electronics

A McGraw-Hill Publication 75 Cents June 29, 1962

INFORMATION
STORAGE/RETRIEVAL

Check the chart ...

you'll find the right instrument

to measure **AC VOLTAGE**
DC VOLTAGE
DC CURRENT
RESISTANCE

hp

turn the page

electronics

A McGraw-Hill Publication 75 Cents June 29, 1962

INFORMATION STORAGE/RETRIEVAL

 hp 400H*	Similar to 400D, 1% accuracy on extra-large 5" mirror-scale meter.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$325.00
 hp 400L	Logarithmic 400D. Accuracy ±2% constant percentage of reading. For log voltages, linear db measurements.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$325.00
 hp 410B	VTVM for audio, rf, VHF measurements; dc voltages, resistances. Minimizes circuit loading, low drift, one zero set all ranges.	dc; ac, 20 cps to 700 MC	dc, 1.0 to 1.000 v, 7 ranges; ac, 1.0 to 300 v, 6 ranges	dc, 122 megohms; ac, 10 megohms/ 1.5 pf shunt	$245.00

 hp 405CR	Automatic digital VM. "Touch and read", direct dc voltage measurements, digital readout. Automatic range, polarity; has 10-line readout for printer, system.	dc	0.001 v to 1,000 v (accuracy ±0.2% of reading ±1 count)	11 megohms	$925.00
 hp 425A*	Microvolt-ammeter reads μv, $\mu\mu$a; 100 db amplifier; measures dc voltages, current as in medical, biological, physical, chemical work.	dc	10 μv to 1 v 11 ranges; 10 $\mu\mu$a to 3 ma, 18 ranges	1 megohm ±3% (v) 1 megohm to 0.33 ohms (current)	$500.00
 hp 428A	Clip-on dc milliammeter, eliminates direct connection, no circuit loading. Measures dc in presence of ac.	dc	3 ma to 1 amp 6 ranges		$500.00
 hp 428B	Similar to 428A, wider range, recorder output for dc to 400 cps.	dc on meter, dc to 400 cps on recorder	1 ma to 10 amps 9 ranges		$600.00

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1501 Page Mill Road, Palo Alto, California. Area Code 415, DA 6-7000. Sales and service representatives in all principal United States areas; **Europe,** Hewlett-Packard S.A., Rue du Vieux Billard No. 1, Geneva; **Canada,** Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal.

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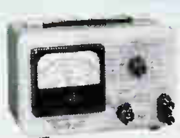
COMPLETE COVERAGE, UNIQUE VALUE, TRUSTED hp ACCURACY AND DEPENDABILITY

Instrument	Primary Uses and Features	Frequency Range	Voltage or Current Range	Input Impedance	Price
 hp 403A	Solid state ac voltmeter, battery-operated, portable. Fast, accurate, hum-free ac measurements.	1 cps to 1 MC	0.001 to 300 v 12 ranges	2 megohms 40 pf shunt, low ranges; 20 pf, mid ranges; 15 pf, high ranges	$275.00
 hp 400D	Wide range ac voltmeter. High sensitivity, 2% accuracy.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$250.00
 hp 412A*	Precision VTVM. 1% accuracy; measures voltage, current, resistance; no zero set needed; 1 ohm to 100 megohm center scale for resistance meas., 60 db dc amplifier.	dc	1 mv to 1,000 v 1 μa to 1 amp	10 to 200 megohms, depending on range	$400.00
 hp 413A*	DC null meter, dc voltmeter, 60 db dc amplifier. 2% accuracy, floating input, 1 mv end scale sensitivity.	dc	1 mv to 1,000 v 13 ranges	10 to 200 megohms, depending on range	$350.00

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W. W. MacDONALD, Editor

Contents continued

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June 29, 1962 Volume 35 No. 26

Published weekly, with Electronics Buyers' Guide and Reference issue, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Indexed Annually in Buyers' Guide and Reference issue.

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N. Y. PRINTED IN ALBANY, N. Y.; second class postage paid at Albany, N. Y.

OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator; Daniel F. Crowley, Vice President and Controller.

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Audited Paid Circulation

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DEPARTMENTS

Accuracy, and Precision

MEASUREMENT has long been a major activity of engineers and scientists. But how many of us know how good our measurements really are?

We may say, for example, that we have used a voltmeter accurate within plus or minus two percent. But does this mean two percent of full scale, midscale or which scale if the meter has more than one?

There is an even more basic problem and that is the statistical variation in meter readings. There used to be an experiment in college Physics I in which each member of the class measured the length of a bar of metal using a meter stick and calipers. The students recorded their answers independenly in tenths of millimeters. If your class was anything like ours, the results could be plotted as a gaussian or bell-shaped curve. Statisticians would say that the measurements were normally distributed.

There are two statistics that characterize almost every distribution: the arithmetic mean or expected value of the random variable and the variance or mean square of deviations from the expected value, a measurement of the spread of the distribution.

Meter readings taken on an unknown voltage can also be thought of as a random variable. And the effects that cause variation, such as worn bearings, play in mechanical parts, random current variations in electrical components and uncertainty of the operator as to the last decimal place, are all such that the random variable should be normally distributed.

If we accept the view that meter readings on a constant but unknown voltage comprise a normally distributed random variable, then certain short-comings of the "plus or minus two percent" figure of merit become evident, even if we specify over what range of what scale we are talking.

The gaussian distribution theoretically extends from plus infinity to minus infinity and accordingly there is a probability, however small, that some meter readings will fall outside of any arbitrarily established limits. However, if we can properly describe the distribution of meter readings, we can make a valid probability statement such as: 99 percent of all readings will fall within plus or minus two percent of center scale reading on the 300-volt scale. It is essential, however, that the distribution of readings be described in terms of the mean of an adequate sample of readings and the sample variance.

The difference between the mean of the meter readings and the true value of the unknown voltage may be thought of as the accuracy of the instrument. The variance of the meter readings may be thought of as a measure of the precision of the instrument.

Fundamentally, in buying an instrument you pay for precision and not necessarily accuracy. Nevertheless, you need to know both accuracy and precision to adequately describe any meter and to make a meaningful probability statement about the quality of the instrument readings you have taken.

Of course, the problems concerning the hypothetical voltmeter are representative of problems connected with all kinds of electrical and electronic test instruments.

We believe that instrument makers and users should work together to establish a figure of merit for test instruments that will set forth both the accuracy and precision of all test instruments at significant points of all ranges over which the instruments are intended to operate. Then, perhaps, for the first time since the French physician Arsene d'Arsonval invented the moving-coil meter at the turn of the century, engineers and scientists will really know how good their measurements are.

Coming In Our July 6 Issue

MICROMINIATURIZATION. A simple, functional silicon-block version of a general-purpose differential amplifier will be described by W. F. DeBoice, of Autonetics, and J. F. Bowker, of Montana State College. The device can be used in navigation, fire-control and computer systems.

Another feature, authored by A. I. Sinsky and H. M. Mayrovitz, of Bendix, tells how to optimize the power gain-bandwidth product of tetrode and pentode tube amplifiers by the proper choice of double-tuned circuit parameters. Other articles give details of a magnetic-core pegboard that generates digital signals, a countermeasures receiver, a two-transistor constant-current circuit and a d-c level shifter.

COMMENT

Transmission-Line Charts Again

This is in reference to the *Comment* column of March 16 (p 4), which printed a letter from R. Guillien of the University of Nancy, France, to the effect that he introduced as early as 1955 the same logarithmic transmission-line charts as those used in an article by Professor H. F. Mathis of The Ohio State University in the Dec. 1, 1961 issue (p 48); also a letter from me to Prof. Mathis, in which I remarked that one of the charts in his article is basically similar to a chart I published 25 years ago in the *Marconi Review;* and a portion of a letter Prof. Mathis sent to me, saying that I might be interested in knowing that A. E. Kennelly published almost the same charts in 1914 in his very large book "Chart Atlas of Complex Hyperbolic Functions," which was published by the Harvard University Press.

I have written to Prof. Mathis, respectfully pointing out that I was well acquainted with the Kennelly charts and made extensive use of them from about 1928. Proof that I was aware of the Kennelly Charts may be seen by referring to the summary at the head of my published paper which I sent to Prof. Mathis.

Also, Prof. Mathis' statement that A. E. Kennelly published "almost the same charts in 1914" calls for a clear understanding of the meaning of the words "almost the same." I also have had access to the 1914 edition of the Chart Atlas, and I fail to find in it anything like the charts I published. The only thing his charts and mine have in common is the complex hyperbolic function; the charting of this function is fundamentally different, in terms of projection, in the two cases. This fundamental difference is expressed in the fact that for the purpose of obtaining input impedance of electrical networks terminated by complex loads, the Kennelly projection necessitates entering the chart twice for every complete calculation. With my chart, only one entry is required to achieve the same result. This and the need to eliminate the application of tedious and time-absorbing interpolation calculations which were necessary in using the Kennelly charts was the objective in devising my chart.

I note with some interest Monsieur R. Guillien's letter, and also note that the postscript in my letter referring to Monsieur Guillien's charts in *L'Onde Electrique*, Dec. 1955, was not published. I also note that references to my articles, in the second paragraph of my letter to Prof. Mathis, have been deleted from the published letter. Evidently Monsieur Guillien has been unaware of my charts to this late date, and I feel I have been remiss in not writing to him at the time he published the charts in 1955, and I owe him my apologies for this neglect.

Finally, I appreciate the statement, leading to Prof. Mathis' published letter, to the effect that he "did not prepare a research paper but one intended to be a working tool, similar to others that had gone before." I could not, of course, expect him to make acknowledgement of previously published papers with which he was not acquainted at the time.

Please note the incorrect spelling of Alexandra in the published version of my letter.

H. CAFFERATA
Marconi's Wireless
Telegraph Company, Ltd.
Chelmsford, Essex, England

The postscript in the letter to Prof. Mathis was deleted for lack of space, and reads:

P.S. I should have mentioned above that this chart projection was published by Monsieur Robert Guillien of [at that time] Sarre University Institute of Physics, in *L'Onde Electrique*, Dec., 1955. He made no reference to my chart in the article. On that occasion I did not get in touch with Monsieur Guillien.

The articles in the Marconi Review appeared in the issues of Jan.-Feb. and Sept.-Dec., 1937.

It was Alexandra Palace, in London, where the world's first television station was set up. Mr. Cafferata devised the chart in question to facilitate its feeder and aerial calculations in 1936.

The above signed letter is an adaptation of one sent Prof. Mathis by Mr. Cafferata, and forwarded to us by Prof. Mathis.

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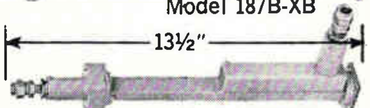

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Three models useful in pressurized systems
VSWR less than 1.10
High average, peak power ratings
Low rf radiation
Calibration heaters in all models

These Sierra high-power waveguide terminations are extremely useful as dummy loads in calorimetric power-measuring systems. They feature rugged construction, with rigid plastic water tube mounted in waveguide section, diagonally oriented for impedance matching. Chokes and shielding minimize rf leakage, and a heater element built into each model permits rapid, accurate calibration of a calorimetric power-measurement system against a low-frequency standard.

