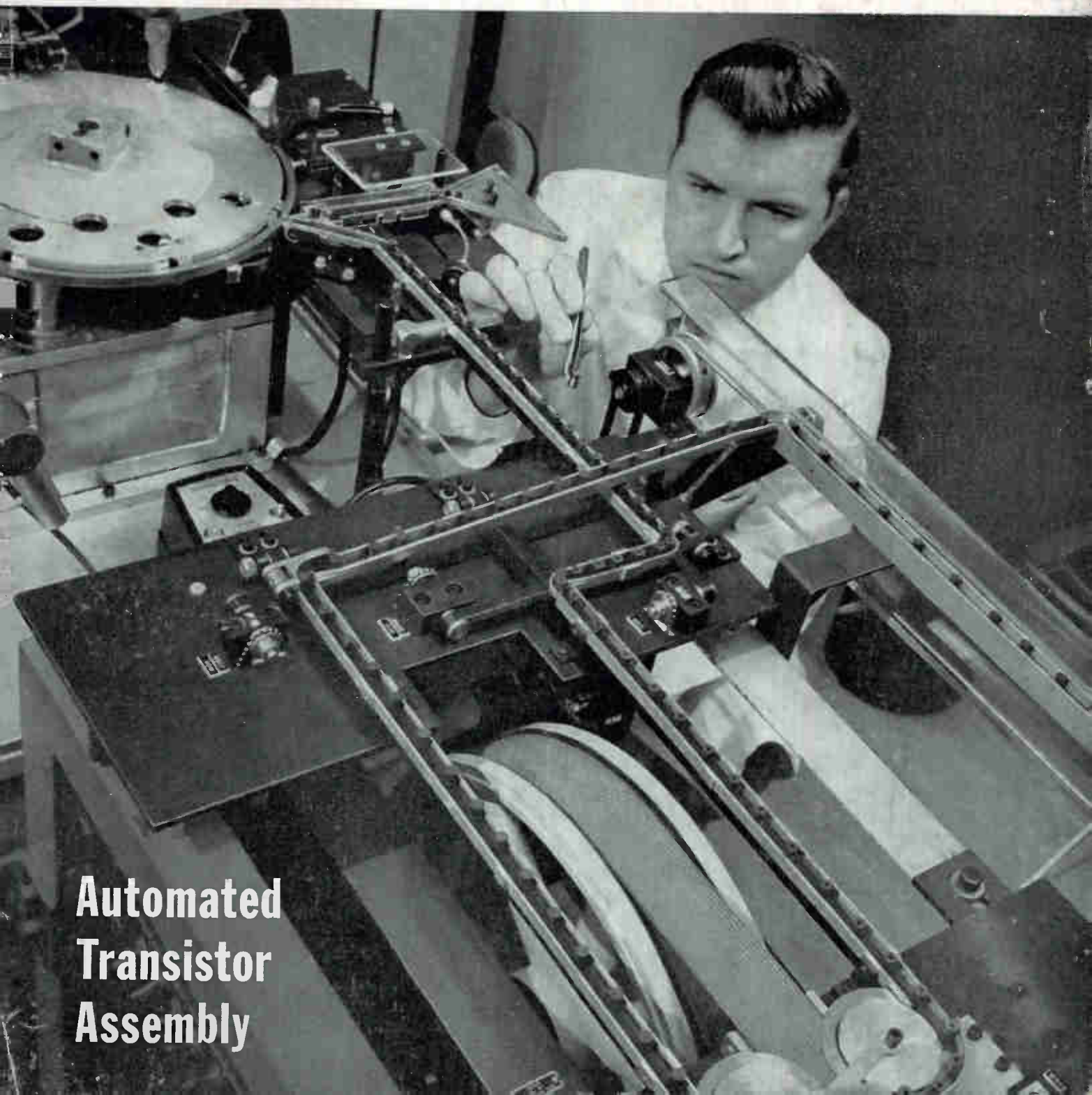
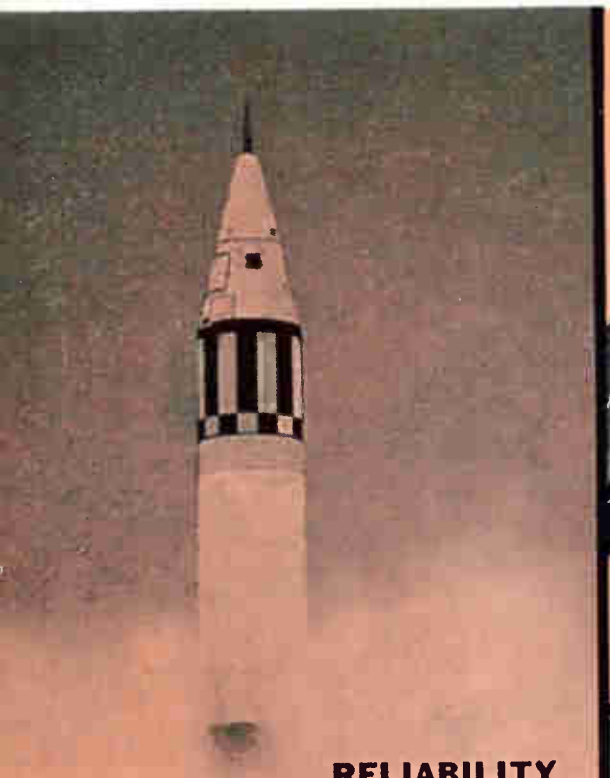


Automated Transistor Assembly

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.

General Catalog G Filter Catalog F

Special Units to Your Specifications

or 1000 Stock Items . . . with UTC High Reliability

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.

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MARCH 25, 1960

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Vol. 33 No. 13

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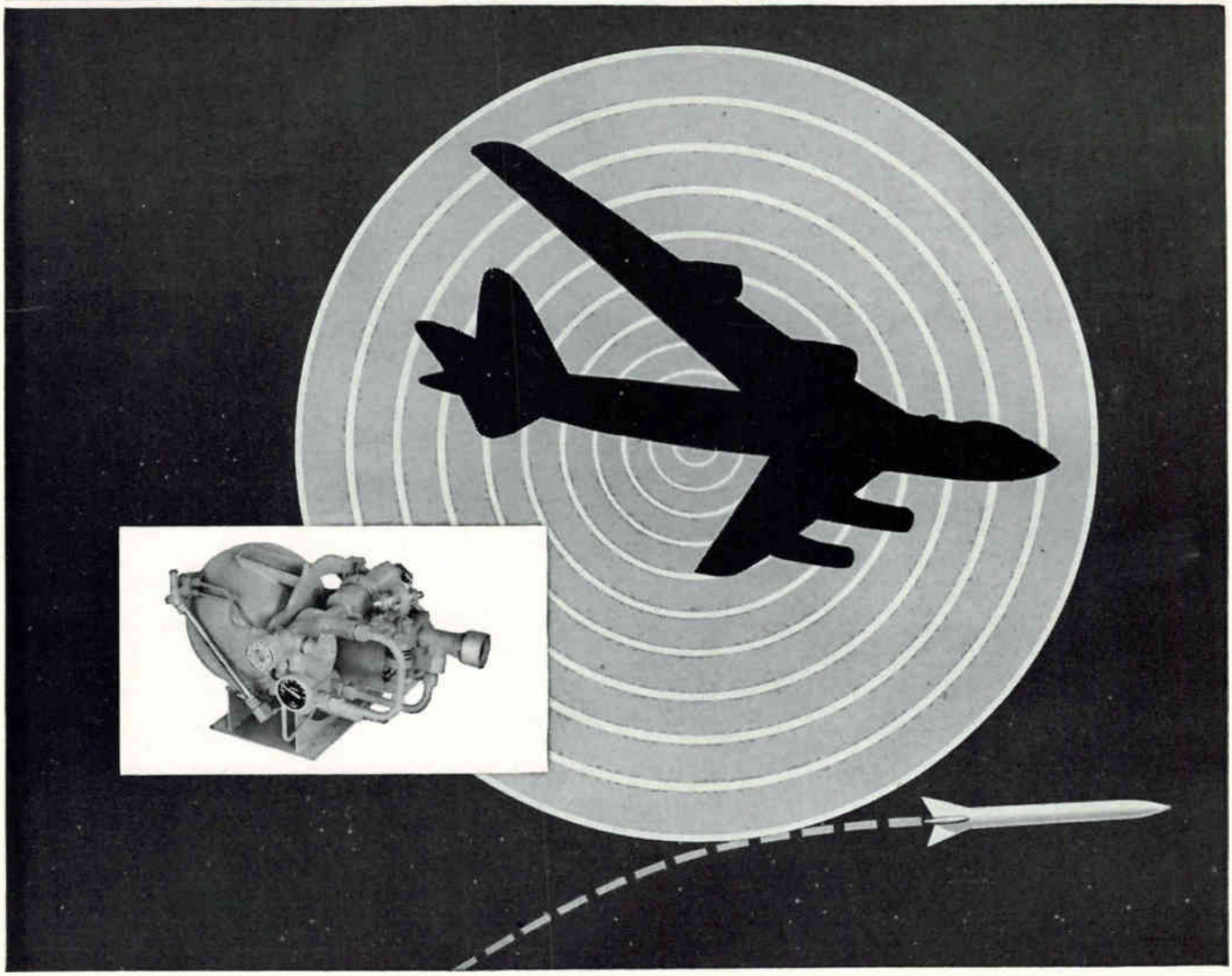

HOW TO HOLD A JAM SESSION 8 MILES UP

Vickers active cooling system (inset) uses FC-75 in countermeasures system

The increasing sophistication of electronic countermeasures systems poses many problems. Among them—how to cool vital components at the environmental and operational extremes encountered in sonic and supersonic aircraft.

For the Sperry countermeasures system, a new airborne active cooling system—capable of dissipating 47KW in a 74-lb. package—was developed by Vickers using 3M Dielectric Coolant FC-75.

This most stable of all fluids offered to electronics has high electric strength of 37KV. It is self-healing, and maintains electric strength after repeated high voltage arcing. It pours at —148°F and boils at 212°F at one atmosphere . . . ideally suited for evaporative cooling.

Compatible with most materials, FC-75 is non-corrosive, non-flammable, non-toxic, non-explosive and odorless. It is thermally stable in excess of 800°F, and will not form sludges or gums under extremely rigorous conditions. These properties make it ideal as a coolant.

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The Microminiature Kernel ATE-34 Adjustoroid® and a New Line of Miniature Encapsulated Adjustoroids

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The new microminiature Kernel ATE-34 Adjustoroid and the miniature ATE-11, ATE-0 and ATE-4 are variable over a 10% range of their inductance. Fully encapsulated, they will withstand high acceleration, shock and vibration environments. All of the above meet MIL-T specifications, 27 Grade 4 Class R and MIL-E 15305 A. Write for Stock Sheet AT-34.

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ATE-4	1 5/16"	1 3/16"	3.5 oz.	1 kc to 16 kc	6 kc	15 hys
ATE-6	1 1/16"	1"	1 1/2 oz.	10 kc to 100 kc	30 kc	.75 hys
ATE-10	1 5/16"	1 3/16"	.1 oz.	3 kc to 50 kc	20 kc	.75 hys
ATE-11	3/4"	1 3/16"	.75 oz.	2 kc to 25 kc	15 kc	5 hys
ATE-12	3/4"	1 3/16"	.75 oz.	15 kc to 150 kc	60 kc	1 hy
ATE-34	27/64"	21/32"	.1 oz.	3 kc to 30 kc	55 kc	1 hy

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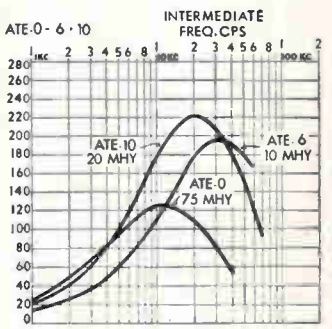

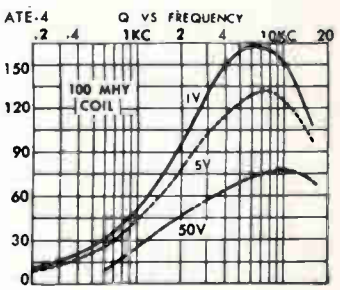

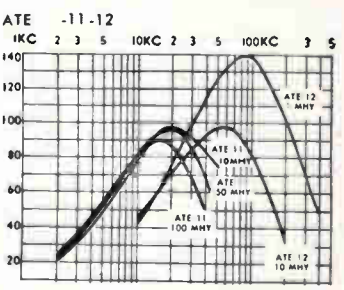

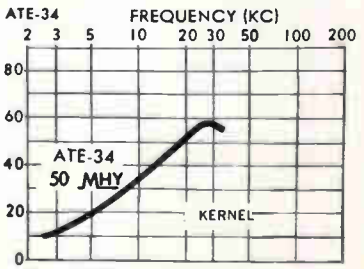

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CROSSTALK . . .

NEW COMBAT CONTROLS. Strategic Air Command's brain and nerve system that will weld the Command's 70 or more aircraft and missile bases into a single striking force is nearing a new stage of development. Prime contractor International Electric Corp. (an organization set up by ITT) is now putting together a prototype system in two new buildings in Paramus, N. J. The center, called "Little SACCS" (Strategic Air Command Control System) will be used for systems engineering and training of Air Force personnel. Associate Editor Mason visited the center and, on p 36, reports first details of the $300-million electronic system.

50 MILLION MILES. Any time now—perhaps today—Pioneer V is shifting transmitters. The U. S. satellite, launched two weeks ago today from Cape Canaveral, has been using a 5-watt transmitter to send signals record-breaking distances back to earth. Now a 150-watt unit is scheduled to come into play, and signal transmissions of hitherto undreamed of distances will become a reality. The previous distance record was 407,000 miles. That was set by Pioneer IV. And it was broken less than a week after Pioneer V soared into orbit. Now scientists say that in August this country's record-setting satellite will be communicating to earth from 50 million miles away. All told, the story is a fascinating one. Pacific Coast Editor Hood has been living with it from the start, spending hours with scientists at Space Technology Laboratories in Inglewood, Calif. His story tells about parametric amplifiers which, for the first time, are being used in the front part of two ground receivers. Hood's article is on p 49.

FOR MEN. If you speak the language of electronics engineers, think you would find it challenging to discuss possible technical articles with potential authors and also cover the industry's news, like to write occasionally yourself and are not above doing some indoor editing too . . . there may be an opportunity for you on our staff. In New York. Or Chicago. Write the Editor.

Coming In Our April 1 Issue . . .

SLED-BORNE RECEIVER. Early tests of ejection seats at Edwards Air Force Base were conducted with a rocket sled and fixed ground cameras controlled over a 460-Mc radio link. When it was decided that better results could be obtained by mounting cameras on a sled, a uhf receiver was developed that could use the existing radio link.

In our next issue, F. M. Gardner and L. R. Hawn of Interstate Electronics in Anaheim, Calif., describe the completely solid-state receiver-controller built to operate cameras on a sled. The unit separates the transmitted subcarriers and reconstitutes the camera-start and timing pulses which operate relays and flash neon lamps.

GRAPHICAL CONVOLUTION. Fourier transform and related techniques are useful in solving many engineering problems, especially those in which time-domain functions are related to their equivalent frequency-domain duties in order to obtain the frequency spectra of the time function.

Next week, R. S. Smith of Laboratory For Electronics in Boston reviews the Fourier and convolution integrals and presents an approach to the graphical solution of the convolution integral in the frequency domain. This technique, which is demonstrated for a Doppler radar carrier elimination filter, is especially useful for time functions that include a series of terms in which the computation in the time domain is tedious. The technique is also used for problems requiring an answer in the frequency domain.

new transistors from Sprague*

SUPER HIGH-SPEED SWITCHING TRANSISTORS TYPE 2N501

	Typical	Maximum	Units
Rise Time (t_r)	9	18	mμsec
Storage Time (t_s)	9	12	mμsec
Fall Time (t_f)	7	10	mμsec

In circuit with current gain of 10 and voltage turnoff.

Also available as special type 2N501A for 100° C. maximum storage and junction temperatures.

This table tells the story. Sprague Type 2N501 germanium micro-alloy diffused-base transistors are the fastest mass-produced transistors available anywhere! They are unexcelled for high-speed computer applications. The ultra-low rise, storage, and fall time cannot be matched by any other transistor.

Ultra-precise process control in manufacture results in superb and consistent high quality. The basic electrochemical process of fabrication takes the guesswork out of transistor manufacturing. The result is outstanding uniformity of product.

Because of the electrochemical process, Sprague is able to fabricate a graded-base transistor with no intrinsic base region. The Type 2N501 can thus maintain its super high-speed switching characteristics right down to its saturation voltage, providing all the advantages of direct-coupled circuitry with no impairment of switching speeds.

Type 2N501 Transistors are available from Sprague now at extremely reasonable prices. They are transistors you can use today! You need not delay your development work for the future when you design high-speed switching circuits with Type 2N501 Micro-Alloy Diffused-Base Transistors.

Write for complete engineering data sheet to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, 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.*

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In 1760, Indian Prince Tepper Sahib trained a 5,000-man rocket corps. Using rocket launchers of the type illustrated the Sahib repelled a British attack against his walled city — and started the defeated British thinking about rockets of their own!

Missiles have become greatly more sophisticated since the Sahib first broke the British Square. As a vital part of one of the world's largest purely electronic companies, Raytheon Missile Systems Division is making great advances in this field. The exciting new Pin Cushion Project for the selective radar systems missile identification and the continually being improved Navy's air-to-air SPARROW III and Army's HAWK, are examples of their outstanding creative work.

We are now seeking talented, qualified people to maintain Raytheon's leadership in this constantly advancing field. Raytheon's Missile Systems Division creates a climate for such talent — perhaps *your* talent.

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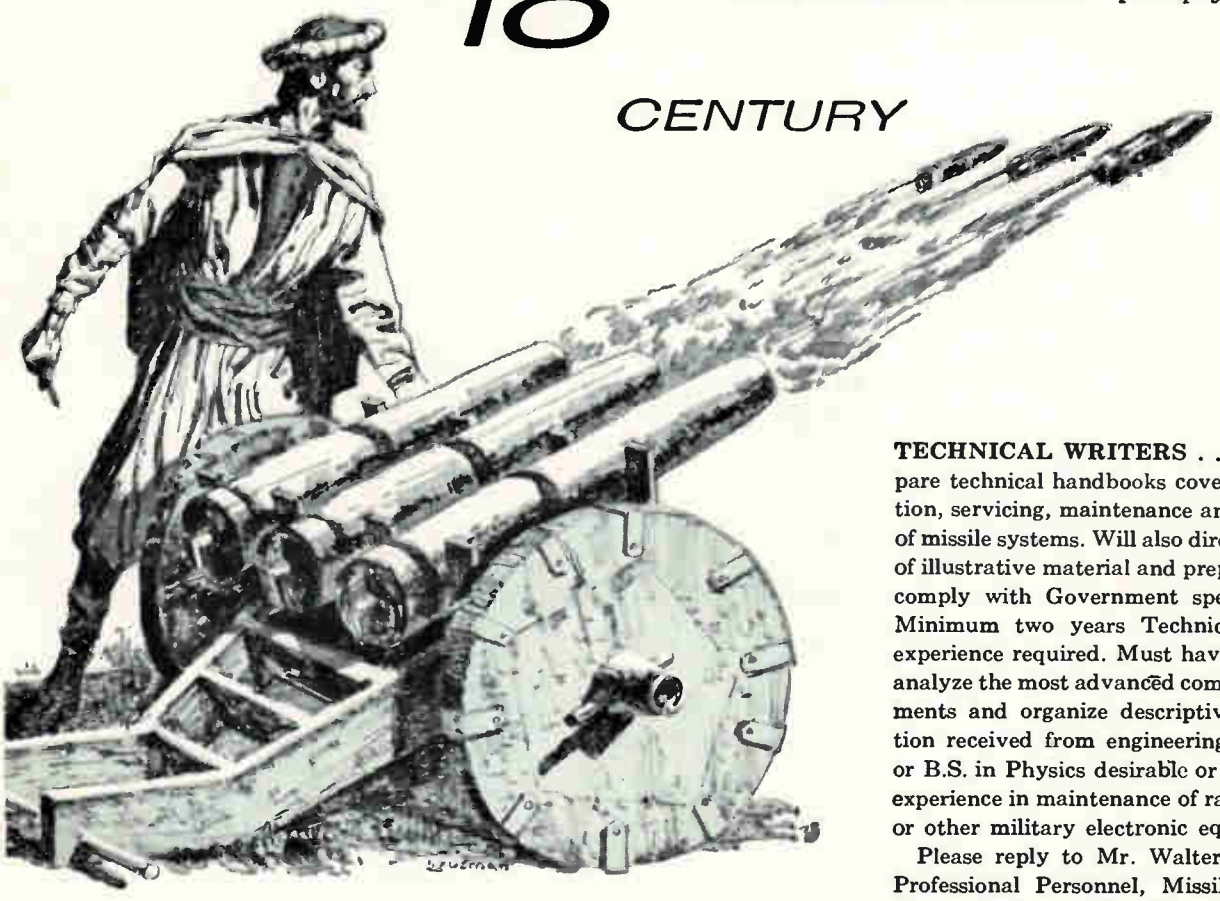

TECHNICAL WRITERS . . . will prepare technical handbooks covering operation, servicing, maintenance and overhaul of missile systems. Will also direct creation of illustrative material and prepare text to comply with Government specifications. Minimum two years Technical Writing experience required. Must have ability to analyze the most advanced complex equipments and organize descriptive information received from engineering. B.S.E.E. or B.S. in Physics desirable or four years' experience in maintenance of radar, sonar, or other military electronic equipment.

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In view of the higher dielectric strength of Natvar Teraglas compared to bias varnished cambric, thinner sections or fewer layers may be used to provide the voltage breakdown protection desired. Consequently, at comparable tape prices, a significant saving may be realized in production costs, while permitting up-grading to Class B (130°C) temperatures.

Natvar Teraglas is available in two thicknesses, .010" and .012"—in tapes, in full width rolls (36"), or in sheets. Ask for Data Sheet and Samples.

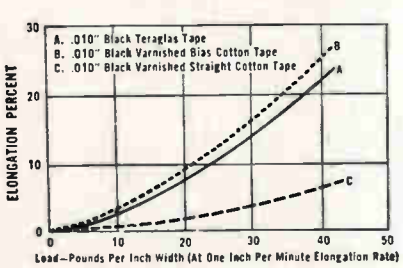
Natvar Teraglas will prove advantageous in many applications — for insulating motors, generators, transformers, cables, switchgear, busbars, and other apparatus and equipment where resiliency and high dielectric strength are desirable.

TYPICAL DATA

Physical Properties:		.010"	.012"
Approximate weight per sq. yd., lbs.		0.54	.62
Breaking Strength lbs./in. width,	Warp	45	45
	Filler	100	100
Tear Strength, grams	Warp	Over 1000	Over 1000
	Filler	Over 1000	Over 1000
Elongation, % (Under 25 lbs./in. width—3 minutes)		7.5	7.5

Electrical Properties:	.010"	.012"
Electric Breakdown Strength (C48-23-50 V/M)	1600	1600
Electric Breakdown Strength (Under 6% stretch)	1600	1600
Electric Breakdown Strength (Under 12% Stretch)	1450	1450
Power Factor, %, at 80° C-50 V/M-60 c.p.s.	2.5	2.5

LOAD-ELONGATION CHARACTERISTICS FOR NATVAR BLACK TERAGLAS



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- Varnished silk and special rayon—sheet and tape
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- Slot cell combinations, Aboglas®
- Teraglas**
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fiberglas tubing and sleeving
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- Styroflex® flexible polystyrene tape
- Extruded identification markers

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hp 403A Transistor ac Voltmeter—1 cps to 1 MC

Battery-operated, weighing less than 5 pounds and small enough to hold in your hand—this new transistor ac voltmeter measures 100 μv to 300 v (max. full scale sensitivity 1 mv) over frequencies 1 cps to 1 MC! Twelve voltage ranges; also reads direct in db from —12 to +2 db. 400 hour battery life equals 6 months of average use; battery voltage may be checked by front panel switch. Noise less than 50 μv. Completely isolated from power line or ground interference. Average reading meter minimizes turnover and waveform errors. Accuracy ±3% to 500 KC, ±5% to 1 MC. Input impedance 2 megohms; generous 600 v overload capacity on higher ranges, 25 v maximum on lower ranges. $250.00.

All of these widely useful -hp- instruments are available in rack-mounted -hp- voltmeter accessories—voltage dividers, coaxial connectors, voltage

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Automatic range, polarity

Here's true "touch-and-read" measuring simplicity. Automatic range, polarity selection; covers 0.001 v to 1,000 v. (Accuracy ±0.2% of reading ± 1 count). New, unique circuitry provides a stability of readings virtually eliminating fatiguing jitter in the last digit. Floating input, multi-electronic code output for use with digital recorders. Uses electronic computing circuits to insure low maintenance, trouble-free operation. Just 7" high! $825.00.

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versatile, precision
OHMMETERS you need.
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hp 400D
10 cps to 4 MC

Regarded by many as finest ac VTVM ever built. Covers all frequencies 10 cps to 4 MC, extremely sensitive, wide range, accurate within 2% to 1 MC. Measures 0.1 mv to 300 v (max. full scale sensitivity 1 mv), 12 ranges. Direct reading in v, db. 10 megohm input impedance with 15 $\mu\mu$f shunt insures negligible loading to circuits under test. $225.00.

hp 400L
Log VTVM—10 cps to 4 MC

Covering 10 cps to 4 MC, this new hp VTVM features a true logarithmic scale 5" long plus a 12 db linear scale. The log voltage scale plus long scale length provides a voltmeter of maximum readability, with accuracy a **constant percentage of the reading.** Accuracy is ±2% of reading or ±1% of full scale, whichever is more accurate, to 500 KC, ±5% full range. Range 0.3 mv to 300 v, 12 steps, (max. full scale sensitivity 1 mv). $325.00.

hp 400H
1% accuracy VTVM

Here's extreme accuracy of 1% in a precision VTVM covering 10 cps to 4 MC. Big 5" meter has exact-reading mirror-scale, measures voltages 0.1 mv to 300 v (max. full scale sensitivity 1 mv). 10 megohm resistance with 15 $\mu\mu$f shunt minimizes circuit loading. Amplifier with 56 db feedback insures lasting stability. $325.00.

hp 410B
ac to 700 MC, also dc

Time-tested standard all-purpose voltmeter. Covers 20 cps to 700 MC, full scale readings 1 to 300 v. Input capacity 1.5 $\mu\mu$f, input resistance 10 megohms. Also serves as dc VTVM with 122 megohms input impedance, or ohmmeter for measurements 0.2 ohms to 500 megohms. $245.00.

models! Also, inquire about multipliers and shunt resistors.

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hp 412A Precision Volt-Ohm-Ammeter

At last a true, precision multi-purpose instrument. Measures dc voltage 100 μv to 1,000 v (max. full scale sensitivity 1 mv), 1% accuracy full scale. Measure currents 1 μa to 1 amp with ±2% accuracy full scale. 13 ranges. As ohmmeter measures 0.02 ohms to 5,000 megohms. Extremely low noise, drift. Recorder output provides 1 v full scale. $350.00.

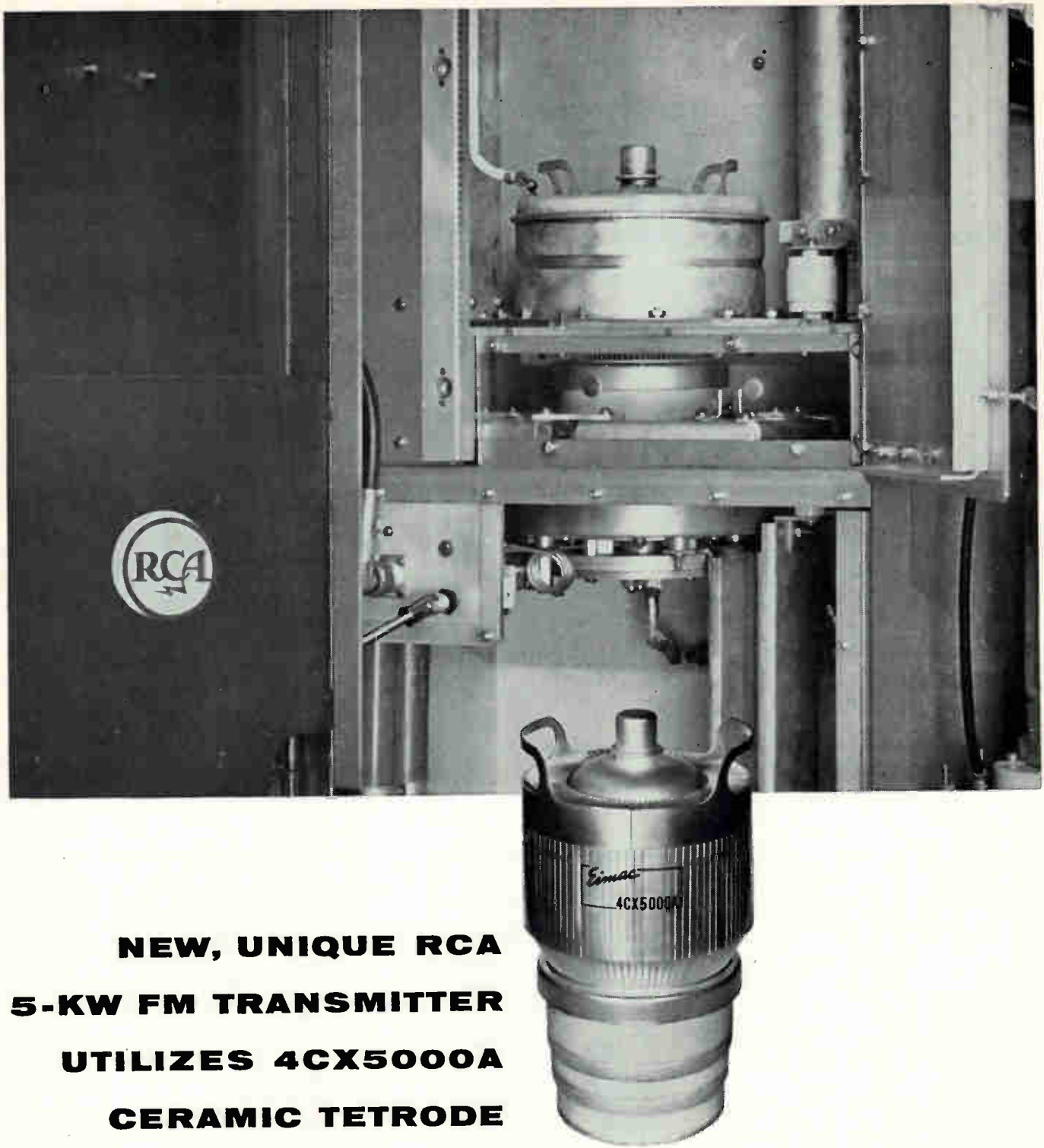
NEW!
hp 425A Microvolt-Micromicroammeter

New, high sensitivity, high stability instrument reading end scale voltages of 10 μv to 1 v in 11 ranges, or currents of 10 $\mu\mu$a to 3 ma in 18 step, 1-3-10 sequence. Accuracy ±3% on all ranges. Drift less than 2 μv under all conditions; very much less under lab conditions. Input impedance 1 megohm ±3% on all ranges. Also usable as 100 db amplifier with up to 1 v output from signals as small as 10 μv. $500.00.

NEW!
hp 428A Clip-On Milliammeter

Employs radical new approach to current measurement which eliminates breaking leads, soldering connections or loading of circuit under test. Revolutionary "current sensing" probe clips around wire under test, measures the magnetic field around the lead. Easily measures dc current in presence of strong ac. Covers 0.3 ma to 1 amp in 6 steps; full scale sensitivity 3 ma. Accuracy ±3%, probe inductance less than 0.5 μh. $475.00.

—unique value, traditional -*hp*- dependability



NEW, UNIQUE RCA 5-KW FM TRANSMITTER UTILIZES 4CX5000A CERAMIC TETRODE

RCA has recently developed a unique new 5-KW FM transmitter which utilizes the new technique of multiplexing. This provides simultaneous transmission of two or more program channels on the same RF carrier to meet increased demands of FM stations for additional program services.

The PA stage of the new BTF-5B transmitter is composed of a single Eimac 4CX5000A ceramic tetrode, which produces the 5000-watt output. This tetrode offers high power gain and excellent stability to assure faithful transmission of the broadband multiplex signals.

That's why the 4CX5000A was the logical choice of discriminating RCA engineers. Its many exclusive ceramic design features help to make possible this conservatively rated, high power, air-cooled transmitter.

These ceramic extras are now available in more than forty Eimac tube types—used in many types of communication, pulse and industrial equipment.

EITEL-McCULLOUGH, INC.

San Carlos, California

Eimac

BUSINESS THIS WEEK

Five Companies "Sell" Microminiaturization Using Present Knowhow, Off-the-Shelf Items

Component density of 2 million units per cu ft is being marketed jointly by five electronics companies in the form of microminiature modules and components described as "high reliability, production line, off-the-shelf" units.

The companies are Aerovox Corp., High-Q division; Cleveland Metal Specialties Co., Electronics division; Pacific Semiconductors; Raytheon's Semiconductor division; and Sylvania's Lighting Products division. They call their approach MICRAM, for "microminiature individual components reliable assembled modules."

Modifications of the packaging technique, and the use of smaller components soon to become commercially available, will provide densities in excess of 8 million components per cu ft, say the companies.

One new component is Pacific Semiconductor's caseless mesa microtransistor 15 mils thick by 25 mils square. The unit's electrical characteristics—similar to those of a high-speed switch—will be announced next month. Company says engineering samples will be available in the second quarter of this year, with pilot production slated for mid-year. **The silicon mesa units will be packaged by surface passivation bonded film technique.** Gold base and emitter leads are two to three mils in diameter; collector lead is a gold-plated ribbon.

Missile-Borne Tv Sends Target Pictures

Miniature RCA tv camera and transmitter, which were inside a capsule that detached from a Redstone missile last week, transmitted high-resolution pictures of the area in which the missile was about to land at the Army's White Sands range. Still aloft after impact, it continued to send pictures of ground damage. The successful feasibility test was reported by RCA Defense Electronic Products and the U. S. Army Ballistic Missile Agency. Company says a slow-scan technique produces high-quality still pictures requiring a very narrow bandwidth.

Air Force to Get Solid-State System Permitting Pilots to Send Digital Data

Air Force has ordered prototype models of a voice-visual air-to-ground and ground-to-air system that will permit planes to send canned "book" messages using digital transmission methods. GE's communication products department in Lynchburg, W. Va. is scheduled to deliver engineering models by the summer.

The solid-state pushbutton system, called DISCOM (Digital Selective Communications), enables a pilot to transmit long-range by digital means when voice transmission is unsatisfactory and to receive his messages on a display unit.

If voice communication is desired, says GE, the ground station can automatically connect the headphone-microphone in the plane to the proper channel. System eliminates messages not intended for the plane.

Four-letter aircraft call is used by a ground operator to set up digital transmission to an aircraft. Operator feeds plane's individual binary code into a memory device associated with the ground control monitor. Code is converted to frequency-shift-keying tones that can be radioed over existing equipment at split-second rates using very narrow bandwiths.

GE says ground-based gear can send 456,000 aircraft call signs of four letters each, adds that selective-calling of specific groups of planes and general broadcasts to all aircraft can also be accomplished.

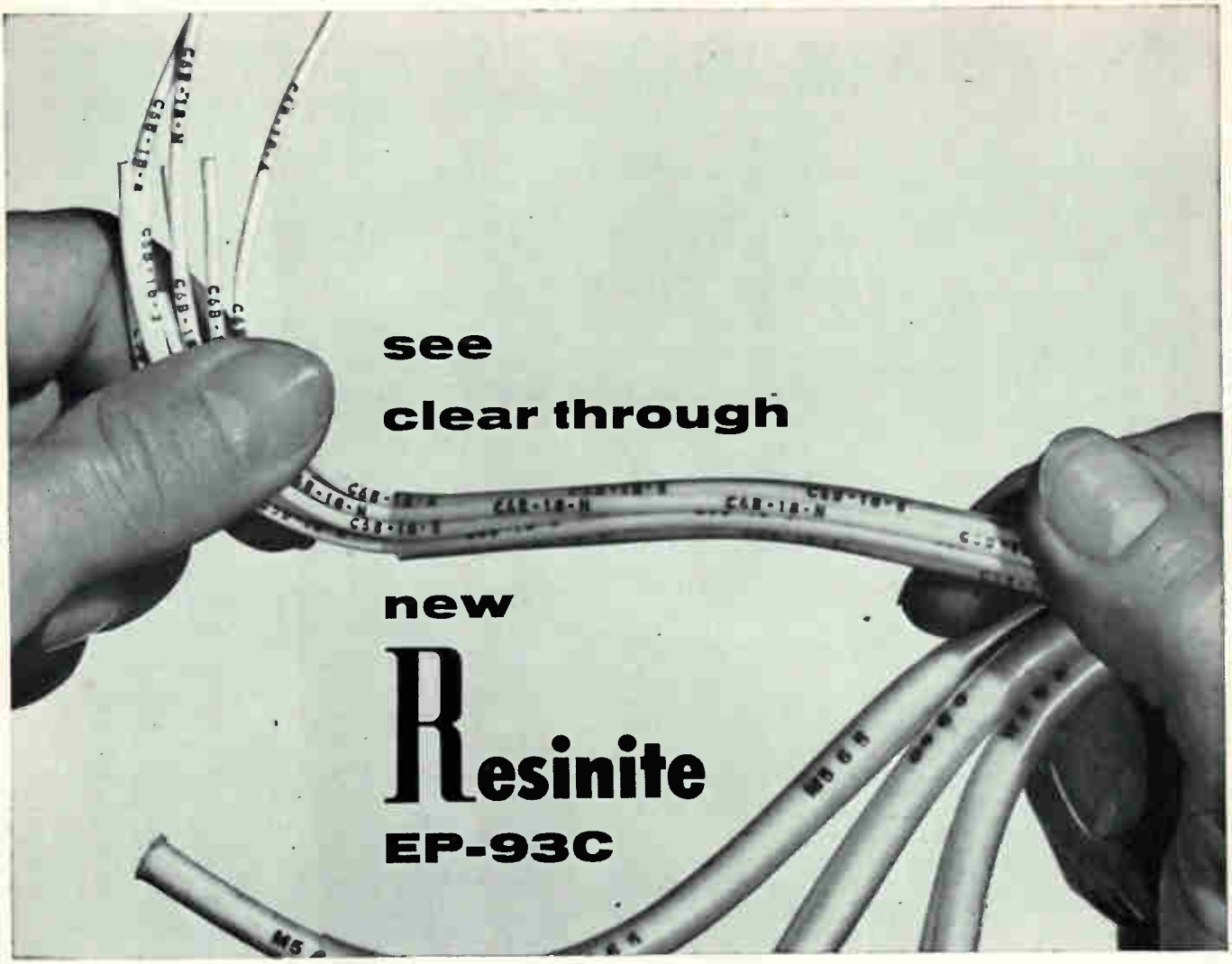
ELECTRONICS NEWSLETTER

Video band recorder/reproducer for analog and pulse signals will be produced by Mincom division of Minnesota Mining and Manufacturing Co. The company says it will offer the unit, designated CM-100, "within the standard instrumentation price range." Each of seven video tracks cover 400 cycles to 1 Mc. At 120 ips it can record up to 1 Mc; at 60 ips, 500 Kc; at 30 ips, 250 Kc; at 15 ips, 125 Kc. Six speeds are provided from 7½ ips to 120 ips.

Ultra-clean electron gun promising greater power ratings and longer life in super-power radar klystrons was reported under development by Sperry Gyroscope Co. scientists this week at the MIT conference on physical electronics.

The gun uses a new type of rugged cathode, described as an "extended interphase coated cathode," that provides electron beam densities far in excess of 1,000 amps/sq cm and promises life cycles exceeding 4,000 hours in long-pulse megawatt radar service.

Sperry says the new gun makes possible much longer pulses, higher power, and higher peak and average power ratings needed for greater range and resolution in pulse compression radars. The gun, reported by Lindsey Anderson of Sperry's Electronic Tube division, uses standard cathode coating materials on a special nickel base. It operates, says the company, in an ultra-clean environment produced by high-vacuum techniques which cut processing time from 20 hours to 2 hours. The gun is understood to be used in new superpower klystrons under development for military radars. **An experimental magnetohydrodynamic generator** which has produced 2½ kilowatts of power and can run continuously for four minutes was displayed by Westinghouse last week. The generator burns furnace oil with oxygen at about 5,000 F, converting burning fuel directly to electricity. Company claims its MHD unit is the first of "appreciable size" to produce electric power steadily from combustion of conventional fuel.



no tint vinyl insulation sleeving for MIL-I-7444B

Developed specially for the new "B" revision of MIL-I-7444, Resinite EP-93C is transparent and colorless (no amber tint).

This material has all the superior characteristics of Resinite specification grade insulation sleevings—and more. Now there is a Resinite material for all types (transparent, tinted or colored) and all size ranges of MIL-I-7444.

Your Resinite Distributor has complete information on EP-93C and other Resinite materials to solve your insulation sleeving problems. For samples and performance data, write:

RESINITE EP-93C

- Smoother, harder surface facilitates installation
- Flexible at –90°F
- Withstands 185°F continuously
- Flame resistant
- Fungus resistant
- All 3 types and size ranges
- Transparent, amber, black, white, red
- Exclusive "Soft-Wound" spooling assures full-round sleeving

Resinite®—specialists in vinyl sleevings and tubing for the aircraft, electronics, electrical and pharmaceutical fields.

Resinite Department, The Borden Chemical Company
1 Clark St., North Andover, Mass., and P.O. Box 430, Compton, Calif.

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When you need industrial tubes fast...to meet a production schedule or lab emergency...pick up your phone and call your local RCA Industrial Tube Distributor. He'll give you priority service —often same-day delivery.

If speed is your need, and the assurance that your order will be "followed-up" systematically, your RCA Industrial Tube Distributor is a man you can count on. He can fill your requirements from the broadest line of industrial tubes—RCA Industrial Tubes.

What's more, your Authorized RCA Industrial Tube Distributor can now offer the designer and manufacturer immediate delivery of industrial tubes from his factory-fresh stock.

Keep him in mind. He can help you when you're pressed for time, and serve you as a regular, dependable source of supply for your small production runs and laboratory requirements.

Consider these extra benefit services: Immediate delivery of new RCA developed types • practical product information • RCA technical assistance when you need it • orders filled from factory-fresh stocks of RCA tubes—noted for performance and reliability in every industrial application. Find out all about this benefit-plus service when you call your RCA Industrial Tube Distributor today.

RADIO CORPORATION OF AMERICA

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

WASHINGTON OUTLOOK

SOME 20 ELECTRONICS INDUSTRY representatives will come to Washington May 24 to discuss export trade problems with the Commerce Dept. The meeting will be one of a series of conferences the government is holding with industry groups to solicit views on how to expand U. S. export trade.

The electronics men will be told of U. S. plans for participation in the major tariff negotiating conference to be held in Geneva later this year under the General Agreement on Tariffs and Trade (GATT). They will get the latest word on the relaxation or elimination of foreign quota and licensing restrictions on U. S. goods.

The government is looking for industry ideas that can be used to guide official U. S. trade negotiators—in GATT and elsewhere—on the diplomatic front. It also wants to learn in detail what gripes U. S. exporters in their dealings with foreign markets. This will lead to official U. S. representations to the foreign nations on behalf of exporters here.

The conferences are part of a drive to push exports of U. S. goods. As of now, the new export program campaign stacks up like this.

- The export-import bank will grant limited credit guarantees against specific political (but not commercial) risks involved in selling abroad.
- Government assistance abroad for U. S. exporters will be increased and improved in quality.
- The Commerce Dept. will expand information services here for exporters, seek closer contact with the exporting community, and try to spur business to organize itself more effectively to compete in foreign markets.

There's a sour note in the new program already, however. Some officials and businessmen here are saying the program is too modest to give more than a marginal boost to U. S. exports. What's needed, some of them say, is a solid plan for government financing credits to private exporters. U. S. exporters are at a disadvantage, industry advisors say, competing against manufacturers—notably in the capital goods field—from countries such as West Germany which offer credit guarantees for exporters.

Government experts are concerned over the outlook for electronics exports this year. They cite the unhappy political situation in Cuba, long a major market for U. S. electronics, and general monetary problems in other Latin American countries, as factors which may result in another drop in electronics shipments abroad.

In 1959, exports of U. S. electronics goods amounted to about $411 million. This was roughly 8 percent under the 1958 volume.

- **A new Air Force agency** may be proposed to control the management of a weapon system through all the cycles of its existence—from start of research through deployment with troops.

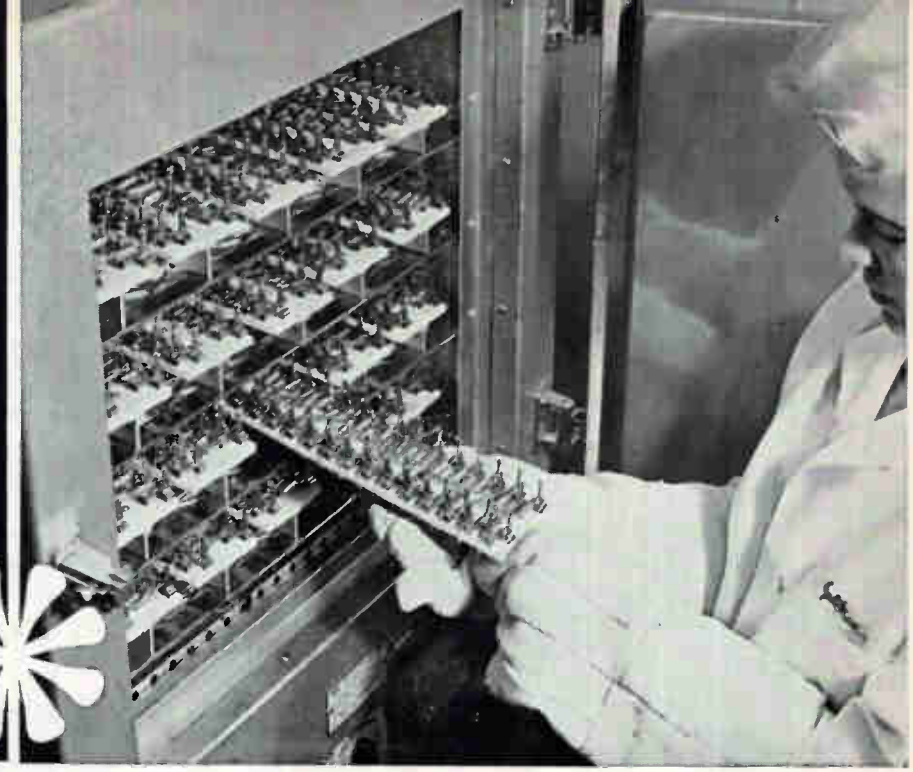
  Under the current procedure, there's a break in the management of a system as it moves from research (Air Research and Development Command) to production (Air Materiel Command) to deployment (the operational command). Some Air Force officials see a weakness in this system because of what they consider a lack of continuity in monitoring a major project's contractors.

  A special board of Air Force Generals, headed by Gen. Samuel E. Anderson, Commander of the Air Materiel Command, is studying the new plan.

- **Effect of military procurement policy** on small contractors will be the subject when the Senate Small Business Committee begins three days of hearings April 5. The Committee is irked by the fact that over $8 billion of last year's $22.7 billion worth of contracts was negotiated with a single source.

tan-TI-*cap* †

CAPACITOR STABILITY ASSURED BY 250-HOUR PERFORMANCE LOAD TEST



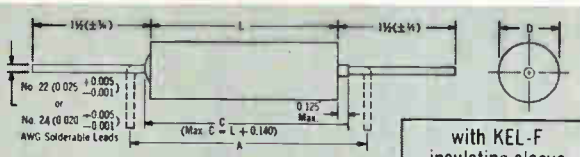
...expanded TI line of type SCM solid tantalum capacitors meets MIL specs

Another assurance to you of Texas Instruments capacitor reliability — 250-hour performance load test on a sample basis of *all* lots of the Type SCM series.

Your margin of design safety is greater with *tan*-TI-*cap* capacitors. Type SCM capacitors are *100% tested* for capacity, dc leakage and dissipation factor, and are aged under load at elevated temperature. SCM units in all 203 standard ratings (6 - 35 volts, 1 - 330 μfd.) meet and exceed the electrical and mechanical requirements of MIL-C-55057 (Sig. C) and/or MIL-C-21720A (NAVY) specifications for solid tantalum capacitors.

Contact your nearest authorized TI distributor or TI sales office today for your immediate and future delivery requirements.

† trademark of Texas Instruments Incorporated



case size	D +0.010 −0.005	L ±0.031	*A ±0.031	wire size AWG	avg. wt. gms.	with KEL-F insulating sleeve: D −0.020 −0.010	with KEL-F insulating sleeve: L ±0.062	with KEL-F insulating sleeve: avg. wt. gms.	with Mylar insulating sleeve**: D ±0.010	with Mylar insulating sleeve**: L ±0.031	with Mylar insulating sleeve**: avg. wt. gms.
F	0.125	0.250	0.482	24	0.4	0.162	0.337	0.5	0.135	0.322	0.4
B	0.175	0.438	0.688	24	1.1	0.210	0.525	1.3	0.185	0.510	1.2
G	0.279	0.650	0.888	22	2.7	0.315	0.735	3.1	0.289	0.722	2.8
H	0.341	0.750	0.988	22	3.3	0.377	0.835	3.9	0.351	0.822	3.4

* Dimension "A" determined by suspending a one-pound weight from one lead and rotating the case from the vertical position to the horizontal position, and then repeating the procedure for the other lead.

** Meets all requirements of MIL-C-55057 and MIL-C-21720A, including dimensions.

All lots of Type SCM *tan*-TI-*cap* capacitors are tested for performance stability at rated temperature and voltage prior to release for shipment. Performed on a lot-sample basis, the test is run for 250 hours or until performance stability is established by successive time interval measurements of the principal parameters of each test capacitor.

Write to your nearest TI sales office on your company letterhead for Bulletin DL-C 1173 which gives detailed specifications on the complete SCM series.

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The Rockette offers important advantages not found in most table model whiteprinters. Its 42" printing width, 15 fpm speed, and 1500 watt vapor lamp provide unusual operating flexibility and capacity. Synchronized developing and exposure speeds assure sharp reproduction especially for longer prints. Exclusive patented perforated rollers provide faster development, shorter travel, and lower ammonia consumption. With the Rockette, you can utilize the widest range of materials to meet every reproduction requirement. Especially useful are intermediates that expedite design changes, save many hours of drafting.

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CIRCLE 17 ON READER SERVICE CARD→

Oui, General Transistor offre des transistors MIL/SPEC

GERMANIUM PNP

2N43A	MIL T 19500/18
2N44A	MIL T 19500/6
2N331	MIL T 19500/4A
2N404	MIL T 19500/20
2N416	MIL T 19500/56
2N417	MIL T 19500/57
2N425	MIL T 19500/45
2N426	MIL T 19500/42
2N427	MIL T 19500/43
2N428	MIL T 19500/44
2N464	MIL T 19500/49
2N465	MIL T 19500/50
2N466	MIL T 19500/51
2N467	MIL T 19500/45

GERMANIUM NPN

2N358A	MIL T 19500/63
2N388	MIL T 19500/65
2N1310	Guidance

SILICON PNP

2N327A	
2N328A	Guidance
2N329A	Guidance
2N1026	Guidance

DIODES

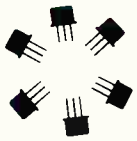
General Transistor also produces high-reliability gold-bonded diodes, three of which are designed to meet MIL requirements: 1N198, 1N277, and 1N281. The spec numbers are, respectively: MIL E 1/700, 1/993A, and 1/961.

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

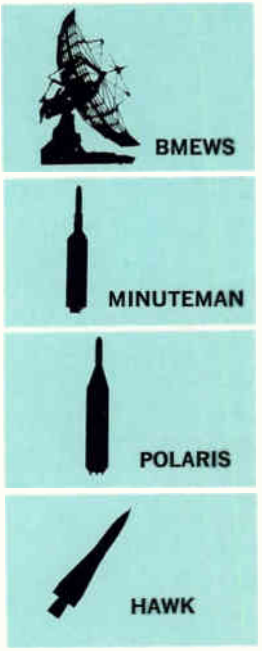
GENERAL TRANSISTOR CORP.

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

These NPN Germanium Types



As witness the deployment of General Transistors on projects such as:

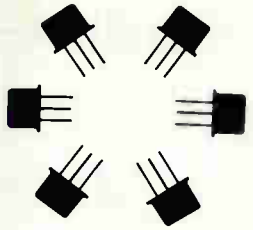


And many other military programs. Why? *Reliability.*

General Transistor is now in its fourth year of production on *quality* NPN germanium transistors. We were one of the earliest suppliers of germanium NPN transistors, and have from the beginning maintained an excellent reputation for highly reliable products. Listed are some characteristically fine types.

Type No.	Collector-Base Breakdown V_{CBO} (Volts)	Punch thru V_{pt} (Volts)	Collector Cutoff Current I_{CO} (μa)	D.C. Current Gain h_{FE}	Alpha Cutoff Frequency f_{ab} (mc)
2N356A	40	40	3	35	3
2N357A	40	40	3	40	6
2N439	40	35	3	60	8
2N440	40	30	3	100	12
2N446A	30	35	2	100	8
2N447A	30	25	2	150	12
2N595	35	30	2	50	5
2N596	35	30	2	70	8
2N1012	50	50	2	60	5
Typical values					

Also on Military Duty



...and here's a flight of high voltage types:

		2N1310			2N1311			2N1312		
DISSIPATION RATINGS:		NPN			NPN			NPN		
TOTAL TRANSISTOR DISSIPATION AT 25°C		GE Alloy Junction 120 MW			GE Alloy Junction 120 MW			GE Alloy Junction 120 MW		
DERATING FACTOR		2 MW/°C			2 MW/°C			2 MW/°C		
STORAGE TEMPERATURE		−65°C to 85°C			−65°C to 85°C			−65°C to 85°C		
CUT-OFF RATINGS:	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**
COLLECTOR BASE VOLTAGE (V_{CBO})	I_C=25 μa	90 v			75 v			50 v		
EMITTER-BASE VOLTAGE (V_{EBO})	I_E=25 μa	20 v	50 v		20 v	50 v		20 v	40 v	
COLLECTOR-EMITTER VOLTAGE (V_{PT}) (PUNCH-THRU)	I_E=25 μa	90 v			75 v			50 v		
COLLECTOR CUT-OFF CURRENT (I_{CO})	V_{CBO}=5 v		3 μa	7 μa		3 μa	7 μa			7 μa
EMITTER CUT-OFF CURRENT (I_{EO})	V_{EBO}=5 v		3 μa	7 μa		3 μa	7 μa			7 μa
D.C. AND SWITCHING RATINGS:										
D.C. CURRENT GAIN (h_{FE})	I_C=5 ma V_{CE}=0.25 v	20			15					
	I_C=20 ma V_{CE}=0.25 v					25		20	30	
D.C. BASE VOLTAGE (V_{BE})	I_C=5 ma V_{CE}=0.25 v			0.5 v			0.5 v			
	I_C=20 ma V_{CE}=0.25 v								0.3 v	
D.C. COLLECTOR VOLTAGE (V_{CE})	I_B=10 ma I_C=100 ma		0.2 v			0.2 v			0.2 v	
SMALL SIGNAL RATINGS:										
CURRENT GAIN COMMON EMITTER (h_{fe})	V_{CE}=5 v I_E=1 ma f=1 kc		35			30			40	
ALPHA CUT-OFF FREQUENCY ($f_{\alpha b}$)	V_{CB}=5 v I_E=1 ma		1 mc			1.5 mc			2 mc	
COLLECTOR CAPACITY (C_{ob})	I_E=1 ma V_{CB}=5 v f=1 mc		11 μμf			11 μμf			11 μμf	
INPUT IMPEDANCE (h_{ib})	V_{CB}=5 v I_E=1 ma f=1 kc		35 Ω			35 Ω			35 Ω	
REVERSE TRANSFER RATIO (h_{rb}) (X 10^{-4})	V_{CB}=5 v I_E=1 ma f=1 kc			15			15			15
OUTPUT ADMITTANCE (h_{ob})	V_{CB}=5 v I_E=1 ma f=1 kc			2 μ℧			2 μ℧			2 μ℧
NOISE FIGURE (NF)	V_{CB}=5 v I_E=1 ma f=1 kc BW=100-		10 db			10 db			10 db	

Because of the relative newness of these transistors, data is presented in detail.

GENERAL TRANSISTOR CORP.

Speaking of Services: GT Hi/Scope Service

100% Lot Preconditioning

Let's assume you have equipment which must undergo severe environmental conditions...be subjected to high mechanical shock and vibration. To be certain that all the transistors you intend to use will withstand this type of exposure, we will set up a preconditioning program that will test out every single unit before we ship to you.

Special Electrical Parameter Testing

Certain transistor applications are so unusual that they cannot be completely described by standard parameters. If you are in such a position, we will design a test fixture to closely approximate actual circuit performance. This procedure will provide assurance that 100% of the transistors delivered to you will perform satisfactorily.

Special Reliability Testing Programs

Must your completed systems meet a high reliability requirement? If so, you may wish special procedures to be established with regard to your reliability programs. This is another GT service. When necessary, we will build such transistors on a specially designed production line, check them exhaustively to hold tight parameter tolerances, and subject large lots to specific and unique life tests. In many cases, we have established a program so that we ship those units which have high survival probability in your application. These things we have done, and will do again, at your request. Sound helpful?

High and Low Temperature Testing

Standard transistor parameters are generally controlled at room temperature. Yet many systems must function at other ambients. If you have a problem specifying electrical parameters at room temperature in a manner that will be valid at high or low temperatures, we are ready to assist. General Transistor is prepared to run any measurements you dictate, at any specified ambient. We can do this on complete production lots if you feel it essential.

Cost Economies Through Parameter Modifications

Yield has a strong influence on transistor cost. To give you the best economies and at the same time give you the most desirable quality, we offer this working arrangement. At your request, General Transistor will suggest slight modifications of your specifications which will allow us to ship the major portion of a production run. We will make the necessary measurements and indicate what the various parameters should be and what proportions of the run will fall into preselected types. If you then design your system to use this production mix, you will benefit from some genuine economies.

Circuit Design

If you are starting on a new program, you may want some information on what performance you can expect from state-of-the-art circuits. We will provide you with such typical circuits at your request, together with data on the performance of our transistor types within these circuits.

Special Selection on Standard Catalog Types

In many instances you may find that a standard catalog transistor is about 90% acceptable, but still needs improvement in a few parameters. In such a case, please ask us about the possibility of getting these improvements. We can tell you what increase in specifications is feasible, and produce the units to this spec. Thus, you get the desired parameters without having to redesign or wait for a custom-built semiconductor.

Qualification Approvals

Let's consider the case where you want to design a certain transistor into a system for the government, yet a government specification does not exist for the transistor. You must be ready to substantiate your use of the non-standard part. Here's what GT can do to help your case. We will run a qualification approval procedure in the same format we would for a military type. Then we'll provide you with this necessary data. This will greatly accelerate your approval for use of this transistor type.

Special Coatings or Encapsulations

In your manufacturing process, do you expose transistors to any kinds of solvents or potting materials? If so, just let us know. By using special highly resistant coatings, we'll make sure that the transistor case and markings are not vulnerable to solvent attacks.

Samples with Parameter Measurements

Assume you want to check out the margins in a design. You require upper and lower limit samples of a certain transistor type. We'll be happy to supply you with sufficient samples to cover the spread in one or two significant parameters. Thus, you can experimentally determine the performance of your circuit.

Special Production Runs

Assume that your transistor application is so unusual that units are not available from standard production. What can be done? We will analyze your requirements and decide whether it would be feasible to make a special production run of transistors to meet your needs.

What More?

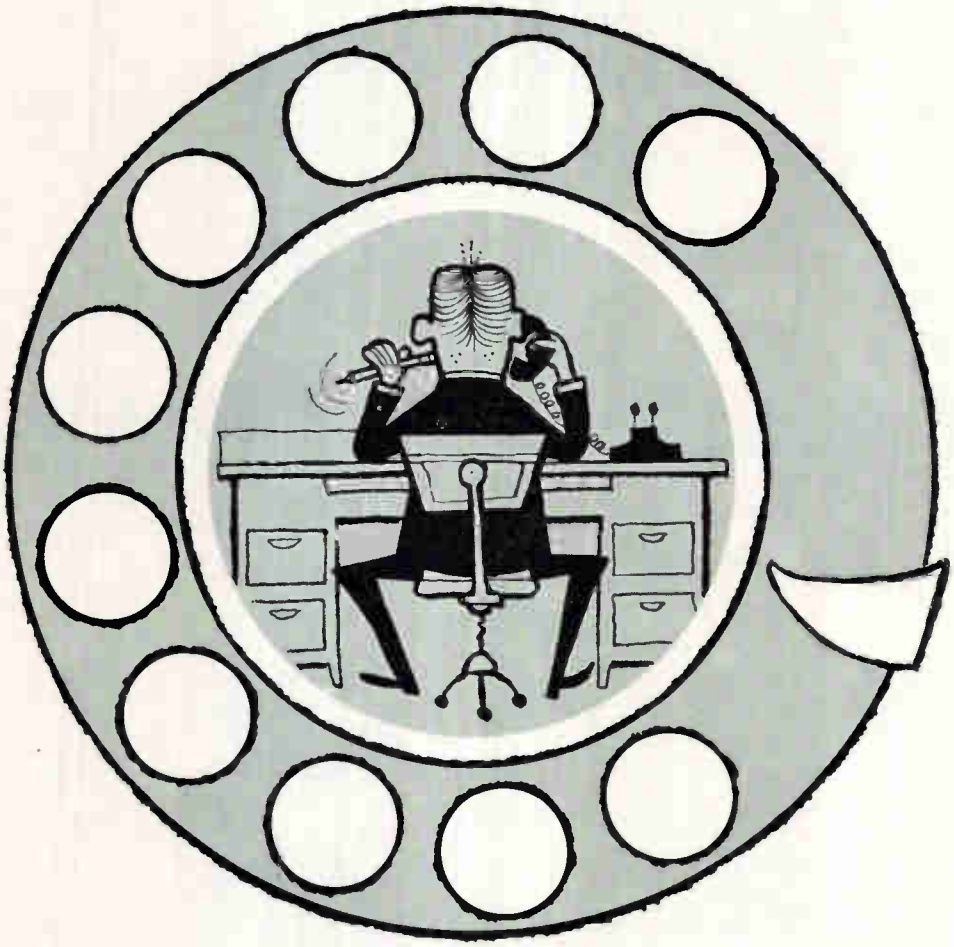
This is our HI/SCOPE service...or a large part of it. Our customers have found it to be extremely useful. We think you will, too. If there is something still further that interests you, why not get in touch with us? Space precludes our going into too great detail here, but we feel sure you'll find any assistance you need at GT. Write or give us a phone call.

GENERAL TRANSISTOR CORP.

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

1064/3.00/2M

Who's the local rep? What's his number?

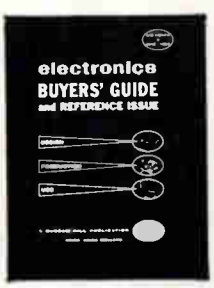


LOOK IN THE NEW

electronics BUYERS' GUIDE

You'll find the local representative . . . his name, telephone number . . . his address. You'll find such detailed information about more than 25,000 local sales offices of more than 4,000 major manufacturers.

There's also a wealth of reference data about markets, materials, components and applications that make buying easier. Catalog information on nearly 700 different advertised products (that's about 42% more than you'll find anywhere else). Also complete lists of manufacturers . . . registered trade names . . . and also, of course, the most complete listing of electronic and related products. Tells what you want to know . . . *when you're ready to buy.*



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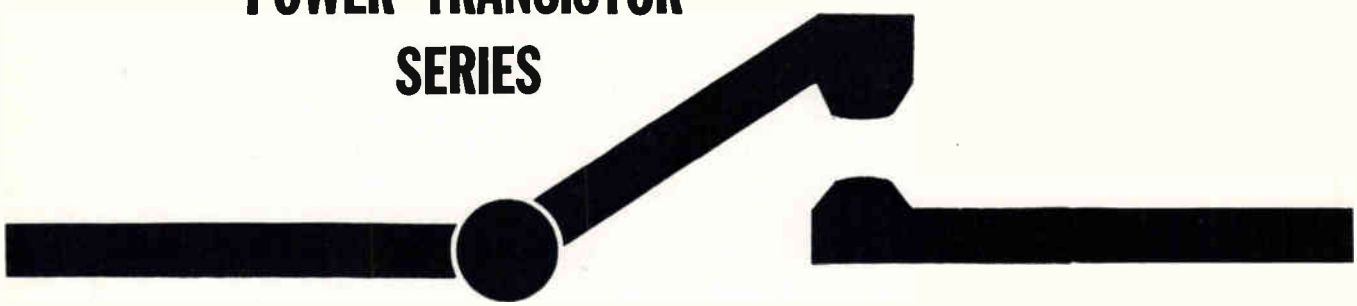
NOW!

Bendix

25-AMP

POWER TRANSISTOR SERIES



Now in production by Bendix* are eight 25-ampere peak current power transistors capable of switching up to 1000 watts—and you can get immediate delivery on all eight types.

Newly improved in design, the transistors have a higher gain and flatter beta curve. The series is categorized in gain and voltage breakdown to provide optimum matching and to eliminate burn-out.

Current Gain hFE at Ic = 10 Adc	Maximum Voltage Rating			
	50 Vcb	60 Vcb	90 Vcb	100 Vcb
	30 Vce	40 Vce	70 Vce	80 Vce
20—60	2N1031	2N1031A	2N1031B	2N1031C
50—100	2N1032	2N1032A	2N1032B	2N1032C

Ask for complete details on this newly improved Bendix transistor series . . . and on the entire Bendix line of power transistors and power rectifiers. Write SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office. *TRADEMARK

West Coast Sales Office:
117 E. Providencio Avenue, Burbank, California

Midwest Sales Office:
2N565 York Road, Elmhurst, Illinois

New England Sales Office:
4 Lloyd Road, Tewksbury, Massachusetts

Export Sales Office: Bendix International Division,
205 E. 42nd Street, New York 17, New York

Canadian Affiliate: Computing Devices of Canada, Ltd.,
P. O. Box 508, Ottawa 4, Ontario, Canada

SEMICONDUCTOR PRODUCTS

Red Bank *Division*

LONG BRANCH, N. J.

Bendix
AVIATION CORPORATION

Reports $48 Million in Sales

RECORD SALES and earnings are reported by Ling-Altec Electronics, Dallas, for the year ended Dec. 31, 1959. Sales were $48 million, net income $1.8 million, equal to $1.31 per share on an average of 1,426,722 shares outstanding before dividends and the redemption of preferred stock

The 1959 operations included non-recurring costs resulting from moving the Ling Electronics division from Culver City to Anaheim, Calif.; costs incurred in the acquisition of three companies; and costs involved in redeeming convertible debentures. James Ling, board chairman, says these costs were practically offset by non-recurring profits from the sale of capital assets.

• **Indiana General Corp.,** Valparaiso, Ind., announces an all-time high in virtually every area of financial activity for 1959. The firm, which is a major supplier of permanent magnets and ferrite magnetic materials, reports consolidated net sales last year of $19,865,219 against $15,283,018 for 1958. On November 16, 1959, General Ceramics Corp. was merged into the Indiana Steel Products Co., and the name of the surviving corporate entity changed to Indiana General Corp.

• **Telectro Industries Corp.,** Long Island City, N. Y., reports net income after taxes of $177,320 for last year on sales of $5,160,434. The firm, which makes magnetic tape recorders and electronic instruments, reported combined sales in 1958 of $3,195,269. Total projected sales for this year are in excess of $7½ million.

• **Sanders Associates,** Nashua, N. H., reports the greatest growth in its history during the first six months of fiscal 1960 ending Jan. 31, with sales up 77 percent to $8,067,035 from $4,562,179 for the corresponding half of last year. Company president R. C. Sanders expects sales to go as high as $17 million for the entire fiscal year. Net income for the period was $192,152, compared with $150,142 for the first half of last year, an increase of 28 percent. Net income per share rose to 46 cents against 39 cents per share for last year. The company's present backlog amounts to more than $18 million.

• **P. R. Mallory,** Indianapolis, reports sales of $86,504,443 and net income of $4,339,042 for the year ended Dec. 31, 1959. Sales were 26 percent above those of 1958, and 11 percent above those of 1957. Net income was 51 percent over 1958, 38 percent over 1957. Earnings per common share in 1959 were $2.87, as compared with $1.85 in 1958 and $2.00 in 1957. At the close of 1959 there were 1,441,009 shares outstanding.

25 MOST ACTIVE STOCKS

WEEK ENDING MARCH 11

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Philco Corp	2,298	36¼	31	35¼
Ampex	1,369	40¼	37⅝	38⅜
RCA	1,278	66⅛	62⅜	65⅜
Collins Radio	851	62¼	58⅝	60⅝
Gen Electric	743	87⅛	84⅝	87
Sperry Rand	741	23⅛	22¼	22½
Westinghouse	739	50⅛	46½	49¼
Int'l Tel & Tel	674	36¼	33⅛	36⅛
Avco Corp	597	13¼	12⅛	13
Litton Ind	584	70¾	65¾	68½
Transitron	555	48⅜	45¼	46⅞
Dynamics Corp Amer	483	12⅝	11⅛	12⅛
Raytheon	438	45⅝	41¼	44
Univ Control	428	14⅜	13⅝	14
Gen Tel & Elec	422	74	70⅝	73¼
Varian Assoc	393	46⅞	43⅝	45⅝
El-Tronics	382	1¾	1½	1⅝
Siegler Corp	368	35⅝	32⅛	34¾
Beckman Inst	359	72½	68½	70
Burroughs	357	30¾	28¾	30¾
Zenith	356	101⅞	95¼	98
Gen Dynamics	354	45⅞	44⅛	44½
Texas Inst	345	175¾	167¾	173
Admiral	340	21½	18⅛	20
Rheem Mfg	310	21⅞	19⅞	21⅞

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

DIVIDEND ANNOUNCEMENTS

	Amount per Share	Date Payable
Clevite Corp	$.30	Mar. 28
Garrett Corp	.50	Mar. 28
Martin Co	.40	Mar. 28
Philco Corp (pfd)	.93¾	Apr. 1
RCA	.25	Apr. 25
RCA (pfd)	.87½	Apr. 25
Textron Inc	.31¼	Apr. 1
Textron Inc (pfd)	1.25	Apr. 1

TARZIAN *designer's line*

silicon rectifiers include 84 high efficiency types

amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	Tarzian Type	Jedec No.
0.325	2800	1960	3.25	19.5	280SM	1N1113
0.35	2400	1680	3.5	21	240SM	1N1112
0.375	2000	1400	3.75	22.5	200SM	1N1111
0.4	1600	1120	4	24	160SM	1N1110
0.425	1200	840	4.25	25.5	120SM	1N1109
0.45	800	560	4.5	27	80SM	1N1108
0.5	100	70	5	30	10M	1N1081
	200	140	5	30	20M	1N1082
	300	210	5	30	30M	1N1083
	400	280	5	30	40M	1N1084
	400	280	5	30	M-500	1N1084
	500	350	5	30	50M	–
	600	420	5	30	60M	–
0.75	200	140	7.5	75	F-2	1N2482
	400	280	7.5	75	F-4	1N2483
	600	420	7.5	75	F-6	1N2484
	100	70	7.5	75	10H	–
	200	140	7.5	75	20H	1N2485
	300	210	7.5	75	30H	1N2486
	400	280	7.5	75	40H	1N2487
	500	350	7.5	75	50H	1N2488
	600	420	7.5	75	60H	1N2489

amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
1.5	100	70	10	100	–	–	10J1	1N1617
	200	140	10	100	–	–	20J1	1N1618
	300	210	10	100	–	–	30J1	1N1619
	400	280	10	100	–	–	40J1	1N1620
2	100	70	30	100	–	–	10LA	1N1085
	200	140	30	100	–	–	20LA	1N1086
	300	210	30	100	–	–	30LA	1N1087
	400	280	30	100	–	–	40LA	1N1088
10	100	70	50	150	–	–	10J2	1N1621
	200	140	50	150	–	–	20J2	1N1622
	300	210	50	150	–	–	30J2	1N1623
	400	280	50	150	–	–	40J2	1N1624
20	50	35	120	200	5RAN	1N1157	5RAP	1N1171
	100	70	120	200	10RAN	1N1158	10RAP	1N1172
	200	140	120	200	20RAN	1N1159	20RAP	1N1173
	300	210	120	200	30RAN	1N1160	30RAP	1N1174
	400	280	120	200	40RAN	–	40RAP	–
35	50	35	210	350	5SAN	1N1161	5SAP	1N1175
	100	70	210	350	10SAN	1N1162	10SAP	1N1176
	200	140	210	350	20SAN	1N1163	20SAP	1N1177
	300	210	210	350	30SAN	1N1164	30SAP	1N1178
	400	280	210	350	40SAN	–	40SAP	–

Rated at from 0.325 to 250 amps,
in complete variety of case designs and terminals

Proved performance, low cost, prompt shipment from stock

Sarkes Tarzian's "Designers' Line" silicon rectifiers offer the small size, high efficiency, mounting versatility, and wide range of ratings that can help solve many of your power conversion circuitry problems. Tarzian's realistic prices make these high quality components practical for almost all commercial and military applications.

The 84 types of Tarzian "Designers' Line" rectifiers feature extremely low junction current density to provide maximum reliability and operating life. Their −55°C to +125°C temperature range makes Tarzian silicon rectifiers ideal for circuits where ambient temperatures are high and small size is desired. Ratings range from 0.325 to 250 amperes.

Tarzian types are available for immediate delivery in production quantities from factory or warehouse stocks. Complete power conversion engineering service on your rectifier requirements is available at no charge or obligation.

For further information contact your nearest Tarzian sales representative or write to Section 4394A, Semiconductor Division, Sarkes Tarzian, Inc., Bloomington, Indiana.

SARKES TARZIAN, INC.
SEMICONDUCTOR DIVISION
BLOOMINGTON, INDIANA
In Canada: 700 Weston Rd., Toronto 9, Ontario
Export: Ad Auriema, Inc., New York City

amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
.35	50	35	210	350	5S3N	–	5S3P	–
	100	70	210	350	10S3N	–	10S3P	–
	200	140	210	350	20S3N	–	20S3P	–
	300	210	210	350	30S3N	–	30S3P	–
	400	280	210	350	40S3N	–	40S3P	–
100	50	35	600	1000	5VAN	1N1165	5VAP	1N1179
	100	70	600	1000	10VAN	1N1166	10VAP	1N1180
	200	140	600	1000	20VAN	1N1167	20VAP	1N1181
	300	210	600	1000	30VAN	1N1168	30VAP	1N1182
	400	280	600	1000	40VAN	–	40VAP	–
	50	35	600	1000	5V3N	–	5V3P	–
	100	70	600	1000	10V3N	–	10V3P	–
	200	140	600	1000	20V3N	–	20V3P	–
	300	210	600	1000	30V3N	–	30V3P	–
	400	280	600	1000	40V3N	–	40V3P	–
150	50	35	900	1500	5WAN	1N1263	5WAP	1N1267
	100	70	900	1500	10WAN	1N1264	10WAP	1N1268
	200	140	900	1500	20WAN	1N1265	20WAP	1N1269
	300	210	900	1500	30WAN	1N1266	30WAP	1N1270
	400	280	900	1500	40WAN	–	40WAP	–

amps. DC (100° C)	peak inverse voltage	max. RMS volts	max. amps. recurrent peak	max. amps. surge 4MS	NEGATIVE Tarzian Type	NEGATIVE Jedec No.	POSITIVE Tarzian Type	POSITIVE Jedec No.
150	50	35	900	1500	5W3N	–	5W3P	–
	100	70	900	1500	10W3N	–	10W3P	–
	200	140	900	1500	20W3N	–	20W3P	–
	300	210	900	1500	30W3N	–	30W3P	–
	400	280	900	1500	40W3N	–	40W3P	–
200	50	35	1200	2000	5XAN	1N1263A	5XAP	1N1267A
	100	70	1200	2000	10XAN	1N1264A	10XAP	1N1268A
	200	140	1200	2000	20XAN	1N1265A	20XAP	1N1269A
	300	210	1200	2000	30XAN	1N1266A	30XAP	1N1270A
	400	280	1200	2000	40XAN	–	40XAP	–
	50	35	1200	2000	5X3N	–	5X3P	–
	100	70	1200	2000	10X3N	–	10X3P	–
	200	140	1200	2000	20X3N	–	20X3P	–
	300	210	1200	2000	30X3N	–	30X3P	–
	400	280	1200	2000	40X3N	–	40X3P	–
250	50	35	1500	2500	5Y3N	–	5Y3P	–
	100	70	1500	2500	10Y3N	–	10Y3P	–
	200	140	1500	2500	20Y3N	–	20Y3P	–
	300	210	1500	2500	30Y3N	–	30Y3P	–
	400	280	1500	2500	40Y3N	–	40Y3P	–

MARKET RESEARCH

Military Marketing Strategy

DON'T LET steadily rising military electronic equipment spending totals trick you into relaxing your military marketing efforts, says Lore A. Frost of Stewart, Dougall & Associates, marketing consultants.

Paradox of today's military market is that total military electronics spending is on the way up, but new business opportunities are on the way down, he says.

Faced with a relatively static budget total and rising equipment costs, the Department of Defense is becoming increasingly selective of the weapon systems it supports, Frost says. Already a number of aircraft and missile systems, considered of marginal value by the military, have been cancelled.

Competition Increasing

Moreover, competition for available electronic equipment contracts is getting more intense as aircraft firms are rushing to build up their electronic capabilities in order to offset declining aircraft dollars.

How can you help your firm get its share of new military business despite these added difficulties?

Examine your technical capabilities in the light of your company's long-run product objectives, says Frost. Ask yourself, in what areas do we have superior technical capabilities and to what degree will these capabilities be needed in the future?

Decide which agencies and prime contractors are going to purchase the type of equipment you are capable of making or designing. Develop a plan for making and keeping these potential customers aware of your capabilities.

Take a hard look at your field engineering sales force, contract administration groups and other customer contact personnel. Do they understand your company's product objectives? Are they creating a picture of your company that is compatible with your product objectives?

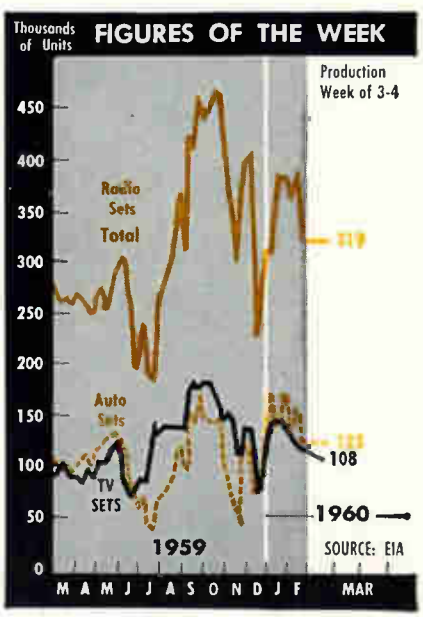
• **Use of on-line computers** to control business and manufacturing processes will become commonplace in the near future, James M. Madigan, development scientist at B. F. Goodrich Chemical Co., told the American Management Association Data Processing Conference.

Madigan played a key role in the selection and installation by B. F. Goodrich of a Thompson Ramo Wooldridge computer to control production of two chemical processes: vinyl chloride, used in the production of vinyl resins; and acrylonitrile, used in the manufacture of synthetic rubber.

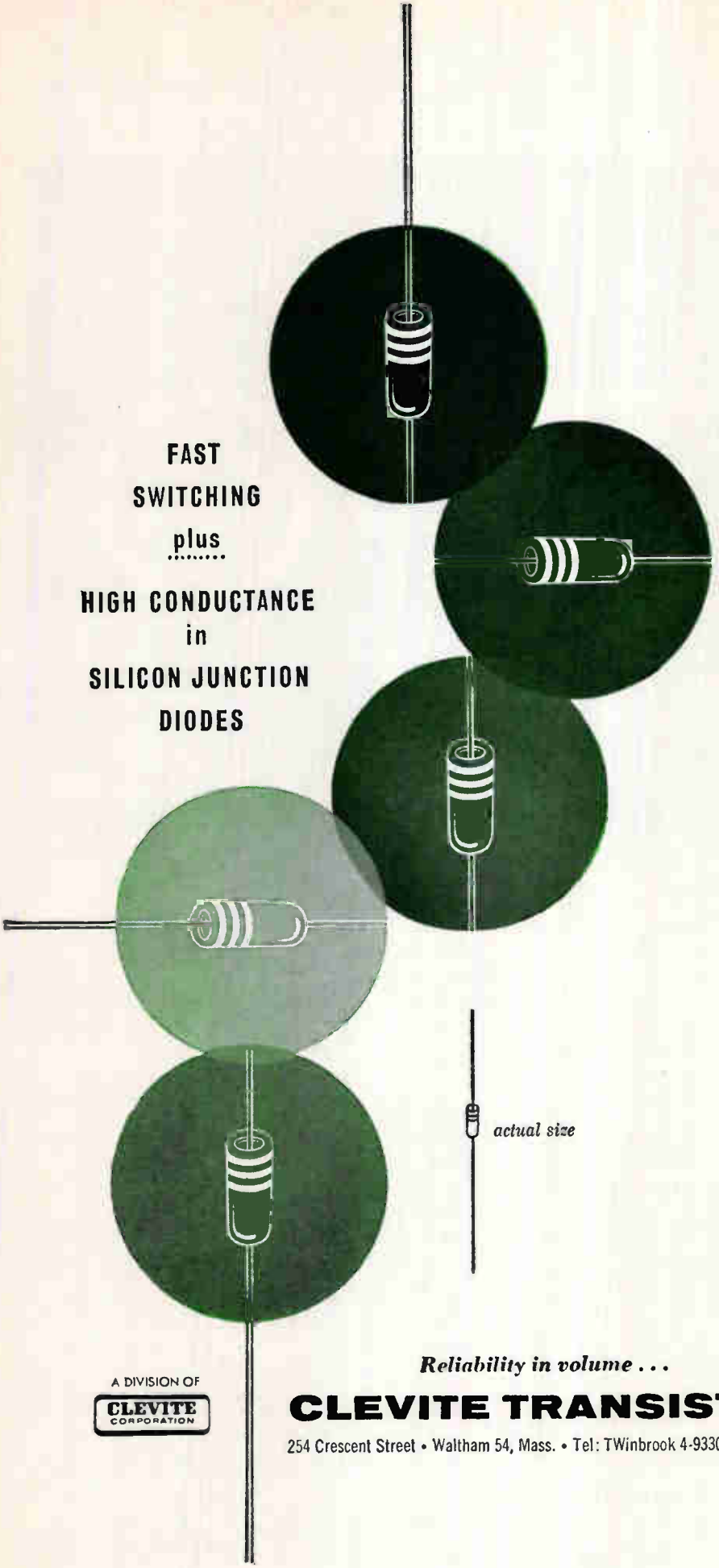
Boosts Efficiency

The RW-300 computer takes an overall look at plant economics and calculates best operating conditions for the day. Efficiency in terms of inventory control and better utilization of raw materials or equipment are its aims. No effort is made to replace labor, since an irreducible minimum is used in these chemical plants.

Processes most likely to use computer control systems are those with a high production capacity where a small increase in plant efficiency can result in considerable dollar savings, he said. On-line computer control systems are already operating or have been announced in the chemical, petroleum, cement, power generation, aircraft, missile, steel and electronics industries.



FAST SWITCHING plus HIGH CONDUCTANCE in SILICON JUNCTION DIODES



actual size

SWITCHING TYPES

New circuit possibilities for low impedance, high current applications are opened up by Clevite's switching diodes. Type CSD-2542, for example, switches from 30 ma to −35v. in 0.5 microseconds in a modified IBM Y circuit and has a forward conductance of 100 ma minimum at 1 volt.

Combining high reverse voltage, high forward conductance, fast switching and high temperature operation, these diodes approach the ideal multi-purpose device sought by designers.

GENERAL PURPOSE TYPES

Optimum rectification efficiency rather than rate of switching has been built into these silicon diodes. They feature very high forward conductance and low reverse current. These diodes find their principal use in various instrumentation applications where the accuracy or reproduceability of performance of the circuit requires a diode of negligible reverse current. In this line of general purpose types Clevite has available, in addition to the JAN types listed below, commercial diodes of the 1N482 series.

MILITARY TYPES

JAN

1N457	MIL-E-1/1026
1N458	MIL-E-1/1027
1N459	MIL-E-1/1028

Signal Corps

1N662	MIL-E-1/1139
1N663	MIL-E-1/1140
1N658	MIL-E-1/1160
1N643	MIL-E-1/1171

All these diodes are available for immediate delivery. Write now for Bulletins B217A-1, B217A-2, B217-4.

Phone for data and prices.

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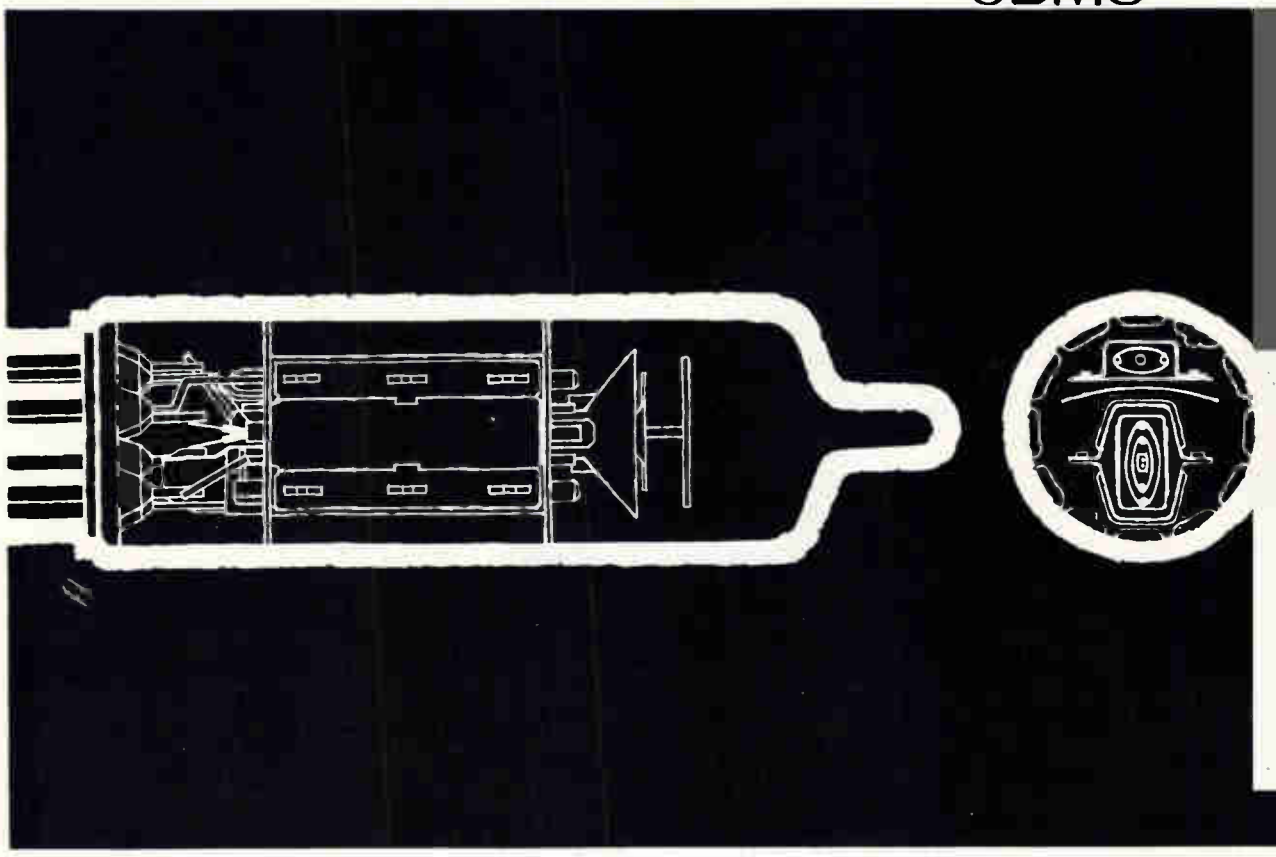

triode pentode

Combined triode and output pentod
separate cathodes intended for use
a combined a.f. amplifier and outpu
or frame oscillator and output tube.

characteristics

Pentode section			
V_a	200	250	V
V_{g2}	200	250	V
I_a	35	28	mA
I_{g2}	7.0	5.7	mA
V_{g1}	−16	−22.5	V
g_m	6.4	5.0	mA/V
r_a	20	25	kΩ
μ_{g1-g2}	9.5	9.5	
Triode section			
V_a		100	V
I_a		3.5	mA
V_g		0	V
g_m		2.5	mA/V
r_a		28	kΩ
μ		70	

SUPPLIES AVAILABLE FROM

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Rogers Electronic Tubes & Compor
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CIRCLE 28 ON READER SERVICE CARD

CIRCLE 29 ON READER SERVICE

MOLECULAR ELECTRONICS

THE THIRD MAJOR BREAKTHROUGH in the history of electronics...

as significant today as the vacuum tube in 1907... as the transistor in 1948.

Molecular electronics use new insights into the structure of matter to create single crystals which perform one or more complete electronic functions in the control and transformation of energy.

Westinghouse can now report startling progress in this fantastic field—in this status report on a U. S. Air Force research program which began less than a year ago.

Fact one: molecular electronic systems are here today—in laboratory models which prove out the principle even as they pave the way for production models. On the next two pages are a number of different molecular electronic devices performing the functions of familiar systems, without conventional components.

Fact two: each one incorporates germanium or silicon crystals—etched, sprayed or alloyed.

Fact three: each one is a functional block which performs the missions usually requiring conventional components soldered together.

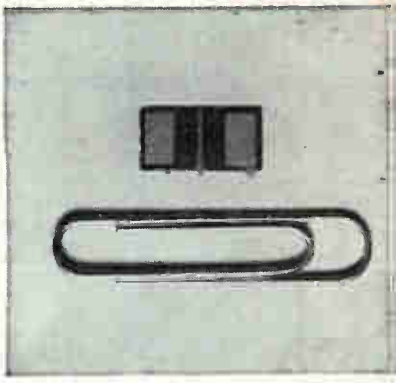
Prediction: soon, multi-zoned crystals will be "grown" and processed directly from the furnace melt—may emerge as ready-made electronic systems.

Prediction: only two to five years from now, the pattern of electronic systems will be changed to the core as a result of this historic Westinghouse breakthrough in research and development. Reliability, miniaturization and simplicity will show exponential progress.

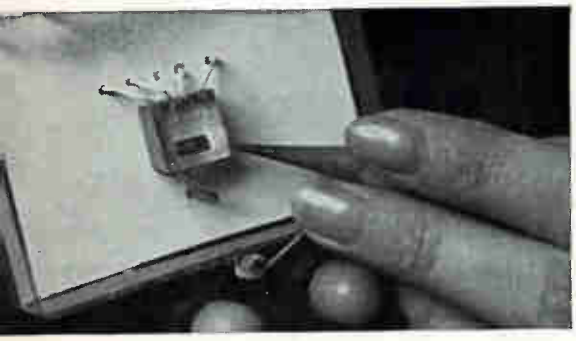
Westinghouse presents working proof of the principle of molecular electronics

POWER AMPLIFIER: Button-sized molecular electronic device held by girl with a pair of tweezers performs the same amplifying function as a conventional 5-watt amplifier, has a frequency range from zero to 20,000 cycles. Working element is a block about as large as the head of a pin.

VIDEO AMPLIFIER: made with a tiny wafer from a ribbon of germanium crystal. This function block also works like a radar amplifier sub-system. Gain is essentially flat to frequencies of several megacycles.



MULTIVIBRATORS: bistable, monostable, and astable—covering frequencies from 1 cycle or less to 3 megacycles. Shown is a free running multivibrator alongside paper clip.

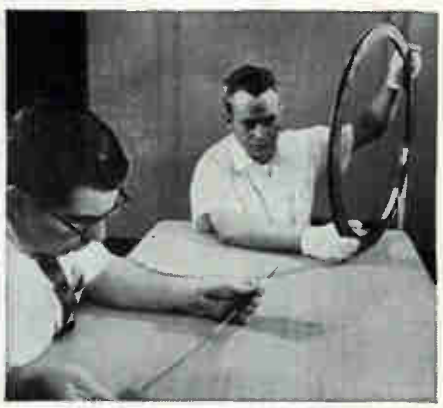


MULTI-POSITION SWITCHES: these molecular electronic devices evolved out of Westinghouse work on multivibrators—the "OR" logic switch illustrated has important potential applications in missile countdown functions.

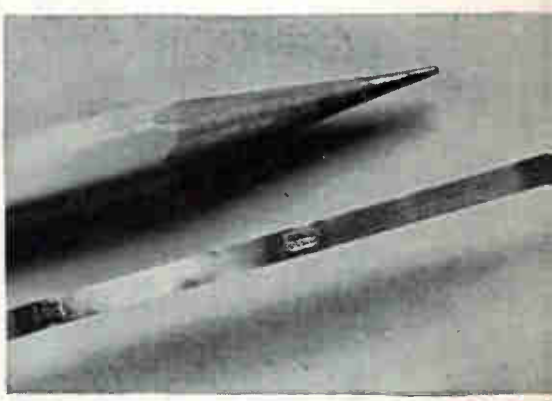
LIGHT TELEMETRY SUBSYSTEM: a single light-responsive monolithic element delivers output whose frequency is a measure of light intensity.

CIRCLE 30 ON READER SERVICE CARD

D-C AMPLIFIER: connected to a solar cell, this tiny block takes an input of 4 milliamps . . . via flashlight beam, raises it to 40-watt output.



CRYSTAL GROWING techniques developed by Westinghouse have already produced germanium dendrites 300 feet long in the special furnace shown at left, above. Crystal ribbons of almost any length are possible. The take-up reel at right holds 300 feet of the brittle dendrite with each turn cushioned on glass-cloth tape.



CRYSTAL RIBBON requires no grinding or lapping. Only a few steps are needed to turn these "educated" crystals into working electronic systems. Above, multiple-junction systems are shown on a crystal section.

The meaning of molecular electronics

RELIABILITY: molecular systems reduce drastically the number of components and internal connections required—and the fewer components and connections the fewer potential trouble spots.

MINIATURIZATION: molecular electronic systems are less than one-thousandth the volume and weight of conventional component systems. This is a conservative generalization—in many cases, much more startling size and weight reductions are possible.

POWER REQUIREMENTS: input power can drop almost as fantastically as size and weight. In a typical light telemetering sub-system, a 5-watt input is required; the transistorized version gets by with 0.75 watts. The same function is still performed by a molecular electronic block requiring but 0.06 watts.

ENVIRONMENT: inherently more resistant to g-loads because of their small mass and few components, Westinghouse-developed molecular systems show promise to be temperature and radiation resistant as well. New semiconductor materials and new large crystal surfaces point to very high temperature and power-handling capabilities.