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Model Number:	187B-SL	187B-S	187B-C	187B-XB	187B-X
Frequency Range:	1.7 to 2.6 kmc	2.6 to 4.0 kmc	5.8 to 8.2 kmc	7.0 to 10.0 kmc	8.2 to 12.4 kmc
VSWR:	< 1.10 to 2.4 kmc < 1.15 to 2.6 kmc	less than 1.10	less than 1.10	less than 1.10	less than 1.10
Power Average:	20 kw	10 kw	5 kw	3 kw	2 kw
Peak Power: (Unpressurized)	2 megawatts	1 megawatt	500 kw	250 kw	150 kw
Max. Air Pressure:	*	*	45 psig	45 psig	45 psig
Waveguide:	RG-105/U	RG-75/U	RG-50/U	RG-51/U	RG-52/U
Connector:	UG-437A/U	UG-584/U	UG-344/U	UG-51/U	UG-39/U
Recommended Water Flow:	2 gpm for 10 kw	2 gpm for 10 kw	1 gpm for 5 kw	0.6 gpm for 3 kw	0.4 gpm for 2 kw
Pressure Drop at Rated Flow:	10 psi	10 psi	10 psi	10 psi	10 psi
Max. Water Pressure:	80 psig	80 psig	80 psig	80 psig	80 psig
Water Temperature:	0 to 70° C	0 to 70° C	0 to 70° C	0 to 70° C	0 to 70° C
Water Capacity:	18.5 cu. in.	3.5 cu. in.	0.85 cu. in.	0.42 cu. in.	0.20 cu. in.
Water Renewal at Rated Flow:	Once per 2.5 sec.	2 times per sec.	4.3 times per sec.	5.3 times per sec.	7.4 times per sec.
Heater Resistance:	4.5 ohms	9 ohms	14 ohms	20 ohms	20 ohms
Heater Rating:	10 kw at 2 gpm	5 kw at 1 gpm	3 kw at 1 gpm	1 kw at 0.6 gpm	1 kw at 0.4 gpm
Length:	50 in.	32 in.	20 in.	17.25 in.	13.5 in.
Price:	$600.00	$500.00	$425.00	$400.00	$375.00

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ELECTRONICS NEWSLETTER

100-Gc Tube Attains 100-Kw Pulse Power

PALO ALTO—Watkins-Johnson Company told ELECTRONICS last week that their developmental backward-wave oscillator has been operated with an output peak pulse power of 100 Kw and an average power of 1 Kw. The pulse power output is reportedly the highest ever achieved at millimeter wavelength. In a recent survey of millimeter-wave devices (p 37, May 25) the reported peak pulse power outputs ranged from below 100 Kw at 50 Gc to 10 Kw near 100 Gc.

The tube is tunable over the range of 94 Gc to 100.5 Gc. It was evolved from a feasibility study performed by the company for the Air Force.

Another tube under development at W-J is a broadband, low-noise traveling-wave tube for use over the band of 70 Gc to 85 Gc. Most of the problems associated with the extremely small sizes of the tube elements have been solved, according to a company spokesman. The tube uses a 2-mil cathode. The helix is wound with 1-mil wire and has a 7-mil outside diameter. Current density in the beam reaches 1,000 to 1,500 amperes a square centimeter.

Laser Pumping May Bridge Submillimeter Gap

LOS ANGELES—Hughes Research Labs last week announced development of an experimental laser-pumped maser. Its optical pumping principles, Hughes said, can lead to devices operating in the submillimeter region between microwaves and the lowest laser frequency, 30,000 Gc.

The Hughes maser uses ruby. Its operating frequency is 22.4 Gc—outside the 200-30,000-Gc gap—but Hughes says the discovery of materials suitable for those frequencies may now be "confidently expected." The company says that efforts to increase maser frequency have been hampered by the unavailability of pumping sources in excess of 150 Gc, limiting maser frequency to 400 Gc. Optical pumping, Hughes said, extends the pumping range by three orders of magnitude.

The maser cavity is a waveguide length loaded with ruby to act as a reflection cavity resonant at 22.4 Gc. Placed in a magnetic field and pumped by a ruby laser beam, it exhibited amplification and emission at 22.4 Gc, Hughes reported. The experiments were performed by D. P. Devor, Jr., I. J. D'Haenens and C. K. Asawa, under a $100,000 one-year contract with the Signal Corps.

NASA Wants Bigger, More Versatile Syncom Satellite

WASHINGTON—NASA plans a second generation of synchronous orbit communications satellites. The agency is negotiating an estimated $2.5-million contract with Hughes Aircraft for study of problems involved in developing an advanced Syncom satellite to fly in a 22,300 mile high equatorial orbit.

Flight units will not be developed under the contract. Hughes will work on subsystems requiring long lead-time developments. The new effort is aimed at a 500-pound, spin-stabilized satellite carrying several wide-band repeaters, each capable of relaying several hundred telephone calls or one TV channel. Diameter would be 5 feet.

The first of three Syncom I satellites, for which Hughes was named prime contractor in August, 1961, is scheduled for flight tests early next year. The 28-inch diameter, 75-pound satellite is limited to a single telephone channel relay and it will fly a figure-eight pattern instead of a true synchronous equatorial orbit.

British Get Together, Too

LONDON—Just like their American counterparts, AIEE and IRE, two British Associations getting together—but only for collaboration. Joint committees from the British Institution of Radio Engineers and the Institution of Electrical Engineers are proposing combined activities in several specialized categories such as medical and biological electronics, and common education standards

Telstar Satellite to Be Launched in July

BELL TELEPHONE LABS' Telstar satellite (p 26, Feb. 16) is to be launched early in July, a spokesman for the labs said last week. The exact launch date will be fixed by NASA. A backup satellite will be ready for launching a few months later if the first launch fails. The launch vehicle will be a Thor-Delta rocket.

Initial demonstrations with the satellite will consist of voice, tv, facsimile and other forms of communication between ground stations at Andover, Me., and Holmdel, N. J., plus about 115 other experiments.

Transatlantic television programs by the satellite are also being planned cooperatively by the three United States television networks, BBC and the European Broadcasting Union. The British Post Office ground station at Goonhilly Downs, scheduled for completion August 1, may be ready before that date.

Reel of New Tape Is Size of 50-Cent Coin

FERRODYNAMICS CORP. is making limited quantities of magnetic recording tape ½-mil thick—¼ mil each for the polyester base and the coating. A 180-foot reel with 40-minute recording capacity is the size of a half dollar. Tape widths are 0.246 inch and 0.075 inch. The company says the tape makes possible recorders the size of a wristwatch.

AIEE Members Vote 7-1 for IRE Merger

AMERICAN Institute of Electrical Engineers announced at its convention in Denver last week that its members have voted by mail to merge with the Institute of Radio Engineers.

With 55,156 eligible to vote, AIEE said 29,464 favored and 4,381 voted against merger. Formal IRE membership approval is expected at a special meeting July 10. The new Institute of Electrical and Electronic Engineers will begin functioning January 1, 1963.

AIEE installed Richard T. Teare of Pittsburgh, Pa., as president. Teare is dean of the College of Engineering and Science at Carnegie Institute of Technology. He succeeds Warren H. Chase, vice president of Ohio Bell Telephone Company.

Amplification in Stars Suggests Plasma Masers

BOSTON—Possibility of developing plasma masers is suggested in a theory of stellar amplification advanced by astrophysicists. Emissions from some remote radio sources, such as Centaurus and Cygnus, is immensely more powerful than those from our own sun and galaxy. A possible answer is that some celestial sources amplify the radiation through the same mechanism by which a maser operates. This is theory advanced by astrophysicist R. Q. Twiss and MIT physics Professors Sanborn C. Brown and George Bekefi. Thus far, experimental efforts have failed to produce and detect maser-type amplification in plasmas.

Instruments Manufacturer To Make Components

SAN FRANCISCO—HP Associates, a Hewlett-Packard affiliate, plans to enter the components field shortly with a line of high-speed photoconductor and photodetector elements. According to Jack Melchor, research director, HPA's line will include both single units and multiple photoelements mounted on a single substrate. Either type will have an order of magnitude faster response than any currently available, says Melchor. HPA has a 1-Mc photodetector in the lab stage now, hopes to be able to produce it in the near future.

Belgian Group Formed For Space Coordination

NEW ORGANIZATION called Belgospace has been formed in Belgium by private industry to coordinate space activities. Composed of major electronic, aviation, metallurgical construction and research companies, the organization will act for industry in its relations with the Belgian government and with space organizations in other European countries.

Punched-Card Accounting Machine Is Half Computer

PUNCHED-CARD accounting machine described as bridging the gap between conventional punched-card machines and electronic data processors will be made by Univac division of Sperry Rand. The machine will read 300 to 400 eighty or ninety-column cards a minute and print 300 to 400 lines a minute. Called the Univac 1004, it includes a magnetic core memory and a program plugboard control which conserves memory capacity. The company says it can perform decision test, logical choices and editing in parallel with computation. Prices will range from $46,000 to $60,000.

Chaff-Dispensing Weather Rockets Pass Flight Tests

MARQUARDT CORP. announced last week the successful completion of a series of acceptance flight tests of production-type Roksonde weather sounding rockets at Cape Canaveral. The rockets are used for wind measurement at 200,000 feet altitude or higher. Now in production for the Department of Defense, the Roksondes are being used to gather meteorological data in support of various missile and space programs and in the high-altitude atomic tests in the Pacific. The production model dispenses radar chaff for tracking by ground radar stations. Another model includes temperature telemetering.

In Brief . . .

HUGHES AIRCRAFT has been named a prime contractor for Polaris fire control systems, receiving a $20-million contract from Navy and a $2.5-million subcontract from GE, also a prime contractor.

NAVY also awarded Sperry Gyroscope a $9-million Polaris contract, for engineering and production on navigation systems for 10 submarines being built to carry the 2,500-mile Polaris missile.

RAYTHEON reports it is developing jam-resistant, two-way, voice communications system using infrared beams. Intended for aircraft use, range will be 100 miles and beamwidth 0.1 degree.

AIRSPEED indicator to be developed by Bendix for Navy's F4H-1 fighter will be controlled by the computer of the ASW-21 datalink system to tell pilot how fast to fly.

PACIFIC MISSILE RANGE will get a new tracking and command-destruct control station at Point Pillar, near San Francisco, in September. Special equipment will include radar antenna vectoring system.

MARTIN will use new multielement infrared detector array for infrared background discrimination study for Navy. Company will also make infrared horizon sensors for Saturn space booster guidance.

VITRO has been awarded an additional $7.8 million for operation and maintenance of the Eglin Gulf Test Range, used for missile, space probe and countermeasures tests.

MILITARY equipment contracts include $3.8 million to Sun Electric for generators and ground support equipment; $2.1 million to Bendix for Pershing missile guidance and control components; $2.1 million to Admiral for manpack transceivers; $1.8 million to Emertron for antennas, and $1 million to Yardney Electric for seawater and aircraft batteries.

New From Sprague!


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"NON-UNIVERSAL" SWITCH!

- Specifically designed to meet your challenging ultra-high-speed needs for "next generation" computers!
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Compare the XT-300 with Present-day Selected "Bests"...

CHARACTERISTICS	2N779A	2N964	XT-300
BV_{CES} @ I_C = 100 μA	15 V min.	15 V min.	**25** V min.
BV_{CEO} @ I_C = 1mA	**12** V min.	6 V min.	**12** V min.
I_{CBO} @ V_{CB} = 6V	**3** μA max.	**3** μA max.	**3** μA max.
h_{FE} @ I_C = 50 mA, V_{CE} = 1V	**40** min.	**40** min.	**40** min.
V_{CE} (SAT) @ I_C = 50 mA, I_B = 5 mA	**.18** V min.	.35 V min.	**.18** V min.
V_{BE} @ I_C = 50 mA, I_B = 5 mA	**.6** V max.	.75 V max.	**.6** V max.
f_T @ I_C = 20 mA, V_{CE} = 1V	200 mc min.	**300** mc min.	**300** mc min.
t (on) @ I_C = 10 mA, R_L = 300 ohms; I_{B_1} = 1 mA, V_{BE} (off) = 1.25 V	60 nsec max.	**50** nsec max.	**50** nsec max.
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For complete information, write Product Marketing Section, Transistor Division, Sprague Electric Company, Concord, New Hampshire.