FUTURE: progress in this new field is so rapid, and the advantages so great, that the molecular electronics concept will find wide applications in air/space electronic systems within 3-5 years . . . In particular, look for great advances in the state of the art in these areas: telemetering • fire control guidance • communications • counter weapons • flight control—as a direct result of the new molecular electronics era.

The Air Arm Division of Westinghouse Electric Corporation holds the U. S. Air Force management contract for this project. It is being supported by the Semiconductor Department, the Materials Engineering Department, and the Westinghouse Research Laboratories.

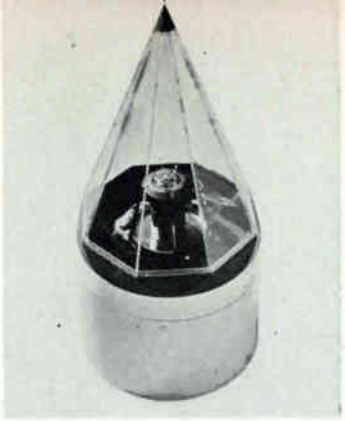
J-02311-1-3

CIRCLE 31 ON READER SERVICE CARD

WESTINGHOUSE / DEFENSE PRODUCTS

1000 CONNECTICUT AVENUE, N. W., WASHINGTON 6, D. C.

Bloodhound



Firestreak

Seaslug

More U. S. Gear Going Into

By Derek Barlow
McGraw-Hill World News

LONDON—A recent spate of tie-ups between American guidance firms and British licensees is ensuring that Britain's second generation missiles — Blue Streak, Blue Steel, Blue Water—carry at least American-developed guidance components if not complete systems.

Here are the outstanding tie-ins:

English Electric manufactures Minneapolis-Honeywell gyros and inertial components under license; Ferranti teams up with Kearfott Co. for floated rate-integrated gyros; Elliott Brothers Ltd. couples with Bendix, while Sperry-Rand supplies U. S.-developed components through its British-based company, Sperry Gyroscope Co. Ltd.

This influx of U. S. guidance systems into British missiles is new. In the first generation missiles—five systems now in operational service—the British provided both the overall system design and components. Of the three main missiles, guidance on the Bloodhound, Thunderbird and Seaslug was all British concept and components.

In the second missile generation Britain still provides overall system design but can't and won't parallel the costly development program proceeding Stateside for higher-accuracy, more complex guidance components. Items like inertial platforms and high accuracy gyros, Britain feels, are more economically obtained through licensing arrangements.

But the information flow is not all one way. On Blue Streak—test firings of this Sperry-guided first British LRBM are due later this year—says Defense Minister Harold Watkinson, "the missile owes something of its design to the American Atlas rocket and we have been able to be of some help to the Americans from what we have learned from the development."

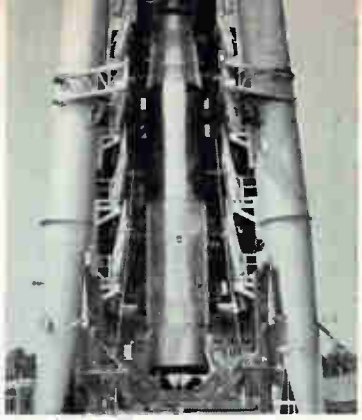
Precise areas where the British helped have not been officially disclosed but ELECTRONICS learns that it is in the system peripheral gear that this information flowback occurs.

Example quoted in a checkup of industry is the NASA interest in linear pot accelerometers,, lead zirconate accelerometers, high accuracy potentiometric transducers and tachogenerators.

Britain's First Two Missile Generations

NAME	TYPE	RANGE MILES	USER SERVICE	GUIDANCE CONTRACTOR	SYSTEM
IN OPERATIONAL SERVICE					
Bloodhound	surface to air	250	Air force	Ferranti and Associated Electrical Industries	Semiactive homing system where missile-borne receiver detects reflected radiation from target
Firestreak	air to air	10	Air force	De Havilland Propellors Ltd.	Passive infrared homing unit with pneumatic actuated controls
Seacat	surface to air	30-40	Navy	Short Bros. & Harland Ltd. Elliott Bros. Ltd.	Believed to be radio command
Seaslug	surface to air	40	Navy	Sperry Gyroscope Ltd. General Electric Company	Beam riding with electrohydraulic servos operating four control fins
Thunderbird	nuclear tactical weapon	40-50	Army	English Electric Ltd. Marconi Instruments Ltd.	Semiactive homing using target illuminating radar
UNDER DEVELOPMENT					
Blue Streak	LRBM	2500	Not known	Sperry Gyroscope Ltd.	Inertial system details not known
Blue Steel	stand-off bomb	300	Air force	Elliott Brothers Ltd.	Inertial system linked to aircraft parent up to launching
Blue Water	surface to surface	45	Army	English Electric	Believed to have lightweight inertial system
TEST ROCKET					
Black Knight	test vehicle	—	Not applicable	Royal Aircraft Establishment	Simple 2-gyro system

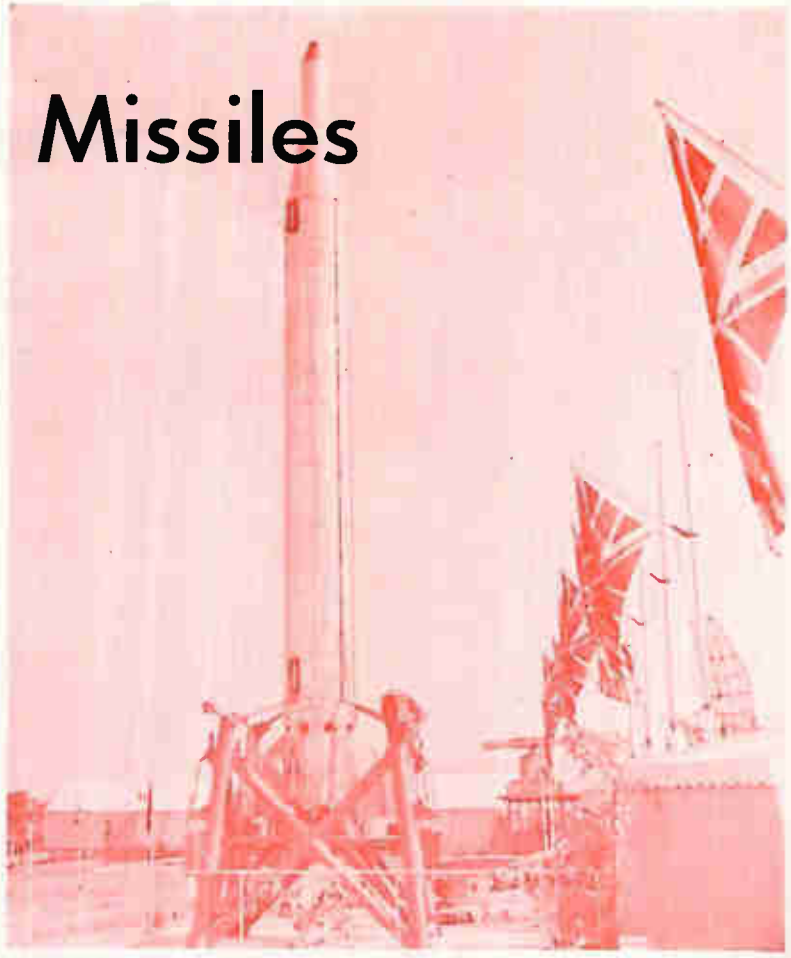
Blue Steel



Blue Streak

Thunderbird

New British Missiles



Black Knight

It's in these categories that British guidance equipment is most likely to show up in the U. S. There's no prospect of a sales push to get them into American missiles. For the most part they are simply going into the catalogs of British firms for sales wherever sales can be found—and the Britsh will be looking much more to industrial applications than missile uses.

Production figures on operational missiles are closely guarded. Only guides available are the expanding deployment of Bloodhound squadrons around four Thor deterrent bases, each squadron divided into two flights of eight missiles.

On Thunderbird, two anti-aircraft army regiments are under training—each comprising two batteries of four launchers, a target illuminating radar and a tactical control radar.

At sea all anti-aircraft defenses on four new escort destroyers will be from Seaslug missiles.

The home operational needs alone provide the manufacturing load for Britain's missile industry; overseas sales are virtually non-existent.

Even after an intensive government-encouraged drive, the future looks bleak. So far only Sweden has ordered British missile systems, the Bloodhound and Seacat.

How Anglo-American guidance deals work out in the future will depend on policy, not techniques.

Recent Defense White Paper, which put new stress on mobility both for nuclear and conventional weapons, emphasized that Britain is looking at mobile-launched missiles as supplements to—maybe even replacements for—the fixed-base Blue Streak.

Not known yet is whether Britain will develop her own or will use the American Skybolt airborne and/or Polaris seaborne delivery system.

A look at the American developments is a major item on Watkinson's agenda for a U. S. trip this spring or summer. Most likely course is adaption of one of the American weapons, and Watkinson himself is known to lean toward the Skybolt since its carriers can be used for multiple purposes.

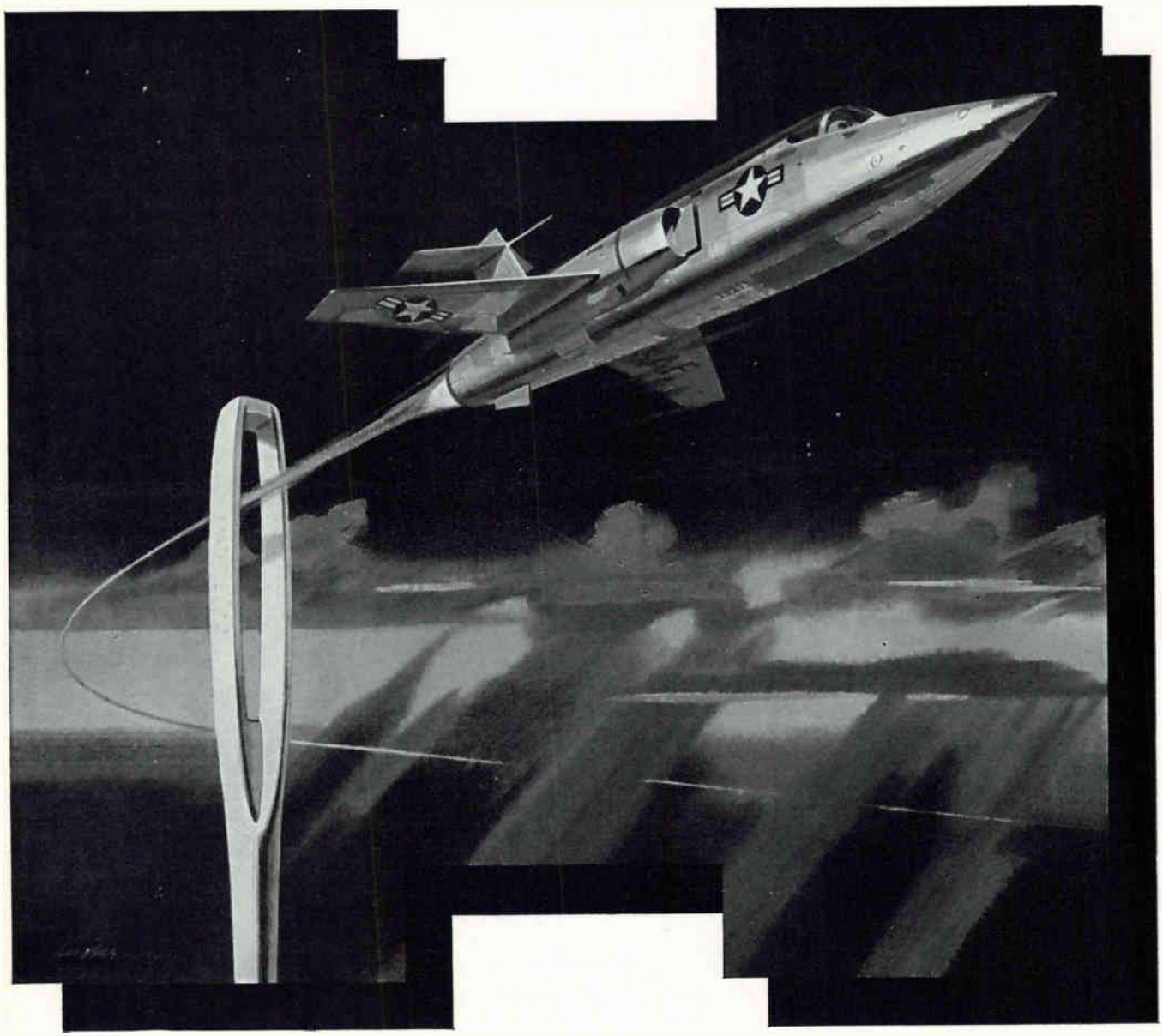
Even in its space role, Blue Streak still awaits a governmental green light for coupling to a modified Black Knight vehicle in a space system capable of putting up a 75-lb lunar probe.

Final unknown is British plans for future short range missiles. On whether or not more U. S.-developed missiles are adopted hangs the future of Britain's control and guidance teams.

To prevent any disbandment, most people believe a further series of British-developed missiles is planned.

Whatever the answers, though, U. S. guidance equipment is sure to have an increasing stake in the British missile field.

How to thread a needle



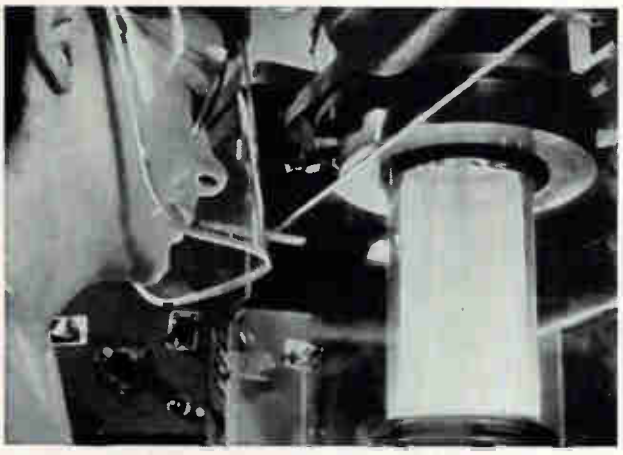
The Fording Test *is typical of the tough environmental tests imposed upon advanced electronic equipment designed and produced by Hughes Fullerton engineers.*

in the dark

TARAN (Tactical Attack Radar and Navigator) is typical of the important new electronic systems developed by Hughes—in an atmosphere famed for its engineering orientation.

Hughes engineers have designed this system to enable pilots to fly blind at very low altitudes in any kind of weather—and actually deliver any kind of armament at tactical targets.

TARAN's amazing abilities are based on several major electronic advances developed by Hughes engineers: A radar system with several times the range and azimuth resolution of current radars. An Automatic Navigation and Display System which pinpoints position continuously and automatically corrects for any navigational deviations. A unique terrain clearance indication warns the pilot of any obstacles when flying at low altitudes. A radar antenna utilizing electronic rather than mechanical lobing.



Molten Ladle *of silicon is watched during first step in the precise manufacture of Hughes semiconductors, just one of the Hughes commercial activities.*

Other Hughes activities provide similarly stimulating outlets for creative engineers. A few representative project areas include: advanced data processing systems, molecular electronics, advanced 3-D surface radar systems, space vehicles, nuclear electronics, ballistic missiles, infrared devices—and a great many others. The commercial activities of Hughes have many interesting assignments open for imaginative engineers to perform research, development, manufacturing of semiconductors, electron tubes, and microwave tubes.

Whatever your field of interest, you'll find Hughes' diversity of advanced projects gives you widest possible latitude for professional and personal growth.

Newly instituted programs at Hughes have created immediate openings for engineers experienced in the following areas:

Electroluminescence	Equipment Engineering
Infra-red	Microwave & Storage Tubes
Solid State Physics	Communications Systems
Digital Computers	Inertial Guidance
Reliability & Quality Assurance	Field Engineering
Systems Design & Analysis	Circuit Design & Evaluation

Write in confidence to Mr. R. A. Martin
Hughes General Offices, Bldg. 6-D3, Culver City, Calif.

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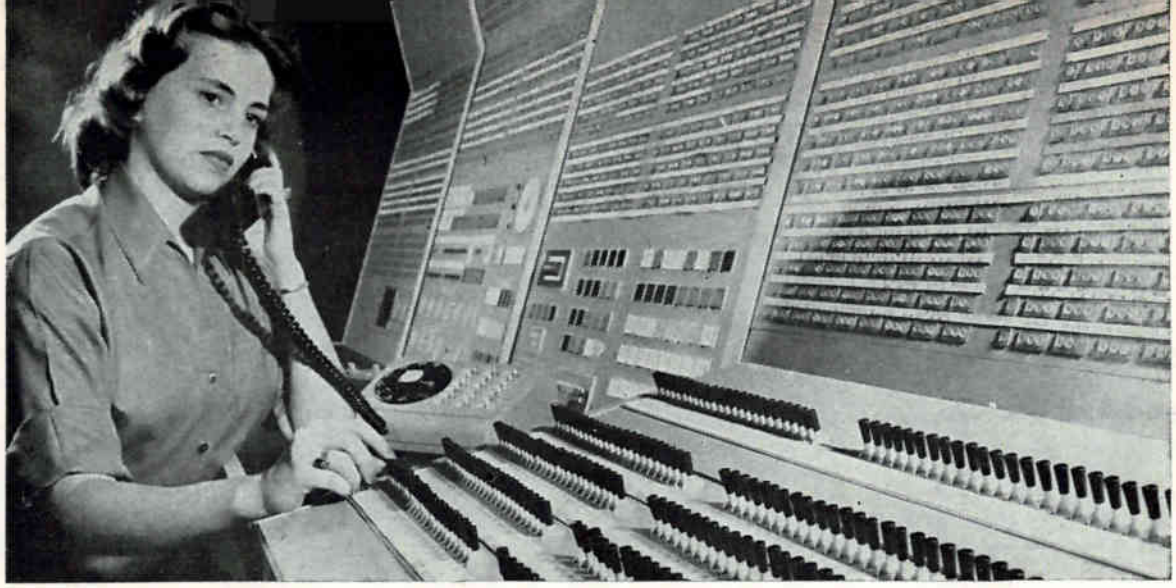

Mock-up of data processing subsystem console for SAC's new world-wide combat control system

First Details on SAC Control System

By JOHN F. MASON, Associate Editor

A COMPLETE PROTOTYPE of the Strategic Air Command's automatic combat control system is being set up in Paramus, N. J., ELECTRONICS learns this week.

The prototype is in a facility resembling SAC's famed underground headquarters at Offutt, Neb.

Object of the big test facility is to check out the new 465-L system called SACCS (SAC Control System). The final control system will be installed at Offutt by prime contractor International Electric Corp. (IEC), a subsidiary of International Telephone and Telegraph. Some $300 million has already been spent on the program.

The system (ELECTRONICS, p 35, Feb. 27, 1959) provides for complete modernization of the existing SAC control system and will insure compatibility with other information and support systems of the Air Force.

IEC's design engineers will use "Little SACCS" in Paramus to check out systems' compatibility, human engineering details for the man-machine complex, and operational and maintenance problems.

Besides instructing operations and maintenance men, general officers will be able to familiarize themselves with the system to establish new working procedures. Improvements in speed, thoroughness and comprehensiveness over the old system will have a big impact on operational and organizational methods used by SAC.

The new system's primary advantage over SAC's present control system is its complete automation. The new electronic complex will eliminate all human steps between data acquisition, communications, data processing and written and visual display.

Four Subsystems

Communications — an indispensable link in the system—will be provided by SAC's normal communications networks, which include telephone, teleprinter, ssb radio, and in the future, relay satellites. The 465-L system, per se, handles requirements at the bases and headquarters themselves: data acquisition, switching, data processing and storing and presentation.

The new system consists of four main subsystems: Remote Communications Complex (RCC), Traffic Control Center (TCC), Data Processing Subsystem (DPSS), and Data Display.

RCC's are the ends of the gigantic nerve system that makes into a single striking arm SAC's 70 or more bases on four continents and ten announced missile sites. Each command post feeds into its RCC information pertaining to local aircraft and missile status and disposition, logistics, maintenance, intelligence, weather, missile readiness, personnel availability and proficiency.

Messages are introduced into the system in several ways: through manually operated teletypewriters for narrative messages; through automatic message composers for messages with few variables; and through semiautomatic message composers for standard messages with original modifications.

Messages may also be introduced directly and automatically from other equipments and systems.

All messages are automatically coded or decoded, converted to or from digital form by the modulator-demodulator (MODEM), and transmitted or received.

A high-speed electrostatic output printer is capable of printing incoming messages at the basic transmission rate.

Though RCC's can communicate with each other, their main function is to exchange information with higher headquarters.

Traffic Control Center

A nerve center for a group of RCC's is called a Traffic Control Center (TCC). Here, messages are both received and sent out. On being received, a message is automatically checked for validity, then transferred to various temporary and permanent magnetic stores.

The TCC automatically switches

and routes all incoming messages. Data not involving the war plan are routed to designated addresses —for example, another RCC. Information pertinent to the war plan is so designated by code at the point of origin and automatically goes from the TCC to the computer for filing and updating.

Any information stored in one computer is automatically transmitted for storage in all computers. Any temporarily non-operative computer in the system can be automatically updated, once it is repaired, by a computer at another TCC. A commander whose computer is on the blink can use the computer at another headquarters.

The focal point of the TCC is the Stored Program Element. This machine is a programmed message switching device. It can receive messages, analyze through programming what is to be done with the messages, and proceed to deliver the messages to other RCC's, to computers or possibly to the Display Subsystem.

Assures Reliability

A Fault and Facilities Control system assures complete reliability of the TCC system. A technical control console monitors the operation of the line equipment and transmission links originating and terminating at a TCC. In many cases faulty operation is automatically taken care of. If one means of communication begins to fade, the equipment will switch to another. If the coding equipment at an RCC goes off, alternate equipment immediately goes on. Vulnerable components are duplicated in the system for automatic replacement. Both visual and audible alarms are provided for failures.

A system status display provides an indication of the status of major elements of the 465-L.

A command status display summarizes information from the entire fault and facilities control where only total failures are displayed.

IBM's Military Computer, used in the DPSS, is similar to the firm's improved SAGE computer, and eight times faster than the 7090. The core memory consists of magnetic cores of 64,000-word capacity, expandable to 128,000 words.

(Continued on p 41)

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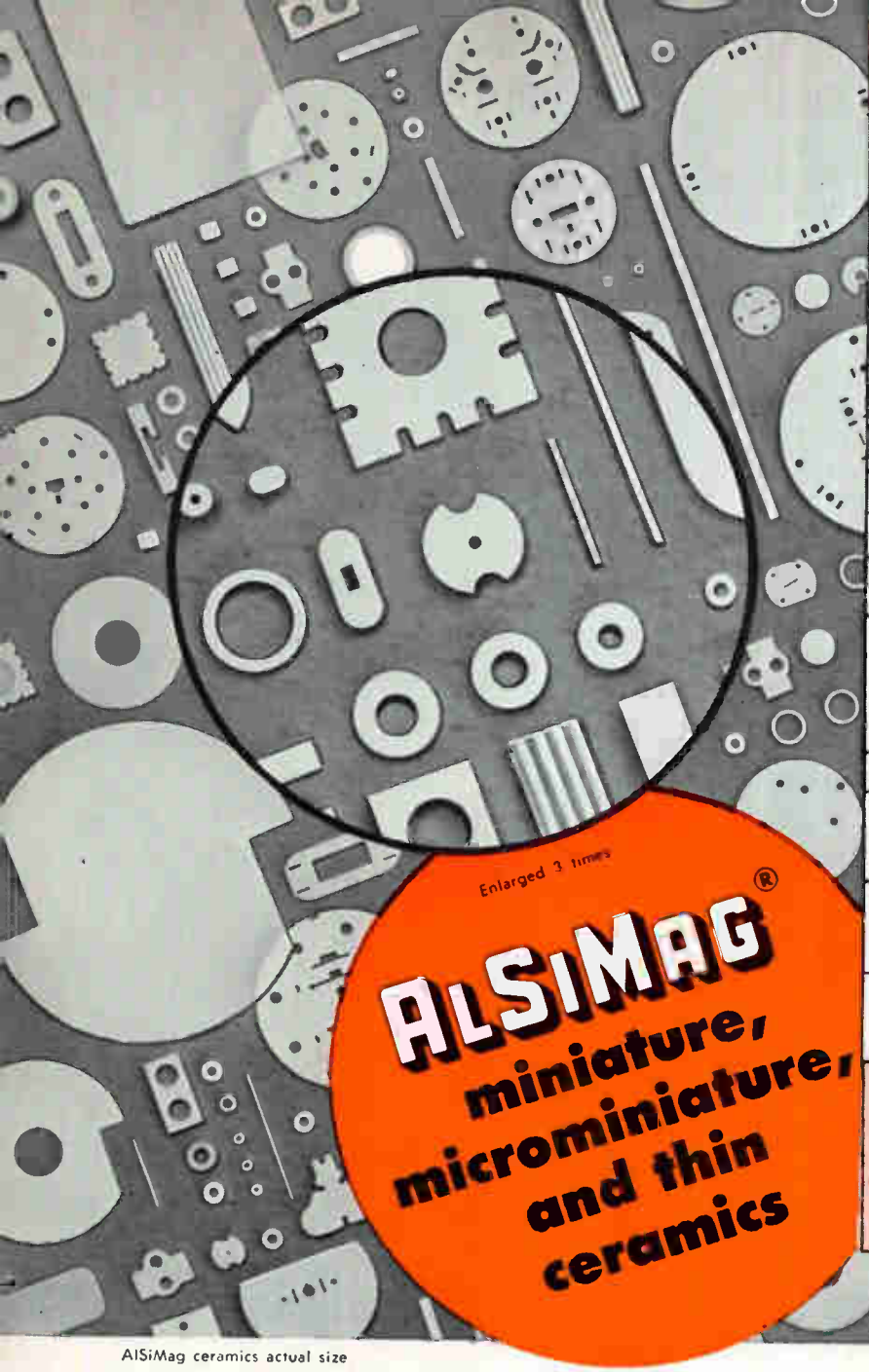

AlSiMag ceramics actual size

Mechanical and Electrical Properties of AlSiMag Alumina Ceramics 393, 548, 614

PROPERTY		ALSIMAG 393	ALSIMAG 548	ALSIMAG 614
Water Absorption		12 to 18 Highly Porous	14 to 17 Highly Porous	0.00 Impervious
Specific Gravity		2.4	2.4	3.7
Density		.087	.087	0.135
Softening Temperature		1 800 3 272	2 050 3 722	1 650 3 002
Safe Temperature at Continuous Heat		1 400 2 552	1 600 2 912	1 550 2 822
Hardness		———	———	9
Thermal Expansion Linear Coefficient		6.0×10^{-6} 7.2×10^{-6}	6.9×10^{-6} 8.2×10^{-6}	6.5×10^{-6} 7.9×10^{-6}
Tensile Strength		———	———	25 000
Compressive Strength		30 000	10 500	400 000
Flexural Strength		10 000	8 000	60 000
Resistance to Impact (½" rod)		3.0	3.0	7.0
Thermal Conductivity (Approximate Values)		.004	.004	.045
Dielectric Strength (step 60 cycles) Test discs ¼" thick		50	50	230
Volume Resistivity at Various Temperatures	25°C.	$>10^{14}$	$>10^{14}$	$>10^{14}$
	100°C.	5.0×10^{12}	$>10^{14}$	2.0×10^{13}
	300°C.	1.0×10^{10}	$>10^{14}$	1.1×10^{10}
	500°C.	7.5×10^{7}	1.0×10^{10}	7.3×10^{7}
	700°C.	3.6×10^{6}	2.7×10^{8}	3.5×10^{6}
	900°C.	5.6×10^{5}	8.0×10^{6}	6.8×10^{5}
Te Value		835 1 535	1 000 1 832	840 1 544
Dielectric Constant	60 Cycles	———	———	———
	1 MC.	5.5	5.5	9.3
	100 MC.	5.3	———	———
	10,000 MC.	———	———	9.1
Power Factor	60 Cycles	———	———	———
	1 MC.	.0005	.0005	.0003
	100 MC.	.0005	———	———
	10,000 MC.	———	———	.0014
Loss Factor	60 Cycles	———	———	———
	1 MC.	.003	.003	.0028
	100 MC.	.003	———	———
	10,000 MC.	———	———	.013

These are the most frequently used AlSiMag ceramic compositions for small or thin designs.

Other AlSiMag formulations are available to meet highly specialized requirements. For advice on such requirements give operating details.

AlSiMag pioneered the custom manufacture of ceramics for modules and for micromodules and has long been known for its leadership in precision ceramics in small sizes and thin cross sections. Long experience has helped produce miniature and sub-miniature ceramics to tolerances generally associated with fine metal work.

Uniformity of material and dimension is necessary to reach goals of micro-miniaturization.

AlSiMag ceramics are playing their part in increasing reliability of these components and in greatly reducing sizes of sub-miniature electronic components.

Even the close tolerances required in vacuum tube insulators and spacers are maintained in these AlSiMag microminiature ceramics without grinding. Tubes with walls as thin as .010" and flat shapes as thin as .005" are produced regularly.

These precision ceramics are widely used as electron tube components . . . supports, spacers, envelopes, windows . . .and as micromodule wafers, transistor bases, relay components, etc.

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SERIES LT/LC		SERIES HN	

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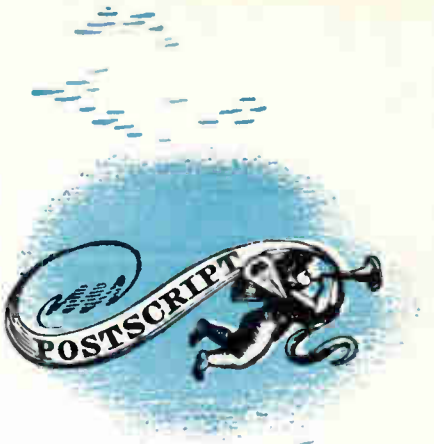

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SAC System

(Continued from p 37)

The fully transistorized DPSS is divided into a central processor unit, peripheral control unit, interrupt and off-line processors.

The central processor includes the arithmetic, instruction control and high speed core memory.

The peripheral control unit regulates the input/output binary stream traffic of the auxiliary drum, tape memories, communication between the TCC and typewriter, the computer, typewriter, printer and punch.

The interrupt system will operate on machine-detected errors.

Data Presentation Subsystem

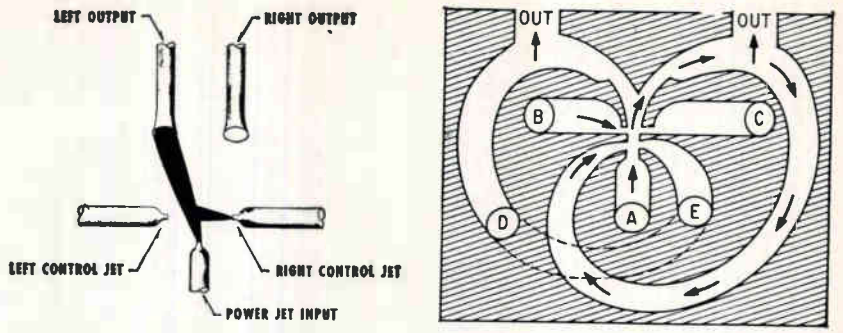
Equipment for the visual display system consists of large display surfaces with automatic projection units called quadrajectors, hard copy printouts supplied by electronic printer units and request panels for interrogation.

The most frequently used pages of information are stored in a ready store drum of the SPE and are kept updated by the computer. When a request panel requires information that is not in a ready store, the TCC signals the computer. The computer then proceeds to extract the information from its files, processes it as desired and returns the answer to the TCC, which then routes data to desired display output device.

One big requirement of the 465-L system is compatibility with all systems within SAC and outside systems with which there is a link.

Computers in USAF's 438-L intelligence system and the 433-L weather system, if not directly tied in with the 465-L, will at least have to speak the same language. Other systems with which the 465-L will be involved include the North American Defense Command's 425-L, and the 473-L. Called Quick Globe, 473-L is the projected communications center for the Pentagon to provide USAF brass with instant status information from all subordinate commands.

Systems Development Corp., under subcontract to IEC, is studying systems analysis, programming for the computer traffic handling, training requirements, and how operations can be streamlined.



Left: Deflection of power stream by control stream is basic amplifier operation. Right: Basic operation of fluid flip-flop showing fluid feedback loop

Future for Fluid Amplifiers?

Army discloses new device which uses gas and liquid pressures instead of voltages

WASHINGTON—A new nonelectronic amplifier is receiving attention this week. It is called a fluid amplifier and was developed at Army's Diamond Ordnance Fuze Laboratory here.

Inventors of the unit—which may lead to a new family of control devices—are three civilian scientists at the lab, B. M. Horton, R. E. Bowles and R. W. Warren.

The fluid amplifier is approximately ¼ in. across and 3/1,000 deep. Unlike transistors and vacuum tubes that require voltage for operation, this amplifier uses gas or liquids under pressure as a source of power.

What It Does

The inventors say the unit can perform amplification, feedback, digital computation, analog computation, normal mathematical functions and memory.

Operational speed up to 20 Kc makes this unit faster than other fluid systems with moving parts, but much slower than electronic circuits.

The basic idea of the fluid amplifier is shown in the left illustration. A source of pressurized gas or liquid is applied to the power jet input. A low-power jet can be applied to the main jet stream to make it pass through the right or left output tubes. As the power stream can be controlled by a much lower power level, the device can be called an amplifier.

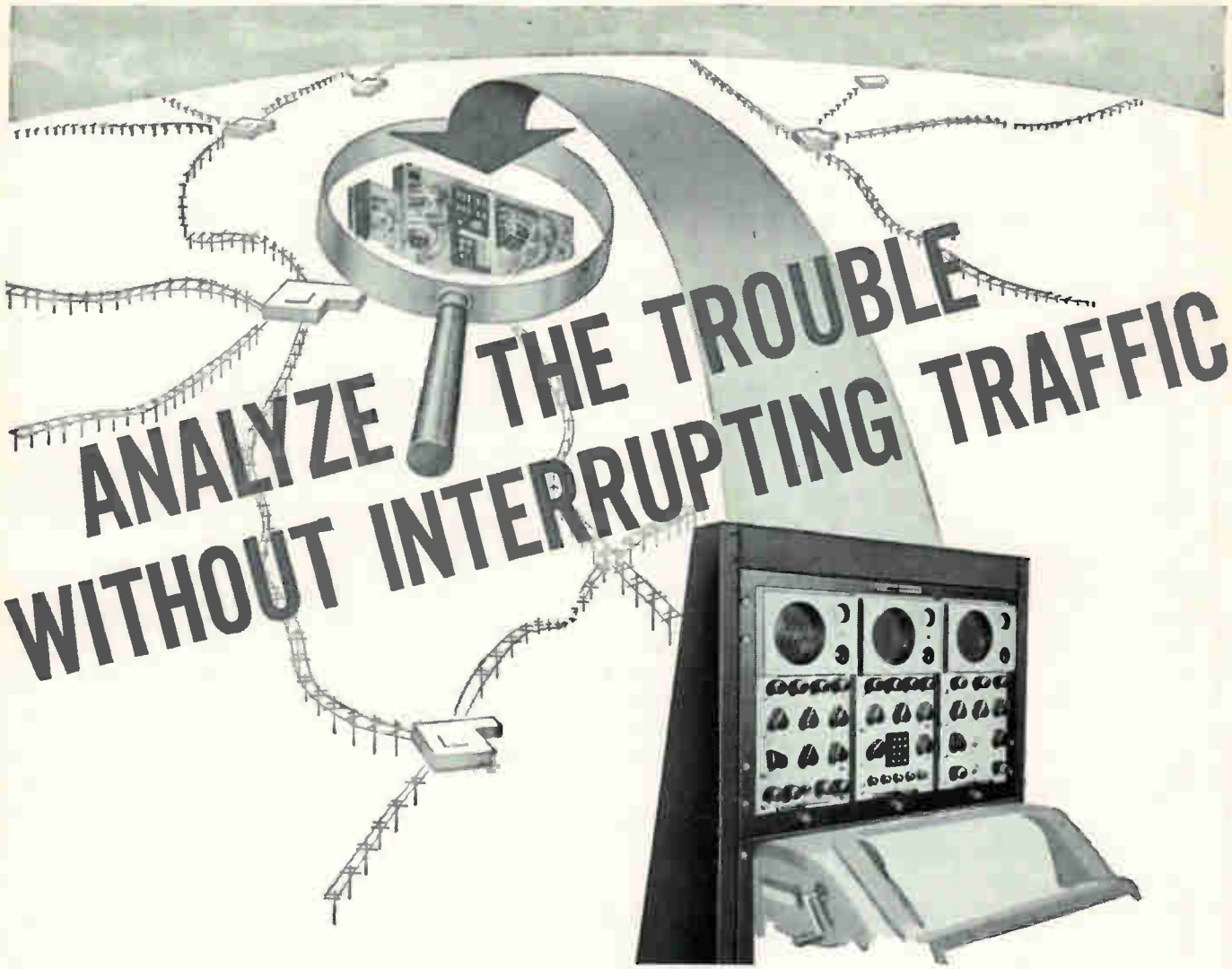
Operation of a typical flip-flop is shown in the illustration on the right. The main power jet input is at A. The pressurized fluid will pass through the throat into either of the two channels at the right or left. Assuming that the control jet is applied through channel B, then the fluid will flow around the right-hand channel back to the throat and be directed against the power jet to reenforce the control jet applied through B. With no control signal applied, the flip-flop will be stable in this condition.

When a fluid pressure is applied through channel C, then the jet stream will pass to the left-hand channel, through the orifice marked D, around the back of the flip-flop and out the orifice marked E and operate on the jet stream to make the other stable state. Output can be taken from either of the two sides.

The gas or liquid power source can be any gas or liquid compatible with material used to make the body of the flip-flop. Bottles of compressed fluids, gas generators or the dynamic pressure of the fluid around the vehicle can be used.

Possible Uses

The device can be used to drive pistons, air motors or can be coupled to similar units to perform logic functions. To transmit signals any distance, pressure switches can be used to convert the pneumatic outputs into electrical signals.



how to reduce down-time on telegraph and data transmission circuits

Radiation's new Telegraph Distortion Monitoring System (TDMS) provides in one compact assembly complete testing, monitoring and signal waveform analyses of telegraph circuits and data transmission lines. This versatile unit makes possible on-line quality control of communications links. It indicates malfunctions, analyzes their causes—without interrupting the flow of traffic.

The Radiation TDMS, with miniaturized components for space-saving compactness, can replace most test equipment now required for teletype maintenance and monitoring. Thus, in addition to reducing circuit outage, the TDMS permits reduction of test equipment costs and increases maintenance efficiency. Portability is achieved at the "push of a button".

For a detailed description of the operation and capabilities of the TDMS, write for Brochure RAD E-100B. Address Radiation Incorporated, Dept. EL3, Melbourne, Fla.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR . . .

RADIPLEX—50—channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER—Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TELEMETRY TRANSMITTER—Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

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The MH is not a new relay.

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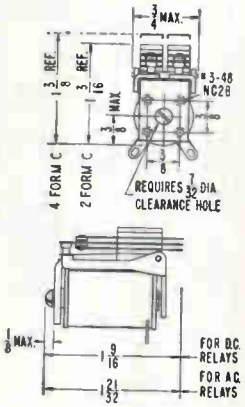
Engineers like its fast action, its small size, its light weight. They like the wide selection of contact forms . . . up to 18 springs (9 per stack, DC) as well as the fact MH relays can be furnished to switch loads ranging from dry circuit to over 5 amps at 115 volts, 60 cycle resistive.

A multiple choice of terminations add to the MH's versatility. This relay, for example, can be adapted for printed circuits, furnished with taper tabs or a long list of other terminals. Get all the facts by calling your nearest P&B sales engineer today.



MH ENGINEERING DATA

GENERAL:

Breakdown Voltage: 500 volts RMS between all elements.

Ambient Temperatures: −45° C to +85° C. (−65° C to +125° C on special order.)

Shock: 30g on special order.

Vibration: 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps. on special order.

Weight: 2½ ozs. max. (open relay)

Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:

Arrangements: Up to 9 springs per stack.

Material: ⅛" silver standard: Palladium or gold alloy also available.

Load: Dry circuits to 5 amps @ 115V AC res.

COILS:

Resistance: 22,000 ohms max.

Power: 100 mw per movable min. to 4 watts at 25° C max. (200 mw min. to meet max. shock/vibration spec.)

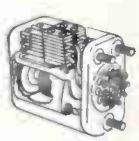
Duty: DC: Continuous. AC: Intermittent (Two pole relay max.) open. Sealed units supplied with full wave rectifier inside can.

Voltages: DC: Up to 110 volts. AC: Up to 230 volts 60 cycles.

The relays below are variations of the MH relay structure.

MA LATCHING
Electrical latch, mechanical reset. Small, versatile and offered with selection of contact arrangements.

MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.



MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY, PRINCETON, INDIANA

IN CANADA: POTTER & BRUMFIELD CANADA LTD., GUELPH, ONTARIO

Wage Hearing Starts

Representatives of EIA, NEMA and four industry labor unions will testify on components wages

WASHINGTON—The Labor Dept. will hold a public hearing here next Tuesday on establishment of a federal minimum wage for electronic component parts plants selling to the government. This is one of three electronics industry cases pending under the Walsh-Healey Public Contracts Act.

Four Issues

Representatives of the Electronic Industries Assn., the National Electrical Manufacturers Assn., and four labor unions in the component parts industry will attend.

Four issues top the agenda:

- How to define the component parts industry. The Labor Dept.'s proposed definition covers plants which make "functional parts for inclusion in electronic end products or assemblies." Included are such parts as resistors, capacitors, relays, switches and such.
- The industry's prevailing minimum wage. A Labor Dept. survey of wages paid in Oct., 1958, shows a national median hourly rate of $1.46. The survey covered 457 plants employing 63,462 workers. Lowest rate recorded was $1 an hour paid to 1,949 workers.
- Whether the Walsh-Healey rate for electronic component parts workers should be set on a national or more local geographic level.
- Provision for employment of beginners or probationary workers at wages below the prevailing minimum rate.

An official ruling on a required

Television Aids Coordinator

In Eastern Air Lines' big new passenger terminal at New York International Airport (Idlewild), all plane and vehicle movements on the apron, and all passenger information, are controlled from a coordinator's tower. Dage tv system keeps coordinator in touch with remote flight-information boards; keyboard lets him enter data on boards. Radio, Telautograph and other communication systems complete tower facilities

Tuesday

minimum wage for electronic component parts workers employed on government contracts is still about one year off.

The Secy. of Labor will set a tentative wage rate following next Tuesday's hearing.

Another Hearing Likely

Both management and labor will then be allowed to file formal opinions on the Secretary's tentative ruling and another Washington hearing will probably be scheduled. The final determination will be made after these steps.

The Labor Dept.'s electronic component parts wage survey disclosed that 3.1 percent of the workers covered on a national level were paid $1 an hour. Hourly wages of $2 and hour and over were paid to 12.4 percent of the workers covered.

The median rate for New England was $1.39. Forty-seven plants employing 11,755 were covered in this region.

The Middle Atlantic's median rate was $1.61. This covered 14,921 workers in 137 plants.

Median rate in the South was $1.18. The region included 35 plants with a total of 5,654 on the payrolls.

The median rate for the Great Lakes region was $1.49. The region included 25,262 workers in 159 plants.

The Middle West's median rate was $1.25. This covered 17 plants employing a total of 2,252 workers.

Median rate for the Western States was $1.61. The region included 62 plants employing 3,618 workers.

Also Coming Up

In addition to the electronic component parts industry, Walsh-Healey cases are in the mill for electron tubes and semiconductors and for electronic subassemblies and end-items.

A tentative ruling for electron tubes and semiconductors is expected shortly. The subassembly and end-item case is at a very early stage. The Labor Dept. is still considering a definition of the industry for purposes of a survey of prevailing wages.

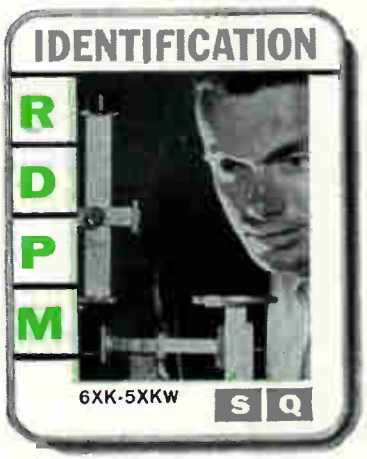
Here's an electronics man who's hard to place.

You know him as the man you've got to reach to sell the electronics industry. His company identification badge (symbolized at right) is the most familiar means of telling at a glance (by its code letters—"R", "D", "P", "M") that you may find him in **R**esearch, **D**esign, **P**roduction, or **M**anagement.

What's the title of this electronics man?

But, whatever his department, whatever his title, the function of this engineering-trained man is likely to involve buying and specifying electronic equipment.

One sure way to pinpoint him: he reads **electronics**, the only magazine that reaches these 52,000 key buyers and specifiers every week. P.4.8



THE ELECTRONICS MAN
"BUYS" WHAT HE READS IN...

electronics

... and the Electronics Buyers' Guide and Reference Issue

A McGRAW-HILL PUBLICATION ABC ABP
330 West 42nd Street, New York 36, New York

PHOTO OF PARAMETRIC AMPLIFIERS PRODUCED BY HUGHES AIRCRAFT COMPANY

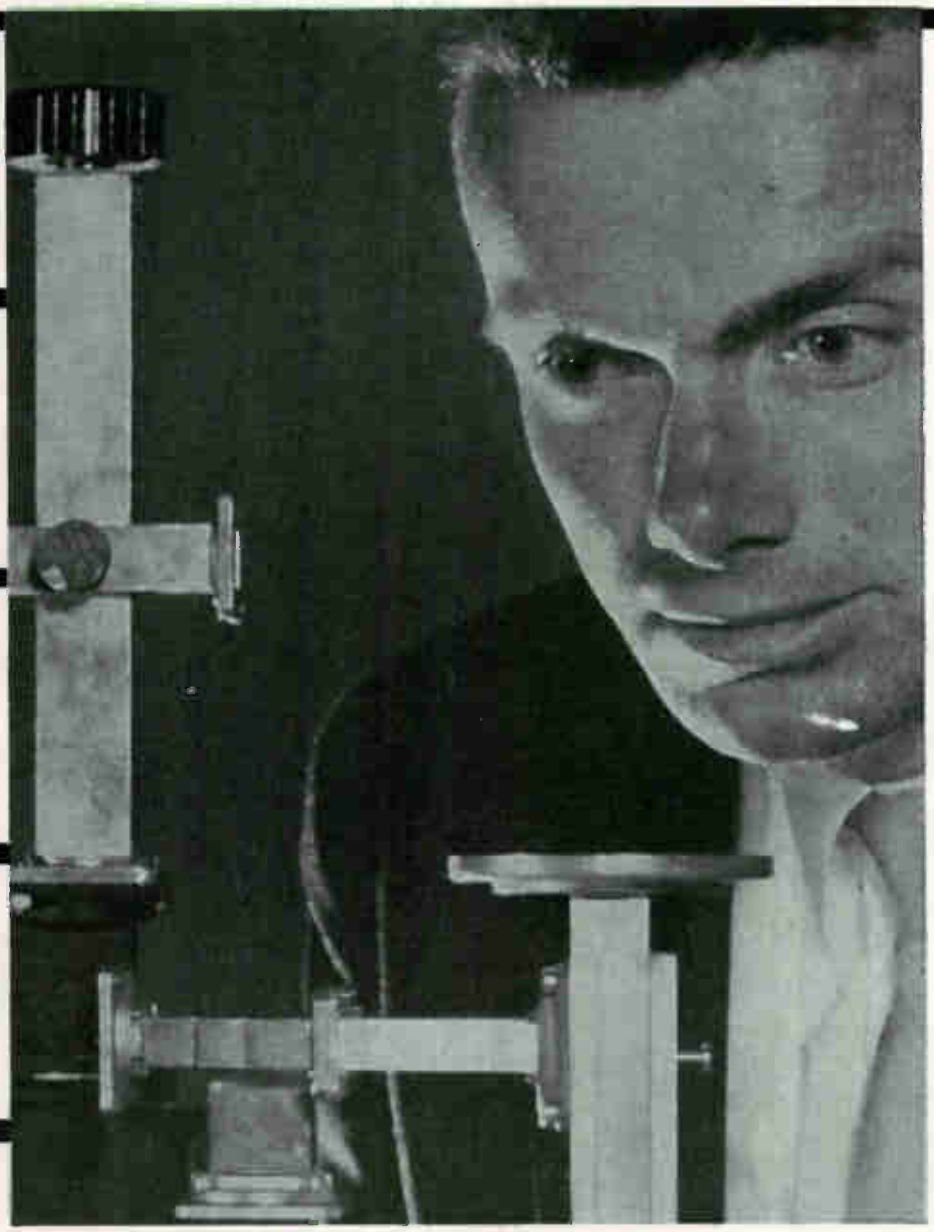
IDENTIFICATION

R

D

P

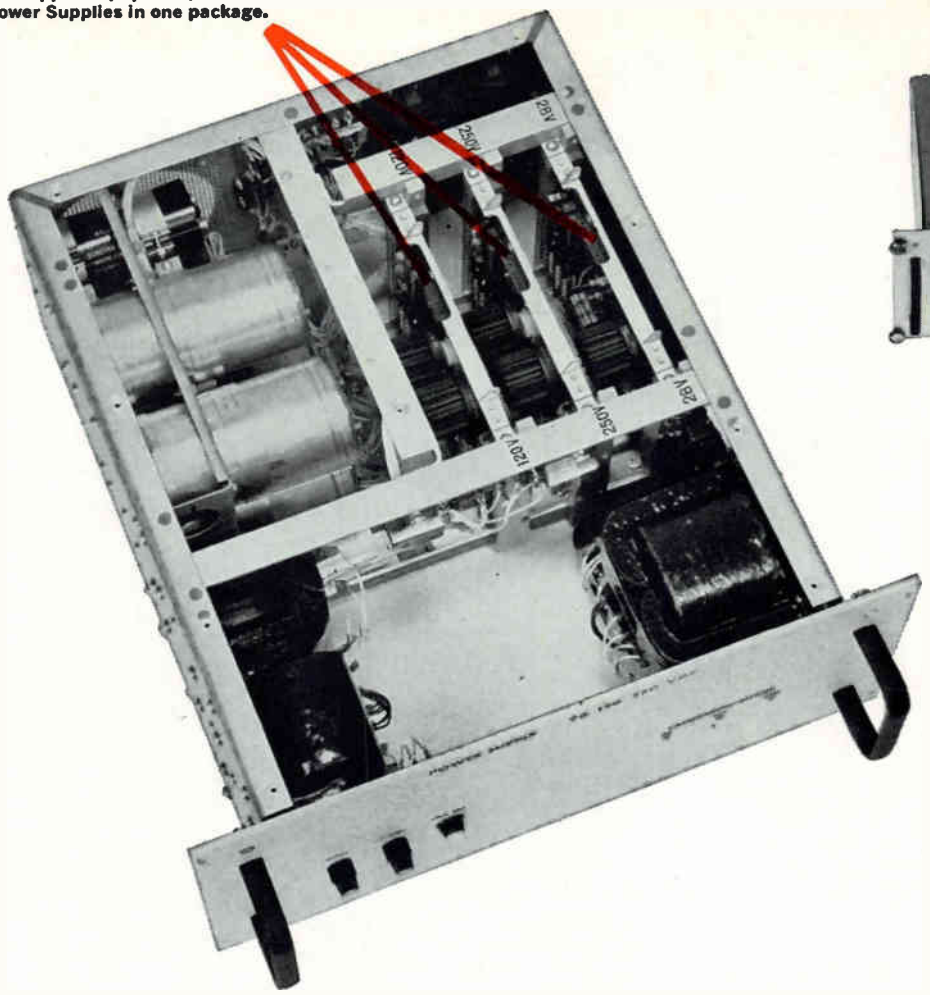
M



6XK-5XKW

S | Q

Model pictured is a unique design, developed by Hydro-Aire Electronics for ground support equipment, which combines three AC/DC Power Supplies in one package.



Another *New* Hydro-Aire Product for the *Aircraft, Missile Support, Missile* and *Electronics* Industries

The AC/DC Power Supply shown is typical of many new electronic products being developed, engineered and produced by Hydro-Aire—a name well known for quality, reliability and fast delivery. The unit illustrated is one of a unique family of fixed voltage, transistorized, power supplies. Through unusual design, Hydro-Aire engineers have combined three power supplies into a single package. The same basic circuit allows regulated outputs over a wide range. Range is determined by selection of transistorized, printed circuit, plug-in modules.

Characteristics Model #50-121

Input: 120 ± 5 % VAC
Outputs: 28 VDC @ 2.5 amp; 120 VDC @ 250 ma; 250 VDC @ 500 ma
Regulation: ±0.1% for combined temperature, time and load variations
Temperature: −10°F to +125°F operating; −54°F to +165°F non-operating
Ripple: 5 millivolts RMS (maximum)
Size: 8¾ x 17 x 20 (for 19″ rack mounting)
Weight: approximately 70 lbs.

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50-Million-Mile Signals Due

Pioneer V will be sending data from that far away in August. Here is how it's being done

INGLEWOOD, CALIF. — If you think Pioneer V is terrific now, wait until August.

Scientists say the new U. S. satellite will then be transmitting data from 50 million miles away.

When Pioneer V was 500,000 miles away 11 days ago, scientists at Space Technology Labs here said gear in 91-lb payload was working "very close to nominal."

Pioneer V easily passed the free world's telemetry distance record of 407,000 miles set by Pioneer IV.

Most significant in Pioneer V, electronically, is the ultra-long-distance communications system built around two miniature transmitters, one of 5-watt capacity and the other of 150-watt, and a digital telemetry device known as "telebit" which collects and stores data from the various sensing devices aboard and sends it to earth upon command. A single dipole antenna of the 400-Mc variety is utilized.

For two weeks information was telemetered by the smaller bi-phase modulation system, operating on command from earth for 30 minutes every 3 to 4 hours. About now the shift to the 150-watt unit will occur—and as its maximum range is approached it will be operating less than 5 minutes each 3 to 4 hours because of vastly greater power requirements.

An interesting observation by an STL scientist pointing up the vast distances involved is that, at 50 million miles, transmission will be commanded "off" before scientists on earth are sure it came on.

Turn On, Off

Command functions to Pioneer V include turning transmitters on and off (with the 150-watt unit this is done in 3 commands—filaments high, filaments low, and plates on), changing from 5- to 150-watt transmission, and changing bits per second rate. The last is now 64 bps, will eventually be reduced to 8 bps and finally to 1 bps. Doppler command equipment is similar to that carried in Explorer VI, and makes possible velocity measurements 10-ft per second.

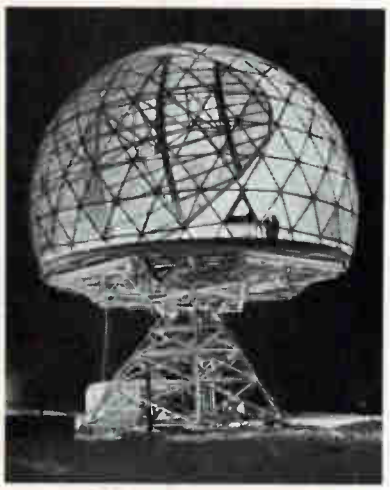
Scientific experiments within the 26-inch payload include:

1.) A half-pound search coil magnetometer; 2.) proportional counter "telescope" capable of distinguishing very high energy radiation in the presence of induced secondary particles; 3.) ionization chamber and Geiger-Mueller tube; 4.) micrometeorite momentum spectrometer. Also included are voltage and temperature sensing devices.

The 25-lb power supply system consists of a total of 4,400 solar cells mounted on four "paddlewheel" arms, and rechargeable nickel cadmium batteries. Maximum charging rate as sun is approached is 26 volts (see ELECTRONICS, p 167, Mar. 11).

Largely responsible for the great extension of communication distances possible are parametric amplifiers which, for the first time, are being used in the front part of two of the ground receivers.

Testing Radome



New radar test tower determines the effects of various radomes on antenna radiation performance characteristics. Distortion is tested in beam shape, side and back radiation, and gain and beam direction. Designed and built to GE specifications by E. W. Bliss Co., the test tower tries radomes of different materials, shapes and structures on GE's AN/FPS-7 multibeam, high-power, long-range search radar

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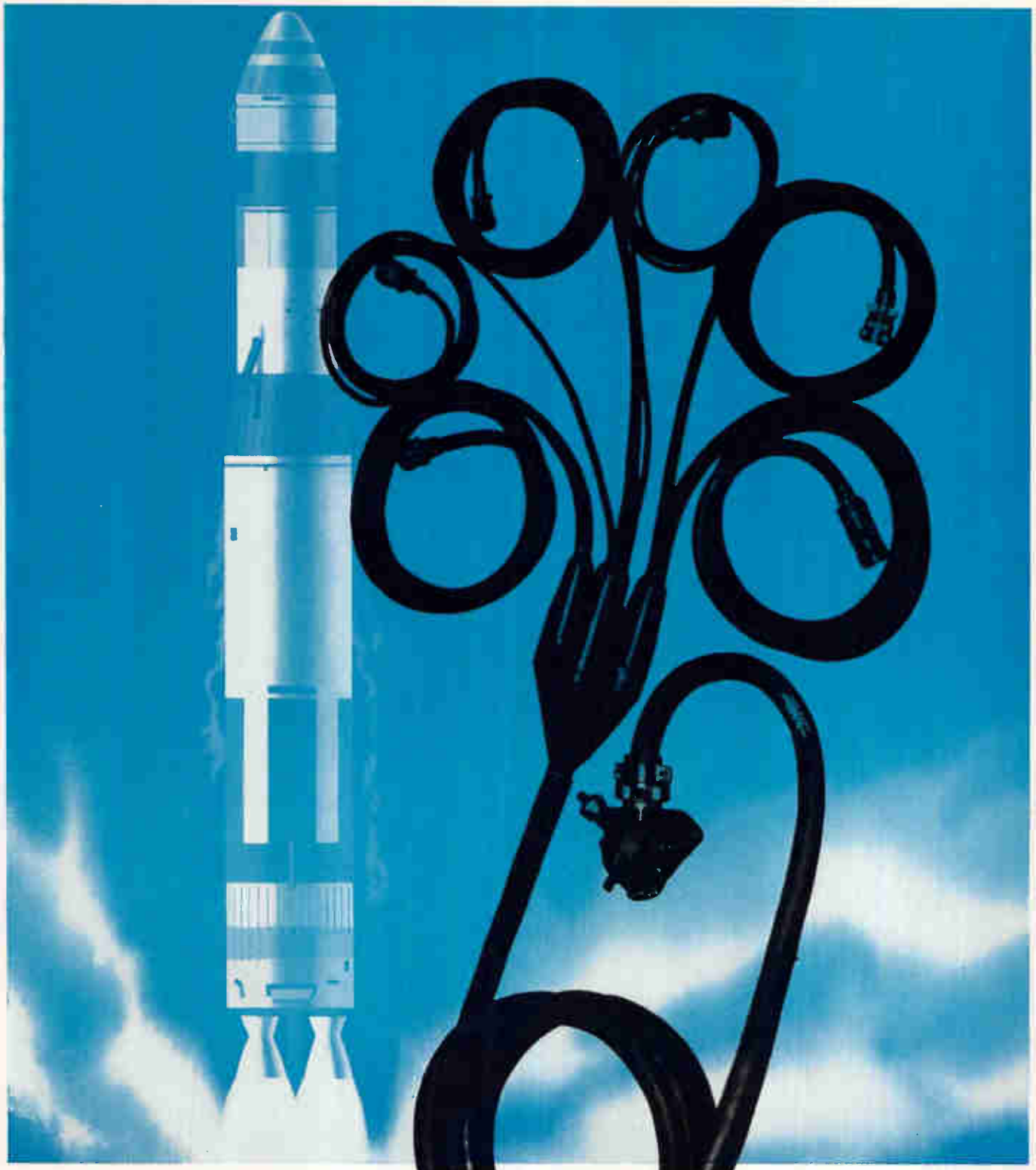

Umbilical

The MSC-built Umbilical Launching Cable... an example of the product diversity of Missile Systems Corporation. Like all products that bear the MSC label, this system has proven its reliability. Just as it is a life-line to the success of a mission, so also are MSC's contributions material to the future accomplishments of *all* facets of the electronic industry. MSC's variety of products form one continual life-line... feeding an industry which is already changing the life patterns of generations to come.

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MEETINGS AHEAD

Mar. 24-25: Human Factors in Electronics, PGHF of IRE, Bell Labs Auditorium, N. Y. C.

Apr. 3-6: National Assoc. of Broadcasters, Engineering Conf. Committee, NAB, Conrad Hilton Hotel, Chicago.

Apr. 3-8: Nuclear Congress, EJC, PGNS of IRE, New York Coliseum, New York City.

Apr. 11-13: Space Conference, Engineering Technology, AIEE, Baker Hotel, Dallas.

Apr. 11-14: Weather Radar Conference, American Meteorological Society and Stanford Research Institute, San Francisco.

Apr. 12-13: Protective Relay Engineers, Annual, A&M College of Texas, College Station, Texas.

Apr. 12-13: Electronic Data Processing, IRE, ARS, Hotel Alms, Cincinnati, O.

Apr. 12-13: Static Relay Symposium, USA Signal R&D Lab, Hexagon Auditorium, Ft. Monmouth, N. J.

Apr. 18-19: Automatic Techniques, Annual Conf.. ASME, IRE, AIEE, Cleveland-Sheraton Hotel, Cleveland.

Apr. 19-21: Active Networks & Feedback Systems, International Symposium, Department of Defense Research Agencies, IRE, Engineering Societies Bldg., N. Y. C.

Apr. 20: Quality Control Clinic, ASQC, Univ. of Rochester, Rochester, N. Y.

Apr. 20-22: Medical Electronics, National Conf., PGME of IRE, Shamrock-Hilton Hotel, Houston, Tex.

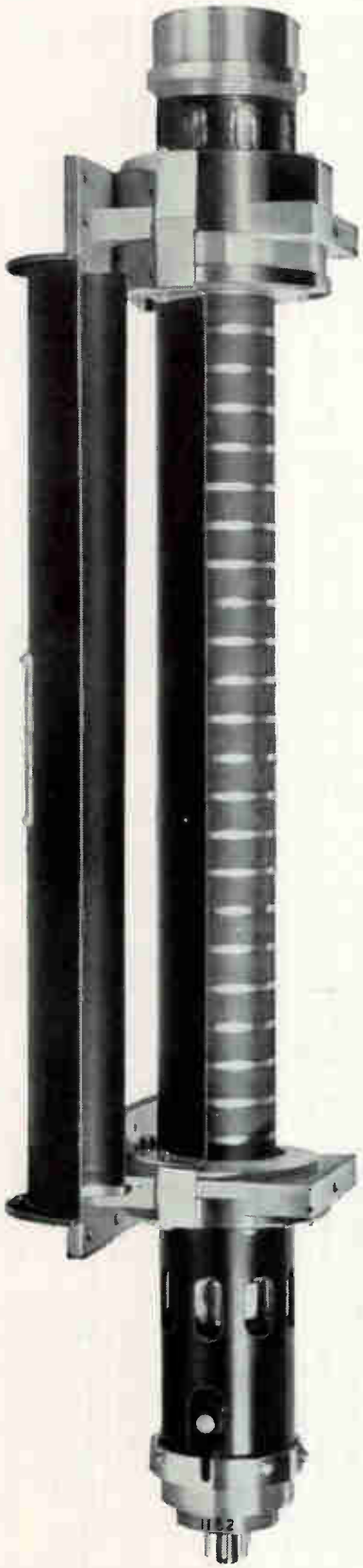
Apr. 20-22: Southwestern IRE Conf. & Electronics Show, SWIRECO, PGME of IRE, Shamrock-Hilton Hotel, Houston, Tex.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Memorial Sports Arena, Los Angeles.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 92.

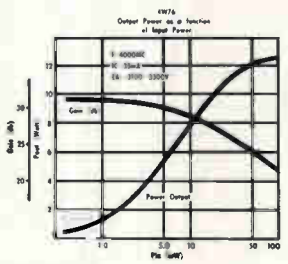
package-type TWT power amplifiers with NEC's new long life cathode

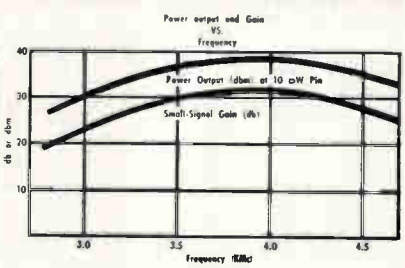


Production of traveling wave tubes at NEC began seven years ago and introduction of the package-type three years later. As chief supplier to Japan's complex network of microwave communications, NEC has become the world's largest maker of TW tubes. With the high development costs amortized and large manufacturing capacity, NEC is now able to supply these tubes at well below usual prices.

NEC's new doped nickel cathode core material, a 10-year development, increases both emission and tube life. It has been thoroughly field-proven in disc-sealed planar triodes for 2000 mc equipment of a large U.S. systems manufacturer (name on request). With its cooler operating temperature, evaporation rate of oxide is less than any other known core materials. This extends tube life up to 50%.

Designers will appreciate the compactness these tubes will give to their systems and operators the reliability and economy. Tubes connect to standard IEC waveguide flanges and can be shipped from stock. For specifications sheets, please write to Tokyo.





4W76

The 4W76 operates in the 4000-mc band and has nominal saturated power output of 10 watts. High amplification over a wide range of power levels results in small-signal gain of approx. 30 db. The band width at half-power points is 1400 mc, but the tube can be used in the frequency range of 2800 to 5000 mc.

Typical Operating Characteristics at 4000 mc

First Anode Voltage	2,640 V	Saturated Power Output	12.5 watts
Helix Voltage	3,220 V	Small-Signal Gain	32 db
Helix Current	0.7 mA	Noise Figure	approx. 25 db
Collector Current	33 mA	VSWR	less than 2 to 1 (from 3500 to 4300 mc)
Focusing Electrode Voltage	-40 V		

NEC TRAVELING-WAVE AMPLIFIERS

PERMANENT MAGNET FOCUSED AMPLIFIERS

4W75	4000-mc band	1.5 watts	8W75	7000-mc band	1.5 watts
4W76	" "	5-10 watts	8W76	" "	5-10 watts
6W50	6000-mc band	5-10 watts	11W17	11000-mc band	1.0 watt

ELECTROMAGNET FOCUSED AMPLIFIERS

4W85	4000-mc band	0.1 watt	4W72A	4000-mc band	1.5 watts
4W86	" "	1.0 watt	7W52	6000-mc band	5-10 watts

Advantages of package-type

NO focusing or impedance matching at installation
NO dummy space for removal
NO power source or current stabilizer for electromagnet

NEC *Nippon Electric Company Ltd.* Tokyo, Japan

COMPONENTS / SYSTEMS

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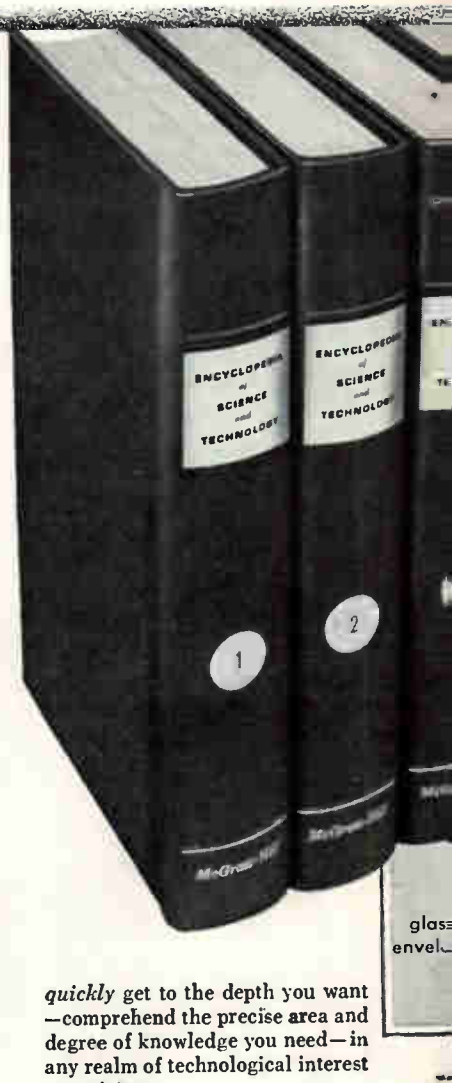

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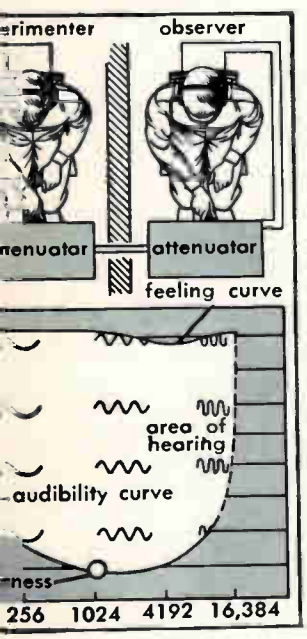

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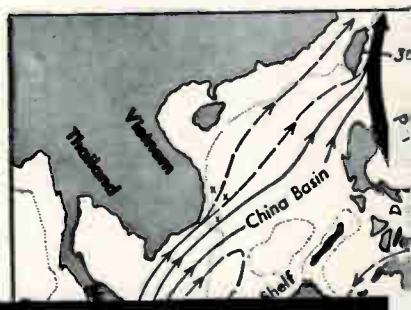

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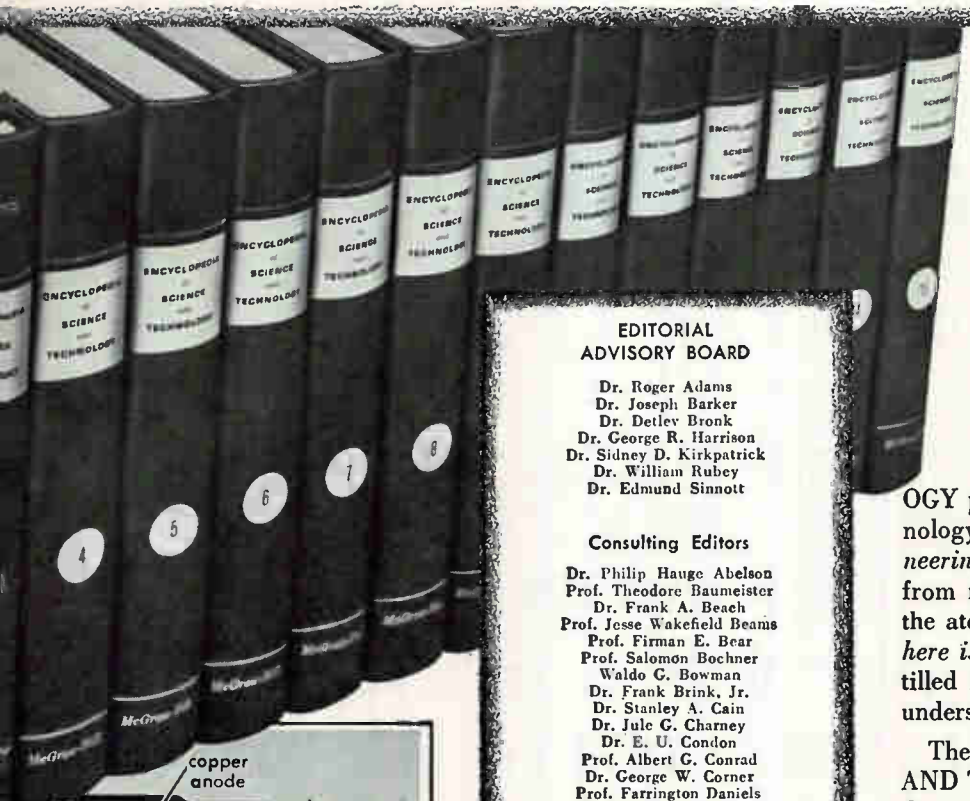

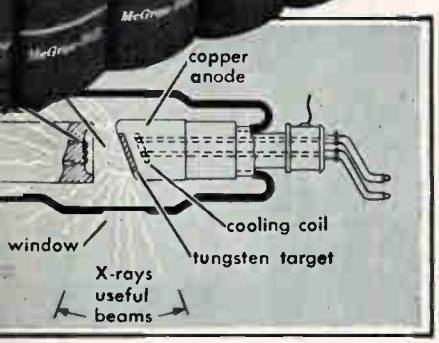

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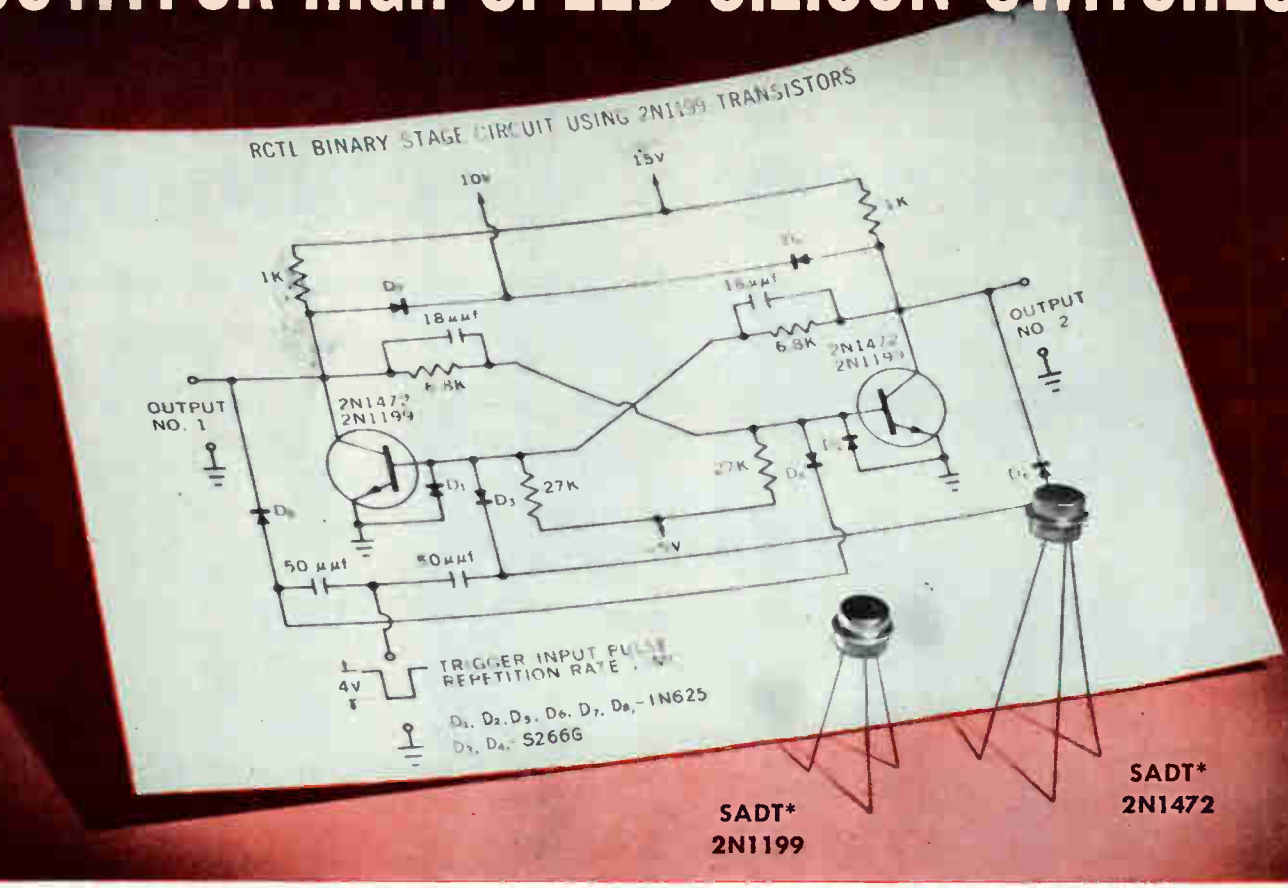

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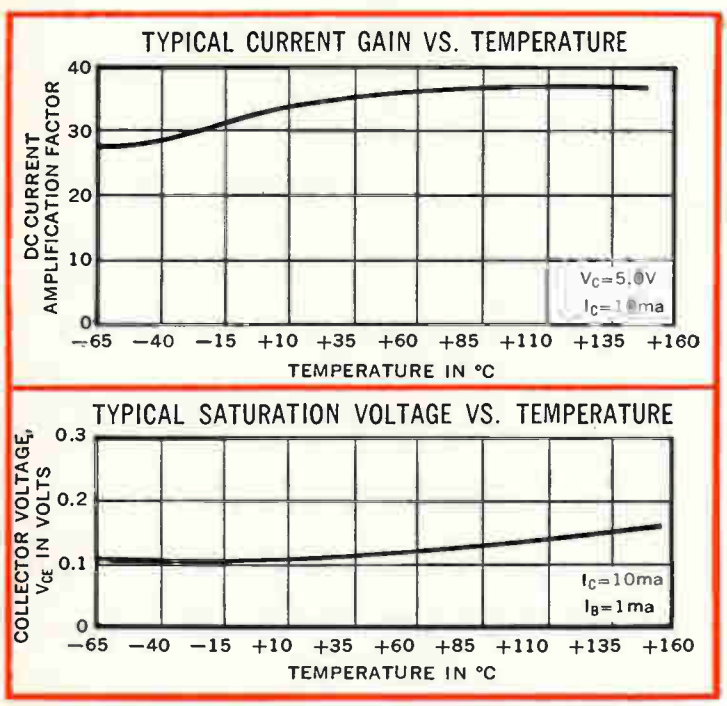

The high frequency response, together with the very low saturation voltage of these silicon Surface Alloy Diffused-base Transistors (typically 0.125 V), permits practical design of 5 mc pulse circuits, using conventional saturated switching configurations. With non-saturating techniques, pulse rates as high as 30 mc are obtainable. The typical switching circuit shown above will operate satisfactorily at trigger pulse rates up to 15 mc. When triggered with a 4-volt pulse at a 10 mc rate, the rise time will be typically less than 24 mμsec over a temperature range of −60°C to +130°C. The typical fall time will be less than 36 mμsec over the same temperature range.

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Automated Assembly of Alloy-Junction Transistors

Transistors of high uniformity and high quality are obtained with this fully automatic electromechanical assembler. Step-by-step inspection insures output of perfect units

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Fully automated transistor assembler. Carbon boats convey transistor components to assembly stations

DESIGN OF THE automatic transistor assembler described in this article is based on the concept that each transistor be assembled and inspected individually, as opposed to the concept of batch manufacture. This approach offers many advantages.

Sequential individual assembly permits individual inspection at every step so that only perfect units are passed to the next step. Each vehicle, or boat, used to transport the transistor assembly through the machine is given off-line inspection; individual rejection of imperfect units is economical. If a boat is misloaded at any step, such misloading is corrected without interrupting the overall assembly process. Processing and quality control are facilitated by elimination of manipulation and judgment variables and by performance of each process step at one station only. Samples are pulled at each step and defects traced directly to the source.

The machine requires only one mechanism for each feed, unload, and inspection station. The high productivity of this single set of tools not only gives close process control but also low cost.

SEQUENCE OF ASSEMBLY—The machine fabricates the transistors from preformed components—emitter and collector dots, the germanium disk, the base washer, the whisker wires, and the mounting base. The machine first assembles the dots with the

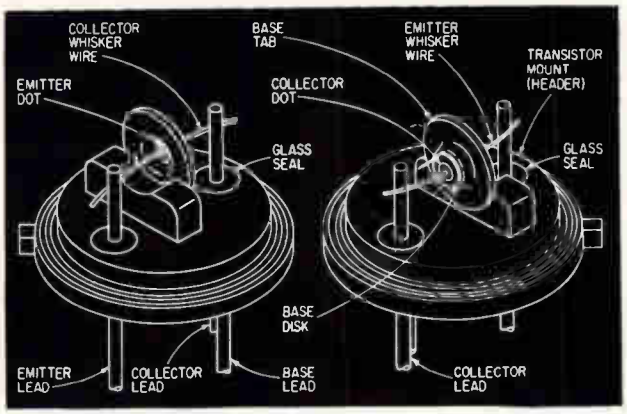


FIG. 1—Alloy-junction npn transistors are assembled from preformed components

germanium disk and alloys them. The machine then assemblies the base washer and the emitter lead and bonds them to the transistor. Next, it bonds the collector lead. Finally, the machine welds the base washer to the transistor mounting base and welds the emitter and collector wires to the mounting base posts. Figure 1 shows the assembled structure.

Each function is performed on an internally driven and controlled turntable. The turntables are interconnected by belt transports, but each is independent, operating only when boats are supplied to it and when there is demand for its output. Ninety minutes are required to complete the assembly of each transistor. Production is at the rate of one transistor every two seconds.

Figure 2 presents a flow diagram of the complete assembly process. The unit type boats—actually machined carbon jigs—are used in the assembly process to confine and position the components of the transistor during the alloying operation. The first component inserted into the boat is the collector dot, accomplished on turntable 1. The boats are fed onto a conveyor belt by a linear vibrating tray. From the conveyor they are injected into pockets of the indexing table.

At the first index of the table, station 2, a photoelectric detector checks for the presence of the boat. The check at this point permits the automatic inhibiting of the dot loading operation if the boat is not present. At the next station the collector dot is inserted into the cavity of the boat. Before leaving the turntable, the boat is again photoelectrically checked to insure proper positioning of the dot. If the dot

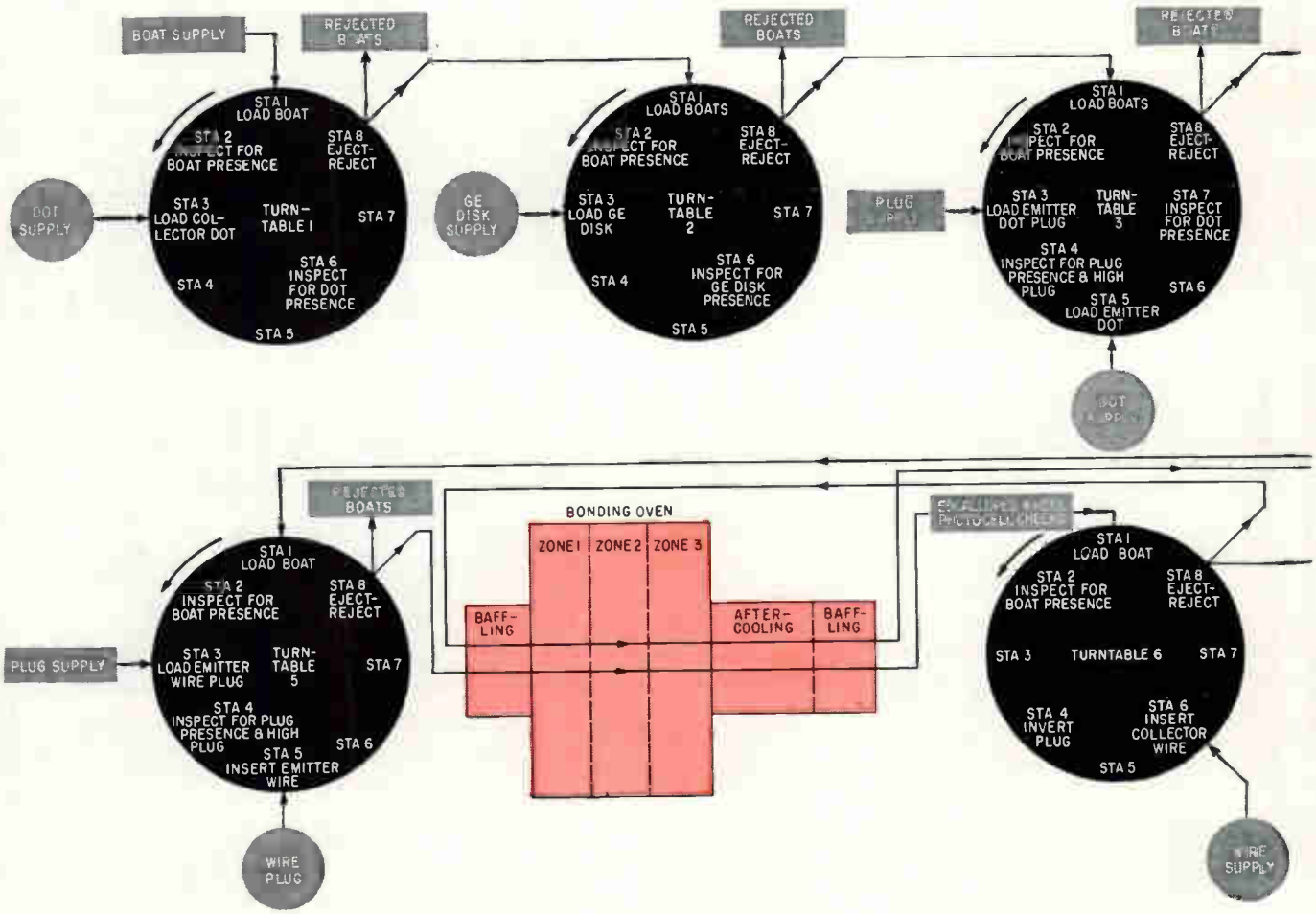


FIG. 2—Flow diagram for the complete assembly process. Machine first assembles collector and emitter dots with the germanium disk and alloys them; it then assembles the base tab and the emitter leads and bonds them to the transistor; next, it bonds the collector

is absent or improperly positioned, the boat is rejected at the output station of the Unit. Accepted boats are placed on a conveyor for transport to turntable 2.

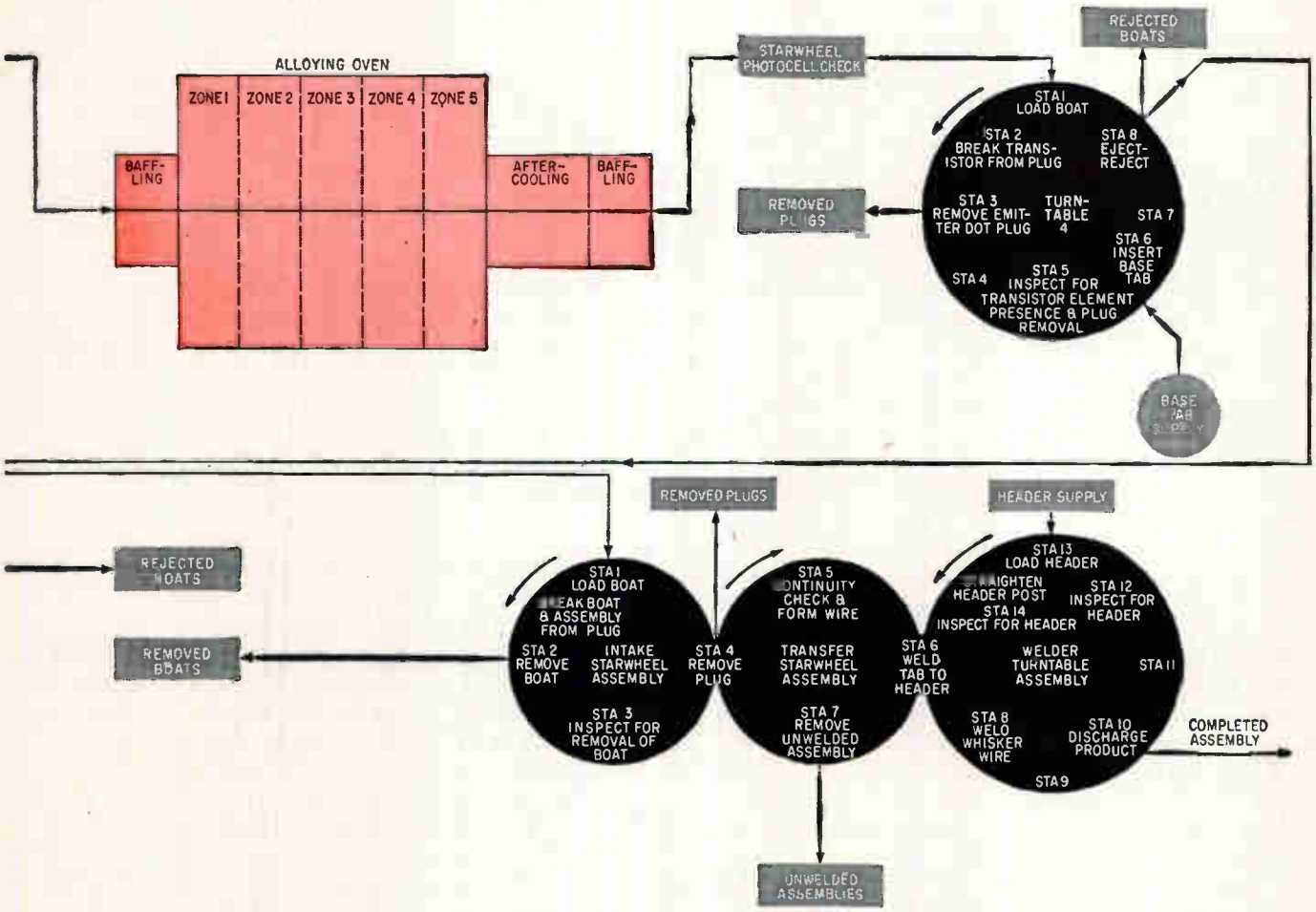
A built-in float or overload between all units in the machine permits a predetermined number of boats to arrive at the input of each unit. An oversupply will automatically restrict the output of the preceding unit.

At turntable 2 the boats are loaded with the germanium disks and checked. The disks are fed into and oriented in a rotary Syntron feeder which will remove chips or broken disks. Accepted disks are then fed into a linear feeder track for delivery to a pickup station. During their trip down the track, the disks pass below two control points called bridges, which prevent out-of-tolerance, dirty, or double disks from reaching the assembly point. At the end of track, accepted disks are picked up by a vacuum probe, carried over, and dropped into the orifice of a cone, which guides them to their proper position in the boat. Another photoelectric check determines the presence and proper position of the disk in the boat. Accepted boats are transported along the conveyor; rejects are removed from the assembly process.

At turntable 3 an emitter dot plug is automatically placed in the boat on top of the germanium disk. Its function is to position accurately the emitter dot in the center of the disk. This plug-loading operation is also controlled through a detector device. If no boat is present in the preceding station, the plug-loading cycle is inhibited. With the plug in proper place, the emitter dot is inserted, and the boat is checked for its presence.

Now, loaded with its cargo of collector dot, germanium disk, and emitter dot, all correctly positioned, the boat is set for the alloying operation. It is loaded onto the oven conveyor belt by a cam-operated pusher. Still on the belt, it is conveyed through the tunnel furnace, where the units are alloyed.

After the alloying, the boats are conveyed to the next operation on a wide belt. This belt also provides overnight or temporary storage for all boats in the oven. On turntable 4, to which the boat is now directed, a probing operation releases the alloyed parts from the emitter dot plug and removes the plug. With the plug removed, the gold-plated base washer is loaded into the boat. These washers are Syntron-fed to a fixed position on the bowl. Here they are picked up by a vacuum probe and placed into the



lead; finally, it welds the base tab to the transistor mounting base and welds the emitter and collector wires to the mounting base posts. During these operations, machine performs 50 individual checking functions

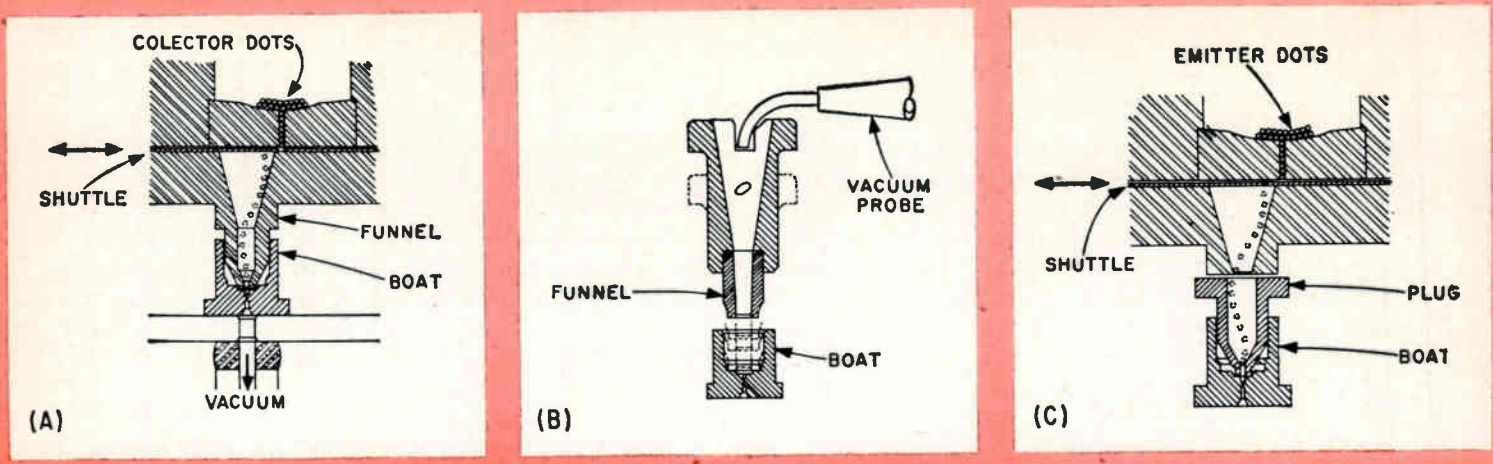


FIG. 3—Transistor assembling operations: collector dot loading at station 3 of turntable 1 (A); germanium base disk loading at station wire insertion at station 5 of turntable 5 (E)

boat on top of the alloyed unit. Accepted boats are then transported to the wire-insertion operation.

An emitter wire locating plug is loaded into the boat on top of the base washer, its function being to position the emitter wire relative to the emitter dot during the bonding operation. After the wire is inserted, the units are moved to the bonding oven over a series of conveyor tracks.

On the first pass through the oven, the base washer is bonded to the germanium disk and the emitter wire to the emitter dot. The bonded output, emerges from the oven and moves to the collector wire unit. Here the complete boat, still containing the emitter wire plug and the assembly device, is inverted to permit the loading of the collector wire through a tiny hole in the new topside of the boat. The boat is then transported back to the bonding oven.

After the second pass through the oven, the output contains the alloyed and bonded assembly of collector dot, germanium disk, emitter dot, base washer, and emitter and collector wires. At this point the assembly is prepared for attachment to the transistor mounting base. Mounting bases (headers) are manually loaded into magazines for placement on the machine, which, in turn, automatically inserts the mounting bases into their holders.

The completed assemblies in their boats are fed into position on the welder unit. As each boat travels to a boat removal station, it is gently lifted and agitated by a cam and sawtooth mechanism. This operation frees the transistor assembly from its nest in the boat. The transistor assembly is then carried by the plug to a station where it is removed from the plug by a tweezer-type gripper. Held by this gripper, the assembly is checked for electrical continuity between the base washer and the emitter and collector wires. During this operation, the emitter and collector wires are formed, providing additional shock resistance to the assembly.

The units accepted by the continuity checker are brought together with the mounting bases, to which the base washers are welded. For those units that are not accepted, the base washer welding operation is inhibited, and the units are ejected. Unwelded mounting bases are recycled without additional handling. After the base washers are welded to the mounting bases, the transistor assembly is rotated 90 degrees, permitting simultaneous welding of both wires to the mounting base parts. This welding completes the machine operation. The alloyed, bonded, and mounted units are discharged and placed on carriers for manual removal. After assembly, the units are etched, tested, capped, and categorized for use.