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CIRCLE 9 ON READER SERVICE CARD

CIRCLE 10 ON READER SERVICE CARD→

WASHINGTON OUTLOOK

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CHARACTERISTICS	2N779A	2N964	XT-300
BV_{CES} @ I_C = 100 μA	15 V min.	15 V min.	**25** V min.
BV_{CEO} @ I_C = 1mA	**12** V min.	6 V min.	**12** V min.
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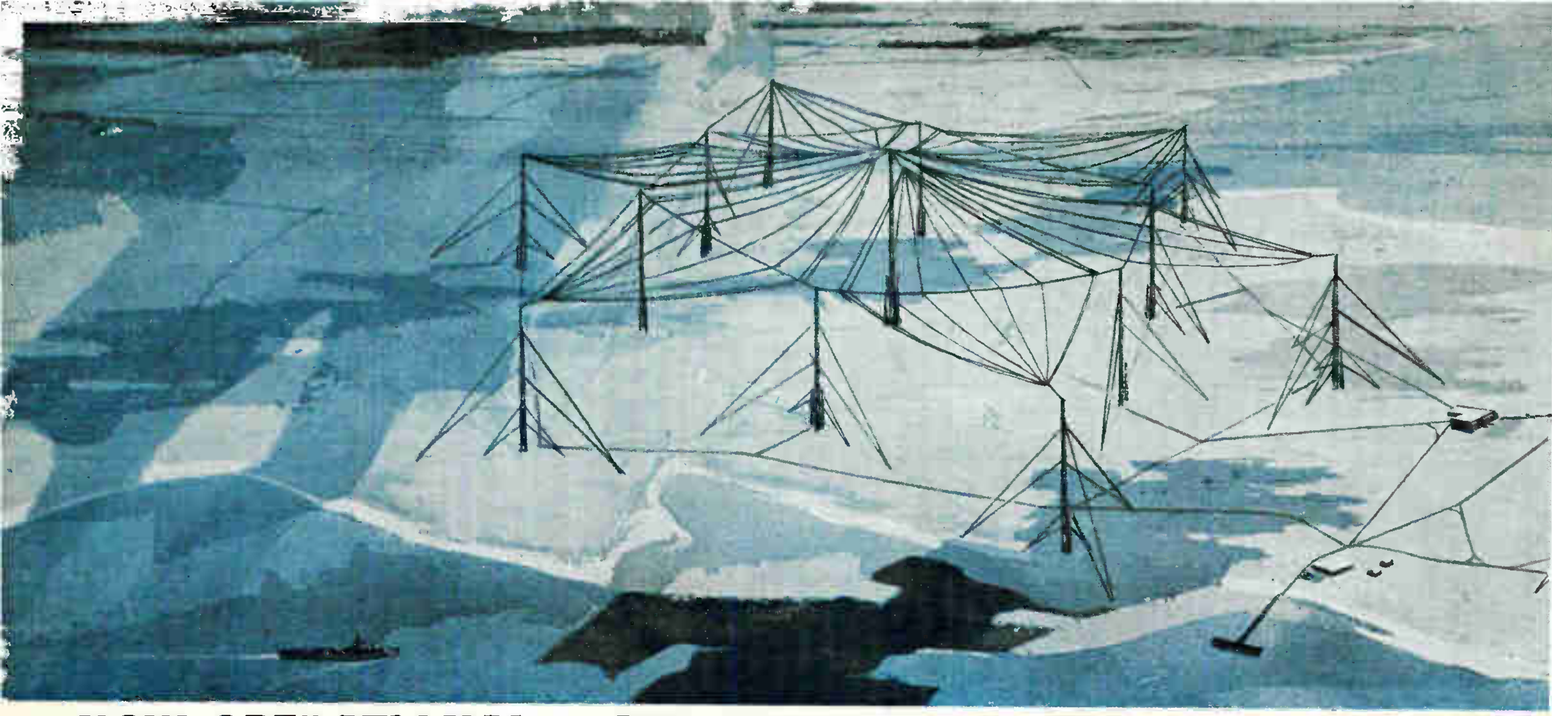

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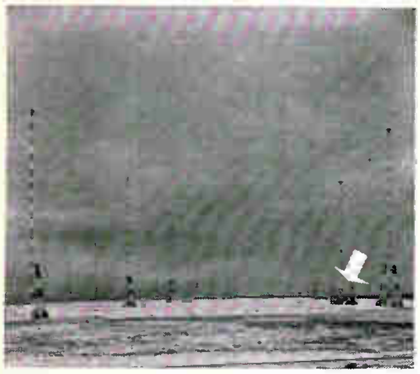
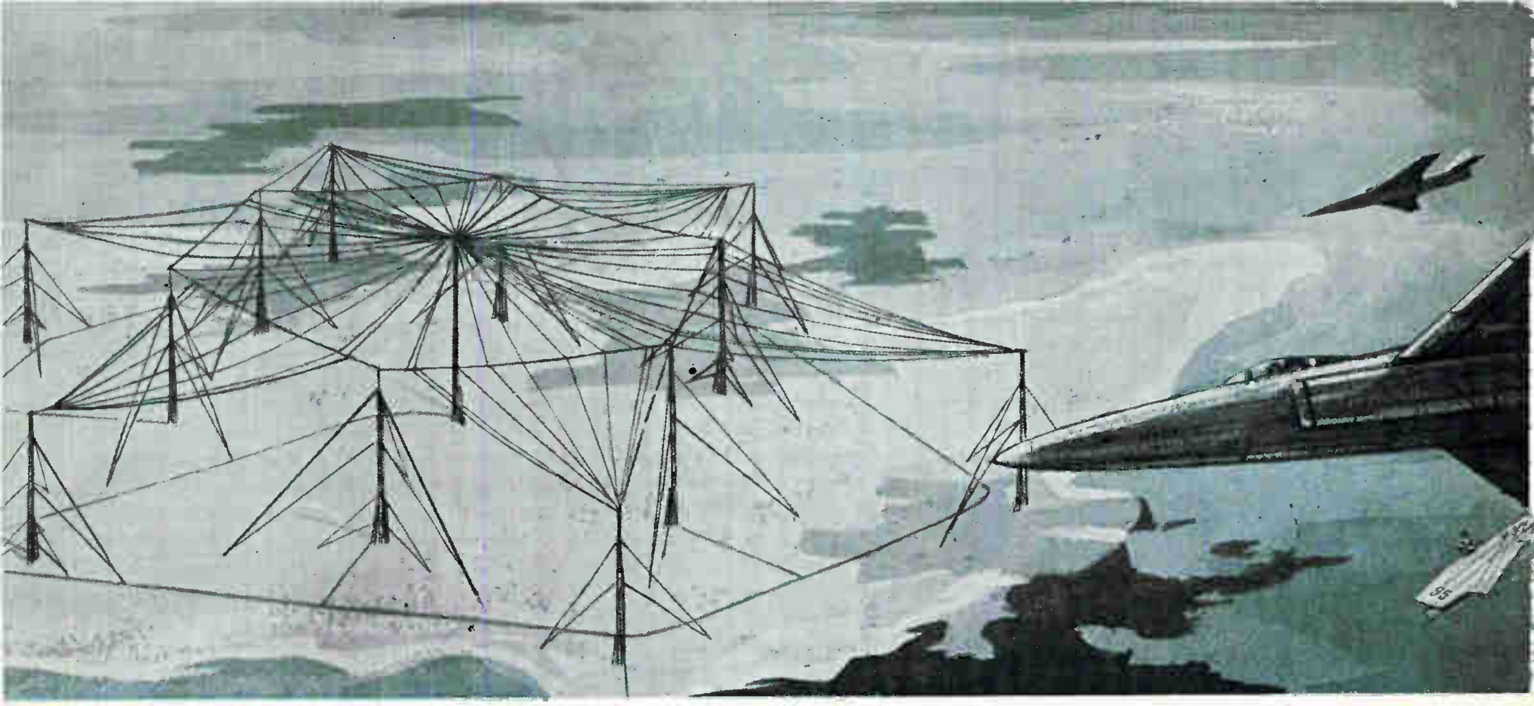


2800 acres . . . an area greater than two dozen Pentagon Buildings . . . two identical antenna arrays . . . center towers nearly as high as the Empire State Building support the gigantic spider web of steel towering a thousand feet up and embracing two square miles . . . nearly an entire peninsula at Cutler, Maine. (Arrow indicates comparative size of Helix House to tower.)

(Arrow points to truck. Compare Helix House size in first photo.) 8-story Helix House contains antenna coupling and automatic de-icing equipment to rid the immense antenna system of ice. Buried beneath the ground: another 11 million feet of copper wire in the radiating system terminating in the sea water itself.

42 counter-weight towers—36 of them like this—carrying tremendous counter balances of 202 tons each to maintain and correct antenna tension and strain from winds up to 150 knots or ice forming on the 64 miles of bronze antenna.

Enormous variometer coil for inductance to tune the antenna system through a range of 14 to 30 KC . . . very low frequency. These VLF radio waves penetrate the depths of the sea to submerged submarines.



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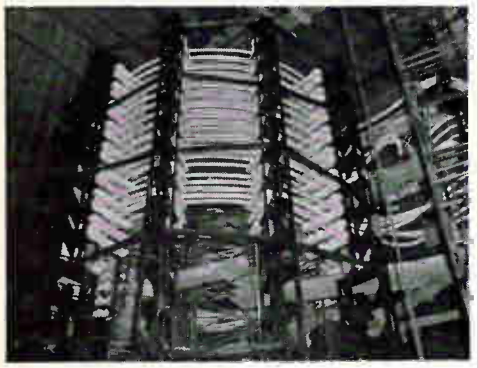

Huge Helix coil 20 feet in diameter and 40 feet tall is wound with 3½ inch Litz Wire . . . just one of the scores of huge components that combine to give this new communication station maximum power . . . range . . . reliability . . . and the special penetration possibilities VLF possesses that no normal high frequency radio provides.

Control console and portion of the unique CEMC Type-125 2,000,000 watt VLF Transmitter that propagates along the curvature of the earth instead of bouncing off the IONOSPHERE: thus eliminating dead communication areas or skip distances to give this Naval voice of command greater range and improved reliability.

In one instant 2,000,000 watts will blast the U. S. Navy's voice of command around the world. At the control console, during operation, push-button simplicity provides a new and highly reliable major element of command to the U. S. Navy . . . another element of that might by which the nation promotes the keeping of the peace.