MECHANICAL DESIGN—Because transistor components are so small and fragile, it was decided initially to feed, assemble, and inspect each component assembly on individual turntables. The nine major operating units (six turntables, two ovens and the welding unit), integrated by the series of conveyors, evolved from this unit concept.

Although the major portion of the units required custom designing, the use of standards reduced design and delivery time and permitted a minimum inventory of spare parts. As a result of the mechanical standardization, it was possible to a large extent to standardize the electrical controls.

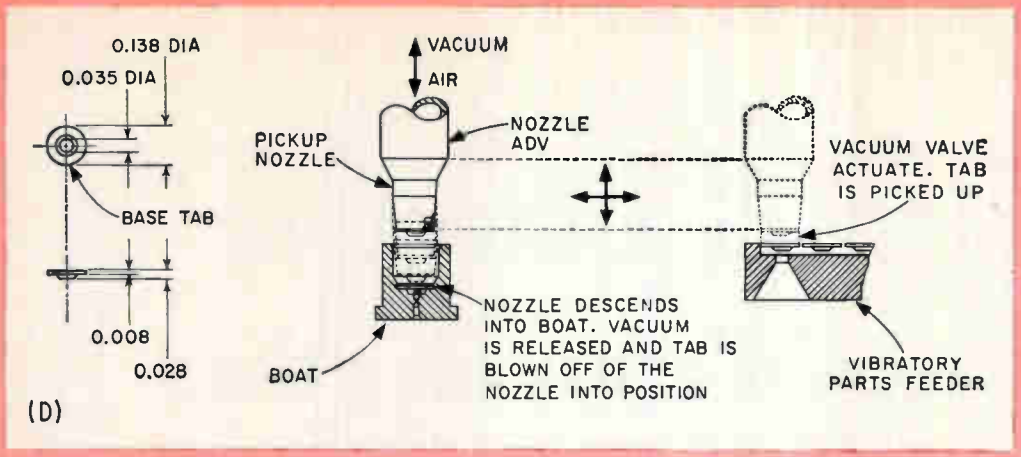
The radial indexing drive units, using Ferguson drive cams, were custom designed and built to provide four switch-controlled output speeds, ranging from 1.4 to 4.1 seconds per cycle. The units provide eight-position indexing, which covers the known requirements and also permits the addition of unplanned operations at a future date without major alteration.

INSPECTION DEVICES—Three basic types of inspection devices are used in the machine.

Mechanical limit switches determine the height of the boats passing through the process. These switches provide protection against damage to the boats and the mechanism from parts too high to pass under the loading station. The switches also give an indication of components improperly assembled.

In the base washer loading unit a vacuum probe lifts the base washer from a vibratory feeder and deposits it in the boat. Since the vacuum achieved in the probe is determined by the presence or absence of the base washer, a vacuum switch checks the operation at this point.

The third and primary inspection device, which is used throughout the assembly process, is a photocell



3 of turntable 2 (B); emitter dot loading at station 5 of turntable 3 (C); base tab insertion at station 6 of turntable 4 (D); and emitter

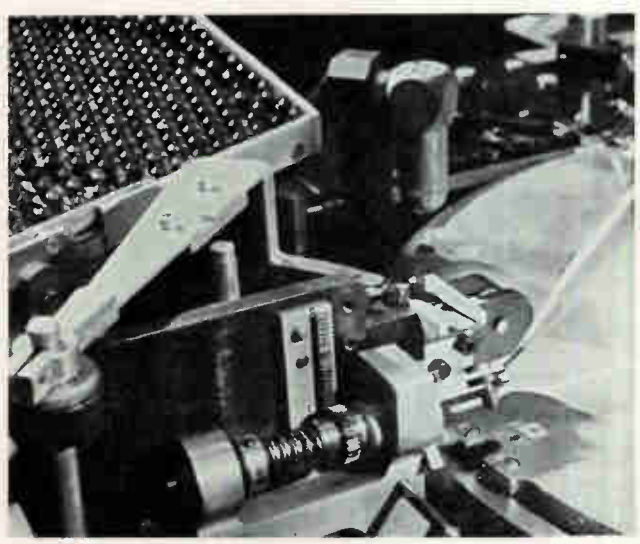
detection circuit. This circuit consists of a Number 12 lamp and a Clairex CL-3 photocell whose resistance decreases with an increase in the intensity of light falling on its surface. The photocell, a current-limiting resistor, and a sensitive relay are in series across the rectified 117 v a-c used as a power source.

This circuit, along with its power supply, is contained in a small plug-in unit. The device is operated when the part being sensed reduces the light intensity and, in turn, the resistance of the photocell increases to the point where insufficient current flows to hold the relay energized. Modifications of current-limiting resistance and relay sensitivity are necessary in several instances, particularly in detecting the presence of germanium disks and emitter dots whose bright surfaces reflect the light. Exclusive of oven temperature and gas flow controls, the machine performs 50 individual checking functions.

LOGIC—With the exception of wire loading, each assembly turntable includes a final checking device that determines whether the boats should continue in the process or be rejected. Provision is made automatically to stop any operation after a preset number of consecutive rejects. Information concerning the disposition of the transistor being assembled—accept or reject—is carried in a relay shift register, in which the information is transferred progressively to relays corresponding to the cycle in which the machine unit is operating.

The final relay of the register establishes a circuit from a cam-operated circuit breaker to the desired solenoid, accept or reject. Current to all solenoids is made or broken by cam-operated circuit breakers; relays are used only to establish the circuit. The repeating reject circuit consists of an elapsed-time meter, which resets whenever an assembly is accepted. The time cycle is adjusted for a maximum number of consecutive rejects, and if no assembly is accepted during this time, the machine stops.

Each turntable is equipped with a conveyor overload detector which stops the table when its output conveyor is full. This detector consists of a photocell unit mounted across the track. A boat interrupting the light beam causes the photocell relay to drop out. A relay logic circuit is then energized to determine whether the boat is to move to the succeeding machine cycle; if the boat should not move, the machine unit will stop until the light beam is reestablished.



Closeup of plug and boat being fitted together. Boats and plugs have tolerances as close as 0.0005 inch for precise positioning of transistor parts during alloying, bonding and welding

WELDING UNIT—In the welding unit a check is performed on the complete assembly operation. The assembled unit—consisting of the base washer, the germanium disk, collector and emitter dots and wires—is checked for continuity before being welded to the mounting base. In this check, current passes through two relays in series with the two transistor leads (emitter and collector), the base washer being grounded. An indication of a correctly assembled transistor is obtained when both relays are energized. Only transistors that pass the continuity check are welded to the mounting base.

Mounting bases to which no transistors have been welded are recirculated while the welding operation and the loading of new mounting bases in the welding and loading indexes of the unit are suppressed. The output of the unit, therefore, consists entirely of mounting bases to which correctly assembled transistors have been welded.

Uncooled IR Detectors For Long Wavelengths

With a spectral response peaking almost at seven microns, the indium-antimonide photoelectromagnetic detector responds to long infrared wavelengths. This uncooled detector permits design of simpler ir systems

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DETECTORS OF INFRARED radiation may be separated into two classes based upon the methods by which infrared radiation interacts with the detectors. A thermal detector responds to the heating effect of the incident radiation; its spectral response is independent of wavelength distribution. A photon detector responds to the rate of photon arrival and has a spectral response characterized by a rapid drop at a long wavelength limit.

Photon detectors essentially count the photons in the incident radiant energy. Photons falling on these detectors, which are made from semiconducting material, interact with the crystalline lattice, freeing electrons and/or holes. Because these carriers add to the normal carrier density created by thermal excitation from the lattice, they are termed excess carriers. In intrinsic semiconductors the interaction of a photon with the lattice produces a free electron-hole pair. In extrinsic material a free electron-bound hole or free hole-bound electron pair is produced.

Thermal detectors, responding to the energy content, not the wavelength distribution of the radiation, have spectral responses which are wavelength independent. On the other hand, photon detection requires the energy of the incident photon to equal or exceed that needed to break the bond between an electron and a lattice atom. If this binding energy is E, then the wavelength λ which the incident photon must have is given by $\lambda \leqq hc/E$, where h is Planck's constant and c is the speed of light. Expressing λ in microns and E in electron volts gives $\lambda \leqq 1.24/E$.

For an intrinsic semiconductor, E represents the width of the forbidden band, whereas for an n- or p-type semiconductor E is the donor or acceptor ionization energy. It can be seen that long wavelength response is accompanied by small values of E. Of the intrinsic semiconductors used in detectors today, indium antimonide (InSb) has the smallest energy gap, the value of E being 0.18 ev at room temperature. Thus the long wave limit, known also as the cutoff wavelength, of an uncooled InSb infrared detector is about seven microns.

Photon Detection

The three photon detection mechanisms widely used are the photoconductive, photovoltaic, and photoelectromagnetic (PEM) effects. The photoconductive effect is the increase in the electrical conductivity of a semiconductor caused by the increase of free carriers produced by irradiation. The photovoltaic effect takes place at a p-n junction in a semiconductor. Hole-electron pairs produced by photons falling on the junction diffuse in opposite directions across the junction, holes to the p side and electrons to the n side, producing a charge separation and therefore a voltage. The photoelectromagnetic or PEM effect, also a diffusion phenomenon, occurs when radiation falls upon a semiconductor immersed in a magnetic field.[1,2]

The PEM effect is illustrated in Fig. 1. Radiation falls upon a slab of semiconducting InSb and is absorbed very intensely in a distance of about 1 micron, giving rise to free electron-hole pairs. These diffuse from this region of high concentration into the bulk. In so doing they cross lines of magnetic flux from a small permanent magnet. Since the electrons and holes are of opposite electrical charge, moving in the same direction, they are deflected toward opposite ends of the sample, at right angles to the magnetic field plane and carrier velocity vectors. If the sample ends are connected externally, a short circuit current will flow as long as radiation falls upon the sample.

Open circuit voltage is equal to the product of the short circuit current and the detector resistance. Since indium antimonide exhibits

Electrical leads of the indium-antimonide element are being soldered to terminals under microscope

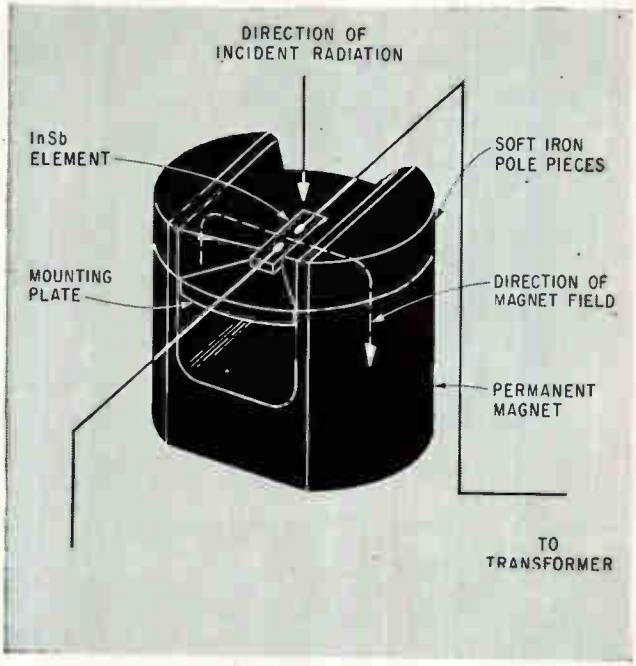


FIG. 1—PEM detector generates a voltage proportional to the intensity of the radiation (wavelength shorter than the long wave limit)

magnetoresistive behavior—an increase in resistance in a magnetic field—the detector resistance is that corresponding to the existing field. If the radiation falling on the detector is suddenly interrupted, the current and voltage will drop to zero at a rate such that $1/\epsilon$ of the steady state value is attained in about 0.2 microseconds in InSb at room temperature.

Surfaces

The condition of the front and back surfaces is of prime importance. Carriers which reach these surfaces by diffusion recombine there at a rate different from that in the bulk. The parameter of importance is the surface recombination velocity, defined as the recombination rate per unit area per unit excess carrier concentration just below the surface. Surfaces with high recombination velocities, such as are obtained through use of abrasive powders, cause the excess carriers reaching the surfaces to recombine, reducing the photosignal. Surfaces produced by selected chemical or electrolytic etches have much smaller recombination velocities and carriers reaching them may still contribute to the photosignal. Analysis shows[3] that a PEM infrared detector should have a low front surface recombination velocity and a high back surface recombination velocity, together with a thickness approximately equal to the ambipolar diffusion length in the magnetic field.

The ambipolar diffusion length is the average distance that the free carriers will diffuse in a magnetic field before recombining in the bulk. A low value of front surface recombination velocity allows the excess carriers produced near the surface to remain free rather than undergoing recombination. A high recombination velocity at the back surface insures that carriers reaching there will recombine rather than being reflected back into the bulk. In the latter event they would be moving counter to the flow of carriers diffusing from the front surface and would be deflected by the magnetic field in directions opposite to those diffusing from the front surface, thereby reducing the photosignal.

PEM Detector

The heart of an InSb PEM detector is the InSb element. Single crystals of InSb are pulled by the Czochralski technique from a crucible containing stoichiometric amounts of ultra-high purity indium and antimony. From theory[3], maximum performance is obtained when both resistivity and electron mobility are high. This condition is obtained by controlled adding of acceptor impurities to the melt.

A slice of the single crystal is lapped with abrasive powders, glued to a glass substrate and cut into rectangular parallelepipeds. These are lapped and etched until the final products are elements 1 mm by 1 mm by 25 microns thick. The front surfaces have low recombination velocities and the back high recombination velocities. The individual element is glued to a brass plate upon which soft iron pole pieces and electrical standoffs are mounted. Soldered leads connect the element ends to the standoffs. The pole piece assembly, mounted upon an Alnico V permanent magnet, is encased in a brass housing having a calcium fluoride infrared transmitting window and a subminiature shielded connector.[3] The over-all package is a cylinder of 1.04 inches diameter and 1.25 inches length, exclusive of the connector.

A figure of merit which describes the performance of infrared detectors is D*, pronounced "dee-star", the signal-to-noise ratio in a 1-cps bandwidth per watt of radiant power falling upon the detector from a black body at a specified temperature.

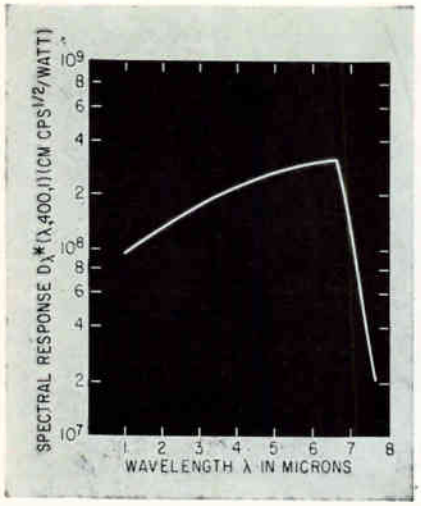
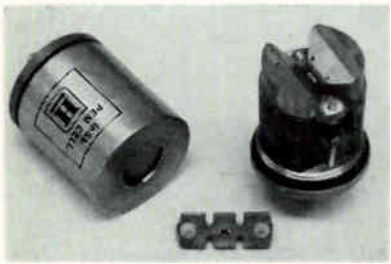


FIG. 2—Cutoff wavelength of the ir detector is a little less than 7 microns



Active element and mounting plate, magnetic structure and complete package

In order to measure D*, sinusoidally modulated radiation[4] from a 500 K black body is allowed to fall upon the detector and the signal-to-noise ratio in a known bandwidth measured. The noise mechanism of the InSb PEM detector is that of thermal noise, the magnitude being about 7×10^{-10} volts in a 1 cps bandwidth. Since the resistance of a typical detector is only about 30 ohms, it is necessary to transformer-couple to a low noise preamplifier.

The output of the preamplifier is coupled to a wave analyzer tuned to the chopping frequency. The total noise measured includes approximately equal contributions from the detector and from the primary windings of the transformer. In this manner the value of D* for 500K radiation chopped at 400 cps in a 1 cps bandwidth—written as D* (500K, 400, 1)—is determined to be 1 x 10^8 cm-cps$^{\frac{1}{2}}$/watt. The value of D* is independent of detector area. In order to determine the noise equivalent power (NEP)—the radiant power falling upon the detector which gives rise to a signal equal to the noise in a 1 cps bandwidth—the value of D* is divided into the square root of the element area. Thus a detector having dimensions 1 mm by 1 mm has NEP (500K, 400, 1) of 1 x 10^{-9} watts/cps$^{\frac{1}{2}}$.

By measuring the spectral response on an infrared monochromator, it is possible to obtain D^*_λ, the spectral variation in D* as a function of wavelength, λ. The value of D^*_λ (λ, 400, 1) as a function of wavelength is shown in Fig. 2. The peak value of 3×10^8 cm cps$^{\frac{1}{2}}$/watt occurs at 6.6 microns. This is approximately the cutoff wavelength predicted from the energy gap considerations discussed earlier. For a 1 mm by 1 mm detector the NEP at 6.6 microns is therefore 3.3×10^{-10} watts/cps$^{\frac{1}{2}}$.

Responsivity—defined as the signal voltage per unit radiant power falling on the detector—is of the order of 0.7 volts per watt of 500K radiation. Response time has been found with a spark decay method to be no longer than 0.2 μsec. The signal is therefore frequency independent from d-c to about 500 Kc. Since thermal noise is also frequency independent, the signal-to-noise ratio is frequency independent to about 500 Kc. This flat characteristic simplifies amplifier design in wide band applications.

Comparative Performance

The InSb PEM detector has a value of D* (500K, 400, 1) about 40 times poorer than the best available infrared detectors today. However, detectors exhibiting this superior performance require cooling to 77K, the temperature of liquid nitrogen, or below. The PEM detector, not requiring cooling, offers a distinct advantage in reduced system complexity. Its extremely fast response, although difficult to utilize completely because of the bandwidth of the transformer, is equal to or better than that of almost all other detectors. Since the detector generates its own photosignal, it requires no bias battery. Its spectral response is the longest of the uncooled photon detectors available today. The simple, rugged construction, and ease of fabrication, have made it possible to construct hundreds of detectors having closely reproducible characteristics.

Applications of the InSb PEM detector center around its long wavelength response and wide band performance. About ten percent of the radiation from an object at room temperature lies within the spectral interval in which the detector is sensitive. Referring to room temperature objects, the detector has a D* (300K, 400, 1) of 2 x 10^7 cm cps$^{\frac{1}{2}}$/watt. A radiometer incorporating a 5 cps bandwidth and a 3 inch diameter f/0.7 mirror has been constructed which demonstrates the performance of the detector. With an angular resolution of approximately 10 milliradians—1 foot at 100 feet—the radiometer easily senses a person at 100 feet by his thermal radiation and will detect the change in radiant intensity when the person opens and closes a suit coat. Such a sensitive and simple device has application in intruder alarm systems.

Other applications which have been explored include a thermal mapping system, wherein by a mechanical scanning technique a thermal picture of warm objects in a wide field of view is displayed upon an oscilloscope and photographed. Application has also been made to the hot box problem, the detection of overheated railway journal boxes, in which the detector has proved very satisfactory. It has also been used in the receiver of an infrared communications link. One application which appears promising involves horizon scanning, used in space vehicles to establish the local vertical by bisecting the angle between the vehicle and opposite horizons. The long wavelength response of the InSb PEM detector should make it useful in detecting the discontinuity between space and earth not only on the sunlit horizon, but also on the dark by means of the thermal radiation from the earth.

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Tape Target Classifier Trains Sonar Operators

New trainer utilizes multiplexing techniques to store the acoustic history of sonar environment on magnetic tape for instruction of land-based students

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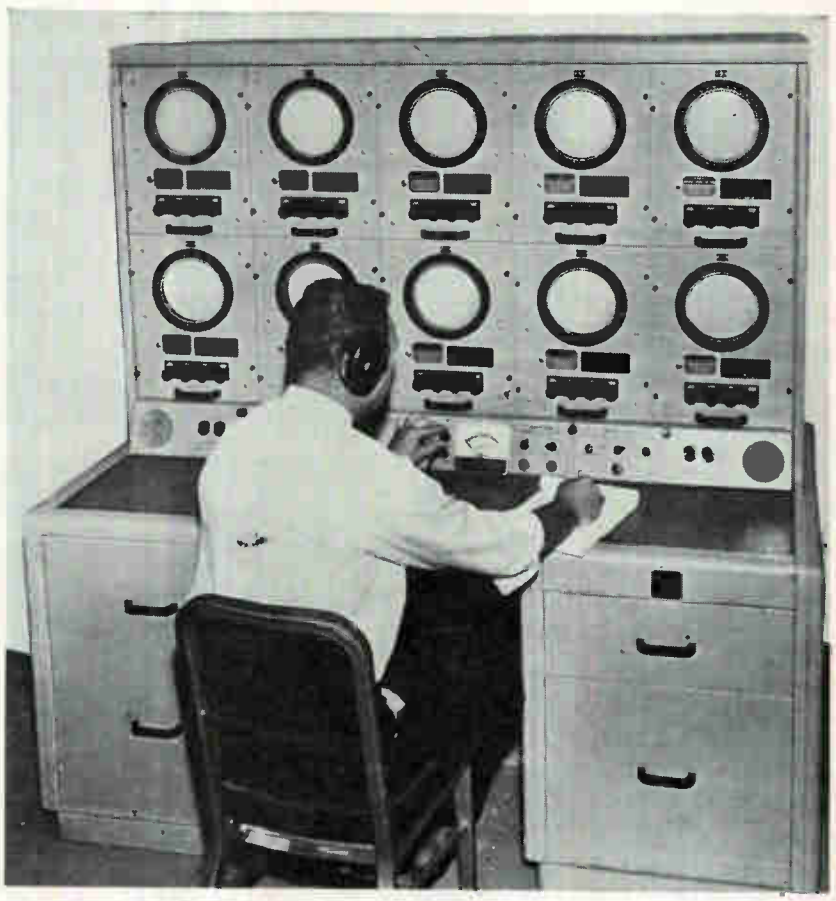
FOR SONAR OPERATORS, the underwater world is a confusing jungle of shadows and extraneous sounds. Sonar returns from pinnacles, old wrecks—even masses of floating plankton coupled with intrinsic sea noises and reverberations—interfere with ready target identification.

A trainer has been developed to acquaint student sonar operators with a realistic presentation of environment before they actually go to sea. The trainer, described here, records on magnetic tape a complete omnidirectional, acoustic history of sonar environment. The tape may be played back into a land-based sonar. Over sixty signals from an active sonar are multiplexed and stored on a 14-inch reel of magnetic tape. Narrow-band audio signals are recorded using pulse-amplitude modulation time-division multiplexing. The ship's course and sonar-sweep signals are frequency modulated and recorded using frequency-division multiplexing. Sonar synchronizing pulses and voice commentary are also taped.

An instrument tape transport utilizing 1-inch magnetic tape running at 60 ips is the basic recording mechanism. Fourteen parallel tracks are spaced on the tape using 14 in-line heads for both record and playback.

Except for transport-drive circuits, all stages are transistorized. Modular construction is used throughout for ease of maintenance, replacement and test. An instructor's station is provided for monitoring and directing.



Sonar instructor can correspond and correct training procedure of ten sonar trainees as they react to taped acoustic histories of actual submarine raids

Record/Playback System

Figure 1 is an over-all block diagram of the record/playback system demonstrating the multiplexing techniques employed.

Signals obtained from a sonar set for recording and reproduction purposes have frequency components in a limited audio spectrum. These signals are recorded as sampled data by pam time-division multiplexing. By sampling the signals at a rate of at least twice the highest frequency of concern, all the

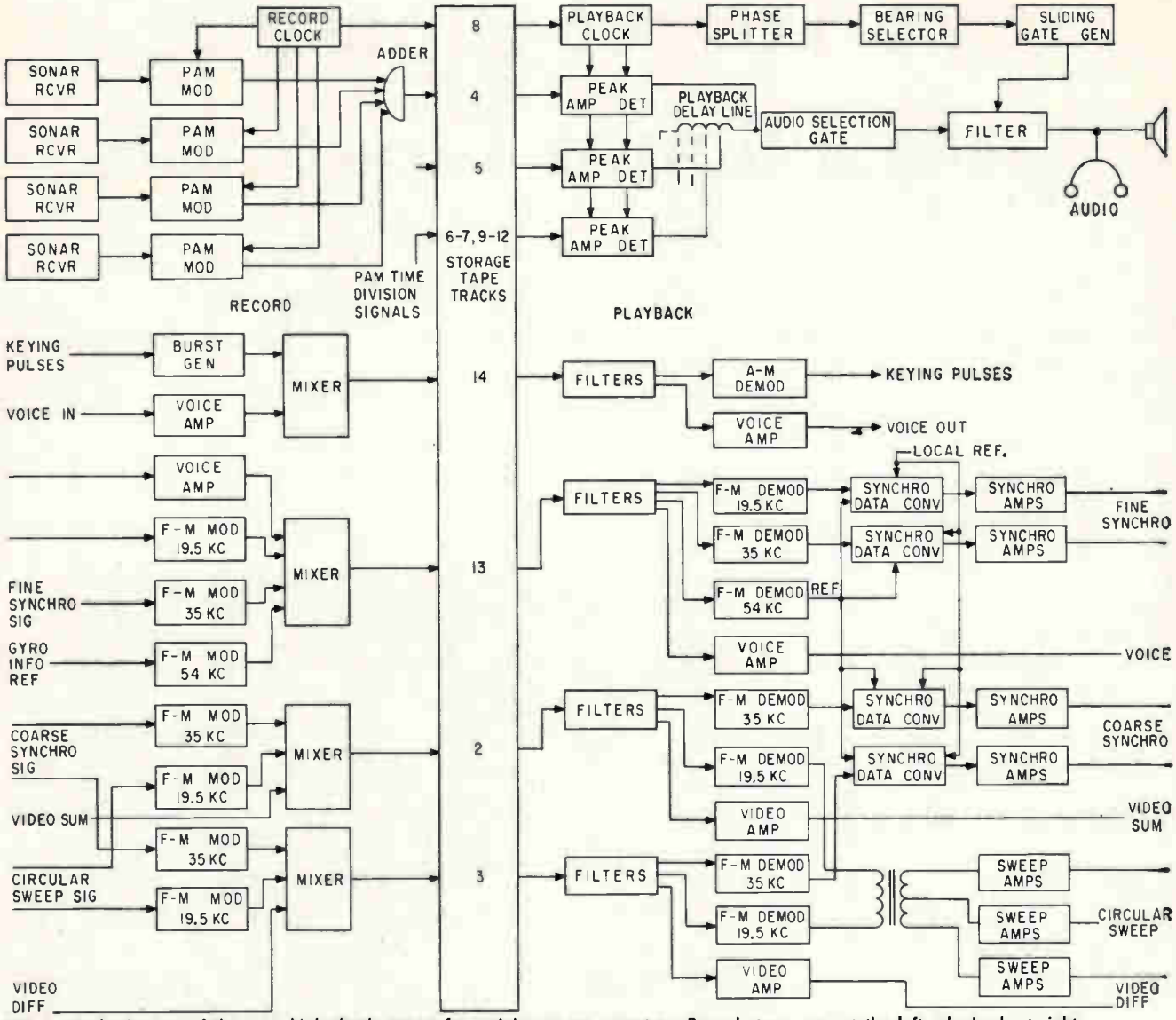


FIG. 1—Block diagram of the record/playback system for training sonar operators. Record stages are at the left, playback at right

signal information is retained. However, practical considerations dictate slightly higher rates.

A record clock generates timing signals at a rate necessary for sampling and in a time sequence necessary for commutating the channels of audio signals obtained from the sonar. The number of channels that can be combined on one track of the magnetic tape depends on the sampling rate and the packing density; that is, the density at which the time-division pam samples can be recorded without objectionable crosstalk between channel positions. The number of tape tracks needed depends on the total audio channels to be recorded.

In a typical sonar, 48 channels of audio information must be recorded, each channel having a range 100 to 1,500 cps. In this unit, a sampling rate of 4 Kc is used and six channels are recorded on each track of tape without undue crosstalk. Eight tracks are required for storing all the audio information.

Clock

The record clock signal is recorded on the tape for purposes of playback synchronization. In the playback portion of the audio system the eight tracks of sampled audio information are recombined in time sequence to form an array of channel positions consistent with the arrangement in the record system.

A selection gate is used to choose a channel or channels of the sampled audio information for listening. This gate is time synchronized with the taped information by the recorded clock signal. Scanning of the audio information by the selector gate is analogous to the searching operation undertaken by an actual sonar operator, and the gate is positioned in playback as a function of the bearing selected by the operator-trainee. After filtering, the selected audio information is presented to the trainee by a loudspeaker.

Course information from the ship's gyro and sonar sweep signals frequency modulate a number of carriers which are frequency-division multiplexed on three tracks of the magnetic tape. The carrier frequencies and f-m parameters are

so selected that at least three signals may be recorded on each of the tracks.

To fill out the spectrum of the frequency-multiplexed tracks a voice-commentary signal is added to one of the tracks and sonar video sum and difference signals are added to the other two respectively.

At the playback end the information in the frequency-divided tracks is separated by appropriate filtering. Demodulators recover the f-m information.

The gyro signals are acted on by the synchro data converters, devices for converting the gyro signals from the ship's reference phase which existed during recording, to the local reference utilized at the playback sonar. The signals are then amplified and directed to the ship's gyro input in the playback sonar.

Keying pulses from the sonar used for recording must also be taped to synchronize and maintain range integrity of the playback sonar. The pulses are recorded as carrier-frequency bursts of duration equal to the pulses. At the playback end an a-m demodulator detects the envelope of the carrier burst and regenerates the keying pulses, which synchronize the PPI display.

Several circuits are given here as an indication of the techniques employed.

FM Modulators

Figure 2 shows the circuit of an f-m modulator which has a 19.5 Kc carrier. In basic concept, the modulator is a sawtooth generator whose repetition frequency is changed by the amplitude of a modulating signal. The sawtooth generator consists of a capacitor run-down circuit which feeds a voltage-comparator circuit. The voltage comparator compares the run-down voltage to a fixed d-c voltage. When these potentials are equal, a step function is generated. This waveform is differentiated, triggering a blocking oscillator whose output causes the run-down capacitor to resume its original state. This restoration generates the rapid portion of a sawtooth waveform. The amplitude of the modulating signal varies the slope of the run-down circuit.

Current Generator

Referring to Fig. 2, the parallel combination of C_1 and C_2 make up the run-down capacitor. Transistor Q_2 is a current generator which controls the time-rate of the capacitor run-down. The modulating signal is fed to the base of the current generator. The amplitude of the a-c signal on the base of Q_2 will change the amount of collector current, which varies the amount of current feeding the run-down capacitors. Potentiometer R_1 determines the maximum frequency deviation by controlling the maximum amplitude of the modulating signal on the base of transistor Q_2.

To obtain linear frequency modulation, the collector current in transistor Q_2 must be linearly related to the voltage amplitude of the input signal. The emitter resistor R_2 provides sufficient feedback to the run-down transistor to achieve this linear relationship.

The voltage-amplitude comparator is a Schmitt trigger consisting of two *npn* transistors, Q_4 and Q_5. Transistor Q_4 is normally not conducting. An *npn*-type transistor is used for the trigger, allowing the run-down signal to be d-c coupled into the base of a transistor that will be nonconducting until the run-down voltage reaches the firing voltage of the trigger. During run-down, this configuration presents an extremely high impedance to the run-down capacitors, which is important in maintaining linear relationship between the modulating input-signal amplitude and the frequency of the sawtooth waveform.

The negative-going step signal coming off the collector of transistor Q_4 is differentiated by the RC network, R_3 and C_3. The output is a negative spike signal which triggers the blocking oscillator through the parallel triggering transistor Q_6.

Blocking Oscillator

The blocking oscillator, incorporating transistor Q_7, has an ON time duration of approximately 2 μsec. The output from the blocking oscillator is a pulse which is fed back to the run-down capacitor to restore its voltage to its original value before run-down started. Diode D_1 prevents the blocking oscillator transformer from loading the run-down capacitors during the run-down. Diode D_2 clamps the restoring portion of the run-down voltage

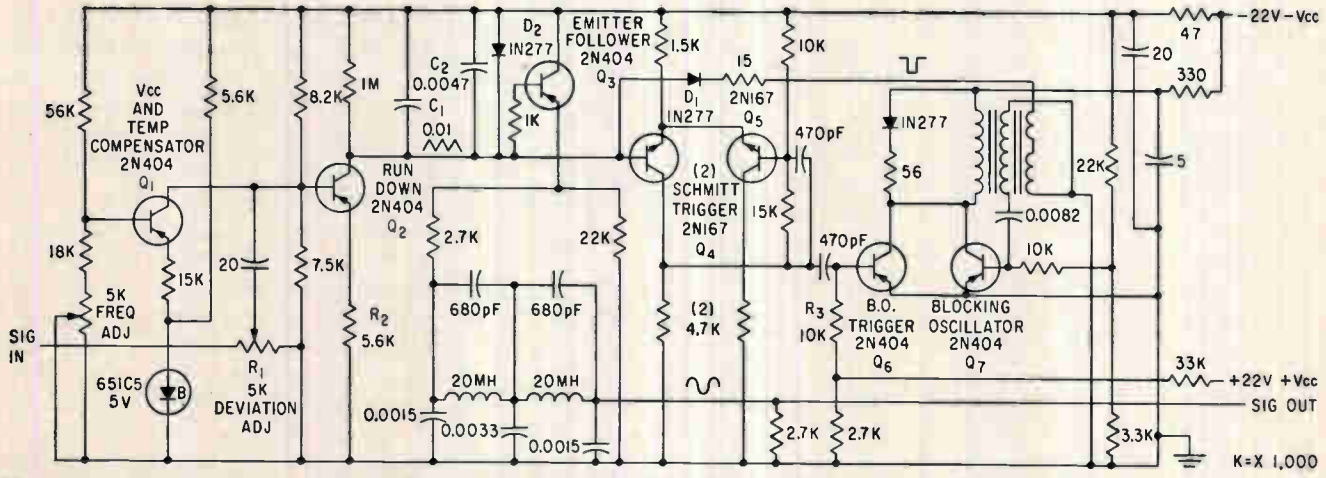


FIG. 2—This schematic diagam is typical af the arrangement af the f-m madulatar stages emplayed in the sanar trainer

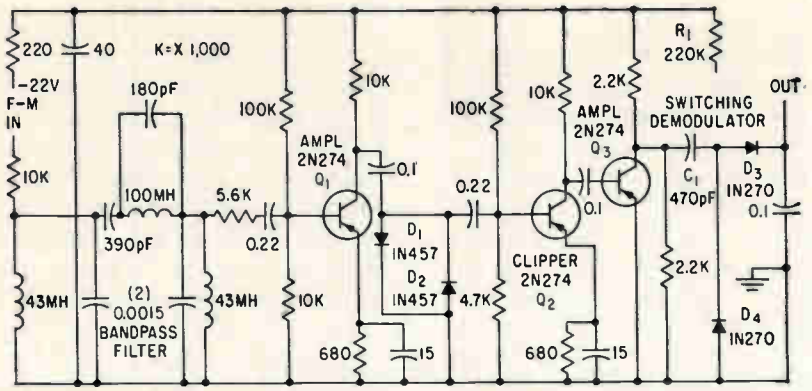


FIG. 3—Frequency-modulation demodulator circuit arrangement used in the trainer

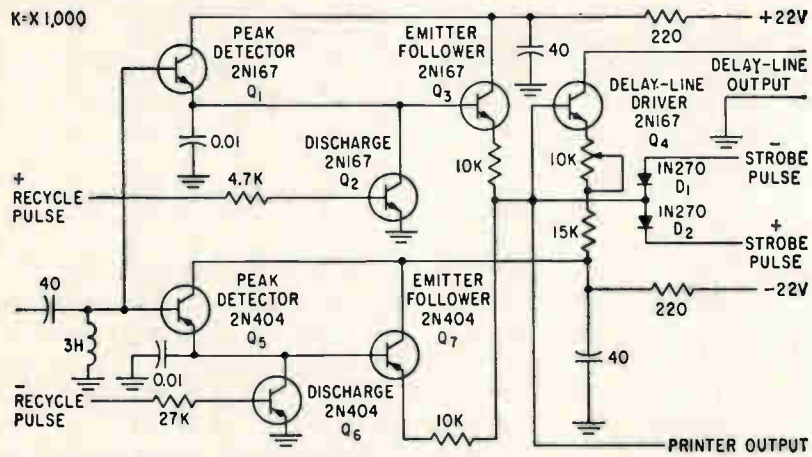


FIG. 4—Peak-amplitude detector schematic diagram

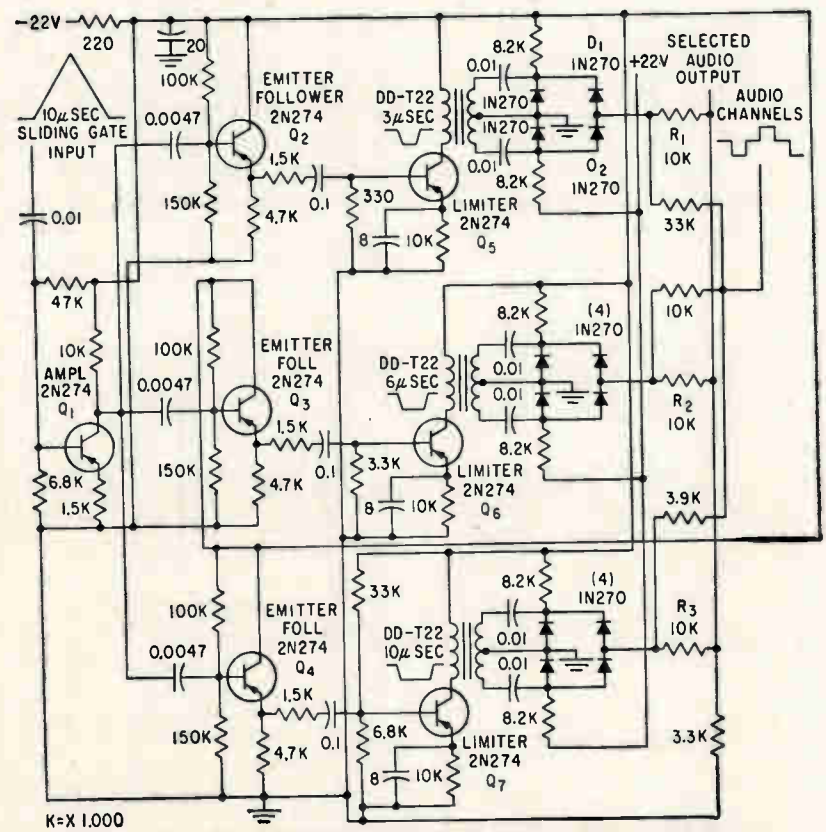


FIG. 5—Schematic diagram of audio selection gate used in the target classifier

to the collector supply voltage $-V_{cc}$.

Feeding the blocking-oscillator signal back to the run-down capacitors can be thought of as positive feedback. The net result is a free-running sawtooth stage. To make certain that oscillation will start when the supply power is first turned on, the blocking oscillator is a free-running type whose natural frequency is considerably less than that of the modulator. The blocking oscillator is, therefore, always triggered by the Schmitt trigger long before it would trigger itself under operating conditions.

Transistor Q_1 keeps the modulator carrier frequency constant, as the temperature or supply voltage varies, by varying the d-c bias on the run-down transistor, Q_2.

The sawtooth signal at the charging capacitor is fed to an emitter follower, Q_3. Output of this stage drives a low-pass filter, the output of which is primarily the fundamental-frequency component contained in the original sawtooth. Harmonics of the sawtooth are extracted to avoid interference on other f-m channels when the signals are multiplexed.

The f-m mixers are simple resistor adding networks which multiply the signals onto one line. This multiplexed signal goes to an emitter follower, whose output feeds the direct-record amplifiers.

F-M Demodulator

As will be recalled, the f-m signals are multiplexed onto one track of the magnetic tape. When the tape is played back, the entire track signal is parallel fed to the demodulators.

A bandpass filter at the input to the demodulator will select the band of frequencies associated with each f-m carrier frequency. Each filter will attenuate the voltage signals of the adjacent channels by at least 20 db.

Referring to Fig. 3, a typical f-m demodulator (19.5 Kc), the output signal from the bandpass filter is amplified by the transistor Q_1 and then clipped by diodes D_1 and D_2. The clipped signal is amplified by transistors Q_2 and Q_3. Output of this stage goes to the switching demodulator. The sine-wave output from the bandpass filter has been

converted to a square wave.

Basic principle of the switching demodulator is explained with the help of Fig. 3. A charging capacitor, C_1, is switched by a square-wave input in combination with two diodes. The capacitor is charged to −11 volts by the square wave through diode D_3 and associated paths. As the input to the switching demodulator is an f-m signal, the frequency of the square wave varies; consequently, the value of the average current varies. The average current attributable to the carrier frequency is in itself large, making small variations in current difficult to detect. The d-c current attributable to carrier is cancelled by resistor R_1, and the only signal found at the base of the next transistor is the varying component of the average current. This process has accomplished the demodulation of the f-m signal.

Peak-Amplitude Detector

Pulse-amplitude modulation time-division multiplex signals recorded and reproduced in a magnetic-tape storage system suffer from two major degradations: (1) an ideal pulse waveform is considerably altered in the record/reproduce process because of the limited bandwidth available; and (2) because of skew and weave of the tape, there is variation (jitter) in timing between tracks of the time-sequenced samples. Since properly timed narrow pulses are necessary for processing in the playback system, circuits are incorporated which reshape pulses from the playback amplifiers. A peak-amplitude detector performs this reshaping and provides narrow 2-μsec pulses coinciding with the reference playback clock and having an amplitude proportional to the peak amplitude of the input-pulse samples. This circuit is shown in Fig. 4.

Pulses obtained from the playback amplifier, representing pam signals from one track of tape storage, are applied to the bases of transistors Q_1 and Q_2, emitter followers with capacitive loads and no bias. These transistors are complementary in that Q_1 is an *npn* type and Q_2 a *pnp* type.

Transistor Q_1 will conduct only when the input signal is more positive than emitter voltage. For example, when a positive pulse is applied to the input, the load capacitor C_1 will charge to the potential applied to the base. When the input pulse decays, the base potential will drop below the emitter voltage, and the transistor will be cut off, preventing capacitor discharge.

The voltage at C_1 will remain at the peak amplitude of the input pulse until a positive recycling pulse causes transistor Q_2 to conduct and discharge the capacitor. Transistor Q_3 is an emitter follower isolating the peak detector from its load.

Modulator

Transistors Q_5, Q_6 and Q_7 comprise similar circuits, but since they are of complementary types, these stages will peak detect the negative pulses appearing at the input.

Crystal diodes D_1 and D_2 are parts of a modulator which produces a pulse output when activated by the strobing pulse, a pulse timed to select the peak amplitude. At the diodes' junction a pulse appears having a width equal to that of the strobe pulse and amplitude proportional to the magnitude of the peak detector output, hence proportional to the peak amplitude of the input pulse. Q_4 is used for coupling to an adjacent circuit.

Recycling and strobing pulses are derived from the playback clock and are timed to facilitate extracting narrow pulses of a-m information in proper sequence to the signals taken from tape storage.

Audio Selection Gate

In playback, pam samples are recombined in the playback delay line to form a time sequential of the channel positions. Function of the audio selection gate is to select from the channel positions the sample chosen for monitoring by the operator-trainee. It is necessary to realize a smooth transition from one channel to another. This is accomplished by making the selection gate slightly wider than the channel sample spacing, and by performing a multiplication of the channel information and the selection gate. The multiplier is capable of producing three voltage levels of a particular audio channel, each level appearing in sequence as the sliding gate passes over the channel, and as a function of the coincidence between the channel and the sliding gate.

Referring to Fig. 5, the triangular sliding gate is amplified and inverted by Q_1 and fed to three isolating emitter followers, Q_2, Q_3 and Q_4.

The emitter followers feed three limiters, Q_5, Q_6, and Q_7, which produce pulses 3, 6, and 10 μsec wide respectively. These pulses are symmetrical about the axis of the sliding gate.

If the selection gate is positioned directly over a channel position, the 3-μsec pulse is then gated with the full voltage of the channel signals, the 6-μsec pulse with two-thirds the signal, and the 10-μsec pulse with one-third the signal.

The number of gates in operation at any one time depends on the position of the sliding gate in respect to the particular channel pulse.

Each of the limiters serves to enable a bipolar AND gate. Typical of these is the gate made up of diodes D_1 and D_2. The gates are fed in parallel by properly attenuated audio-channel signals.

Pulse spacing of the audio channels at the output of the playback delay line is approximately 5 μsec. Since the sliding gate is approximately 10 μsec wide at its base, at least one audio pulse sample must always be within the gate. As the selection gate slides away from one sample it picks up a portion of the next, thus providing the necessary smoothing between channel positions.

The bipolar outputs of the AND gates are summed across resistors R_1, R_2 and R_3 to give the final output of the audio selection gate.

Performance

The sonar trainer described was built for the U. S. Naval Training Devices Center, Port Washington, N. Y.

Designed to meet MIL-E-19100 specifications, units have been operated both ashore and on shipboard with a minimum of maintenance.

Industrial Hysteresigraph

Instrument provides rapid and accurate record of magnetic characteristics of materials. Vibration isolation of galvanometer used in instrument permits application in manufacturing plant

By R. R. BOCKEMUEHL and P. W. WOOD, General Motors Research Laboratories, Warren, Mich.

MANY IMPORTANT measurements of d-c magnetization and hysteresis characteristics of magnetic materials are bypassed because of inadequacies of available measuring equipment. An expensive instrument that requires extensive environmental isolation and highly skilled operators can often be justified for a research laboratory application but is impractical for most quality control and product development activities of a manufacturing plant.

A practical hysteresigraph, shown in the photograph, has been developed.[1] This instrument employs a continuous d-c integrating technique.[2, 3] Circuit simplicity and use of commercially available components results in an instrument having relatively low cost, simple operation and good flexibility and which records magnetic B-H characteristics rapidly, accurately and reliably in industrial environments.

Integrating Principle

Voltage induced in a coil is proportional to the rate of change of the flux bounded by the coil. The induced voltage must be integrated to produce a signal analogous to that flux. The circuit shown in Fig. 1 performs this integration with a high gain d-c amplifier and mutual inductance derivative feedback loop. Feedback voltage is equal to the mutual inductance M times the rate of change of the amplifier output current I. The large mutual transconductance, G_m, of the amplifier causes the feedback voltage to equal the input voltage minus a small error signal equal to I/G_m: $Md_I/dt = Nd\phi/dt \times 10^{-8} - I/G_m$

If the last term is neglected, the equation shows that any change of flux $\Delta\phi$ produces a proportional change in output current of $M\Delta I = N\Delta\phi \times 10^{-8}$ where N is the number of turns in the sample coil.

The error signal I/G_m introduces an integrating time constant equal to the product of MG_m. Thus the integrator is analogous to a simple RC integrator but has a time constant several orders of magnitude greater than is possible with an RC circuit. True integration is approached when the period of the measurement is much less than the integrating time constant.

The B-H characteristics of a ring sample can be recorded directly on an X-Y recorder by plotting the integrator output current versus the sample magnetization current. Actually, sample flux versus magnetization current is recorded but these terms can be converted to flux density and field intensity respectively by considering the dimensions of the sample. A bar sample requires a second integrator for field intensity measurement in order to integrate the air flux which is proportional to H.

The d-c amplifier in such a system must have a G_m of several hundred thousand mhos and must have negligible equivalent input noise and drift with respect to input signals. These input signals are much smaller than 1 microvolt.