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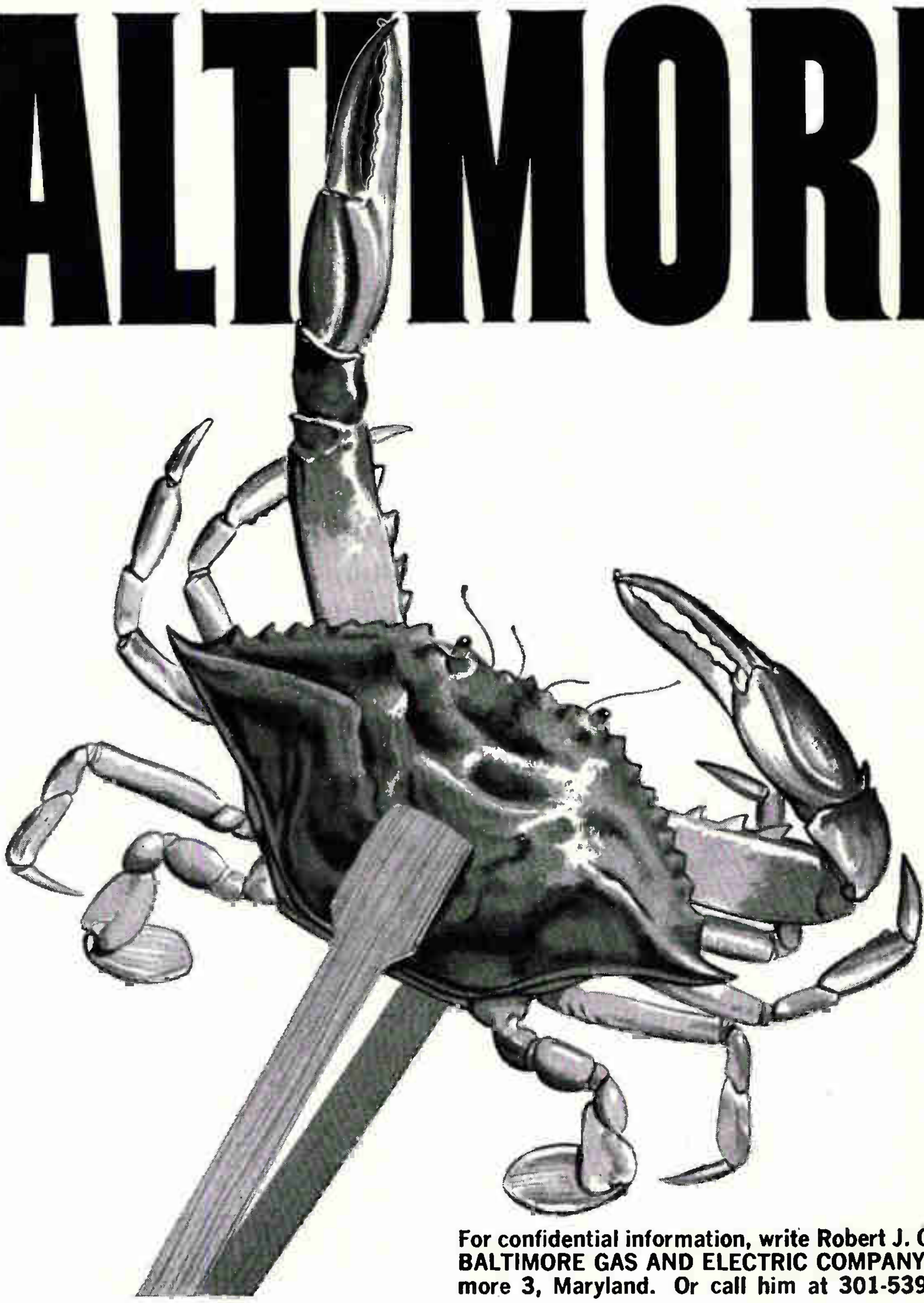
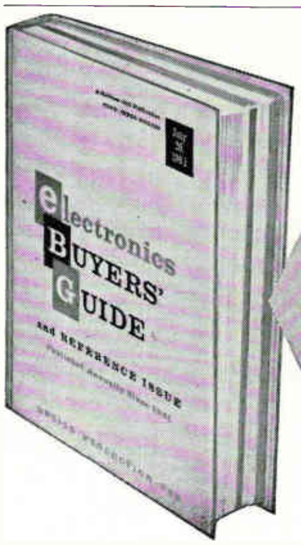


For confidential information, write Robert J. George, BALTIMORE GAS AND ELECTRIC COMPANY, Baltimore 3, Maryland. Or call him at 301-539-8000.



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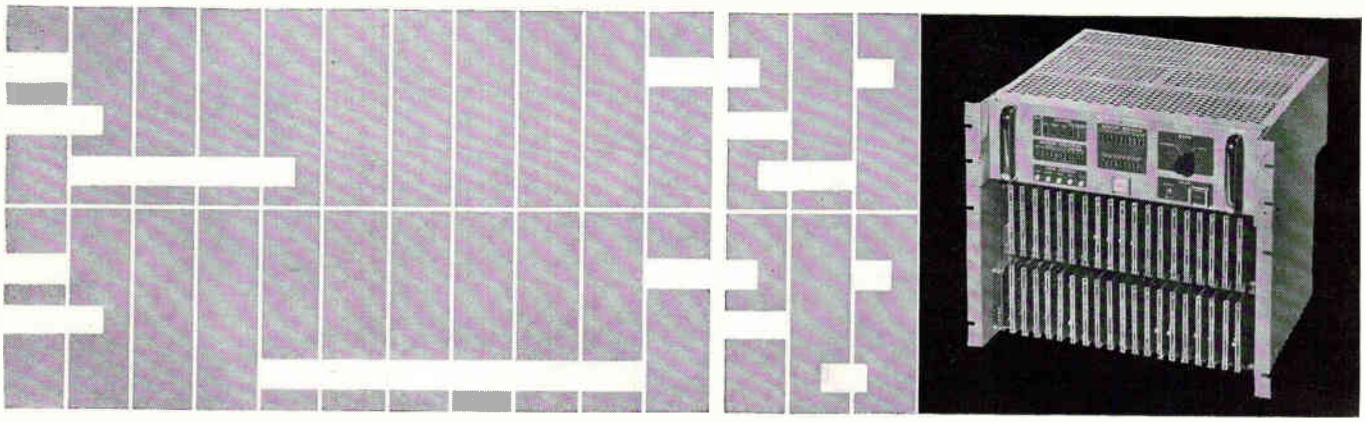
SERIES	M		L	K	J	I	H	G	F	E	D
CYCLE TIME	10μ sec (Full Cycle)	10μ sec. (Half Cycle)	5μ sec. (Half Cycle)	6μ sec. (Full Cycle)	3.3μ sec. (Half Cycle)	5μ sec. (Full Cycle)	2.5μ sec. (Half Cycle)	3.3μ sec. (Full Cycle)	2μ sec. (Half Cycle)	2μ sec. (Full Cycle)	1.1μ sec. (Half Cycle)
DATA ACCESS TIME	3.5μ sec.	4μ sec.	3.5μ sec.	2.5μ sec.	2.5μ sec.	2μ sec.	2μ sec.	1.5μ sec.	1.5μ sec.	1.0μ sec.	0.70μ sec.
CAPACITY ... (Any bit length desired)	AS REQUIRED			AS REQUIRED		AS REQUIRED		AS REQUIRED		AS REQUIRED	
ACCESS MODES	Random Access Sequential Non-Interlaced Sequential Interlaced Random/Sequential Non-Interlaced Random/Sequential Interlaced			Random Access Sequential Non-Interlaced Sequential Interlaced Random/Sequential Non-Interlaced Random/Sequential Interlaced		Random Access Sequential Non-Interlaced Sequential Interlaced Random/Sequential Non-Interlaced Random/Sequential Interlaced		Random Access Sequential Non-Interlaced Sequential Interlaced Random/Sequential Non-Interlaced Random/Sequential Interlaced		Random Access Sequential Non-Interlaced Sequential Interlaced Random/Sequential Non-Interlaced Random/Sequential Interlaced	
OPERATIONS	Load Unload Clear/Write Read/Restore	Load Unload	Load Unload	Load Unload Clear/Write Read/Restore	Load Unload	Load Unload Clear/Write Read/Restore	Load Unload	Load Unload Clear/Write Read/Restore	Load Unload	Load Unload Clear/Write Read/Restore	Load Unload



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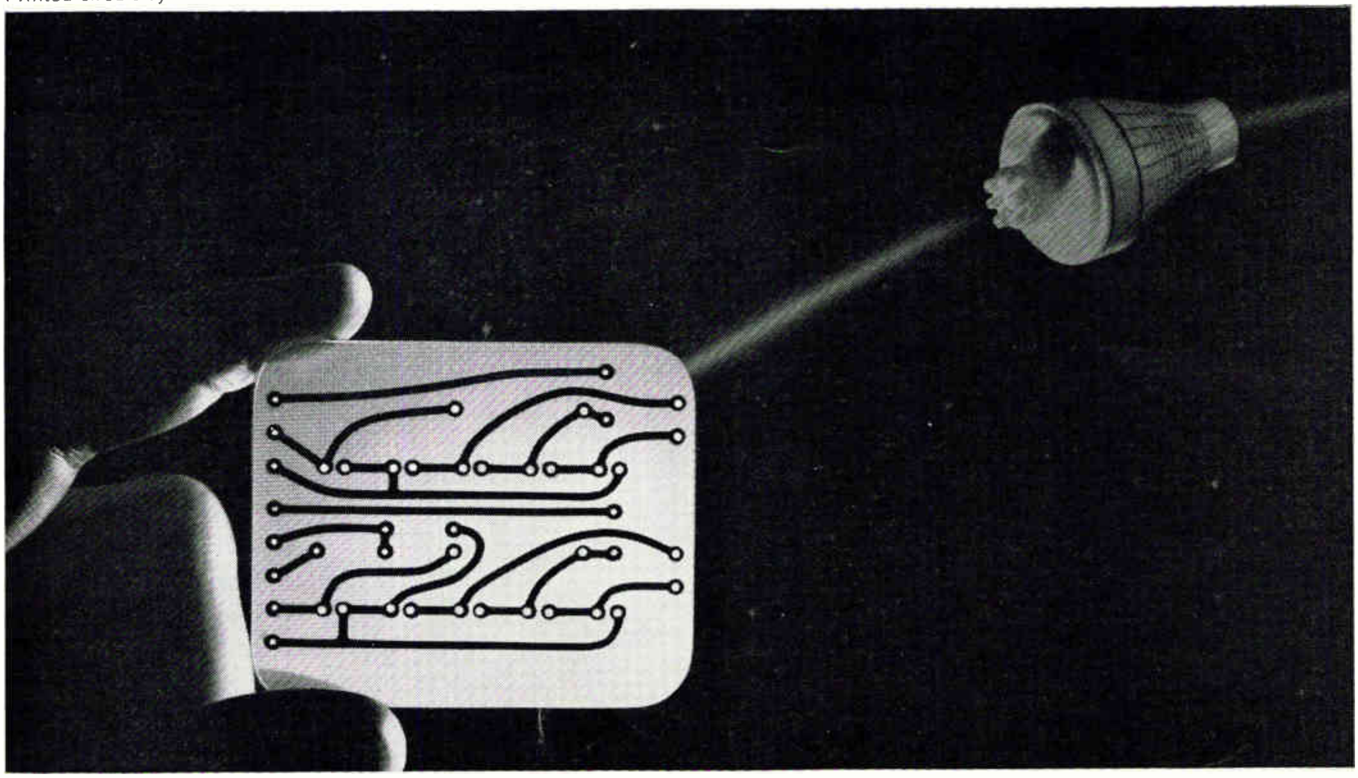


CIRCLE 18 ON READER SERVICE CARD→

Hardware?

Maybe connectors were "hardware" twenty years ago.

That's when the P-38 was the hottest fighter plane we had. Pilots were proud when they could hit 300 MPH and go up to 50 or 60 thousand feet. With this kind of performance requirement, most connectors worked without a hitch. You just connected them and forgot about them, like nuts and bolts.

HOW TIMES HAVE CHANGED

Now we're up around Mach 5 and altitude has been pushed into outer space. Nose cones light up like giant soldering irons and components have to operate in a near vacuum.

Fortunately, Amphenol engineers saw that the old "hardware" concept was headed out the window. Programs coming up were going to need connectors that could put up with terrific environmental conditions of heat and altitude cycling. For example, at high temperatures most of the elastomers used as insert materials or connector seals either melt into a puddle, turn into a cinder, or set-up and lose compression.

What's more, connectors now have to keep on functioning *all* the time, with no allowance for failure. So— Amphenol designers went to work developing a connector to meet the new space-age standards.

DISSECTING MOLECULES

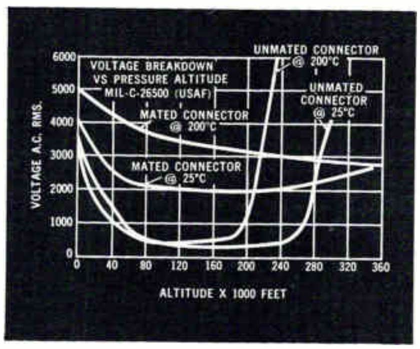
The Amphenol Materials Lab, with the help of a shiny new infra-red photospectrometer, began dissecting elastomer molecules. They were able to pinpoint the weak spots in molecular structure where breakdowns begin. Then they were able to plan and build new molecules, with built-in "armor" to protect against failure. Result: an exclusive silicone rubber compound that maintains its integrity and elasticity under severe temperature extremes and also withstands exposure to violent new propellants like hydrazine and nitrogen tetroxide.