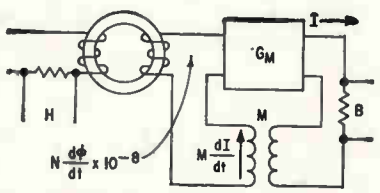


FIG. 1—Voltages induced by flux changes are integrated by amplifier with mutual inductance feedback

Galvanometer-Photocell Amplifier

The circuit diagram of the instrument is shown in Fig. 2. A voltage gain of about 3×10^6 is obtained with the galvanometer-photocell amplifier. Minute deflections of the galvanometer produce a large change in the relative light intensities on the two photocells connected in the bridge circuit. Magnitude and polarity of the photocell bridge unbalance signal is proportional to the galvanometer deflection. Potentiometer R_1 balances small quiescent differences in the two photocells. Output impedance is reduced with cathode follower V_1 which is biased so that zero output voltage exists when the galvanometer current is zero.

Although vacuum phototubes are usually used in amplifiers of this type because of their low noise, a significant increase of gain is realized with gas phototubes without introducing excessive noise. The principal noise developed is caused by vibration of the galvanometer. Vibration isolation is obtained by mounting the internally oil damped galvanometer and its associated optical system on a 140 pound iron block. When operated near heavy rotating machinery the recorded noise level is equivalent to a flux-linkage change of 2.5 maxwell-turns; the vibration produces slit image deflections less than 10^{-7} cm. Thus vibration noise will be negligible in almost any reasonable location in a manufacturing plant.

The signal level at the output of the galvanometer-photocell amplifier is considerably greater than

Uses D-C Integration

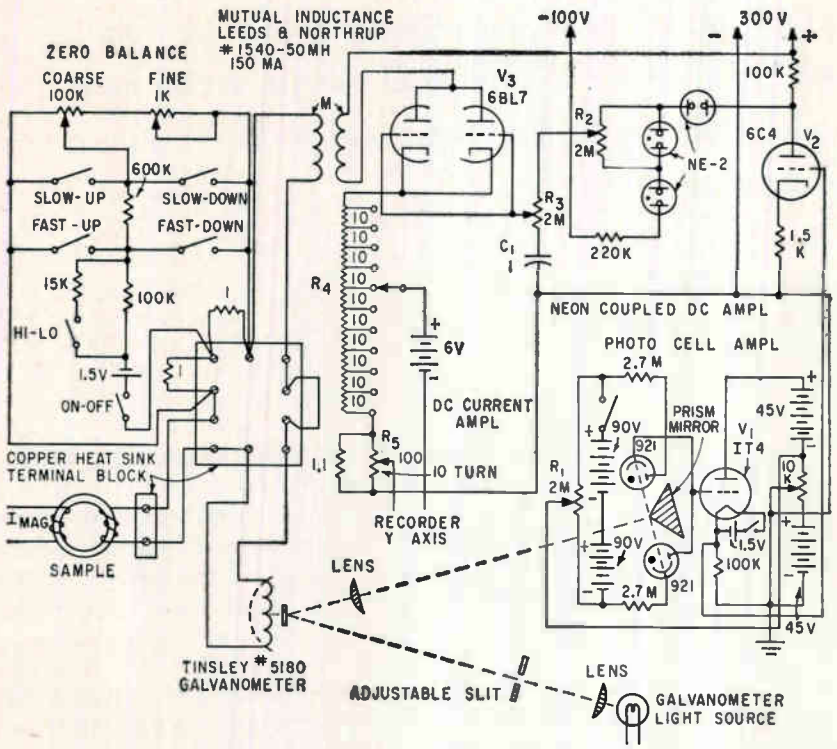


FIG. 2—Instrument uses momentary contact switches to adjust zero position of recorder

Output of instrument is fed to X-Y recorder to obtain magnetic characteristics

the noise and drift levels of the succeeding vacuum tube amplifiers. Conventional triode voltage amplifier, V_2, is coupled to current amplifier V_3 through a direct coupled neon bulb network and a simple low pass filter. The neon coupling network greatly simplifies power supply requirements. Potentiometer R_2 provides a bias adjustment for the current amplifier but does not affect the signal amplitude. Bandwidth of the amplifier is limited to eliminate high frequency instability caused by large amplifier gain and derivative feedback. Network R_3C_1 provides an adjustment of the rate of signal attenuation as a function of frequency and permits an optimization of frequency response and stability.

Current through current amplifier V_3 depends primarily on grid voltage and cathode resistance. The amplifier plate is effectively a constant current source for the primary of the mutual inductance. Calculations involving the sample dimensions and the desired recorder full scale values determine the settings of R_4 and R_5 needed to calibrate the recorder directly in units of flux density. A similar network (not shown) permits direct conversion from magnetization current in a ring sample to units of field intensity. Full scale recorder calibration can be adjusted continuously from 250 to 500,000 maxwell-turns. A dry cell in the calibration circuit cancels the voltage due to quiescent amplifier current.

The galvanometer-photocell electronic amplifier combination has a mutual transconductance of 2×10^5 mhos. This, in conjunction with the 50 mh mutual inductance provides an integrating time constant of 10^4 seconds. Errors resulting from this time constant are less than 0.01 percent of full scale per sec of recording time. Time to record a complete hysteresis loop is typically between 10 and 30 sec.

The input circuit of the instrument is formed by a series loop which includes the sample coil, the galvanometer, the secondary of the mutual inductance and an adjustable voltage network. A d-c potential of 1 mv in this input loop will be integrated causing the amplifier output current to drift at a rate of 2 ma per second. Therefore, thermal potentials must not only be constant but must be effectively cancelled to eliminate drift. The battery and potentiometer network in the input develops a potential difference across two 1-ohm resistors and is adjusted to cancel existing thermal potentials. Input circuit loop connections are made on an insulated copper block which has a thermal time constant compatible with the integrating time constant.

The instrument performs satisfactorily with X-Y recorders having full scale sensitivity of 5 or 10 mv. Full scale pen speeds of 1 to 2 sec are desirable.

The magnetization current source must be smoothly variable throughout a range including both positive and negative currents. If the maximum current requirement is less than 10 amp, simple power transistor circuits[4] are applicable.

Three units have been constructed having identical characteristics. Shakedown time has been negligible and 100 percent reliability has been realized.

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(1) R. R. Bockemuehl and W. E. Sargeant, A Practical Hysteresigraph *Fifth Conference on Magnetism and Magnetic Materials*, Detroit, 1959.

(2) R. F. Edgar, A New Photoelectric Hysteresigraph *Trans AIEE*, 56, p 805, 1937.

(3) P. P. Cioffi, A Recording Fluxmeter of High Accuracy and Sensitivity, *Rev Sci Instr*, 21, p 624, 1950.

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Solving Noise Problems in

Computer reading and writing should occur when the signal-to-noise ratio is highest. Strobing pulses define these times. Instead of using a strobe pulse that is derived from the computer's clock, this system uses a drive-sampling core to generate precisely-defined strobes

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Computer Advanced Development Dept., Sylvania Electric Products, Inc., Needham, Mass.

COINCIDENT-CURRENT memories sometimes encounter a low peak-signal-to-peak-noise ratio. The standard method for getting around such situations is by strobing, that is, using the output at the time of peak signal-to-noise ratio. In the transistorized memory for the Mobile Digital Computer (MOBIDIC), the optimum strobe time was not well defined, since the computer had to perform over a temperature range of −30 C to +55 C. Normal variations in circuit delays for such environmental extremes make any choice of fixed strobe time questionable. For this reason, the new system obtains its strobing pulses directly from driven cores, rather than being tied to an arbitrary timing scale fixed by the computer clock. Such a system overcomes the problems of variations in driving circuits, temperature variations in peaking time, and waveform variations due to load changes.

The Noise Problem

Coincident-current memories, widely used in modern computers, are limited in size and speed by stray noise occurring during the read-out operation.[1]

In an array of $n \times n$ cores, the sense winding threads n^2 cores, one of which is fully selected by the coincidence of two half-current drives, and $2n - 1$ of which are half-selected by a half drive. Freeman has shown that the noise voltage contributed by the $2n - 1$ half-selected cores of an array appears on the sense winding before the peak ONE output from the fully-selected core.[2] The noise voltage (ZERO) can be even greater than the voltage due to a sensed ONE. Thus, the signal-to-noise ratio is less than one, and amplitude discrimination alone is inadequate to distinguish between ZERO and ONE.

Figure 1 shows typical waveforms. Here the peak noise voltage is less than, but of the same order as, the peak signal voltage. Noise voltage may have the same polarity as signal voltage, although this is not indicated in Fig. 1.

Conventional Solution

The usual approach in overcoming the noise problem is to apply a narrow pulse to a gate input of the sense amplifier at the time of optimum signal-to-noise ratio. This time occurs after the noise has died down and is close to the peak of the ONE signal. The strobe pulse is usually generated by the system clock, either by delaying the clock pulse which initiates the READ sequence or by selecting a particular clock pulse in a multiphase system; therefore the strobe pulse is fixed in time relative to the clock.

In a large memory system employing many driver circuits it is inevitable that there will be variations in the delay between the time the clock starts the READ sequence and the time the READ current actually reaches the drive line. This variation in circuit delay is especially noticeable in transistorized memories due to marked variations in transistor gain, cutoff frequency and storage charge. In addition to various delays, there are variations in drive-current waveform, caused by changing load impedances; these change as addresses are changed between word registers containing mostly ONE's or mostly ZERO's.

Thus, even if we are free to adjust the strobe time, adjustment is at best a compromise among the delays observed in the completed system. As the machine ages, other factors effect changes in peaking times, and may well increase the variance among various addresses. Thus, the strobe time may have to be readjusted and the margins may well worsen despite all adjustments.

The waveforms in Fig. 2 show the variation in read-out time due to drive current waveform variations alone; there is a fixed circuit delay from the initiating pulse to the start of the drive current. Normal drive current has a rise time of about 0.36 μsec. Early and late drive currents, which cause worst-circuit conditions, are indicated by broken-line waveshapes in Fig. 2B. The normal drive produces a core output (Fig. 2C) to drive the sense winding, which in turn, drives the unstrobed sense amplifier. Normal sense-amplifier output (Fig. 2D) begins 0.94 μsec after the start of drive current.

For a slow-rise-time drive current, sense-amplifier output starts 1.04 μsec after the start of current drive; for a fast-rise-time drive current, output lag is about 0.8 μsec. If a particularly noisy ZERO were read out (Fig. 2E) by the slower

Digital Computer Memories

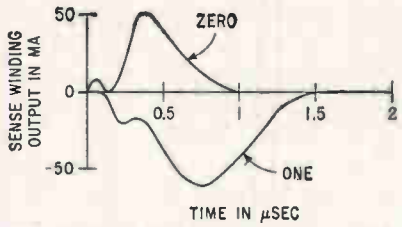


FIG. 1—Noise picked up by a sense winding often approaches signal strength

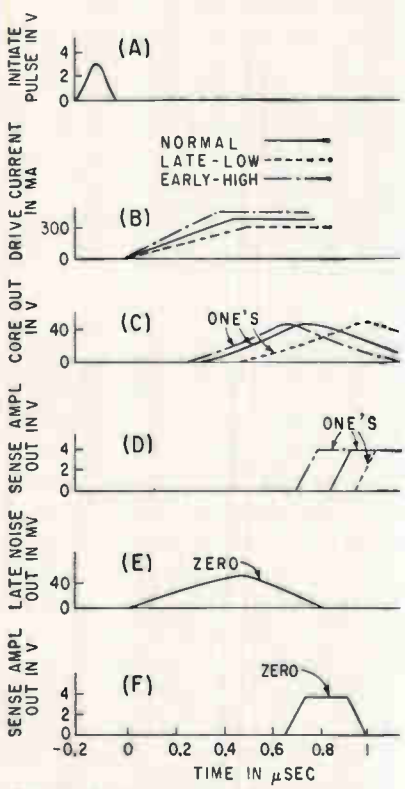
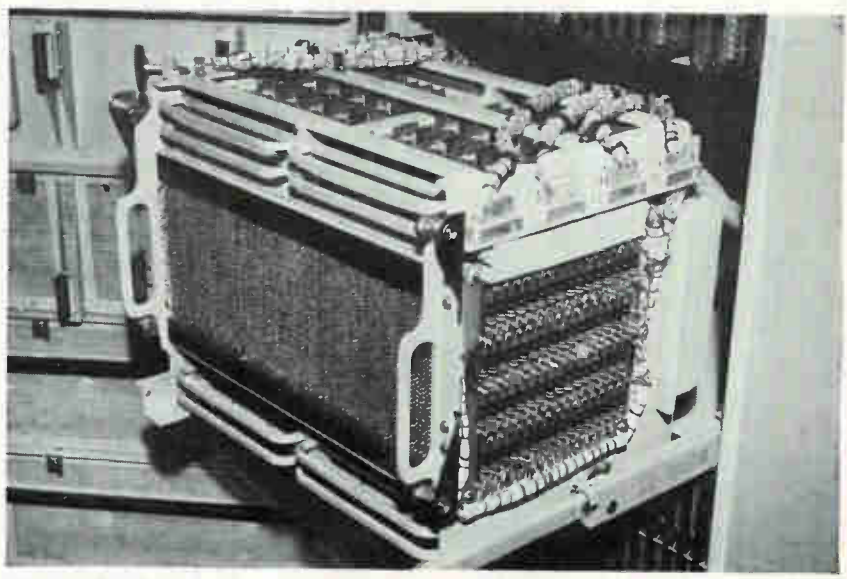


FIG. 2—Clock pulse (A) initiates drive current (B), which may be early or late. Ungated sense amplifier's outputs (D) and (F) are shown for ones (C) and zeros (E)



Closeup of MOBIDIC memory array shows some switching transformers and load resistors

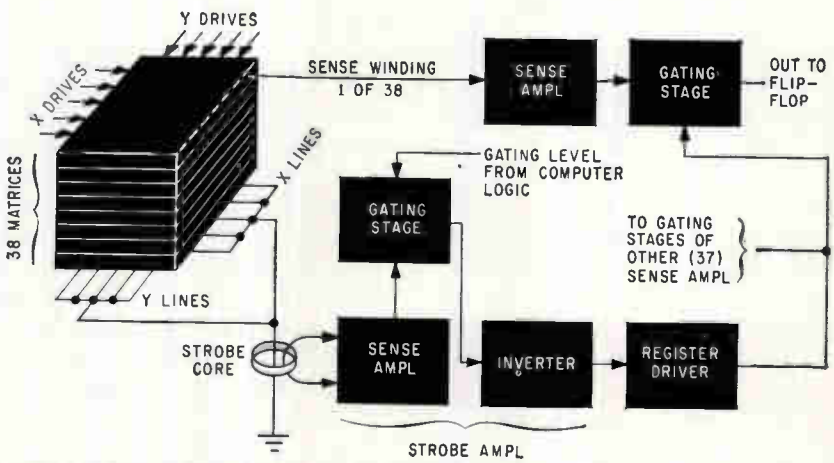


FIG. 3—Memory system shows one of the 38 sense-winding lines

(and lower) drive current, it could cause a sensed output (Fig. 2F) lasting until 1 μsec from drive-current start; this time is only about 0.1 μsec before the end of the early ONE read out by a faster, higher amplitude, drive. To permit errorless readout under the conditions shown in Fig. 2, the strobe should start at 1 μsec, early enough to get an early ONE and late enough to reject a late ZERO. The operating margin would be very narrow.

Because of the circuit delays between the initiation of the READ pulse and the start of the drive current, a marginal situation is certain. It is difficult if not impossible to hold the delay down to less than ±0.15 μsec in a transistorized computer, especially when the circuits are subject to wide ranges of ambient temperature. Therefore, the conventional strobe is inadequate for transistorized drive circuits operating over a wide range of environments.

Current-Derived Strobe

With a strobe pulse derived from the drive current, the effects of circuit delay variations are avoided and the system is marginally satisfactory. However, the operation of the system is still dependent upon maintaining tight control over the drive-current waveform. Overshoot on drive current could still read out the ONE'S so early that the strobe pulse would miss entirely.

Core Derived Strobe

This method produces a strobe pulse sensitive not only to the time at which current starts, but also to the waveform of the current. The ONE output of a memory core which has the same drive as the selected

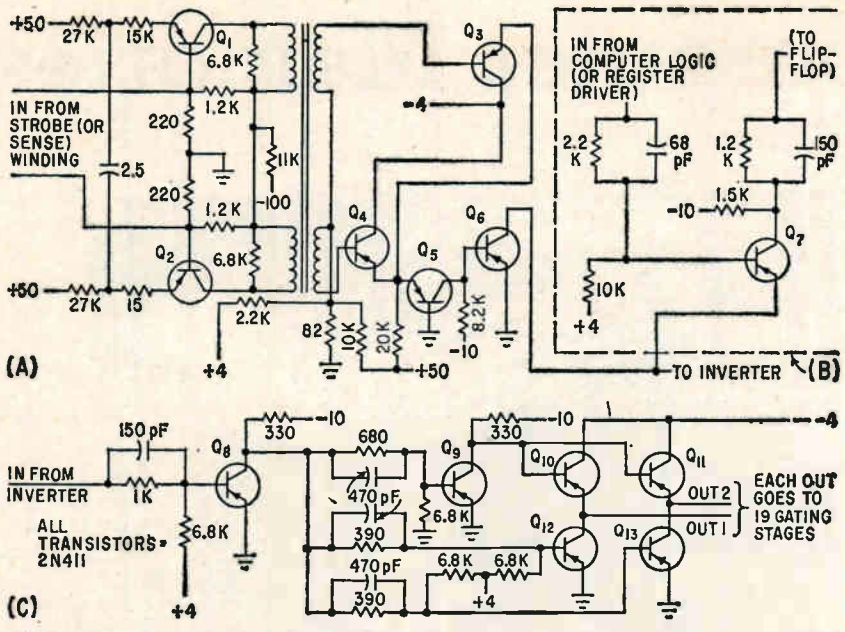


FIG. 4—When a sense amplifier (A) is driven by a sense winding it functions with gating stage (B), which drives a flip-flop; here gating stage is not connected to inverter (C)

memory word provides the desired strobe pulse.

Figure 3 shows the basic method. The strobe core receives the coincident currents from the x and y coordinates of the memory. The strobe-core ONE output drives a sense amplifier which is gated open by its gating stage. This sense amplifier amplifies the ONE input, shapes the portion above the discrimination level, and supplies an input to a register driver. The delayed output of the register driver opens the gating stages of 38 sensing amplifiers which receive inputs from the 38 sense windings threading the 38 matrices of MOBIDIC's memory.

In Fig. 4, the inputs and outputs which are not enclosed by parentheses are the strobe-line connections indicated in Fig. 3; inputs and outputs enclosed by parentheses are the sense-winding-line connections indicated in Fig. 3.

The circuit delay may be adjusted so that the leading edge of the strobe pulse arrives at the sense amplifiers at the optimum strobe time. Once set, the strobe will move back and forth in time as driving conditions change. Figure 5 shows the same set of conditions as caused marginal operation in Fig. 2, but with a core-derived strobe. The strobe is now flexible, with no possibility of error; the late ZERO, (Fig. 5B), previously marginal, now has a full 0.12 μsec after its end before the strobe starts. A ONE read out by the same drive would arrive at the sense amplifier gate 0.1 μsec or more before the strobe starts. Driver circuit delays occurring before the start of the drive current have no effect on the relative time between strobe and output. With the fixed strobe of Fig. 2, a variation in delay of ± 0.1 μsec would be excessive; with the core derived strobe, delay variations of over 1 μsec would be tolerable by the memory section, and only system timing would dictate the limits.

Test Results

In a test of a core-derived-strobe system, one driver had a 1.8-Mc transistor where the specification required an 8-Mc unit. Whenever that driver was used, an extra delay of 0.8 μsec was observed, but no errors resulted. No fixed strobe could work reliably with such wide variations.

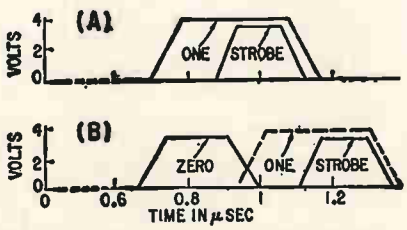


FIG. 5—Time relation of strobes to early (A) and late (B) waveforms

Modes of Operation

Another advantage of this system arises in single-pulse operation, required in all large scale systems. A fixed strobe would have to be derived from the initial clock pulse and delayed by a delay line of at least 1.3 μsec.

While it may be thought at first that the strobe pulse could be supplied from a single core, as shown in Fig. 3, this is usually not true. For instance, in a memory which is driven from a switch-core matrix, one core inserted in the ground return of both the x and y coordinates would receive the coincident x and y drives in addition to the saturation noise current of $2^2\sqrt{n-2}$ switch cores; with typical switch core material of 90-percent squareness the amount of overdrive to the single strobe core would be 140-percent, resulting in an early strobe with very little sensitivity to waveform variations. This formula and the percent of overdrive are functions of the winding configuration.

A matrix of memory cores may be employed with selective wiring such that the noise currents are spread out where they do not affect operation.

For the 64 × 64 memory in common use, an 8 × 8 matrix of strobe cores insures against any noise current in the selected strobe core. A compromise 4 × 4 matrix may be chosen for wiring simplicity; in this configuration only one half-selected switch core supplies current to each coordinate of the strobe core matrix and this amount of overshoot on the driving pulse causes negligible timing variation.

If space allows, a complete 64 × 64 strobe plane may be preferable; the wiring complexity of the smaller strobe matrices probably costs more than the extra 64 × 64 strobe plane at today's prices. Moreover, in certain cases the larger matrix may be indispensable.

References

(1) W. N. Papian, New Ferrite Core Memory, ELECTRONICS, p 194, Mar 1955.

(2) J. R. Freeman, Pulse Responses of Ferrite Memory Cores, *Proc of WESCON Computer Sessions*, Aug 1954, 1955. (Also MIT Lincoln Lab, Memo M-2568-1.)

Boosting Function Generator Output With Transistors

By D. R. CHICK,
Associate Engineer, Texas Instruments Incorporated, Dallas, Texas

Engineer checks performance of function generator

Function generators using diodes are normally followed by d-c amplifier to compensate for reduction of output. Since circuit described uses transistors no further amplification is needed

IN COMPUTERS and in other devices, it often becomes desirable to use a circuit whose output is a specific function of its input voltage. Such circuits are termed function generators. A diode function generator, which is common in computer circuits, will be reviewed first so that a comparison may be made between it and the transistor function generator which is described later. Diode function generators produce a curve by approximating it with a number of straight lines.

Figure 1A shows a basic circuit. The diodes are biased by series batteries, but voltage divider resistors may be used. Zener diodes could alternatively be substituted, but they are often undesirable owing to certain inherent disadvantages. Reasons for avoiding Zeners in this application are that most types have wide variations of voltage with extreme temperature changes and they require considerable current (8 ma) to establish their breakdown voltage.

Operating Principles

Referring to Fig. 1A the current through diode D_1 is V_{IN}/R_1 and is represented in Fig. 1B by line AB. Since there is no bias on this diode, the line AB passes through the origin. (The small, but finite forward voltage is neglected). Battery B_1 in series with diode D_2 biases this diode off until the input voltage reaches a level corresponding to point B'. Current through D_2 is represented by line $B'C'$, and the bias delays the start of this line to B'.

Current through diode D_3 corresponds to line $C''D''$, with battery B_2 biasing D_3 off until the input voltage corresponding to point C'' has been reached. Currents through D_1, D_2, D_3 add in R_L to give the output voltage. Since R_L is much smaller than R_1, R_2, and R_3, the output voltage will be much smaller than the input voltage.

Usually the output from a diode-type function generator is between ten and one hundred times smaller than the input, so further ampli-

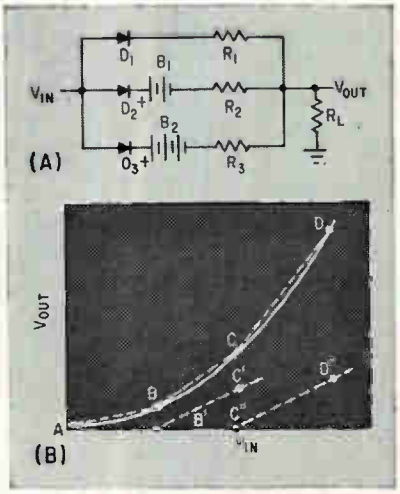


FIG. 1—Function generator uses battery-biased diodes

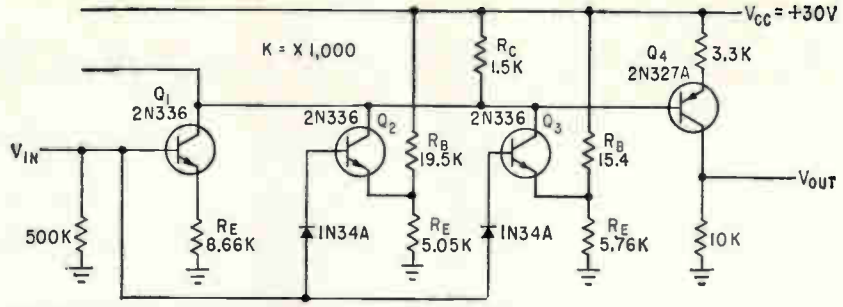


FIG. 2—Analog voltage of required function is developed across R_C and inverted by Q_4

fication of the output is generally necessary. Because a stable d-c amplifier adds expense and complexity, it is desirable to use a function generator whose output does not need to be amplified. Using transistors instead of diodes, a function generator whose output voltage is several times greater than the input can be designed, thereby obviating the need for a d-c amplifier.

Transistor Circuit

In the transistor function generator of Fig. 2 the currents in each transistor are represented by the slopes of the line segments of Fig. 1. The magnitudes of these currents are determined by the input voltage V_{IN}, V_{CC}, and the values of each emitter resistance. The transistors are biased off by making their emitters positive with respect to their bases. The output signal is developed across common collector resistor R_c and is referred back to ground by an inverter amplifier Q_4.

Emitter resistors are chosen to give the proper current through each transistor. The common collector resistor is small enough so that with maximum input voltage none of the transistors have a collector-emitter voltage near the saturation value. ($V_{CE} = V_{CC} - V_{in} - I_{total}\ R_c$). The mathematical function to be generated can be more accurately approximated by increasing the number of transistors and letting each one represent a smaller line segment of the ideal curve.

Inverter

The last transistor (Q_4) is the inverter amplifier, whose emitter resistor is chosen to give the desired operating current at maximum input voltage. Its collector resistor is chosen to give the desired output voltage, without causing the transistor to approach saturation voltage.

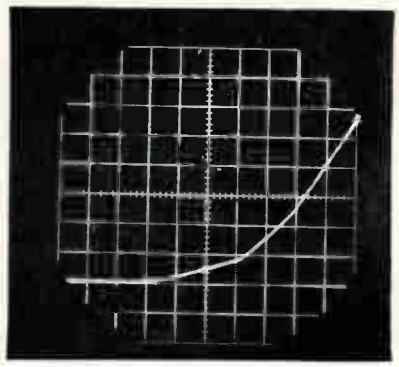


FIG. 3—Output of function generator

One application of this circuit is to compute the ground range of a radar target when the slant range is given. A solution of the equation is a curve whose slope decreases as the independent variable increases. The normal output of the transistor function generator of Fig. 2 is a curve whose slope increases with the independent variable. If the slant range equation is subtracted from a constant voltage a new curve will result. This curve will have the proper slope (Fig. 3). Subtraction can be performed by this circuit if the output is taken between the common collector resistor and ground.

This circuit is used normally to generate a curve whose slope has a positive derivative.

Temperature Stability

To give this circuit temperature stability, it was necessary to put two silicon diodes in series with R_c (see Fig. 4). The forward voltage across these diodes changes with temperature in approximately the same manner as V_{BE} of the inverter amplifier transistor, and causes the input to that stage to decrease with temperature. This decrease in input voltage compensates for the increase in gain at high temperatures which is caused by the decrease of V_{BE} at high temperatures.

Output of this amplifier across R_c was about ten times as large as the output of a trial diode function generator. The output could be made larger by increasing R_c. To allow for this increase in voltage across R_c, V_{CC} must be increased. The factors that limit the magnitude of the output are I_{Cmax}, V_{CC} (which is limited by V_{CE}), V_{CEsat} and R_c.

If it is desirable that the output function be changed from time to time, ease of adjustment can be improved by making the emitter resistors larger than required to bias each transistor. In Fig. 4, R''_E is selected as the smallest value of R_E expected to be used and is determined by the desired maximum current through the transistor being biased. R'_E is added to give desired adjustments. The total resistance is now R'_E plus R''_E. The value R_{bias} is selected to give the proper bias point for the transistor. Because the bias current does not flow thru R'_E, it does not effect the turn-on point of the transistor.

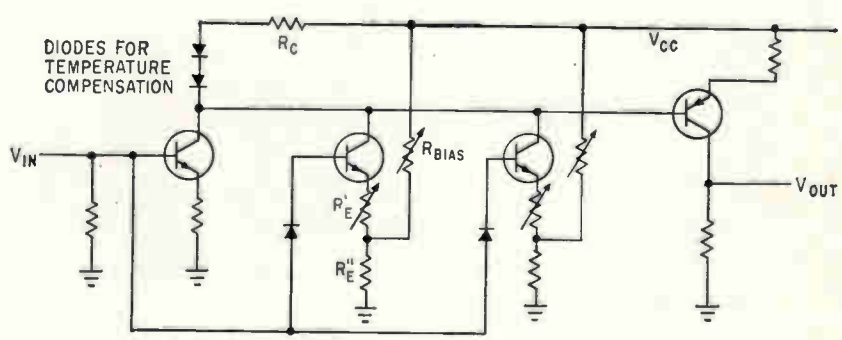
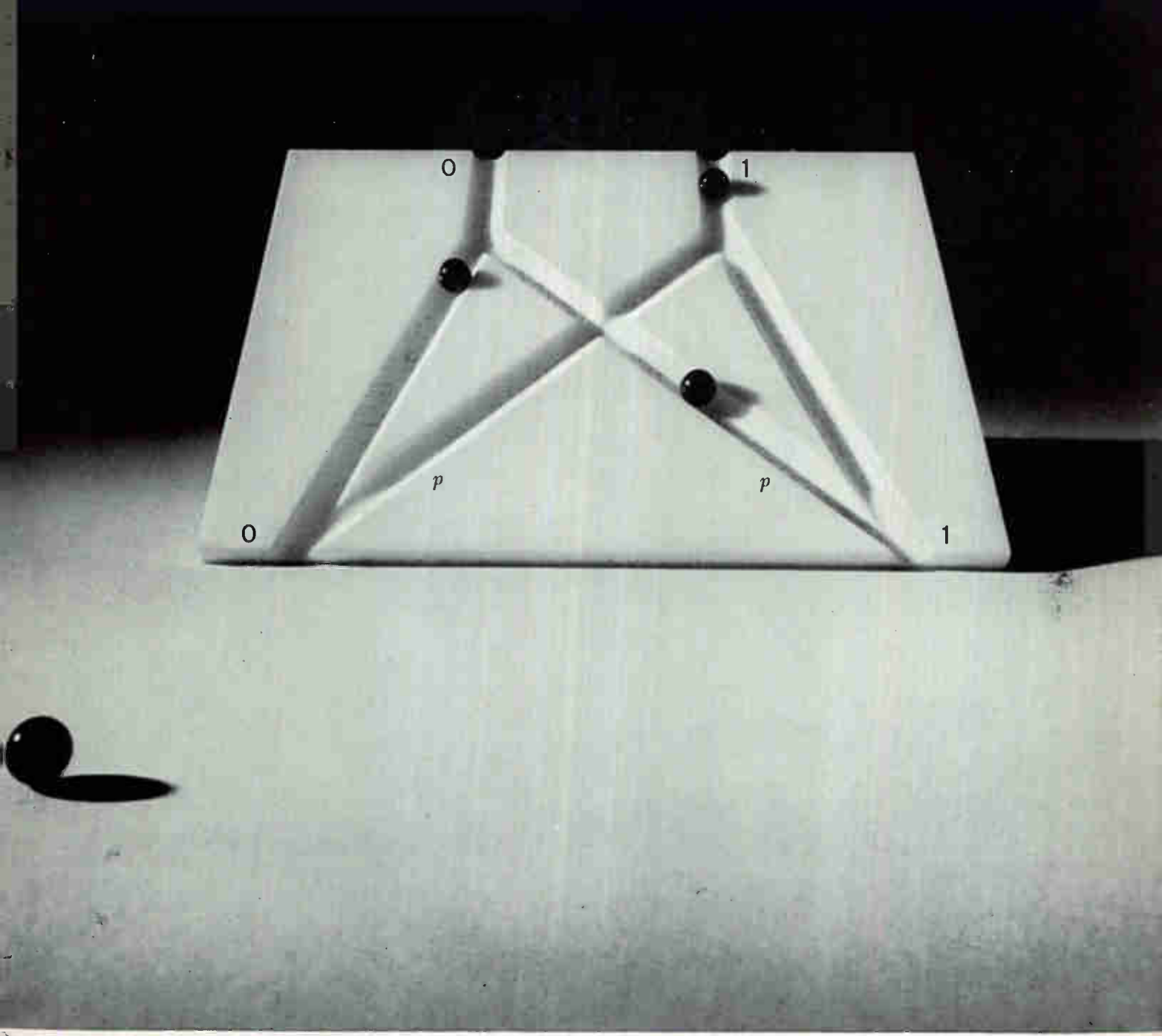


FIG. 4—Silicon diodes have reduced forward-voltage at high temperatures; they stabilize overall gain



This model of the binary symmetric channel symbolizes the probability of error, p. How can a one received in the zero slot be caught and corrected?

Group codes for prescribed error patterns

Information signals, representing zeros and ones, are transmitted through a binary symmetric channel at such high speeds that they are subject to channel noise. Through group codes it is possible to detect and correct automatically large classes of errors that may arise from such disturbances.

Usually, in optimizing these codes all possibilities are classified and samples of each are evaluated. But this task can become enormously complex. For large information blocks, such as a 70-place code, there may be billions of possibilities to evaluate. To reduce the need for these exhaustive methods, IBM scientists have evolved a preliminary theory for constructing group codes through a correlation analysis of error patterns.

Correlated patterns of errors are organized into equivalent classes and a code is formulated to overcome the error-producing characteristics of the communications channel. A code for one pattern of errors may be transformed mathematically into codes for other patterns of the same class. By prescribing which error patterns can be corrected, codes with a minimum number of checking signals may be formulated.

This optimizing process can have practical significance since every checking signal for a given number of information signals in a group code increases the cost and delay in information processing. In addition to the work described here, other approaches to the problem of code simplification are being made at IBM through linear programming and computer simulation.

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Table I—Characteristics of Paper and Plastic Capacitors

Capacitor Style	Voltage Rating (25 C)	Capacitance Rating	Max. Temp Range	Diss. Factor Limit (25 C)	Volumetric Efficiency	Min. Insulation Res (Ohms × F)			Capacitance Change			Remarks
	Volts d-c	μF	Degrees C	Percent	μF/in.³	25 C	85 C	125 C	−55 C	85 C	125 C	
Subminiature Paper Dielectric	100–1,000	0.001–1	− 55 + 85 +125[a]	1	0.03–2	2,000	20	10	−10	+5	+10	Mil. Spec. MIL-C-25, Styles CP04, 05, 08, 09, 10 and 11
High-Reliability Paper Dielectric	200–600	0.001–1	− 55 +125	1	0.03–1	15×10^3 to 25×10^3	.....	20 to 250	+2 to −7.5	.....	+ 7.5 −3	Mil. Spec. MIL-C-14157, Styles CPM08, 09
Mylar[b] Dielectric	200–1,000	0.001–1	− 55 + 85 +125	0.6	0.1 –2	5×10^4	5,000	100	− 5	+5	+12	MIL-C-19978 (Navy) MIL-C-26086 (USAF)
Polystyrene Dielectric	50–600	0.001–1	− 55 + 85	0.1	0.01–0.7	10^5	10^4	.....	+ 1.5	−1.5	....	MIL-C-19978 (Navy) MIL-C-26086 (USAF)
Teflon[b] Dielectric	200–600	0.001–0.[f]	− 55 +200	0.1	0.03–0.3	10^5	.....	200[e]	+ 2	.....	− 4[e]	Dielectric absorption 0.1 percent Dielectric absorption 0.1 percent[f]
Metallized Paper	50–600	0.01 –6	− 55 + 85 +125	1–1.5	0.2 –9	500 to 6,000	20 to 250	10	−10	±5	+10	For 50 vdc units, use Sig Corps SCL-6412, as a guide. For others, MIL-C-18312 (Navy)
Metallized Mylar[b]	200–600	0.01 –12	− 55 + 85 +125	1–1.5	0.2 –4.6	2,000	250	50	−10	+5	+15	MIL-C-18312 (Navy) can be used as a guide
Metallized Difilm[c]	200–600	0.01 –12	− 55 +125	1–1.5	0.2 –6	2,000	.....	10 to 40	−10	±2	+10	Dual dielectric combination of metallized paper and plastic film
Stripped Lacquer[d]	50	0.1 –5 6	− 55 + 85	2	5–17	600	100	.....	+ 2 −10	+7 −3	....	Under Signal Corps and Western Electric production-development
Deposited Teflon[b]	50	0.1 –15	− 55 +125	0.5	50	2×10^4	.....	1,500	± 2	.....	± 2	Current Signal Corps development

[a] Characteristic E-85C, characteristic K × 125C: [b] Dupont: [c] Sprague Electric Co.: [d] cellulose acetate: [e] limits are for high temperature of 200 C: [f] MIL-C-19978 (Navy) and MIL-C-26086 (USAF)

Paper and Plastic Film Capacitors

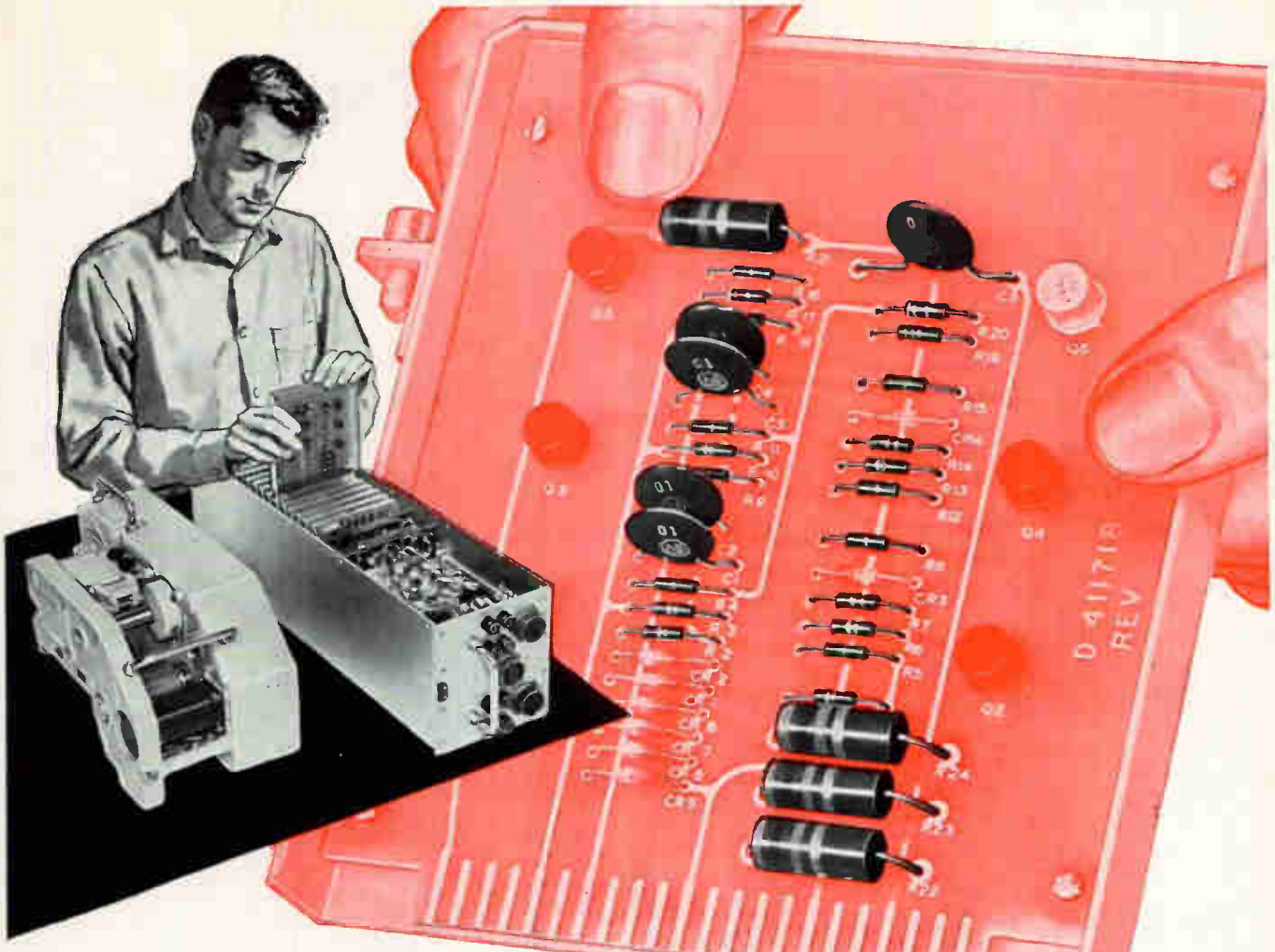
Characteristics of semi-precision capacitors currently used in military equipment are listed with pertinent parameters

By ALBERT LUNCHICK,
U. S. Army Signal Research and Development Lab., Fort Monmouth, N. J.

PAPER AND PLASTIC film capacitors comprise a major portion of the overall capacitor field. These capacitor types generally fall between the low-capacitance precision r-f types, such as mica and ceramic, and the general-purpose ceramics and high-capacitance electrolytics.

In this respect, they can be classified as semi-precision capacitors suitable for filter, blocking and bypass applications. Premium polystyrene and Teflon capacitors are actually precision capacitors with exceptionally high insulation resistance, low losses and low dielectric absorption, and are relatively temperature stable.

Table I lists only those parameters necessary to compare the different types and limits the listing to hermetically-sealed, metal-encased axial-lead tubular designs that form the bulk of military purchases of capacitors using paper and plastic film dielectrics. It is not possible, nor is it intended that the chart be all inclusive with respect to other military film types or the ever increasing variety of commercial types being offered.



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Ground-Based Missile Roll Control

By R. LOWRIE, The Martin Co., Orlando, Fla.

MISSILE roll can be controlled with photosensitive or infrared detectors in a ground-based system. The usual reference gyro and command commutator are not required in the missile, reducing cost, weight and complexity of expendable hardware. In their place, only two colored flares are needed.

The optical tracker is effective to several miles, permitting continuous, unambiguous, automatic control of roll angle within a few degrees. Temporary loss of visibility (from small clouds, for example) need not interrupt control because the system maintains a roll reference for a short time. The unit can be housed in a 6-inch diameter cylinder 18 inches long.

Data acquired by the system can also provide a continuous counter readout of missile range.

System Operation

The system in Fig. 1 is aimed at the missile during flight with an angular tolerance of ±10 degrees or more. Manual or automatic angle tracking can be used. Two flares, one red and one blue, are mounted on opposite tail fins of the missile.

A lens system with color filters passes light from the flares through a slitted rotating disk to two photo detectors. Circuits use the detector outputs to control a motor that drives the rotating lens assembly to track the missile in roll. A commutator attached to the lens assembly encodes directional commands for transmission to the missile.

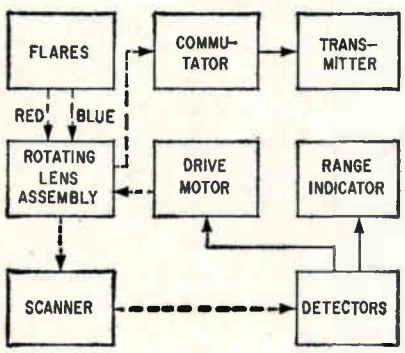

FIG. 1—Red and blue flares on missile enable roll tracking system to generate roll control signals for transmission to missile

Four identical lenses in the rotating lens system would produce images of the flares like those in Fig. 2A without color filters. Images *B* and *C* are inverted by prisms. Two red and two blue color filters in the lens assembly produce two images of each missile flare at the focal plane, as in Fig. 2B.

The scanning disk behind the lens assembly rotates constantly at about 600 rpm. It has two slits 180 degrees apart, one covered with a red filter and the other with a blue filter. Each slit passes light from the two images of the same color.

If the optical system is tracking the missile in roll, images *A* and *C* are aligned on a radial of the focal plane and the rotating disk crosses them simultaneously. However, when the missile rolls out of phase

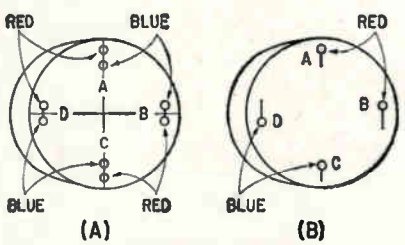

FIG. 2—Four unfiltered lenses would produce flare images at (A) while two red and two blue color filters produce those at (B)

with the optical system, the slits do not cross the images simultaneously. The time difference is proportional to roll tracking error.

Detectors

As the slits pass the image spots, light is focussed on both photo detectors, which are also filtered so that each responds to only one color. Detector output pulses are amplified and compared according to time.

Each detector produces two output pulses. The first pulses from each detector (from images *A* and *C*) control the lens assembly motor, which is driven faster or slower depending on which detector

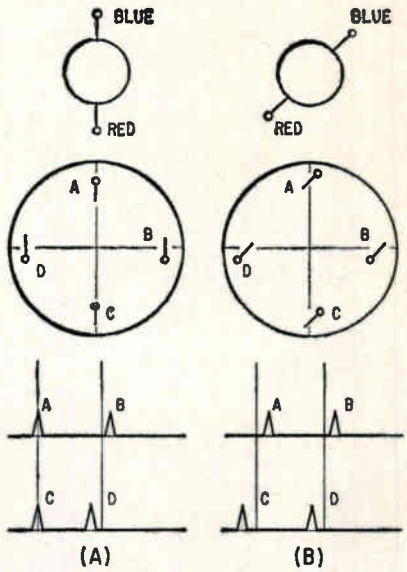

FIG. 3—Missile position at top of (A) is being correctly tracked in roll so that first two detector pulses coincide in time. With incorrect tracking at (B), they do not

sees its flare first. If rotation rate corresponds exactly with that of the missile, coincidence of the detector signals keeps motor speed constant. Two conditions of missile and lens assembly position and the relative outputs from the red and blue photo detectors are shown in Fig. 3.

A time difference between pulses *A* and *C* can control the lens assembly motor with a circuit like that in Fig. 4. The two relays have fast close and slow dropout characteristics because of the large capacitors. The first pulse from a detector closes its relay for about 50 milliseconds, locking out the other relay. This action continues at the repetition rate of the scan disk as long as one photo detector produces a pulse before the other.

The relays directly control direction of rotation of the lens assembly motor. Relay actuation time could be made proportional to time difference between pulses into the photo detectors.

Time order of the second two pulses (from images *B* and *D*) is used to avoid 180-degree ambiguity. The time between these pulses is also proportional to range. If flare separation is known and the missile

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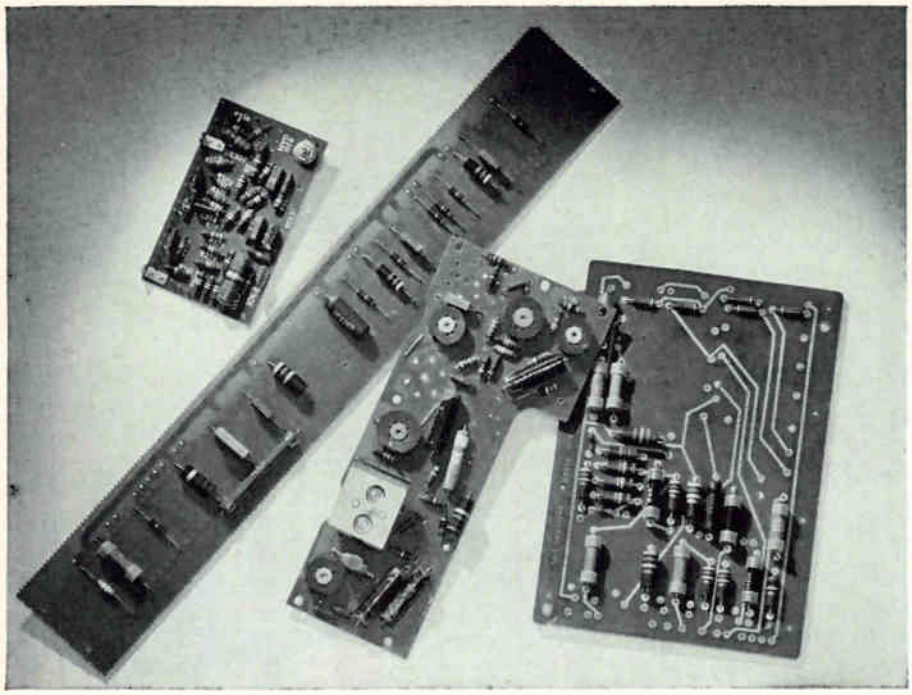


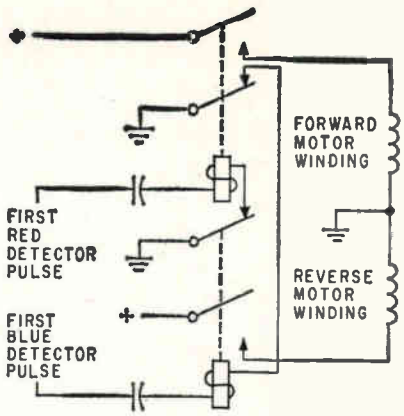


FIG. 4—First detector pulse actuates its relay and locks out the other relay

is being properly tracked in roll, this time difference can be used to operate a missile range indicator.

Electronics Advances In Ignition Systems

HIGH-VOLTAGE transistorized automobile ignition system may soon be marketed by Electric Autolite. It has been under development for several years (ELECTRONICS, p 20, June 27, 1958 and p 78, Nov. 21, 1958). The same company has been developing a low-voltage, capacitor-discharge, transistorized ignition system designed around the characteristics of a special surface-gap spark plug.

Through use of a high-voltage transistor - switched transformer, the system switches more current and faster than conventional systems, but does it without erosion or bluing of distributor contacts. Thus, the ceiling on ignition system voltage is lifted making it practical to put significantly more current into the system thereby getting more voltage out. The system also provides a solution to the problem of voltage falloff at high speeds.

The distributor contacts function only to trigger a transistor and time the firing sequence of spark-plugs. This technique eliminates poor and erratic firing of spark plugs caused by arcing which steals energy from system and delays firing. Current through contacts is 1/15th that of conventional system while higher system current, resulting in higher rate of energy buildup, is provided.

The transistorized units will be

made available for 12- and 6-v negative ground battery systems as well as stationary systems operating off a-c power.

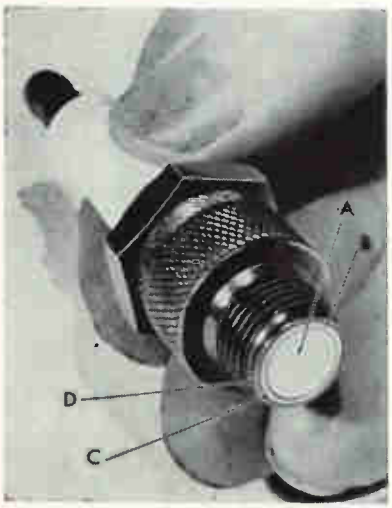
Surface-Gap Plugs

The surface-gap plug consists of center and ground electrodes made of a high-melting point precious metal, a gap of ceramic semiconductor material and a conventional spark plug shield. (Materials used have not been revealed.) Internal arcing is prevented by an enlarged tapering of the gap below the surface. Required operating voltage is under 1,000 v for a new plug; aging increases needed operating potential to about 5,000 v.

Cost will prohibit use of this system for the commercial auto market in the foreseeable future except as optional equipment.

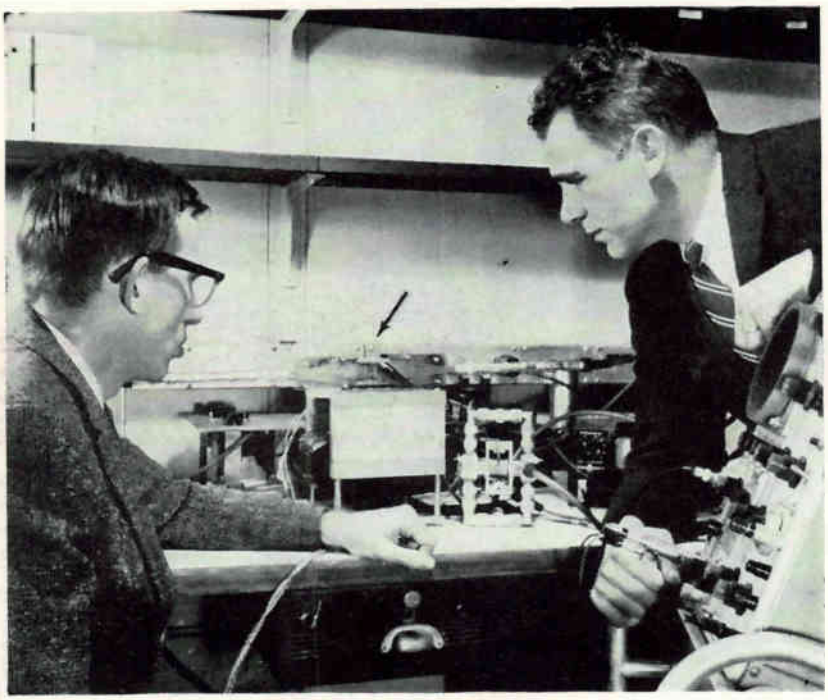
Advantage of the new plug is its ability to fire under fouled condition—in fact, operation improves as the atmosphere becomes more foul. The plugs will fire underwater or when immersed in oil.

Evaluation tests for the Army are currently being conducted by the Research Division of the Detroit Tank Arsenal. Under normal engine operating conditions, the plugs last slightly longer than ordinary plugs; however, when fouling or other engine troubles occur, the new plug gives 10 to 1,000 times the life of the older types. Life runs up to 117,000 miles on high speed turnpike driving have been recorded.



Autolite's surface gap spark plug consists of center electrode (A), semiconductor gap (B), ground electrode (C) and shell (D)

Microwave Amplifier Uses Tunnel Diodes



Laboratory model of a new traveling wave solid-state amplifier (arrow) is inspected by W. W. Anderson and M. E. Hines. The amplifier makes use of the negative resistance of tunnel diodes, in combination with nonreciprocal ferrite attenuation, to achieve a high amplification ratio without self-oscillation

A NEW broad-band microwave amplifier, described by M. E. Hines and W. W. Anderson of the Bell Telephone Laboratories, makes use of the negative resistance of the tunnel diode in combination with non-reciprocal ferrite attenuation[1]. A high amplification ratio is achieved without self-oscillation.

Signal Strength

The amplifier increases the strength of radio signals over a broad range of frequencies in the microwave range above 1,000 Mc and will have applications in radar, microwave radio relay, satellite communications, and waveguide transmission systems. Power requirements are low and the device costs less and has great reliability for signal amplification.

The device is built on a traveling-wave concept with a row of Esaki diodes along the center of a stripline waveguide. The negative resistance of the diodes causes the power in a signal wave to increase progressively as it travels along the waveguide. By including non-reciprocal ferrite attenuation in the structure, the device is made to absorb waves traveling in the undesired reverse direction and to amplify waves traveling in the desired direction. This feature allows a large total amplification to be obtained with complete stability by eliminating internal feedback which has previously caused oscillations and other difficulties.

The new amplifier opens a large field of useful applications for the Esaki diode by eliminating one of the major difficulties in applying it as a signal amplifier. The model described recently operated most efficiently at 1,000 Mc, according to M. E. Hines. It is expected that the frequency of operation of future models can be extended to above 4,000 Mc, still using germanium diodes. Much higher frequencies, perhaps into the millimeter wavelength range, should be possible with diodes of indium antimonide which have been made by R. L. Batdorf, also of Bell Laboratories.

At present, the device is in an early research stage.

REFERENCE

(1) M. E. Hines and W. W. Anderson, High-Frequency Negative-Resistance Circuit Principles for Esaki-Diode Applications, Solid State Circuit Conf., Digest of Technical Papers, Feb. 1960, Lewis Winner, N. Y. C.

Spiral Magnetics for Computer Memory

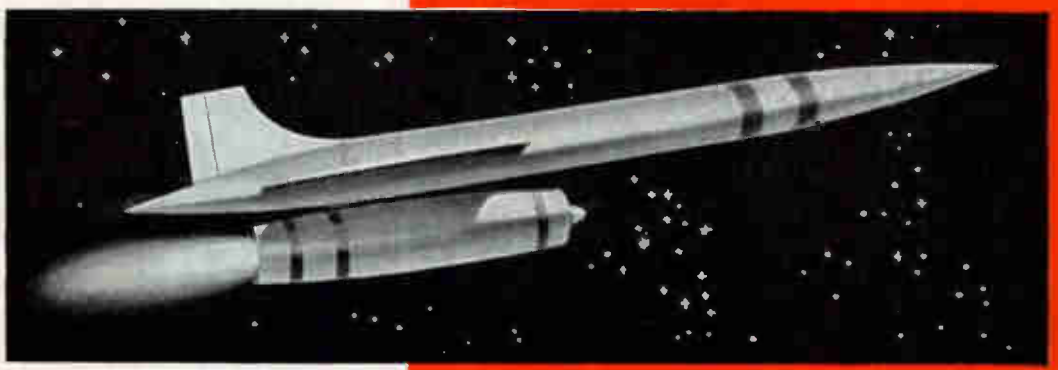
EARLY WORK by A. H. Bobeck of Bell Laboratories showed that a copper wire wrapped with a spiral winding of magnetic tape produces a spiral magnetic path when a current is passed along the tape and the copper wire.

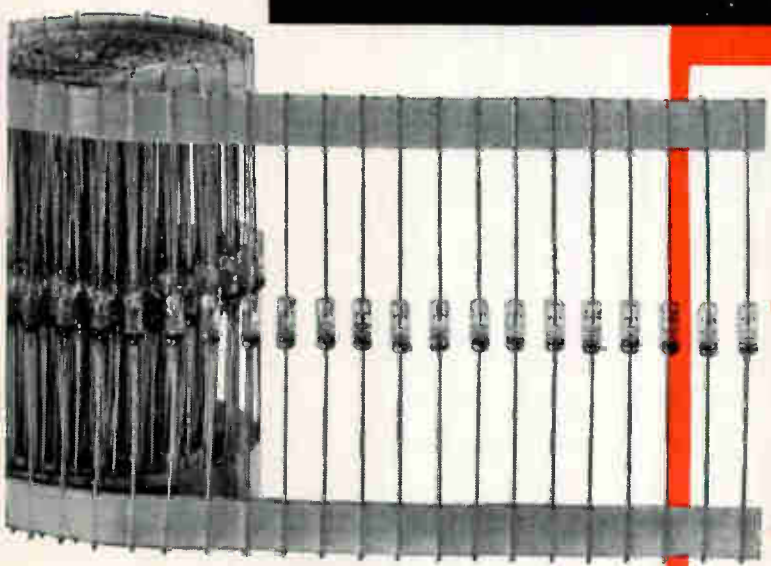
If such wires were then woven into a grid, with copper wires running perpendicular to the spiral magnetic paths—and if tiny permanent magnets are placed at these intersections—the intersections could be used to store bits of information in a temporary computer memory.

The concept is based on the inhibiting action of the permanent

Basic components of the Twistor module are discussed by H. L. Stadler and D. G. Clemons of Bell Laboratories. Readiness for mass production was accomplished through the closely coordinated research-engineering work of Bell and Western Electric. A partially assembled module is in the foreground, with a completed unit behind it

CBS Indium-bonded Diodes Give You Missile Reliability





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- Centrifuge, 20,000 G
- Vibration, 15 G at 50-2000 cps
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magnets on the current.

Recently (ELECTRONICS, p 11, Jan. 29) Bell announced that this technique is now used in an actual computer memory array built by inter-weaving the twisted magnetic tape, the copper word coils and program cards that contain tiny permanent magnets located at specific positions on the plastic card. When a magnet memory card is read by a computer, an electric pulse is transmitted if there is no magnet at the wire intersections, or the electric pulse is blocked if there is a magnet present (see Fig. 1).

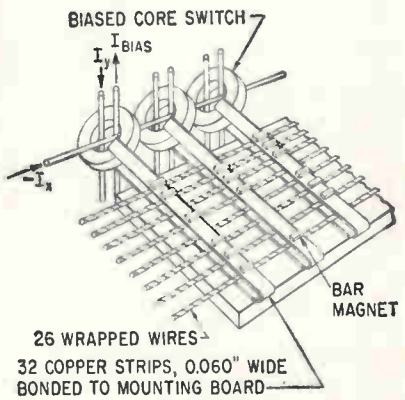


FIG. 1—A section of a Twistor-magnet memory frame. Three cores of the biased core switch or transformer and their word coils or solenoids are shown, with eight intersecting Twistors. The bar magnets are shown as tiny blocks on the word coils. For simplicity, the plastic tapes supporting the Twistor wires and the word coils have been eliminated, as has the plastic card carrying the bar magnets

The first step in the manufacture of the Twistor Magnetic-Memory Frame is the preparation of the magnetic tape used in wrapping the copper carrier wire. Moly permalloy wire is drawn to a diameter of about 0.001 in thick, then roll flattened to a tape 0.0035 in. wide by 0.0003 in. thick. A specially designed test set continuously checks the magnetic quality of the wire, allowing identification of that part of the product which could cause faulty operation of the memory.

Wrapping the Tape

The wrapping process required a development program of its own. A machine was designed which could wrap the tape about 3 mil (40 AWG) carrier wire quickly with a high degree of uniformity. High uniformity is necessary to minimize varia-

tion in the magnetic characteristic of the final assembly. An output of 300 feet of Twistor per hour is possible with the machines now in use. With a 45 deg helix, this requires 1,140 turns of tape per foot of carrier wire of a speed of 5,700 rpm for the wrapping head. Drawing permalloy tape to these small dimensions and then applying it in helical form were significant firsts in this development.

Memory Module

Twenty-six pairs of Twistor-return wires are then laminated between sheets of Mylar tape. These wires are positioned on 0.100-in. centers across the width of the tape. The separation between a Twistor and its associated return wire is 0.020 in.

The memory module is built up of arrays of tiny permanent bar magnets located on plastic cards which are superimposed on the grid sensing element. The bar magnets are formed by first bonding a 0.001-in. thick sheet of VICALLOY I, a magnetic material, to a plastic card. The card is then photoetched to eliminate all magnetic material except the small bars left at specifically desired locations.

An array of tiny transformers is made, one connected to each word coil of the module. A registration mechanism insures that the magnets on any program card are properly aligned over the bit position. The unit is assembled into a compact, mechanically rigged, reliable memory package.

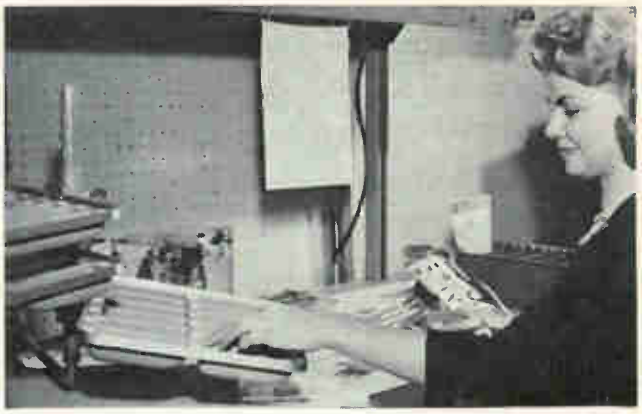
The signal from the Twistor is about 6 millivolts at an impedance level of 10 ohms and is about 1 microsecond long.

X-Ray Detector

INVESTIGATIONS into causes of malfunction of the cathode spot in high-voltage mercury-arc tubes are being made by Ferranti Ltd, London, England. They report the possibility that X-rays may be generated inside the tube causing the emission of photoelectrons which in turn may affect normal functioning.

A suitably sensitive X-ray detector is being constructed to check this malfunction.

Trays with numbered cavities provide each assembler with a parts kit for a specific assembly or subassembly



Modular assembly station has trays on swing-out fixture, flotation vise, iron stand, picture and model of assembly

Sequential Trays Speed Assembly

SPECIALLY-DESIGNED part trays and tote boxes are reducing the costs of producing electronic equipment at Eclipse-Pioneer Division, Bendix Corp., Teterboro, N. J. Trays present components to assemblers in assembly sequence. Tote boxes form a protective enclosure to minimize handling damage.

One type of parts tray is injection molded of linear polyethylene to provide a series of numbered cavities. The trays are loaded in the stockroom and delivered to assemblers in cases containing enough trays for a complete assembly. The case fronts are clear plastic removable dust shields. If more than 1 tray is needed, they are lettered alphabetically.

In preparing the trays, assemblies are first analyzed to determine the proper method and sequence of assembling the components. Parts numbers are written on Ozalid masters which diagram the location of the numbered cavities, acting as templates. Reproductions of the masters are used to load the trays and instruct assemblers. The masters are kept up-to-date for further use.

The trays speed up assembly by eliminating parts hunting and preventing error. Plastic is used because it does not create dust or particles and, when light-colored or left a natural white, it prompts cleanliness. One of the materials handling objectives is the complete elimination of cardboard or wood packaging for precision parts.

Another type of sequential parts tray also has numbered cavities, but is mounted on an upright metal fixture which swings the trays in front of the assembler. Both types of trays permit work to be divided among a number of assemblers by merely limiting the number of trays delivered each station.

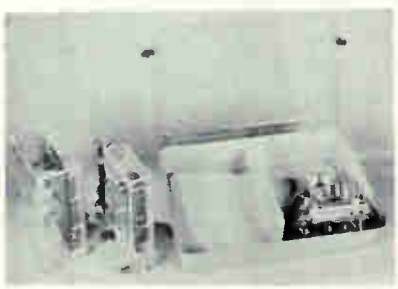
Tote boxes for odd-shaped or delicate assemblies are provided with clear plastic dust covers and separators or protective inserts to cradle the assemblies. Some provide a temporary housing of metal or plastic.

Assembly stations are generally provided with detailed pictorial process sheets and a model assembly cased in clear plastic. Flotation vises of the type made by Flotron Corp., Englewood, Calif., are used. These have a ball and socket base for easy positioning and will accept a variety of fixtures. The roll of

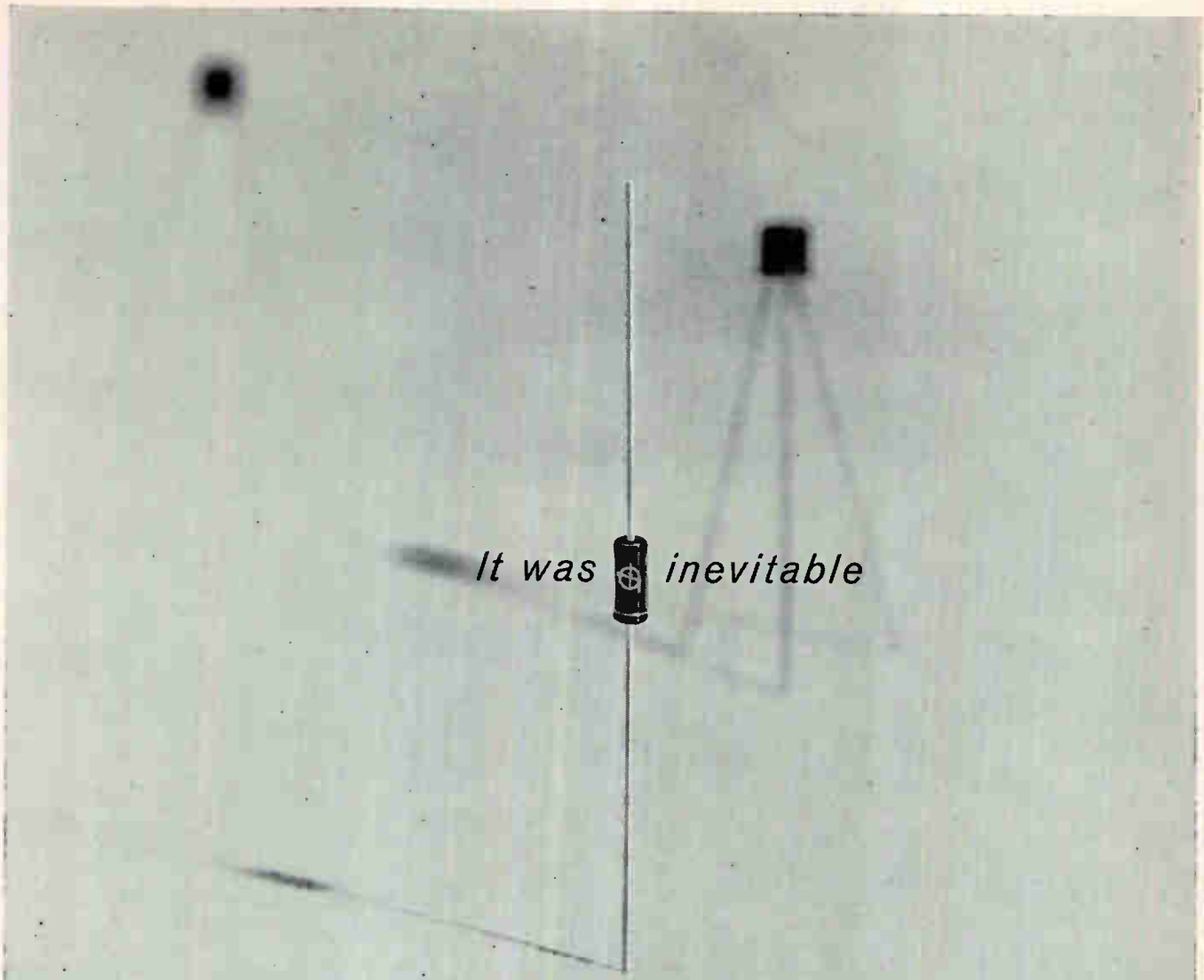
COST REDUCTION

These methods were demonstrated during a cost reduction symposium Eclipse-Pioneer sponsored in February for its suppliers on the F-105D air data computer and flight instruments. Personnel interviewed estimated the methods described reduced assembly costs 12 to 55 per cent, depending on the assembly. The official estimate of savings during the past 12 months from these and other improvements in production techniques and personnel training is $3.1 million. Vendors were urged to institute similar cost reduction programs. Bendix supplies Republic Aviation, which reported that in cooperation with its vendors it is reducing the cost of each aircraft from $3 million to $2 million. Republic said the savings would permit it to supply the Air Force with additional aircraft.

Trays are loaded in stockroom and delivered in closed case



Tote boxes are designed to minimize handling damage



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I_R	Reverse Current		.100 μA	@ V_R =30v, 25°C
V_F	Forward Voltage Drop		1 v	@ I_F =10 mA
C	Capacitance		2 $\mu\mu$f	@ V_R =0v
t_{rr}	Reverse Recovery Time To Ir=1 ma		4 mμs	@ I_f =I_r=10 ma
	Maximum Power Dissipation		200 mw.	
	Temp. Range Operating		–65°C to 175°C	
	Storage		–65°C to 200°C	

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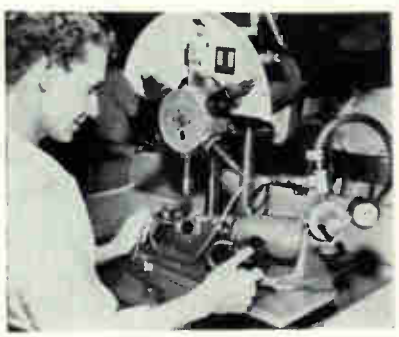
Harness wire dispensers are stacks of tubes

solder is mounted under the bench and solder is pulled up by hand as required through a hole drilled near the vise. The soldering iron holder is mounted on a heavy aluminum base equipped with wells for a wiping sponge and a bottle of flux or cleaner.

Wires for harnessing are kept in tubes stacked in a frame. These dispensers are made in modular sizes so they can be piled up for assembly at a single station or divided to break up work. Tubes are open at both ends for front or back loading, at the assembly station or in a stockroom.

Bench Setup Assembles Potentiometer Dials

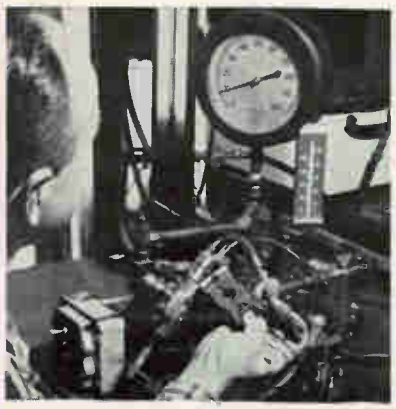


Assembler holds parts during machining

POTENTIOMETER dials and knobs are drilled, tapped and assembled at a single setup with a 6-spindle turret drill made by Burgmaster Corp., Gardena, Calif. An instrument manufacturer added an air cylinder-operated fixture which presses the parts together and holds them during drilling, tapping and fastening by a socket set screw. The turret is double-tooled, performing the operations twice in each rotation. Spindle speeds shift as the turret indexes. Tapmatic heads provide torque adjustment for the taps and hex wrenches.

Tubing Completes Hermetic Seals

UMBILICAL TUBING provides a convenient method of closing a hermetically sealed container. At Newark Controls Co., Bloomfield, N. J., swage-closed tubing is used routinely for temporary seals at pressures of 80 psi and has been found adequate at pressures as high as 1,200 psi.



Nippers swage and clip tubing when desired pressure is reached

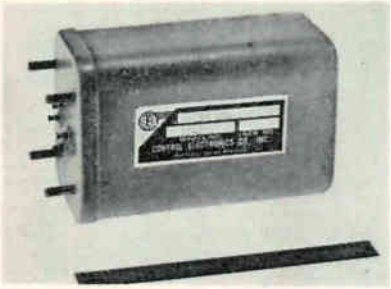
Permanent seal is made with solder

The firm uses the tube method to seal pressure and gas density switches on a fixture valved to permit evacuation, gas filling and pressure measurement.

Copper tubing is soldered into the switch body and is connected by another length of tubing to a manometer. Gas or dry air is fed into the switch after evacuation. At the desired pressure, nippers are used to close the tube and clip it close to the switch body. The tube end is bent close to the body and the seal made permanent with a covering of solder.

Switch bellows are evacuated and sealed by similar methods and stored after evacuation. Umbilical tubes connected to instrumentation outside the test chamber is used for high temperature testing. Gas density-pressure-temperature graphs are used as references.

On The Market



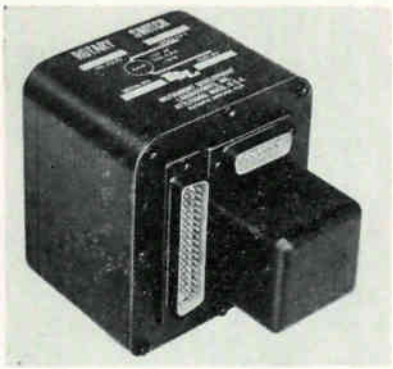
Square Wave Filter
two models

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. LF-125 square wave filter maintains a constant insertion loss to within 0.1 db over an input signal range of 0-20 v rms. It was designed to convert a 30 cycle, 60 v peak-to-peak square wave input into a sine wave output with less than 1 percent distortion. One model has an input impedance of 50 K ohms; the other, 100 K ohms. Both have been designed for an output to the grid and attenuation of 40 db or more at the third and higher harmonics.

CIRCLE 301 ON READER SERVICE CARD

Sampling Switch
motor-driven

INSTRUMENT DEVELOPMENT LABORATORIES, INC., 67 Mechanic St., Attleboro, Mass., has produced a 2-pole, 60-position, low-level sampling switch which has run continuously at 60 rps for more than 200 hr without contact bounce or signal contamination. Switch has performed satisfactorily while undergoing missile vibration testing of 20 to 3,000 cps at 35 g's for 35 minutes per axis. Designed for application to an area defense missile guidance radar system, the switch samples Doppler velocity data for range-rating purposes. It occupies only 43.7 cu in., weighs less than 2.5 lb and consumes only 7 w of power at 100 v, 400 cycles single phase.



CIRCLE 302 ON READER SERVICE CARD

Low Capacity Bridge
self-contained

MARCONI INSTRUMENTS, INC., 111 Cedar Lane, Englewood, N. J. Three terminal capacity measurements from 0.002 $\mu\mu$f to 1,000 $\mu\mu$f can be made with the model 1342 bridge. Accuracy is $\pm$0.2 percent. Instrument is valuable for measuring tube interelectrode capacity, circuit strays, r-f network components, etc. Extreme resolution makes temperature coefficients and small capacity changes easy to measure. Operation is based on a transformer ratio-arm bridge operation at 1 Kc. This technique uses only one capacitive and resistive standard which can be selected for extreme accuracy and stability.

CIRCLE 303 ON READER SERVICE CARD

Metal Nameplates
adhesive backings

HALLMARK NAMEPLATE, INC., 19 Gazza Blvd., Farmingdale, L. I., N. Y. Perf-i-Kal metal nameplates are announced. Company uses new production techniques to enable small manufacturers and producers of prototype equipment to obtain nameplates in 1 to 100 piece quantities with fast delivery. Material ranges from 0.003 to 0.125 thick aluminum, with adhesive backings to conform to MIL-N-25076-1, and -2 as well as pressure sensitive types. Holes are provided in material over 0.0055 thick where screws or pins are required. Anodized, enamelled, or lithographed finishes available with or without fungus resistant coating as per government specifications.

CIRCLE 304 ON READER SERVICE CARD

Transponder
for C-band

AERO GEO ASTRO CORP., 1200 Duke St., Alexandria, Va. Application of this transistorized unit permits secure long range tracking compatible with present day instrumentation radars. PWC Ratio (pounds-watts per cu in.) of only 1.67 has been achieved in the design, as opposed to ratios on the order of 5 to 6 for earlier equipments. Electrical characteristics represent superheterodyne-sensitivity, single or three pulse interrogation, and a

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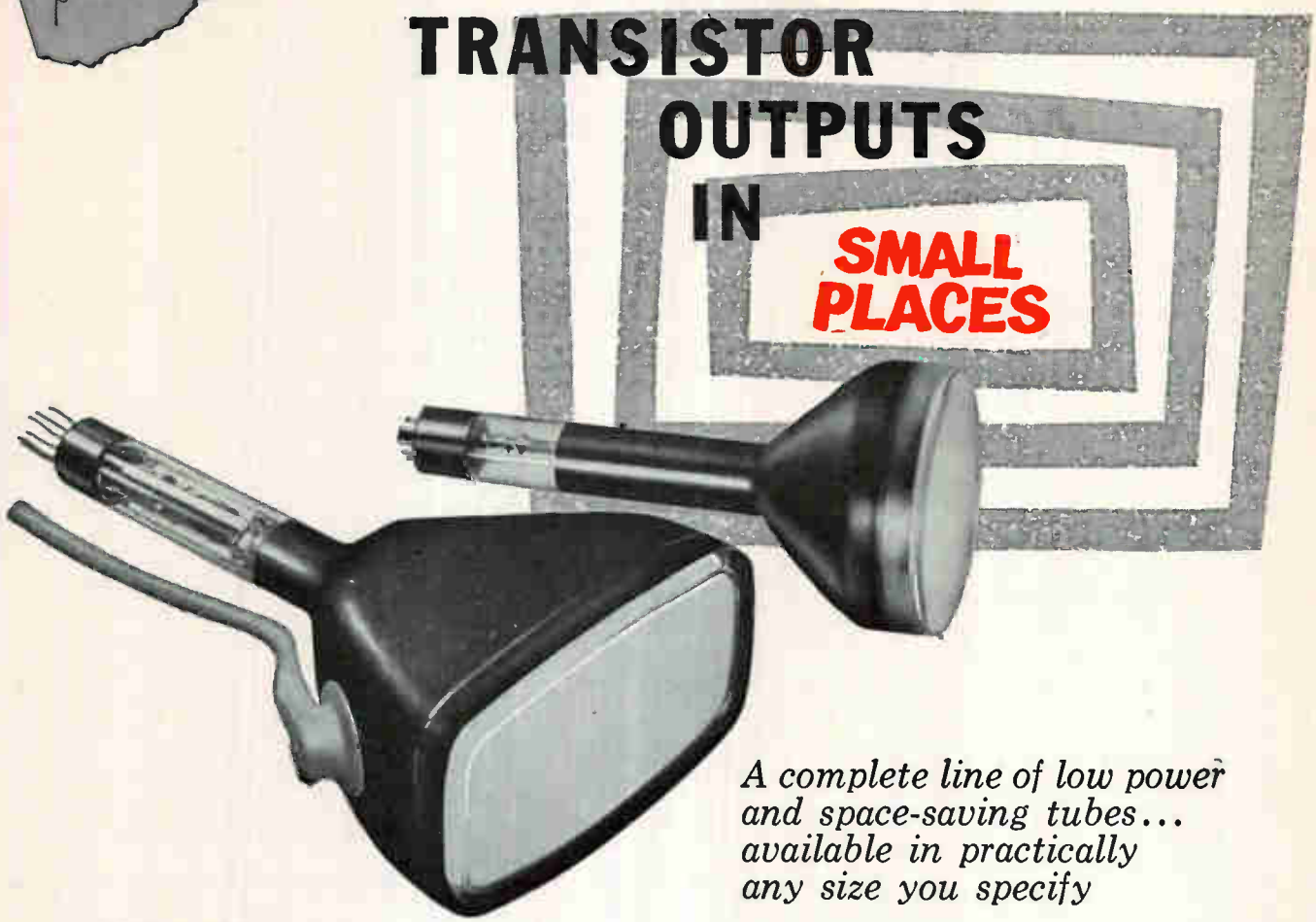

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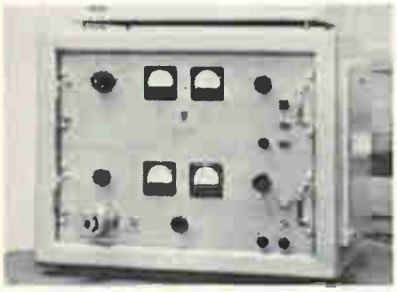
400 w transmitter output. Internal duplexing for single antenna operation in the d-c to d-c converter are incorporated. Overall dissipation at a nominal repetition rate is under 30 w. Unit is 128 cu in. in volume and weighs 7 lb 2 oz.

CIRCLE 305 ON READER SERVICE CARD



Klystron Supply
adjustable voltages

N. V. PHILIPS' GLOEILAMPENFABRIEKEN, EMA Dept., Eindhoven, Holland. Type PP4485 klystron power supply has been fully adapted to the requirements of klystrons operating in the millimicrowave range. Adjustable voltages available are: + 1,000 up to + 2,250 v d-c (50 ma max.; ripple less than 10 mv) for the resonator; 0 up to − 600 v d-c (1 ma max.; ripple less than 10 mv) for the repeller plate; 0 up to − 300 v d-c (ripple less than 10 mv) grid bias; 6 up to 7 v a-c (3 amperes max.) heater voltage. Four meters for indication of the repeller-, the resonator- and the heater-voltage, as well as the resonator-current are mounted on the front panel. Safety devices to protect the klystron and to prevent mishandling during operation are part of the circuitry.

CIRCLE 306 ON READER SERVICE CARD

Noise Figure Meter
high sensitivity

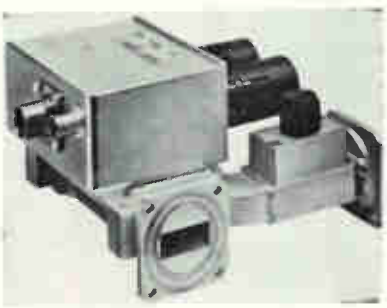
HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 344A, specifically designed to measure the noise figure of operating radar sets, operates automatically and has a simple front panel calibration. It provides a continuous noise figure presentation on most radar receivers. The meter's extremely high sensitivity permits decoupling noise source up to 20 db from the main transmitter line to minimize system degradation.

CIRCLE 307 ON READER SERVICE CARD

V-T Voltmeter
3 to 600 Kc

SIERRA ELECTRONIC CORP., 3885 Bohannon Drive, Menlo Park, Calif. Model 125A compact frequency selective voltmeter covers the range of 3 to 600 Kc. It has both narrow and wide selectivity settings plus a flat voltmeter position. This triple mode measurement capability makes it a versatile instrument for carrier measurements, wave analysis and general laboratory use. Its measurement range (tunable mode) is − 90 dbm to + 32 dbm; flat mode, − 30 dbm to + 32 dbm.

CIRCLE 308 ON READER SERVICE CARD



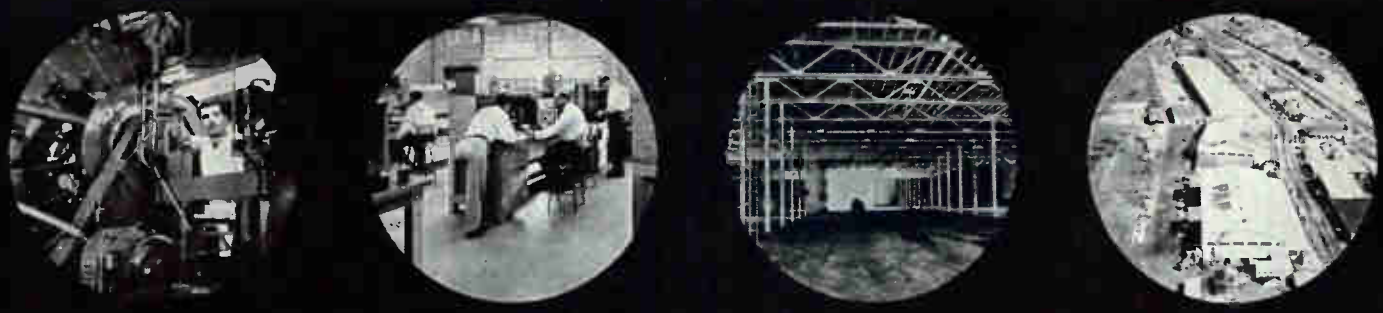
Mixer-Preamplifier
has a 15 db gain

LEL, INC., 380 Oak St., Copiague, N. Y. Model MMX-5 matched microwave-mixer assembly covers the 8,500-9,600 Mc range and provides an i-f output bandwidth of 100 Mc. It has an i-f center frequency of 250 Mc, and an overall noise figure of 10 db. MMX-5 provides the design engineer with a microwave receiver front end capable of handling the short pulses required for high resolution radar systems.

CIRCLE 309 ON READER SERVICE CARD

Shift Registers
miniaturized

AMP INC., Harrisburg, Pa. New line of shift registers permits nondestructive output—both dynamic and static—plus any serial/parallel input/output combination. Design permits a minimum number of components and a minimum number of



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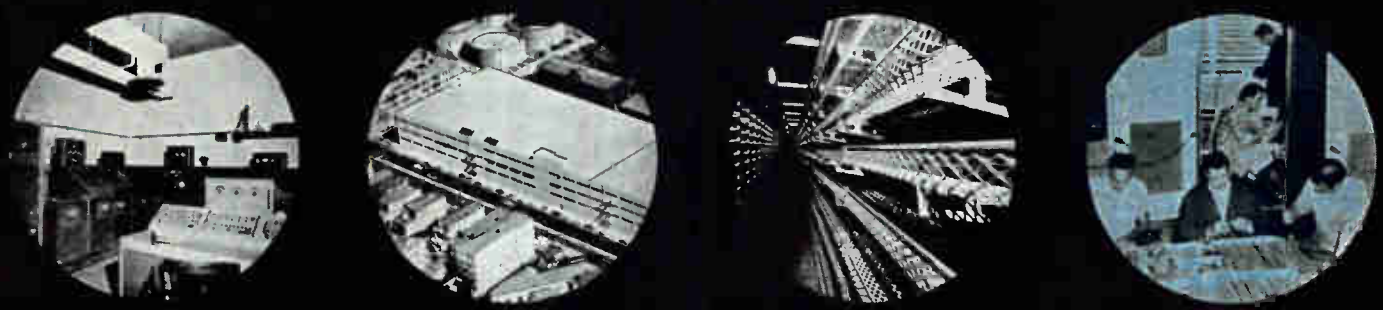

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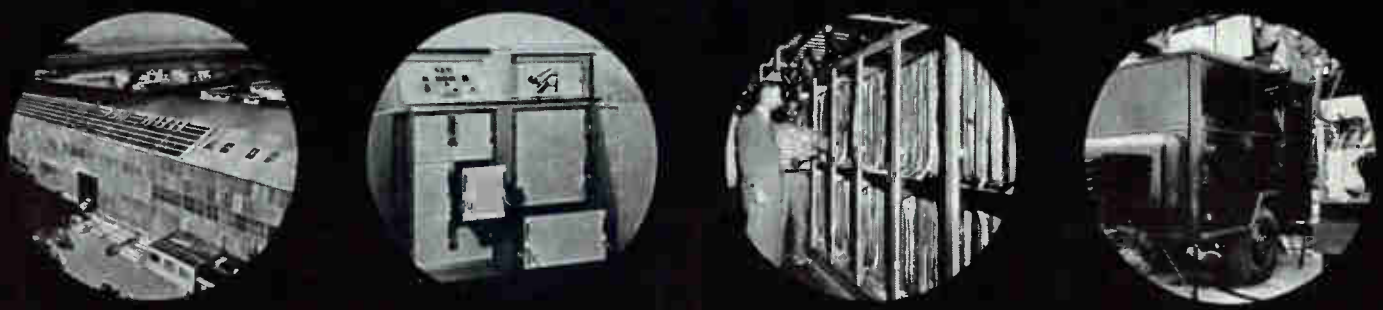

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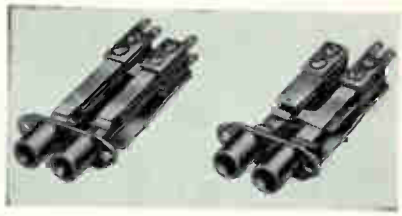
bit to bit interconnections. The AMP-MAD shift register uses only copper wire and toroidal ferrite cores. No other parts are necessary. Unit has a temperature range from − 40 C to + 75 C without compensatory equipment; each minor aperture offers an output level up to 100 mw at several volts. Shift register is immune to nuclear radiation.

CIRCLE 310 ON READER SERVICE CARD



Twin-Jacks
long frame type

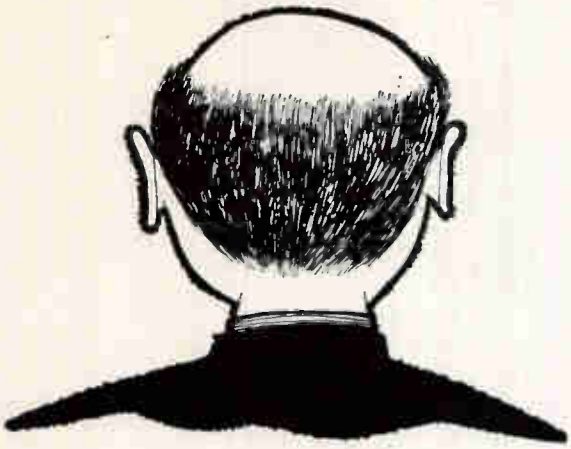
SWITCHCRAFT, INC., 5555 N. Elston Ave., Chicago 30, Ill. Frame of the "Twin-Jax" is double width with two mounting ears on 1⅜ in. centers; bushings (sleeves) are on ⅜ in. centers. Available in two types: MT-388 (Military type JJ-088) has a new circuit "shorting" feature that is "broken" when a two-conductor plug is inserted into either sleeve, individually or simultaneously; MT-389 has three-conductor jacks interconnected, so that the circuit is broken when a plug such as No. 482 (PJ-051) is inserted in one of the jacks.

CIRCLE 311 ON READER SERVICE CARD

Transducer
variable reluctance

TAVIS ENGINEERING, 1711 S. Mountain, Monrovia, Calif. Model 4-100 DeCeducer is a rugged and completely flexible d-c input d-c output

IT'S WHAT'S IN HERE THAT COUNTS



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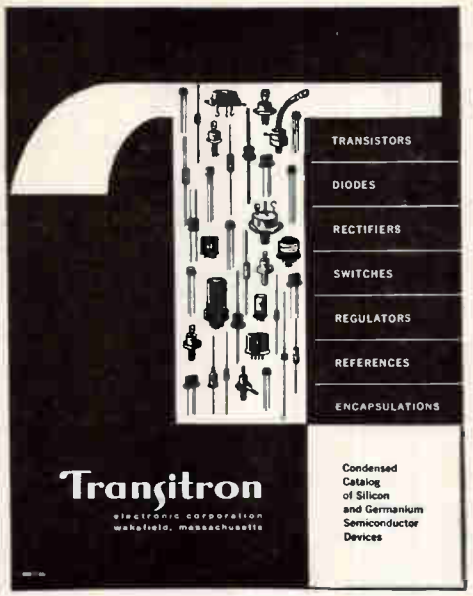


NEW SEMICONDUCTOR BOOKLET

A new 12-page color booklet describing basic types of semiconductors, with ratings and characteristics — silicon transistors, silicon diodes, silicon rectifiers, silicon regulators and references, germanium diodes, controlled rectifiers and switches

now available from:

TRANSITRON ELECTRONIC CORP.
Box CC, Wakefield, Massachusetts

CIRCLE 202 ON READER SERVICE CARD

TAILOR THE TERMINAL TO THE BOARD

CAMBION Swaging Tools are designed to precisely seat and securely stake *all* CAMBION Terminals. For each type of terminal there's a CAMBION punch-and-anvil combination. Precision-machined from fine steel for long wear, standard sets are available for only $5.00 each to match the following CAMBION Swaging Machines:

HAND SWAGERS for small volume staking. Can be used manually, in a kick press, or in a riveting machine. PRESSURE SWAGERS for normal production. These sturdy, hand-operated, cam-action rolling tools are easily adjustable for a wide range of board thickness. HOPPER STAKERS for high production. These semiautomatic stakers faultlessly feed and stake thousands of terminals without interruption at a rate of approximately 100 a minute. Write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. for full details on these and other products in the wide line of

CAMBION®
The guaranteed electronic components

CIRCLE 97 ON READER SERVICE CARD

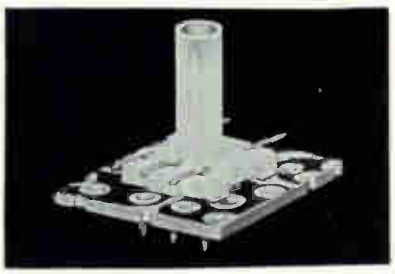
pressure transducer specifically designed for aircraft, missile and test applications. Instrument features extreme output stability over a wide range—24 to 32 v d-c of input voltages. Only 12 oz in weight, unit covers a range of pressures from 0-5 psi to 0-5,000 psi and is available in differential, absolute or gage pressure types. Outputs are virtually unaffected by temperature, vibration shock and a wide variance of input voltages.

CIRCLE 312 ON READER SERVICE CARD

Pulse Generator
shaft-driven

W. & L. E. GURLEY, Troy, N. Y., has available a shaft-driven device that delivers electrical pulses at its output terminals. Model 8601 photoelectric pulse generator may be used either as a rate generator or as an angle measuring unit. When used as a rate generator, the output frequency is read in terms of shaft speed. When used to measure angles, the total angle is determined by totalizing individual pulses. Typically the output voltage of the unit is 0.1 to 0.25 v at 50 K load impedance. Several standard disk patterns provide up to 500 pulses per revolution.