At the same time, Amphenol design engineers were hard at work perfecting metal-to-metal shouldering of mating shells that allowed precision control over compression of the sealing ring. In addition, the metal-to-metal design damped vibrational stress nine times more effectively than resilient damping. Finally, they incorporated a semi-rigid anti-deflection disc to control insert expansion under thermal stress.

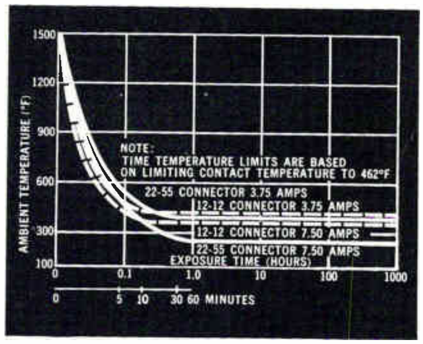
Having all the pieces, we put them together, called it the Amphenol 48 Series, and started testing. In the vacuum chamber, 48 Series connectors operate very nicely at a simulated altitude of 500,000 feet. They are quite comfortable in the hot box at 200°C ambient, *carrying full rated current.* They don't even mind going up to 600°C, if they don't have to stay too long. In short, Amphenol 48's can take almost anything you throw at them.

PROJECTS WANTED

Amphenol designers have established criteria for determining connector time-temperature-current capability. This information will be especially valuable to engineers presently engaged in "exotic" projects, perhaps the kind of project where previous connectors have failed to measure up to the new space-age standards. If this is the case, contact an Amphenol sales engineer. He's a "space-age hardware" expert. Or, write directly to Bob Dorrell, Vice President, Engineering, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



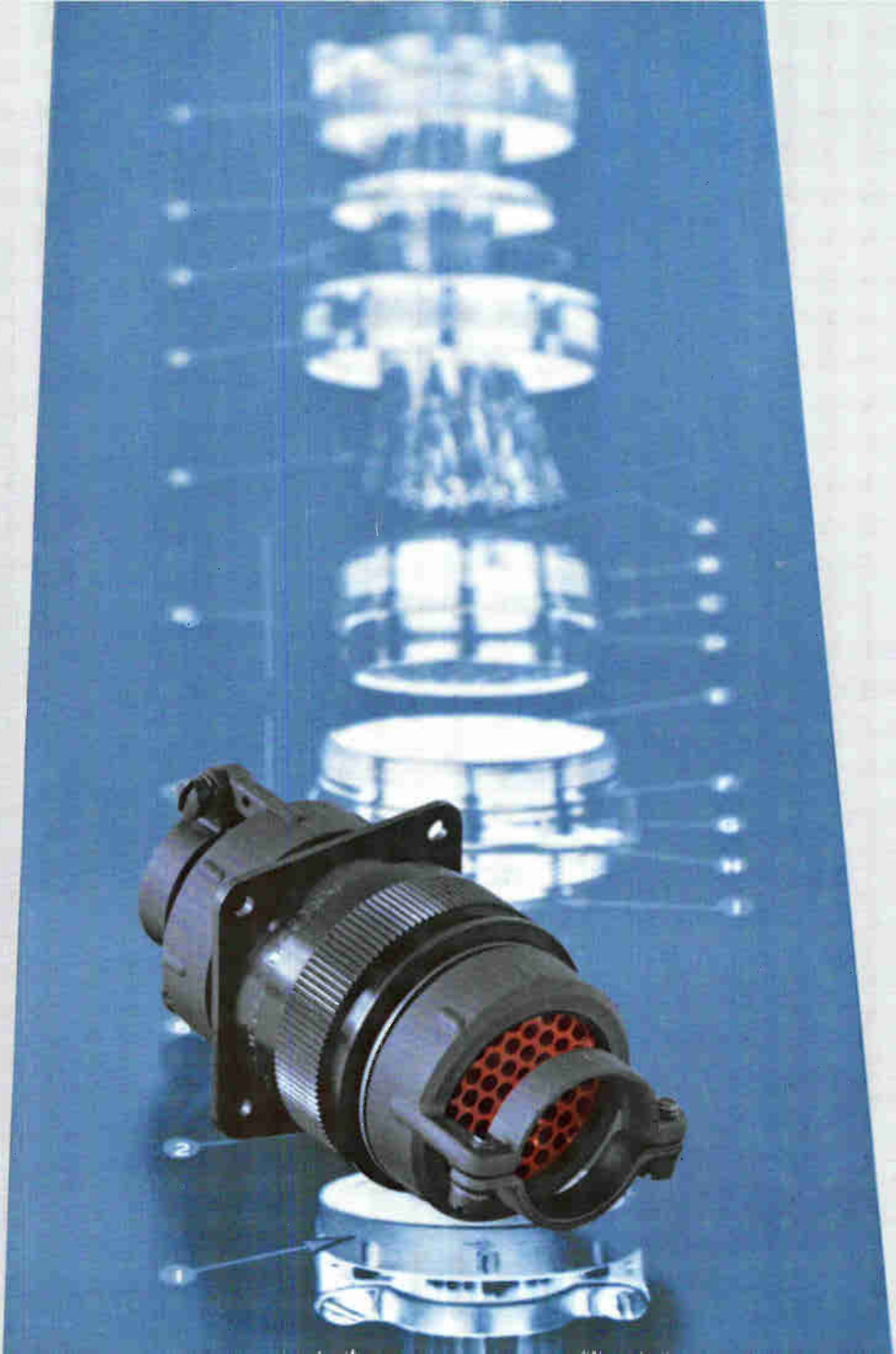
High altitude air has low dielectric strength. By maintaining an air-tight seal 48 Series Connectors enjoy extremely high voltage safety factors.



While Amphenol 48 Series Connectors are nominally rated at 200° C, they can also withstand considerably higher short-time temperature exposures.

Amphenol 48 Series Meets Mil C 26500 (USAF).

AMPHENOL **Connector Division** / Amphenol-Borg Electronics Corporation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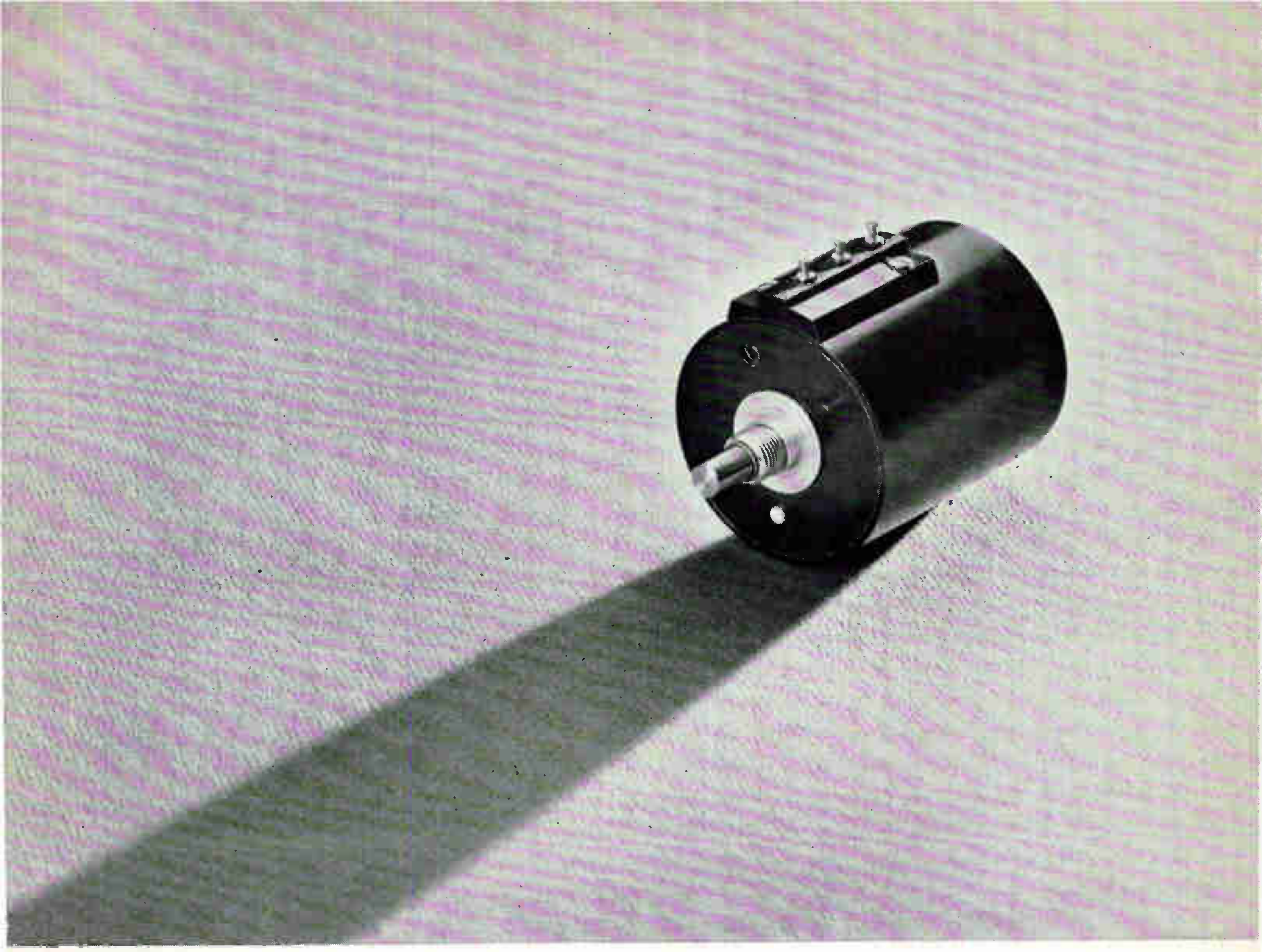

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If you are a discriminating buyer of commercial potentiometers, you should know something about the new Borg 2200 Series Micropot®—a precision, ten-turn, wirewound potentiometer in the $10 price bracket (considerably less in quantities).

You will find few, if any, $10 potentiometers to match its performance.

What are its credentials? *Long life*—two million revolutions. *High accuracy*—linearity tolerance of ±0.25%. *Wide temperature range*—from −55°C to +105°C.

You can gang the Borg 2200 up to three units, being assured of low torque. You choose from thirteen standard resistances (25 ohms to 200,000 ohms), with or without rear-shaft extensions.

This is no ordinary $10 potentiometer. Note its capstan terminals which feature welded terminations. Inside, a unique contact carrier design minimizes backlash and prolongs rotational life. These two features—among others—are usually found only in higher-priced potentiometers.

Want to know more about the new 2200 Series Micropot? Contact your nearby Borg technical representative or Amphenol-Borg Distributor. (He also has data and discount schedules on the complete Borg Micropot and Microdial® lines.) Or write directly to R. K. Johnson, Sales Manager:

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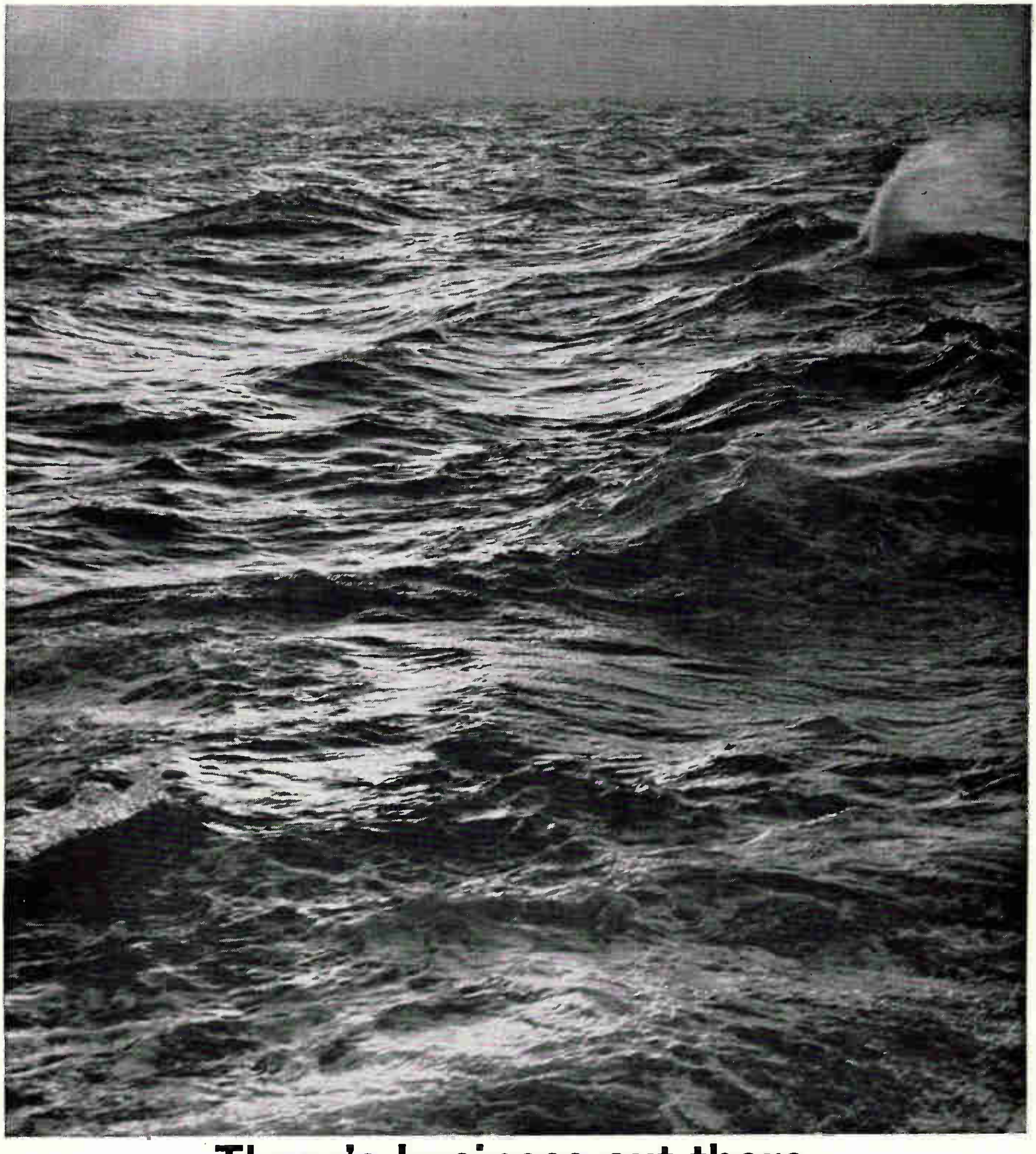

CIRCLE 23 ON READER SERVICE CARD→

New "Switching" Power Supply Gives More Current at Less Cost

Just out. Con Avionics announces a new line of transistorized "switching" power supplies that provide more current, more reliable current, at a lower cost to you.

The secret? This unit continuously turns itself on and off. The result is exceptionally high current for its size and price. High efficiency is built in through low pass dissipation, high reliability, minimum components and small size. Most of the semi-conductors operate in the switch mode, adding to the long life of the supply.

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Prices subject to change without notice.

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☐ Send literature on new "switching" power supplies
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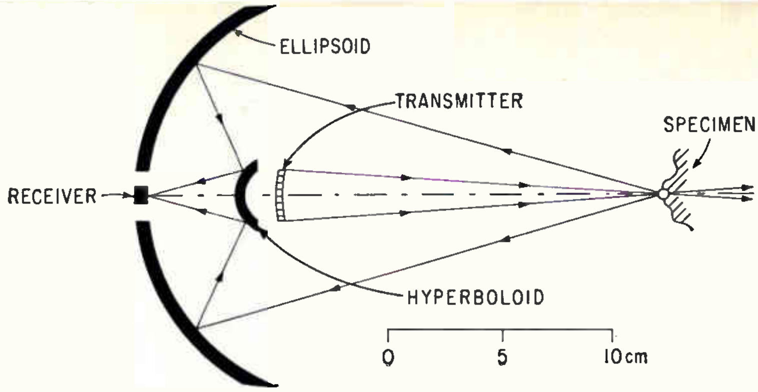


ULTRASONIC MIRROR *improves recording resolution by separating transmitting and receiving transducers. Actual mirror is shown on facing page*

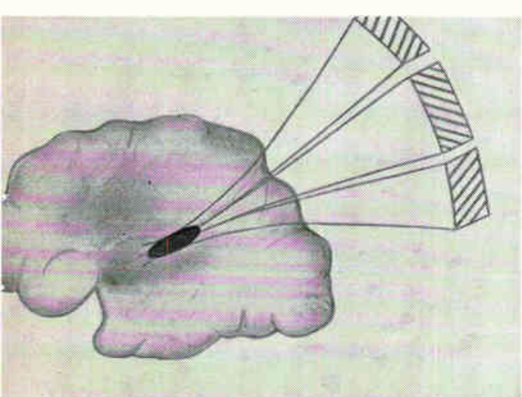
Medical Researchers Explore Advances in Ultrasonic Diagnosis and Cancer Treatment

Radial transducer array may permit bloodless brain operations

By CLETUS M. WILEY
Midwest Editor

MONTICELLO, ILL.—Among the new directions outlined this month at a symposium on ultrasound in biology and medicine were techniques to improve surgery, ultrasonography (ELECTRONICS, p 49, Feb. 3, 1961) and cancer treatment.

The symposium was jointly sponsored by the University of Illinois biophysical research laboratory and the Office of Naval Research. It was attended by some 50 physicians and engineers, including delegates from Australia, Great Britain, West Germany, Italy, Sweden and Japan.



RADIALLY FOCUSED BEAMS *from array of transducers concentrate power in the region of the brain to be treated*

BRAIN OPERATIONS — William Fry, of the University of Illinois, discussed using high-powered arrays of transducers for brain lesions. At present, only a few transducers are used. Their beams are radially focused on the lesion area (see sketch) with high precision.

Although still more experimental than clinical, the use of ultrasound in such operations does not tear blood vessels as a needle may, avoiding hemorrhage. Operations can be completed in a few minutes and results may be evaluated in a couple of hours, instead of the 14 hours now required by other methods.

The biggest disadvantage at present is the necessity of removing a small section of skull to admit the ultrasonic beams. Fry proposed a radial array of many transducers about the skull, to concentrate sufficient power in the lesion area without opening the skull. Each unit would operate at only the temperature of a mild fever.

Precise control of ultrasonic lesions—to tenths of a millimeter, with tolerances limited to 10 percent of the desired size—has forced the university's biophysics lab into the standards business, reported Gene Leichner.

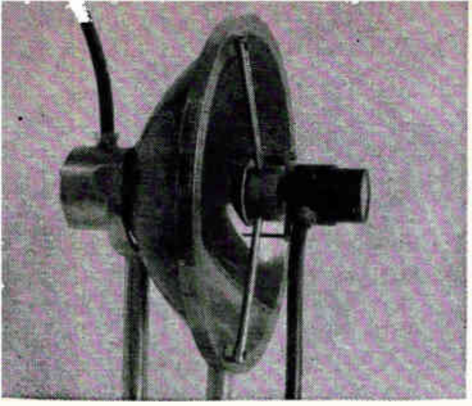
The lab developed a steel-ball deflection standard to calibrate probes that monitor lesion temperatures. Feedback from a closely regulated d-c source controls voltage to the transducer. During the discussion, electrical brain waves were suggested as a feedback signal source.

BRAIN MAPPING—Fry also proposed using the radially focused arrays of transducers for brain mapping. His computations indicate that such arrays could site lesion positions so accurately that neither land-marking nor stereotactic positioning would be required. Contrast would be enhanced by deflection differences of 1½ to 2 times between white and gray matter.

The university laboratory is completing a 2-Kw to 2.5-Kw power supply to drive the 0.5-Mc to 10-Mc transducers it uses, but does not now have the funds for the instrumentation that mapping would require. Data storage and presentation systems could be used in the system for on-line analysis of electrode pickups.

ULTRASONIC MIRROR — An ultrasonic mirror for diagnostic apparatus, discussed by Carl Hertz, of the University of Lund, Sweden, separates the transmitting and receiving transducers, as illustrated. By recording echoes free of reflections in the direction of the outgoing beam, the mirror increases transverse resolution. Two-dimensional cross sections of biological tissues are obtained by reflectoscope techniques.

One University of Lund reflecto-



scope system synchronously records electrocardiogram, phonocardiogram and movements of several other structures on continuously running photofilm. A second method traces a two-dimensional picture of selected heart structure movements with an ink-spray Mingograph, requiring no further processing.

CANCER DETECTION — Ultrasound is effective in soft tissues where x-rays would be useless, according to Douglas Howry, of the University of Colorado, Denver. Echoes bounced off the heart with reverberations recorded on tape and crt's provide the first safe and simple method of visualizing interior structures, he said.

Ultrasound is especially valuable in determining whether cancer has spread to the liver from original tumor sites in the breast or stomach, Howry said.

A prototype tomograph probe movable over 360 degrees for compound scanning of eyes, neck or other areas of the body in 5 to 15 seconds was introduced by Douglas Gordon, of Richmond, England. Discussion developed the possibility of phase-discrimination, delay-line scanners, or a transducer mosaic.

Greater acoustic impedance of cancerous tissues makes it easier to detect small levels of reflected energy from bordering areas, reported Toshio Wagai, of Tokyo. A modified industrial ultrasonic flaw detector picked up a 1-Mc to 10-Mc change in 0.1-mm tissue increments for an A-scope display. A B-scope displayed plane sections of the human body as tomography, detecting echoes from breast and liver tumors.

The Japanese confirmed by operation and autopsy 61 cases of brain tumor, detected through the skull by the A-scope. Tumors in some regions of the brain, they found, can be more effectively diagnosed by transmitting, at a frequency of 2.25 Mc, ultrasonic waves through the oral cavities.

The Japanese team used 5-Mc to 10-Mc ultrasound for breast tumor diagnosis. It was pointed out that ultrasonic examination is very useful for detecting a nonmalignant growth's change to malignancy. The patient can be examined frequently without pain or danger, allowing detection of cancer at an early stage.

The Japanese also reported encouraging success in detecting gallstones not visible to x-rays, at 2 Mc to 5 Mc.

CANCER TREATMENT — Destruction of malignant tumors by combining ultrasonic waves with x-rays was reported by Karlheinz Woeber, of Bonn, West Germany. Citing experiments with skin cancers of 50 patients over the past five to seven years, he reported that ultrasound seems to sensitize tumors so they are more easily destroyed by x-rays. Combination treatment may enable physicians to spare normal tissue by reducing x-ray dosages by one-third.

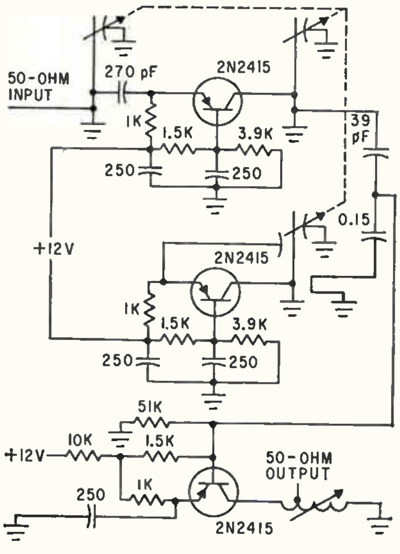
Transistors Provide Gain In Tv Tuner

CHICAGO—Texas Instruments presented a prototype uhf-television tuner last week at the IRE Conference on Broadcast and Television receivers.