CIRCLE 313 ON READER SERVICE CARD



Coil Form
one-piece

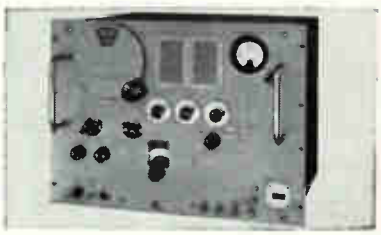
AMERICAN MOLDED PRODUCTS CO., 2727 West Chicago Ave., Chicago 22, Ill., introduces a one-piece coil form for printed circuit i-f and oscillator coils. The integral construction results in a big saving of time and material. Tube and base cannot come apart. Coil form has a constant core torque and is expressly designed to prevent wire breakage.

CIRCLE 314 ON READER SERVICE CARD

Alumina Abrasives
semiconductor grade

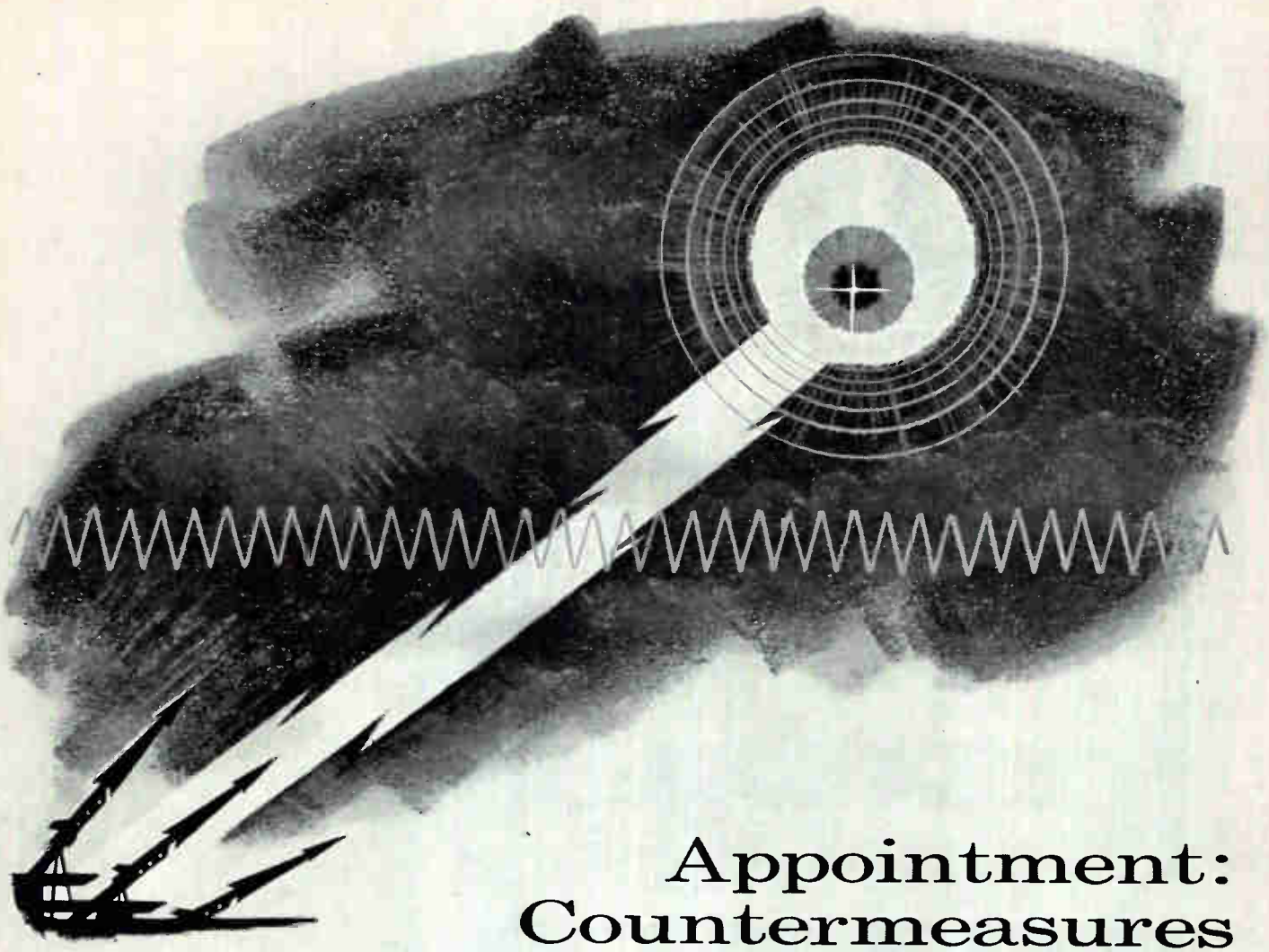
GEOSCIENCE INSTRUMENTS CORP., 425 Park Ave., New York 22, N. Y., announces two new electronic-semiconductor grades of levigated alumina abrasives known as Corunda (liquid sapphire & liquid ruby). These abrasive crystals meet the critical requirements of the industry and will produce the ultra high polished surfaces necessary for advanced device fabrication.

CIRCLE 315 ON READER SERVICE CARD



Signal Generator
high power

DYMEC, 395 Page Mill Road, Palo Alto, Calif. DY-5381 signal generator delivers a minimum power output of 250 mw over the range from 8,500 to 10,000 Mc, with outputs up to 400 mw in the vicinity of 9,500 Mc. It features a continuously-operating power monitor which permits power setting repeatability within ± 0.5 db over a wide ambient temperature range. Instrument includes a 100 db rotary-vane attenuator; output power accuracy is ± 1 db ± 2 percent of attenuator setting. Types of modulation provided internally are pulse and f-m, separately or simultaneously, and square-wave. Pulse length is variable from 0.5 to 25 μsec; repetition rate is adjustable from 35 to 3,500 pps. Internal f-m is at power line frequency with a



Appointment: Countermeasures

SANTA BARBARA is Raytheon's California operation, and is devoted to the Engineering, Marketing, and Production of active and passive ECM and ECCM equipment for aircraft, missiles, and satellites; infrared systems and devices; guidance, mapping, and fire control components.

Countermeasures appointments range from junior to department manager levels. Technical areas are: advanced systems design, microwave components design and application, circuit theory applying backward wave oscillators and traveling wave tubes. Infrared appointments open in reconnaissance and communications systems, circuitry and filter theory, components and servo systems.

Location is excellent. The city of Santa Barbara is a quiet community of 56,000. It has no smog, no million-car traffic. Nearby mountains and offshore islands keep mean temperature 57° – 70° all year. A Spanish setting plays host to theatres, museums, universities and a growing electronics center.

For information on programs coincident with their professional interests, engineers and scientists may write: Mr. Donald H. Sweet, Manager, Management & Professional Recruiting, Raytheon Company, 624 Y Worcester Road, Framingham, Massachusetts.

RAYTHEON

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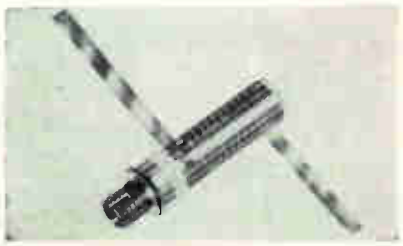
SANTA BARBARA OPERATION
EQUIPMENT DIVISION

maximum deviation of ± 7.5 Mc. Internal square-wave frequency is adjustable from 35 to 3,500 cps.

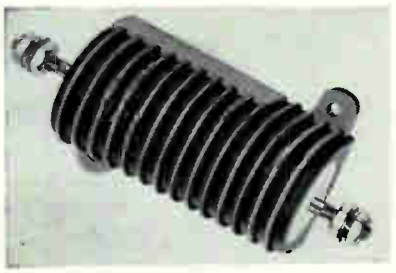
CIRCLE 316 ON READER SERVICE CARD



Metallized Inductors compact devices

JFD ELECTRONICS CORP., 6101 Sixteenth Ave., Brooklyn 4, N. Y., announces metallized inductors for mounting on either panels or p-c boards. Fused to stable, low-loss glass dielectric cylinders, they provide a low temperature coefficient of inductance and frequency. Inductive range extends from 2 μh to 0.05 μh in steps of approximately ½ μh, with an overall length of 1 19/32 in. to 9/16 in., depending on the value of inductance required. One of the outstanding characteristics is the ability to maintain a high Q over a broad frequency range.

CIRCLE 317 ON READER SERVICE CARD



Power Resistor noninductive

DALE PRODUCTS, INC., Columbus, Neb. New addition to the type NH noninductive precision resistors is rated up to 100 w. The NH-100 is housed in an aluminum radiator finned housing which allows great heat dissipation, particularly when panel mounted. Resistance range is from 5 ohms to 20 K ohms, depending on tolerance. Tolerance range is from 0.05 percent up to 3 percent. Resistance element is sealed in silicone and inserted into the

aluminum housing, offering great protection from shock, vibration, moisture and salt spray. All connections are welded. Temperature coefficient is 0.00002/deg C. Overall length of the housing, not including leads, is 3½ in. Width, not including mounting lugs, is 2¼ in.

CIRCLE 318 ON READER SERVICE CARD

Silver Solder Pot weighs 6 lb

DEE ELECTRIC Co., 1101 N. Paulina St., Chicago 22, Ill. Model 202 silver solder pot has a new design heating element so made that it protects the windings from contamination by the fluxes used in soldering. This new design has quite uniform temperature distribution along its depth, which gives the pot an extensive operating life. A replaceable ceramic crucible ¾ in. diameter is utilized. This operates over a range of 1,200 to 1,700 F. Operates directly off 110 v. Has built-in regulatory rheostat. Size 6 in. metal cube, with metal housing containing pilot light.

CIRCLE 319 ON READER SERVICE CARD

D-C Power Supply transistor regulated

OPAD ELECTRIC Co., 43 Walker St., New York 13, N. Y. Model TR40 laboratory type supply is designed to operate from 105-125 v a-c 50/60 cycles and furnish 4 to 32 v d-c at 0-15 amperes. Regulation is held to within ±½ percent for the stated line voltage and load current

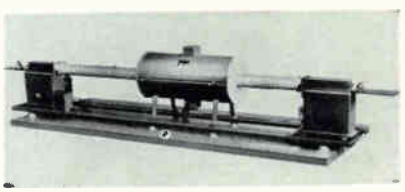
changes. Maximum rms ripple does not exceed 3 mv. Panel controls include a power switch, main voltage control, vernier voltage control, line and load fuses in indicating type fuse holders and 2 percent accurate d-c voltmeter and ammeter

CIRCLE 320 ON READER SERVICE CARD

Transistor Index for quick selection

ZEUS ENGINEERING CO., 635 S. Kenmore Ave., Los Angeles 5, Calif. The index, used to facilitate selection of transistors, consists of a deck of punched Keysort business cards. Each card describes a particular transistor by means of both sorting slots and data printed on the card. Selection is accomplished manually by means of a Keysort needle. Sorting on all ten available parameters is accomplished within 2 or 3 minutes. For unique requirements, approximately 40 unused holes are available for insertion of additional data. It contains data on substantially all military and commercial transistors manufactured by 32 major companies.

CIRCLE 321 ON READER SERVICE CARD



Alloying Furnace continuous firing

SANDLAND TOOL AND MACHINE CO., 52 Duryee St., Newark, N. J. Model 20-D-2 continuous firing, inert atmosphere alloying furnace was developed for the producers of high quality semiconductor devices. It has provisions for precise control of temperatures up to 1,875 F, pre-

cision control of speeds from $\frac{1}{16}$ to 4 ipm, and can maintain an inert atmosphere in the entire furnace. Price is $2,995, less heat controls.

CIRCLE 322 ON READER SERVICE CARD

Ceramic Capacitor
low-voltage

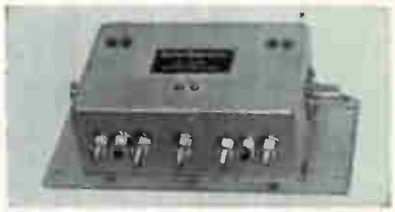
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. Type H Tiny Mike capacitors are designed to meet the limited space, low-voltage requirements of transistorized radios, portable wire and tape recorders, electronic timing devices and a wide variety of other miniature battery-powered and line-powered equipment. They are excellent for bypass and coupling. Operating temperature range is +10 C to +85 C; working voltage is 50 v d-c. Three sizes are available: 0.350 in. diameter by $\frac{1}{8}$ in. thick, 0.500 in. diameter by $\frac{1}{8}$ in. thick, and 0.625 in. diameter by $\frac{1}{8}$ in.

CIRCLE 323 ON READER SERVICE CARD

Telemetry System
airborne, pcm type

TEXAS INSTRUMENTS INC., 6000 Lemmon Ave., Dallas 9, Texas, has developed a 25-lb, $\frac{1}{2}$-cu ft pcm telemetry system for missiles and space vehicles. System multiplexes and encodes 64 analog channels; processes five 8-bit parallel digital data channels plus a serial digital data channel at a nominal bit rate of 200 Kc. A key feature of the all solid-state package is its high-speed multiplexer which handles low- and high-level data, or a combination of both, with only a single low-level amplifier. Overall accuracy of the system is ±0.25 percent—made possible by a unique bidirectional servo loop that nulls out system drift. System is designed in individual modules so that the basic design can be rapidly modified to meet the needs of other missiles or space vehicles.

CIRCLE 324 ON READER SERVICE CARD



UHF Filter
defines bandpass

APPLIED RESEARCH, INC., 76 S. Bayles Ave., Port Washington, N. Y. Model HFF-T(B)-5 uhf bandpass filter utilizes distributed parameter multipole tuned elements to achieve great selectivity and low insertion loss. Center frequency of the model shown is 1,010 Mc, with passband of 870 to 1,150 Mc. Attenuation at 575 and 1,740 Mc is better than 40 db. Filter uses five inductively coupled resonant sections. Construction features insure maximum reliability with minimum size. The case, of brass with rhodium plating and gold flash, weighs 3¼ lb. Dimensions are $7\frac{5}{8}$ in. long by $5\frac{3}{4}$ in. wide by $2\frac{9}{16}$ in. high. Connectors are type C. Mounting centers are $7\frac{1}{8}$ in. by $2\frac{3}{4}$ in. Units operate out of and into a 50-ohm impedance.

CIRCLE 325 ON READER SERVICE CARD

Insulation Coating
high temperature

COLUMBIA TECHNICAL CORP., 61-02 31st Ave., Woodside 77, N. Y. HumiSeal type 1H34 is a high temperature, heavy-duty service, insulation and protective coating. It is extremely practical in many military applications and particularly in those where radioactive environment is involved. A one-component system on silicone resin basis, it is characterized by 6-month long pot life and excellent electrical properties at temperatures above 400 F. HumiSeal 1H34 may be applied by spray, dip or brush.

CIRCLE 326 ON READER SERVICE CARD

Literature of

FACILITIES BROCHURE. John Gombos Co., Inc., Webro Road, Clifton, N. J., has available a brochure illustrating its facilities for the design and manufacture of microwave components and assemblies, electromechanical and mechanical assemblies, electronic subsystems, and for aluminum dip-brazing.

CIRCLE 350 ON READER SERVICE CARD

MEASUREMENT STANDARDS. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md., has available a 6-page folder containing a reprint of two articles on modern electronic measurement standards.

CIRCLE 351 ON READER SERVICE CARD

STATIC TIME SEQUENCER. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y. A 4-page brochure on a solid state static time sequencer includes technical specifications, functional block diagram, system operation, photos and sequential time functions.

CIRCLE 352 ON READER SERVICE CARD

SALT BATH FURNACE. Lindberg Engineering Co., 2443 West Hubbard St., Chicago 12, Ill. Bulletin No. 151 "Lindberg-Upton Salt Bath Furnaces" is now available.

CIRCLE 353 ON READER SERVICE CARD

DUAL POWER SUPPLY. George A. Philbrick Researchers, Inc., 285 Columbus Ave., Boston 16, Mass., has released a specification sheet on a compound regulated, dual power supply, model R-100B.

CIRCLE 354 ON READER SERVICE CARD

MEMORY CORES. Radio Corp. of America, Somerville, N. J. Two technical bulletins describe ferrite cores which feature 1-μsec performance with 25 percent less power, 40 percent greater operating margin.

CIRCLE 355 ON READER SERVICE CARD

MAGNETOSTRICTIVE DELAY LINES. Control Electronics Co., Inc., 10 Stepar Place, Huntington Station, L. I., N. Y. A comprehensive data sheet gives extensive in-

the Week

formation on the theory of operation of fixed and variable magnetostrictive delay lines.

CIRCLE 356 ON READER SERVICE CARD

CIRCUIT BREAKER. Airpax Electronics Inc., Cambridge Division, Cambridge, Md. Bulletin B-07 describes the new series 500 hermetically sealed electromagnetic circuit breaker.

CIRCLE 357 ON READER SERVICE CARD

RECORDING SYSTEM. Southwestern Industrial Electronics Co., 10201 Westheimer Road, Houston 27, Texas. The MS-15A magnetic-seismic field recording and monitoring system is described in an illustrated bulletin which includes specifications.

CIRCLE 358 ON READER SERVICE CARD

AMPLIFIERS & ACCESSORIES. Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. A 4-page reprint tells how to broaden the utility of 150 A/AR oscilloscopes with a line of convenient precision amplifiers and accessories.

CIRCLE 359 ON READER SERVICE CARD

SMALL TUBING DATA. Posen & Kline Tube Co., Inc., Box 549, Norristown, Pa., has available a basic guide to the selection and use of stainless steel tubing ranging from 33-page hypodermic needle sizes to heavy-wall high pressure tubing up to $\frac{3}{8}$ in. o-d.

CIRCLE 360 ON READER SERVICE CARD

MILITARY SYSTEMS. Ford Instrument Co., Division of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N. Y. An 8-page well-illustrated brochure describes the company's aero-space, ground systems and naval systems capabilities.

CIRCLE 361 ON READER SERVICE CARD

PHOTOGRAPHIC EQUIPMENT. Burke & James, Inc., 321 South Wabash Ave., Chicago 4, Ill. A 130-page catalog (No. 459-S) illustrates and describes a wide line of photographic equipment and instrumentation. Prices are included.

CIRCLE 362 ON READER SERVICE CARD

electronics buyers' guide and reference issue
THE ELECTRONICS MAN'S BASIC BUYING BOOK

A McGRAW-HILL PUBLICATION
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NEW BOOKS

Semiconductors

By R. A. SMITH

Cambridge University Press, Cambridge, 494 p, $12.50.

Dr. Smith's book represents a reasonably complete treatment of the basic physics of semiconductors. Emphasis is definitely on the basic fundamentals of semiconductor theory with only a very short section dealing with the application of these materials. The application section, and to a certain extent the theory treatment, have been somewhat outdated by the developments which have occurred in the last few years (the book was apparently completed in late 1957 or early 1958). For example, one should not look for a discussion of the Esaki effect in this book.

Numerous footnotes supplement those sections of the book which, for practical purposes, are of limited scope. Thus, the book would serve well as a reference for the engineer or physicist engaged in semiconductor research. Of particular note is the fact the element semiconductors, other than silicon and germanium, and the compound semiconductors are given more space than is usual in a book of this type. The book would also be a good reference text for a graduate electrical engineering or physics course. However, its value to the electrical engineer who is not engaged in semiconductor research is questionable.—RENWICK W. BELL, *Sperry Gyroscope Company, Div. of Sperry Rand, Great Neck, N. Y.*

THUMBNAIL REVIEWS

Ten Founding Fathers of the Electrical Science. By B. Dibner, Burndy Library, Norwalk, Conn., 48 p, $1.00 (Reprint). This monograph is as noteworthy for the beauty of its format and illustration as for the information contained. Briefly and lucidly, it traces the history and significance of electrical discoveries prior to the death of Maxwell in 1879. It makes a perfect student's keepsake—the main reason it has been reprinted. Its essays describe the work of Gilbert, von Guericke, Franklin, Volta, Ampere, Ohm, Gauss, Faraday, Henry and Maxwell.

R-L-C Components Handbook. By D. Mark, John F. Rider Publisher, Inc., New York, 146 p, $3.50. This book presents the various important factors in selecting a resistor, capacitor, inductor or transformer as well as stipulating the various types of available components and their special features, including miniaturized components. The book is intended for use with texts on basic electricity and electronics and is of particular value to students, amateur radiomen and repairmen.

Electrical and Electronic Drawing. By J. Baer, McGraw-Hill Book Co., Inc., New York, 1960, 218 p, $6. This book is refreshing in that it finally puts between two covers a concise background of electronic symbols that are being used in the field. It also covers the preparation and use of schematic diagrams, block diagrams, graphs, pictorial drawings and the like. However, the selection of art used in the illustrations could have been brought more up to date and drawn with a bit more snap.

Shorewave Propagation. By S. Leinwoll, John F. Rider Publisher, Inc., New York, 151 p, $3.90. This book presents basic principles of shortwave radio propagation from a theoretical as well as a practical viewpoint. Although professional communications engineers may profit from this book, it will be of special interest to amateur radiomen. Use of mathematics has been avoided and difficult concepts explained with analogies. Also included is a pulout chart for simple conversion of global times.

German-English Science Dictionary (Third Edition). By L. De Vries, McGraw-Hill Book Co., Inc., New York, 592 p, $7. This dictionary aims at the technical language of today's science-oriented world and hits the mark admirably. It has been updated to include a number of terms not heretofore readily available and includes a number of tables and listings that should prove of frequent value to the translators. The section at the beginning contains a sound review of the basics of German that admirably points up the sort of information that can so easily slip from the memory of readers not having frequent use for their language studies.

Value Engineering, (1959). Engineering Publishers, Elizabeth, N. J., 165 p, $6.00. Value engineering can be described as the art of getting the desired function for the least money. This book, consisting of papers given at the 1959 EIA Conference on Value Engineering, outlines the philosophy and methods used by leading practitioners. The amount of savings made possible by respecifying everyday parts is often dramatic.

The D stands for Dorothy . . .

CORRESPONDENTS dealing with Colvin Laboratories, East Orange, N. J., often receive concise, spirited letters signed D. P. Vogel. More than one letterwriter is surprised to discover that the D in this signature stands for Dorothy, and that behind the correspondence is an attractive woman.

On the other hand, those who know Dorothy Vogel as a cordial human being are sometimes surprised to discover that she has a mind to match the fast pace of today's electronic world, a well-indexed memory and a healthy proportion of ability and ambition.

Colvin Labs, headed by aircraft expert Charles Colvin, specializes in precision transducers. It was organized as a proprietorship in 1950 and incorporated in 1953. Miss Vogel has been with the company since the early days of its incorporation.

The 29-year-old Concordia (N. Y.) graduate went to Pace College in New York at night to learn commercial matters from the academic side. Then she served as secretary to the president of Fischer Chemical Co. between 1950 and 1953, acquiring practical knowledge.

When she began working for Charles Colvin as his secretary, she received her first lessons in electronics. "Mr. Colvin," she says, "is an excellent teacher," which should come as a surprise to no one since Colvin, at one time, was a faculty member at the Guggenheim School of Aeronautical Engineering.

After proving her value as a secretary, she took over the purchasing agent functions for Colvin Labs., thereby gaining insight into still another aspect of the company's operation. Later she assisted Colvin in product planning and was so useful in that capacity that he took what then appeared to be a risk and made her plant manager. She is now general manager of Colvin Labs.

"It gives me a wonderful challenge in using my brains," she says, pointing out that the last five years have given her practically a baccalaureate education in instrument engineering. The 100 or more employees of Colvin—about 20 percent engineering—work well with their soft-spoken brunette manager.

"I like managing because my first interest is in people," she smiles. "It's not just a matter of selecting bright people. It's also necessary to create the right atmosphere to allow them to do their best."

She speaks of developing the corporate personality almost in a way one might speak of developing a family—with the difference, she points out, that the individual personality is the goal of family development, but the shared personality of the corporation is her goal at work.

Married in 1955 to Long Island real estate broker Robert Morris, she emphatically points out that she does not operate her home in the same way she manages things at Colvin.

Organize New Company

FORMAL announcement was recently made of the formation of a new scientific organization named Photronics Corp. in Flushing, N. Y.

Company's stated mission is to design, develop and produce highly specialized, sophisticated equipment in the field of optics, electronics and electromechanics.

Management consists of Hugh McGovern, president, formerly vice-president of J. W. Fecker, Inc., subsidiary of American Optical Co.; Ralph Wight, vice-president, formerly employed as chief physicist and optical designer of J. W. Fecker, Inc.; William C. Ebeling, chief engineer, specialist in electronics systems design, and Paul Fidelman, production engineering specialist.

McGovern says that by virtue of the background and engineering experience of Photronics' personnel, his company is particularly well qualified to meet unusual scientific challenges associated with optical and electronic instrumentation.

RS Electronics Gets New V-P

ROBERT B. PARKS has been named vice president of RS Electronics Corp., Palo Alto, subsidiary of Regan Industries, Inc., Burlingame, Calif. He was most recently general sales manager and chairman of the production and engineering planning committee of the Sentinel

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MILITARY ELECTRONICS DIVISION — CHICAGO 24, ILLINOIS

URGENT PROBLEMS RELIABLY SOLVED

Radio Company, Evanston, Ill.

In his new post, Parks will coordinate general business procedures involved in the research and development, engineering, and production operations of RS Electronics. He will make his headquarters in the company's Palo Alto plant.

The Regan Industries' subsidiary manufactures amplifiers, receivers and electronic components for military and commercial applications.

Appoint Hager Section Manager

CHARLES K. HAGER has been named section manager of Automatic Controls for Temco Electronics, a division of Temco Aircraft Corp., Dallas, Texas. Prior to joining Temco in June, 1959, he was director of applications research at Varo Mfg. and previously had been employed at Convair and Mandrel Industries.

Before his promotion to section manager responsible for design and development of automatic controls and control systems, Hager was a scientist in Temco's development and analysis group.

Name Anderson S-C Vice-president

JACK G. ANDERSON was recently appointed vice president for government relations at Stromberg-Carlson, Rochester, N. Y. Stromberg-Carlson is a division of General Dynamics Corp.

New vice president comes to S-C from Hoffman Electronics Corp. of

Los Angeles, where he was vice president for marketing. He had been with Hoffman since 1954, first as manager of Air Force operations and later as director of military marketing.

Elect Edwards Board Member

WALTER G. EDWARDS, executive vice president of Marc Shiowitz and Associates, Inc., Hawthorne, Calif., has been elected to the board of directors of this computer consulting firm.

Prior to joining MS&A in 1958, Edwards was chief engineer of The National Cash Register Co., Electronics division.

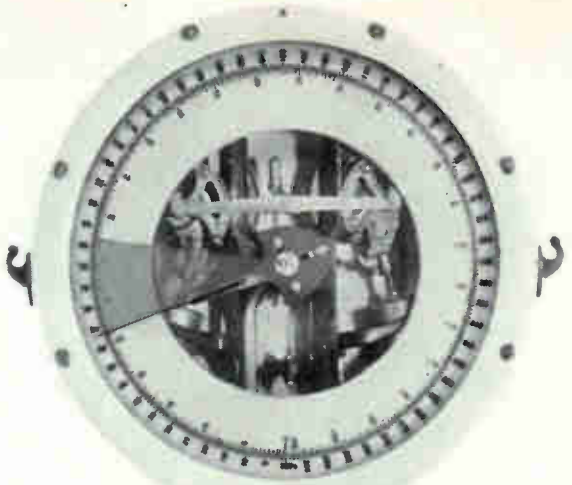
News of Reps

The Sag Harbor Industries, Inc., Sag Harbor, N. Y., appoints **A-D Associates** of Valley Stream, N. Y., and North Plainfield, N. J., to represent its line of custom built multiple and bobbin wound military and industrial coils in New York City and state of New Jersey.

Essex Electronics, Division of Nytronics, Inc. of Berkeley Heights, N. J., has appointed **Engineering Services Co.** of Kansas City, Mo., manufacturers reps, to handle its standard line of electronic components in Nebraska, Kansas, Missouri, Iowa and southern Illinois.

Burnell & Co., manufacturer of toroids, filters and related networks, announces the appointment of the **Tex-O-Koma Sales Co.**, Grand Prairie, Texas, as its rep for Texas, Oklahoma, Kansas and Missouri area; **Found Brothers Aviation, Ltd.**, of Malton, Ontario, in the provinces of Ontario and Quebec.

Harris Transducer Corp., Woodbury, Conn., recently appointed **J. P. Dearie Co.** of Boonton, N. J., as manufacturers' rep for New York, New Jersey, Maryland, Delaware, Virginia and eastern Pennsylvania.



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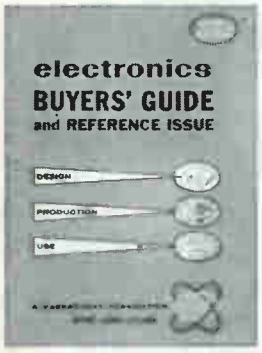

Advertisers, being practical, like things that work! That's why the **electronics** BUYERS' GUIDE and Reference Issue has 42% more advertisers than the nearest competition. With the "GUIDE" advertisers reach more of the right people . . . readers get a correspondingly bigger choice of products and services to select from. Clear evidence that the "GUIDE" carries the most weight in advertiser confidence and acceptance.

Exclusive! 64-page Reference Section that gives buyers basic market, materials, and design data that buyers refer to again and again. The only directory in the field that contains this valuable reference data, Accurate, authoritative, easy to read. 9.62

electronics Buyers' Guide and Reference Issue
THE ELECTRONICS MAN'S BASIC BUYING BOOK
A McGRAW-HILL PUBLICATION
330 West 42nd St., New York 36, N. Y. ABP ABC .

1960 Issue Closing Dates: Published July 20; Complete Plates May 1

BACKTALK

Exhibitions

I was interested to see the letter from reader Cyril J. Mitchell (February 19th), as this firm is the organizer of the International Instruments, Electronics and Automation Exhibition which sets out to allow the British engineer to compare products from overseas.

Starting in 1957, covering British products only, the show went international in 1958. The third one, opening on May 23rd this year at Olympia, London, covers over 500 exhibitors from a dozen countries, taking 150,000 square feet of net booth space. The U.S.A. is well represented, and Mr. Mitchell's own firm has a very large showing of international products.

E. D. HART

LONDON

R-F Effects

I was very much interested in the article "New Biological Effects of R-F Energy" on page 38 of the December 4, 1959, issue of ELECTRONICS.

Could you please send me the name of the investigator who postulated that desoxyribonucleic acid acts as a signal generator.

ELWOOD E. RICHARD

CHICAGO

The postulation was made in a paper prepared by C. Susskind and P. O. Vogelhut, University of California, Berkeley, entitled "Analytical and Experimental Investigation of Unicellular Organisms Under Microwave Irradiation."

The paper was presented November 11, 1959, in Philadelphia at the 12th Annual Conference on Electrical Techniques in Medicine and Biology.

Tube and Semiconductor Sales

In your Market Research Department, p 22, March 4, you say in paragraph one, ". . . electronic tube shipments increased 145 percent between 1954 and 1958—from $451 million to $1.1 billion."

The following is more accurate: The $1.06 billion electronic tube shipments include not only tubes but also semiconductors. In fact, the big increase was in semiconductors.

Semiconductor shipments in 1958 are estimated at $210 million. The 1954 value of shipment figure is not $451 million, as the story indicates, but $709,614,000 and this includes $25 million semiconductor shipments.

The increase in semiconductor and tube shipments in the period mentioned is about 54 percent instead of 145 percent. If you cancel out conductors, you would get roughly a 25 percent increase in tube shipments.

DONALD PARRIS

BUSINESS AND DEFENSE SERVICES ADMINISTRATION

DEPARTMENT OF COMMERCE

WASHINGTON, D. C.

Thanks for bringing this clarifying comment to our attention. Bureau of Census summary of 1958 shipments reported these figures as electronic tubes without noting that semiconductors were included.

Back Issues for Sale

I have the following back issues of ELECTRONICS, unbound, that I am interested in selling: 1937—complete; 1939—less Jan., Feb., Sept.; 1944—only Sept. through Dec.; 1945 through 1959—missing only Jan., 1955.

I also have most of the annual indices; the first ten-year index and the second ten-year index.

R. V. BERTHOLD

APPLIED RESEARCH, INC.

76 SOUTH BAYLES AVE.

PORT WASHINGTON, N. Y.

Satellite . . . And Acumen

Congratulations on the editorial acumen you exhibited in timing the publication of "Solar-Cell Power Supplies for Satellites", p 167, March 11, with the launching of Pioneer V.

JACK SKILOWITZ

HARTSDALE, N. Y.

MANUFACTURERS' REPRESENTATIVES

IN THE ELECTRONIC INDUSTRY

As a service to readers, ELECTRONICS presents the advertisements for some of the leading manufacturers' representatives in the electronic industry. These firms are qualified to help the *Manufacturer* with his distribution problems: the *Buyer* with his product needs.

SAMUEL K. MACDONALD, INC.
manufacturers representatives over 25 years
1531 SPRUCE STREET, PHILA. 2, PA.

Territory:
Pennsylvania • New Jersey
Delaware • Maryland
Virginia • West Virginia
District of Columbia

Other Offices:
Pittsburgh
Baltimore
Washington, D.C.

SEARCHLIGHT SECTION

(Classified Advertising)

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EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $24.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.40 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.40 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.
DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

BUSINESS OPPORTUNITY

Electronic, nuclear design bureau in European Common Market with "avanguardist" patents and prototypes for commercial and military field starting mass production and worldwide export wish capital, cooperation, extension, propositions. BO-3967, Electronics.

PLATING SPECIALISTS
for the
ELECTRONICS INDUSTRY
Gold, Silver, Nickel, Tin, Cadmium PLATING to any thickness.
PALUMBO BROS., INC.
347 Ferry St. Newark 5, N. J.
MArket 2-5060 • Est. 1915

CIRCLE 460 ON READER SERVICE CARD

WANTED
TAPE RECORDER
USED AMPEX 300 CONSOLE TYPE
REPLY S. GRABL
AMERICAN RECORDING TAPE CORP.
COSTA MESA, CALIFORNIA

CIRCLE 461 ON READER SERVICE CARD

LOOKING FOR

USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of March 11th.

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

DISPLAYED	——RATES——	UNDISPLAYED
The advertising rate is $34.33 per inch for all advertising appearing on other than a contract basis. An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page. Subject to Agency Commission.		$2.40 per line, minimum 3 lines. Box Numbers—counts as 1 line. Discount of 10% if full payment is made in advance for 4 consecutive inserations. Not subject to Agency Commission.

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ORDNANCE RESEARCH LABORATORY

ENGINEERS ELECTRONICS

CHALLENGING R & D OPPORTUNITIES

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Opportunities for Graduate Study
Faculty Appointments for Qualified Applicants
Excellent Working and Living Conditions

Send Resume to

ARNOLD ADDISON, PERSONNEL DIRECTOR
ORDNANCE RESEARCH LABORATORY
THE PENNSYLVANIA STATE UNIVERSITY
BOX 30, UNIVERSITY PARK, PA.

ELECTRONIC ENGINEER

Opening in growing concern located in university town in southwest. 2 to 8 years experience in circuit design, telemetering, transistor circuitry, or data handling required. Pleasant working and living conditions.

DORSETT LABORATORIES, INC.
P. O. Box 862 Norman, Oklahoma

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Send to office nearest you.
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CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Nuclear Instrumentation (or related) experience plus articulateness and a desire for a broad view of technical development in the nuclear field can be converted into an exciting career as an editor on the staff of Nucleonics magazine, a McGraw-Hill Publication. Send complete resume, salary requirements to The Editor, Nucleonics Magazine, 330 W. 42 St., New York 36, N. Y.

SELLING OPPORTUNITY WANTED

Manufacturer's representative organization established eleven years in engineering sales, desire to represent electronic component manufacturer for Military and Industrial application. Northern Illinois and Northern Indiana, Twin Cities, Minneapolis and St. Paul, Minn. RA-3909, Electronics.

SENIOR ELECTRONICS ENGINEER

EE or Physicist, experienced in Pulse Circuitry, and the design and use of Pulse Transformers. Will assume immediate technical responsibility.
Attractive salary, modern company benefits including educational assistance plan. Pleasant living in Lancaster county.

Call, Write, Wire, E. Lynn Ervin

HAMILTON WATCH CO.
Lancaster, Pa.

We need REPS.

to sell our printed circuit services to industry. We offer a comprehensive electronic background plus an experienced staff and adequate facilities. We have a lot to offer. Ours is an electronic firm of long standing. We do a good business right now. We want to expand this segment of our work. Do you want to work with us? Why not write and tell us about yourself.

Charles Allegri, Treas.
ALLIED ALLEGRI CO., INC.
141 River Road Nutley 10, N. J.

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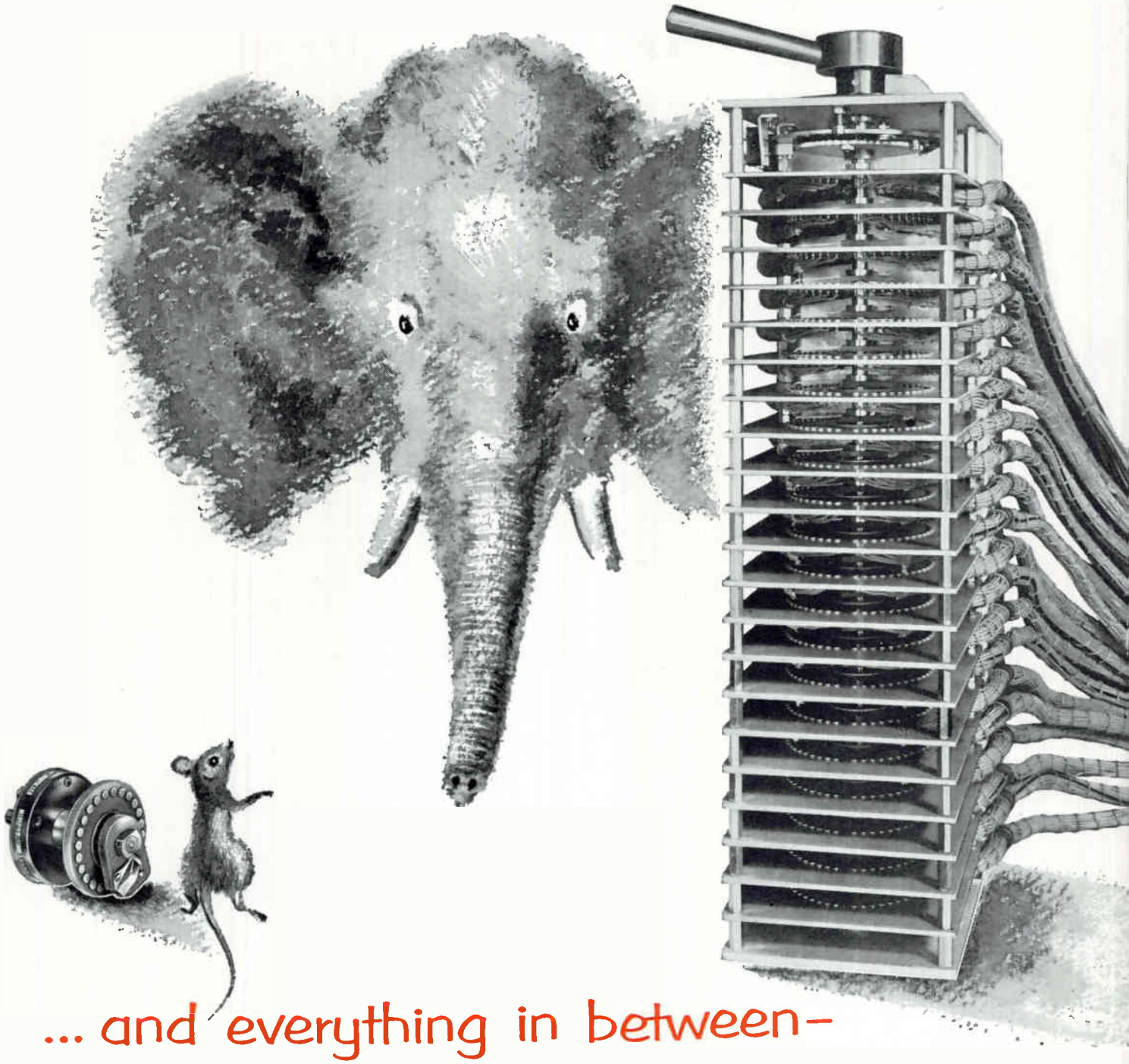


... and everything in between—

With Over 3500 Standard Switches In The Daven Line From Which To Choose—and which in turn can be modified to provide countless additional switch combinations—it's easy to see why *Daven* is equipped to meet your most exacting switch requirements on short notice.

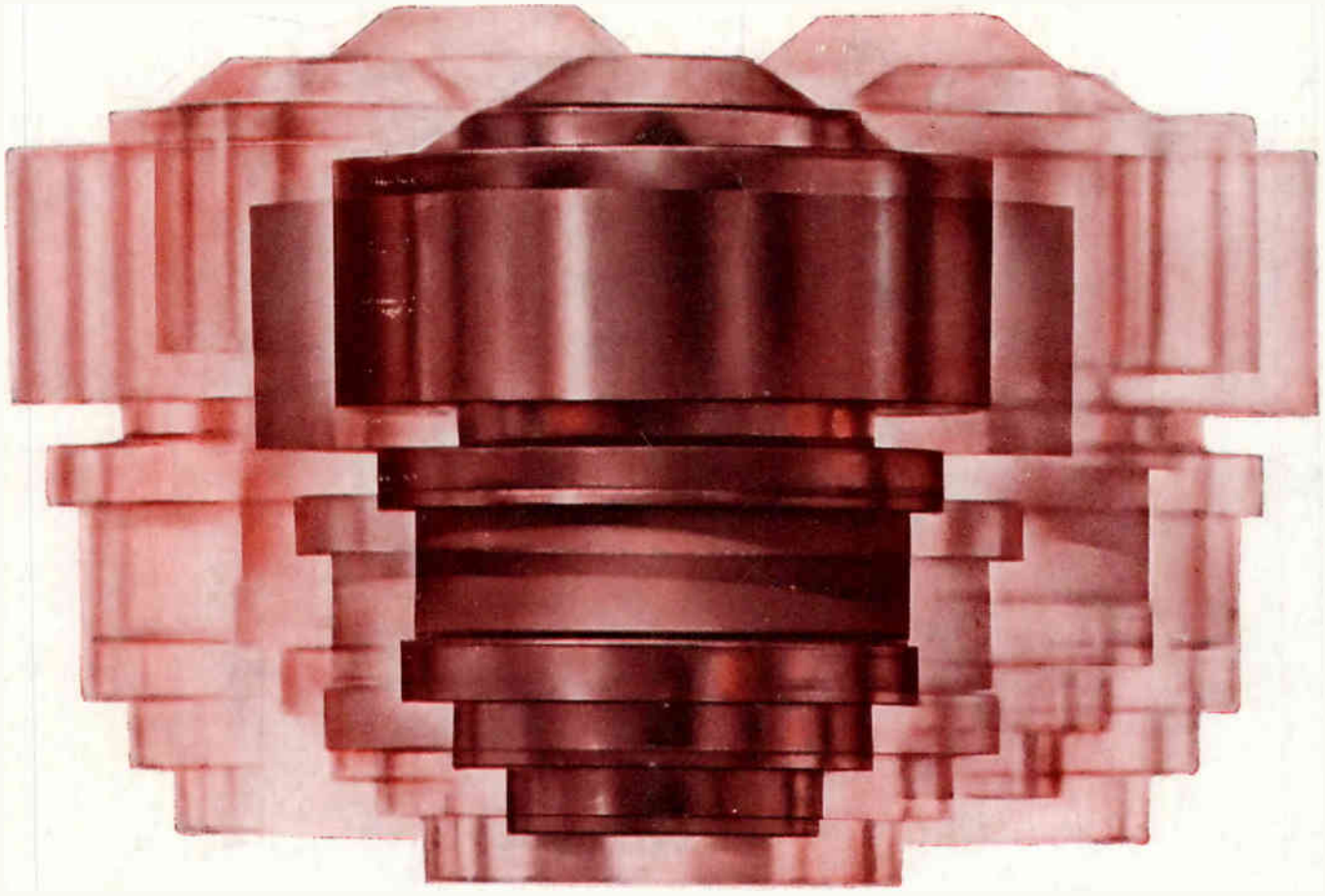
Knee-Action Rotor Lowers Contact Resistance . . . Gives Longer, Trouble-Free Switch Life! Every *Daven* switch features the exclusive, patented *Knee-Action* rotor arm with two separate wiper blades, each individually spring-loaded—to insure extremely low and uniform contact resistance throughout the life of the switch. *Daven's* special design renders these blades tamper-proof . . . they withstand rugged treatment in the field. Because of their self-wiping action, little or no servicing is required.

Compact Design for Smaller-Size Components—With *Daven's* space-saving design, up to 8 poles per deck can be supplied . . . a significant factor for maximum performance where depth and mounting space are at a premium. *Daven* switch sizes start at ½" diameter x ½" in depth. Solid silver alloy rotors, slip rings, and contacts are used exclusively. These switches meet all applicable military specifications.

Write today for FREE catalog.

THE DAVEN CO. LIVINGSTON, NEW JERSEY

THE BIG LARGEST MANUFACTURERS OF ATTENUATORS



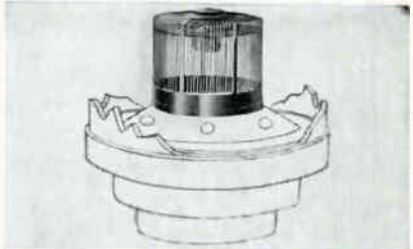
ENGINEERED TO WITHSTAND 20 G VIBRATION

New RCA-7650 and -7651 Ceramic-Metal Beam Power Tubes promise dependable operation even when subjected to vibrational accelerations well over 20g.

When you're designing equipment for missile use, you can't take chances. You must be *sure* you're using the toughest tubes you can get. That's why the exceptional ruggedness of RCA-7650 and RCA-7651 is so important to you.

These two unique new ceramic-metal beam power tubes will actually withstand 20 g vibrational acceleration without adverse effect. In fact, both types have successfully undergone variable-frequency vibration tests (20-2000 cycles) with peak accelerations of twice that amount! Resistance of these tubes to vibration as well as to shock means dependable operation during the critical moments of launching and after. No wonder missile-equipment designers are so enthusiastic about these new tubes.

Both RCA-7650 and RCA-7651 feature a coaxial electrode structure which makes them adaptable to either coaxial-cylinder or parallel-line circuits. Both utilize RCA's exclusive grid-making technique for precision grid line-up and exceptional structural rigidity. Capsule data on these two forced-air-cooled types are shown in the adjacent chart. Technical bulletins on these types are available from RCA Commercial Engineering, Section C-19-Q-4, Harrison, N. J. For further information about these tubes and other RCA Ceramic-Metal Power Tubes, contact the RCA Field Representative at our office nearest you.



Type	Operation	Max Plate Volts	Max Plate Input Watts	Max Plate Dissipation Watts	Useful CW Power Output Watts		Power Gain	
					at 400 Mc	at 1215 Mc	at 400 Mc	at 1215 Mc
RCA-7650	CW	2500	1250	600	800	450	14 db	7 db

Type	Operation	Max Plate Volts	Max DC Plate Amperes During Pulse with 10 μs duration and duty factor of 0.01	Max Plate Dissipation Watts	Useful Power Output at Peak of Pulse Watts at 1215 Mc	Power Gain at 1215 Mc
RCA-7651	Screen and Plate Pulsed	8000*	9	600	39000	8.6 db
	Grid Pulsed	4000	9	600	20000	5 db

*Peak Positive

RADIO CORPORATION OF AMERICA
Electron Tube Division **Harrison, N. J.**

Government Sales: Harrison, N. J., 415 S. 5th Street, HUmboldt 5-3900; **Dayton** 2, Ohio, 224 N. Wilkinson St., BAldwin 6-2366; **Washington** 6, D.C., 1625 "K" St., N.W., District 7-1260
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