The tuner, using three transistors, exhibits a noise figure of 7 db to 9 db over the 470-Mc to 890-Mc uhf-tv band, provides a conversion gain of 3 db to 9 db depending on frequency and draws 18 ma at 12 v. TI says that conventional vacuum tube tuners usually show a conversion loss and more noise, and require higher power.

The design takes a transmission-line approach. The first stage is an r-f amplifier with tuned input and output. The second stage uses the tuning capacitors of the transmission line ganged to the tuning capacitor of the oscillator transmission line to provide a 45-Mc i-f output. The third stage is a mixer.

TI will not manufacture the tuner but will make design information available.



UHF TUNER *circuit has three transistors*

High-Speed Computer Has Slower-Speed Elements

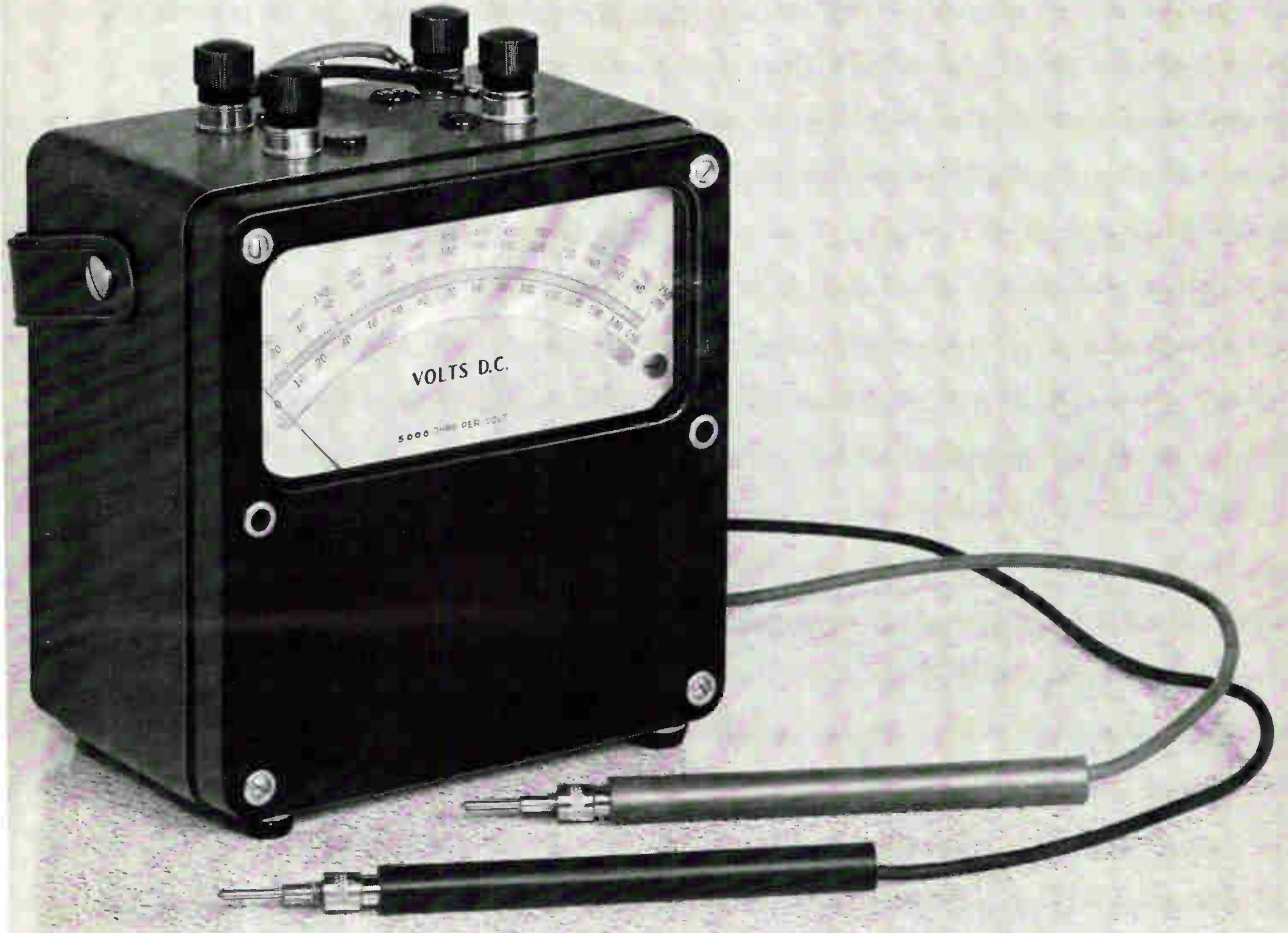
WESTINGHOUSE is developing a new, high-speed digital computer for Rome Air Development Center and the Army Signal R&D Laboratory. Called Solomon (Simultaneous Operation Linked Ordinal Modular Network), it is a digital, stored-program system using a network of identical functional elements interconnected by a common, central control.

Each of 1,024 processing elements can calculate, store, transmit and receive data from its four nearest neighbors. In a decision-making mode, a comparison is made between the processing element mode and the instruction mode. The processing element carries out an instruction only if the modes agree.

Solomon uses many low-cost, moderate-speed elements working together instead of a single high-speed unit. Westinghouse says its speed, for a wide variety of scientific problems, will be 15 to 250 times faster than existing conventional machines.

CIRCLE 27 ON READER SERVICE CARD→

RELIABILITY BY DESIGN



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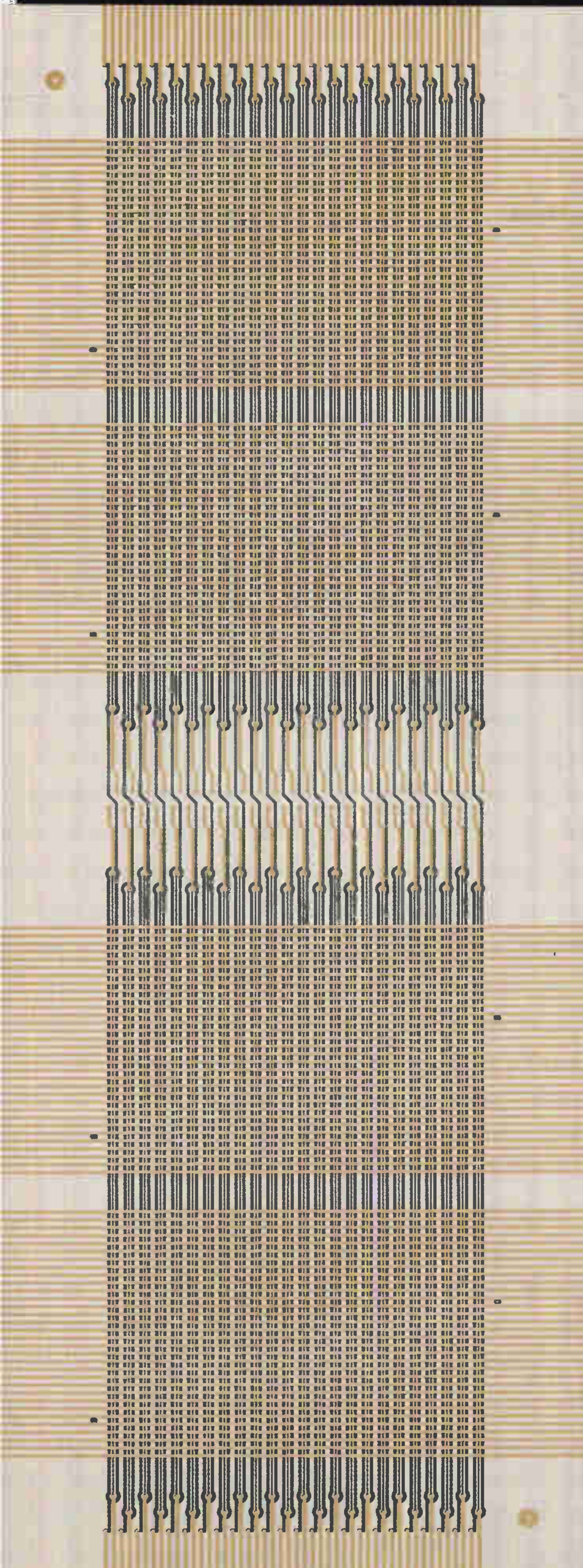
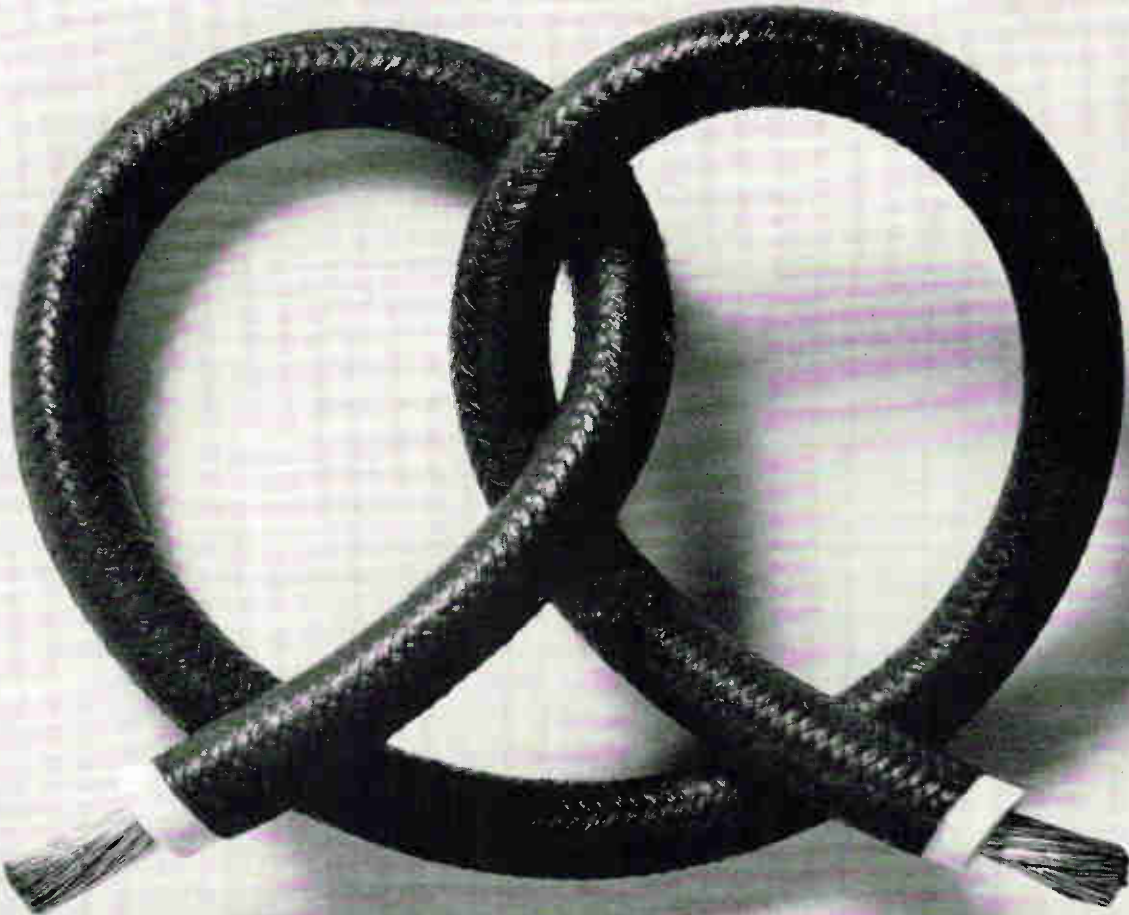
Precision Fork Oscillators					
TYPES	5	25	2001-2	50N	30
FREQUENCY	200 to 1,000 cps	200 to 1,400 cps	200 to 4,000 cps	50 to 360 cps	240 to 20,000 cps
ACCURACY	±.002% to ±.5%	±.002% to ±.5%	±.001%	±.05% to ±.01%	±.002% to ±.5%
TEMPERATURE RANGES	−65° to +125°C	−65° to +125°C	+20° to +30°C	−55° to +85°C +15° to +35°C	−65° to +125°C
OUTPUT	Dependent on external circuitry used	Dependent on external circuitry used	Approx 5 at 250,000 ohms	Dependent on external circuitry used	Dependent on external circuitry used
INPUT	28 volts or less	28 volts or less	Heater Volt. 6.3, 12, 28	28 volts or less	28 volts or less
B VOLTAGE			100 to 300V at 5 to 10 ma		
SIZE	5/16x3/4x3"	23/32x3"	3-3/4x4-1/2x6"	1x4-1/4"	1-19/22x 1-19/22x1-1/3"
WEIGHT	1-1/2 oz.	2 oz.	26 oz.	4 oz.	3-1/3 oz.

Precision Frequency Standards						
TYPE	10	27	15	32	52	15P Portable
FREQUENCY	360 or 400 cps	360 to 1,300 cps	360 cps 400 cps	240 to 2,000 cps	30 to 360 cps	360 or 400 cps
ACCURACY	±.005%	±.002% to ±.5%	±10 ppm ±250 ppm	±.002% to ±.5%	±.05°C ±.01%	±50 ppm
TEMPERATURE RANGE	+10° to +35°C	−65° to +125°C	−40° to +71°C −40° to +71°C	−65° to +125°C	−55° to +35°C +15° to +35°C	0° to 40°C
INPUT	1.4v at 6 microamps	28 volts or less	1.4v at 6 microamps	28 volts or less	28 volts or less	Self-contained Battery
OUTPUT	0.1 volt	8 volts RMS	1 volt	5 volts	5 volts	1 volt
LOAD	50,000 ohms or more	70,000 ohms or more	50,000 ohms or more	50,000 ohms or more	70,000 ohms or more	50,000 ohms or more
SIZE	1-3/8x1-3/8x3/8"	23/32x3"	1x2x2-1/4"	1-19/32x 1-19/32x1-1/5"	1x4-1/8"	1x2x3-1/2"
WEIGHT	3/4 oz.	2 oz.	4 oz.	3-1/2 oz.	4 oz.	4 oz.





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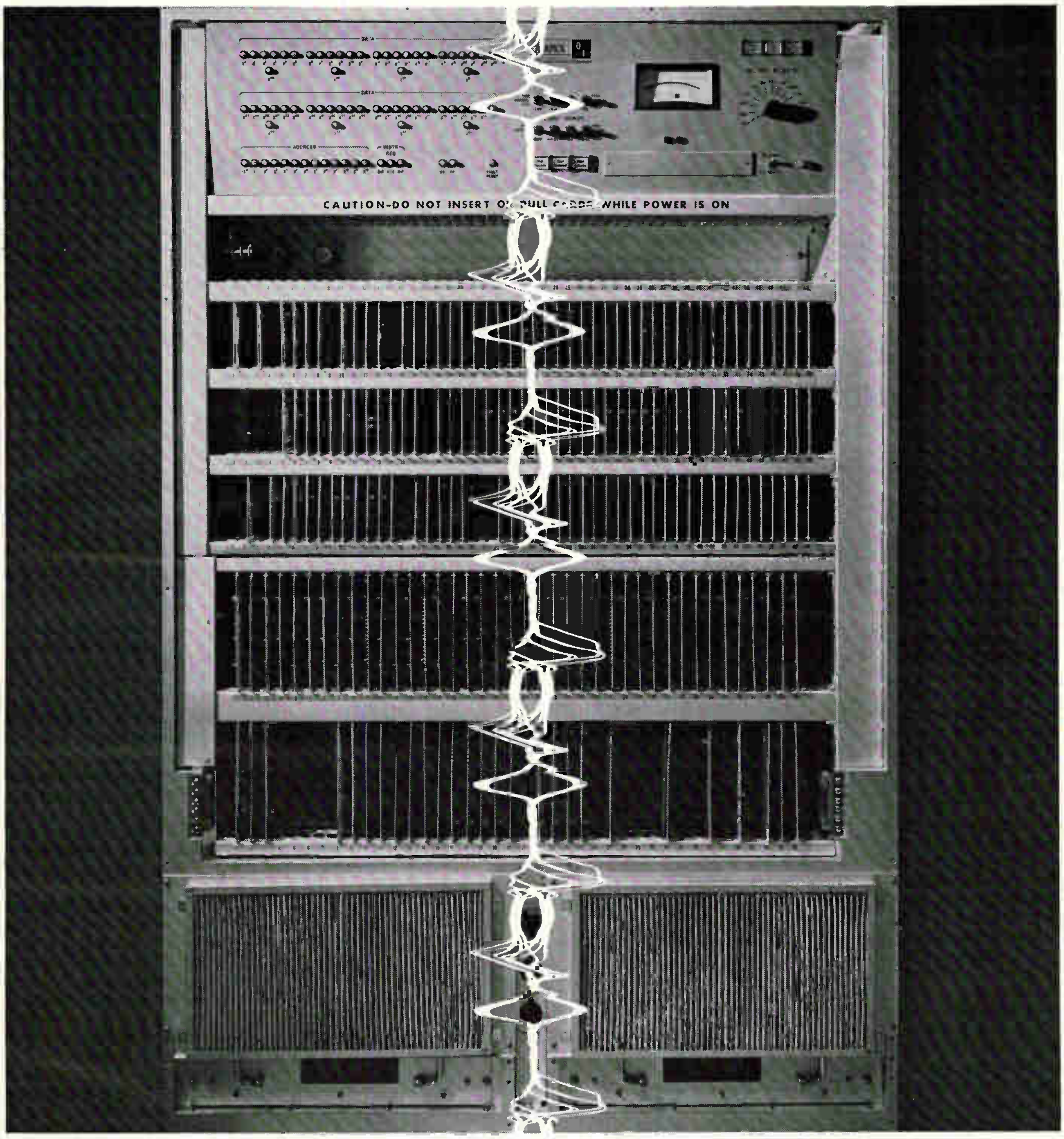
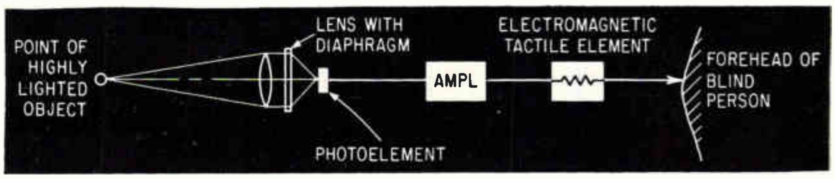


Who knows enough about memories to make this and 39 other models? AMPEX.

Only Ampex brings you such a wide range of core memories—with cycle times from 24 to 1.5 microseconds and capacities from 128 to 32,000 words. These memories have the flexibility needed for random access applications or high speed sequential or buffer operation. Examples? The RB with a capacity of 1024 words and a memory cycle in 8 microseconds. The RVQ with a capacity of 4096 words and memory cycle in 6 microseconds. The RQL, RQA and LQ each with a 32,768 word capacity and memory cycles in 6, 5 and 1.5 microseconds respectively. These are only five of the 40 models of memories from Ampex. And still more are yet to come. For data write the only company providing tape and recorders for every application: Ampex Corp., 934 Charter St., Redwood City, Calif. Sales, service engineers throughout the world.

INFRARED RANGING *system built by Communications Industries*



ONE CHANNEL *of the 80-channel Elektroftalm developed in Poland. The 80 output pins, vibrating against the wearer's forehead, provide him with a tactile picture of the light pattern falling on a camera mosaic*

New Guidance Systems for the Blind Use Photoelectric and Ultrasonic Techniques

One forms tactile image on wearer's skin, another simulates bat's sonar

By NILO LINDGREN
Assistant Editor

NEW YORK—Around-the-world interest in developing guidance devices to enable blind persons to walk about more freely was evident last week at the International Congress on Technology and Blindness.

Among the promising developments are an American infrared ranging system, an English ultrasonic system, a Swedish ambient-light obstacle detector and a Polish 80-channel system that produces a tactile "picture" for its user.

INFRARED—The infrared ranging system, described by T. A. Benham and J. M. Benjamin, Jr., is based on optical triangulation. A hand-carried, lightweight package, it can detect obstacles at three ranges, up to 4 feet, up to 10 feet, and up to 30 feet. It was developed by the Biophysical Electronics division of Communications Industries, Bala Cynwyd, Pa., in cooperation with Haverford College. (An earlier model was reported last year in a survey of such devices, ELECTRONICS, June 23, 1961, p 49).

In the new model (see photo) the upper lens contains a xenon arc lamp firing sharp pulses that can be focused on obstacles. The receiver lens gathers the light radiated back from obstacles and focuses it on a silicon photodetector. The amplified incoming signals activate a button that vibrates on the traveler's forefinger. The new model's long-time duty cycle of 25,000/1 (spike on for a microsecond, off for 1/40 second) avoids the problem of short transients. The device uses Fresnel lenses made of unbreakable plastic.

Full evaluation of the obstacle detector will begin sometime after July 1. A disadvantage of this device is that it detects obstacles but cannot detect step-downs or step-ups. Communications Industries has been designing a curb detector based on optical triangulation, but the first model was unwieldy. Work is continuing on other designs. A simpler step-down detector incorporated in a cane has been developed by Franklin Institute but it does not detect step-ups or obstacles.

ULTRASONIC — An ultrasonic portable guidance device based on the location methods used by bats was described by Leslie Kay, of the University of Birmingham, England. Still experimental, it transmits a 10-degree-wide ultrasonic beam. Reflected signals are converted to audible signals whose character indicates the presence, in a range of 10 to 30 feet, of posts, steps, curbs, holes, bushes and other objects.

The device is a wide-band, c-w, f-m system rather than a pulse system. It has been found that the ear can better discriminate between signals of differing frequency than signals arriving a differing time intervals. A frequency band from 30 Kc to 60 Kc is used. Somewhat similar work on an ultrasonic device was described by Dr. J. D. Pye, of the Institute of Laryngology and Otology, London.

LIGHT SCANNER—An ambient-light obstacle detector with tactile outputs was reported by Dr. B. Jacobson, of the Karolinska Institutet, in Sweden. It is a further development of the Kallmann Optar principle. A lens focuses a sharp image of an object in one plane only. The distance between the lens and the image is a function of the distance to the object. In an obstacle detector, the practical problem is to know when an image is focused sharply on a plate.

In the Swedish design, the light focused on the plate scans it by a system of vibrating mirrors. Light leaks through a small aperture in the plate onto a photomultiplier. When a sharp image is focused on the plate, transients are obtained in the multiplier current. When the image is out of focus, no sharp light gradients sweep over the aperture and no transients occur. The transients activate a tactile output system mounted in the handle of the carrying case. By varying the lens-plate distance, ranging is possible.

Tests show that the device's sensitivity is satisfactory under average daylight conditions, but is limited in poor light.

Dr. Jacobson also described a magnetic compass that provides a tactile signal telling the blind user when he is on course. This device appears most useful for moving across broad open areas when the blind traveler loses other environmental cues and drifts completely off his course.

TACTILE ARRAY—The Polish device, called Elektroftalm, relies on ambient light to provide a tactile "picture" on the forehead of a blind traveler.

Described by W. Starkiewicz, of the Pomeranian Medical Academy, it is being developed under the auspices of the Polish Academy of Science.

The first model consisted of 80 photoelectric channels (see diagram), each comprised of a germanium photocell, transistor amplifier, and an electromagnetic tactile element. The photocells are formed into a mosaic in an optical camera onto which a picture of the surrounding objects is projected. The camera is mounted on the blind person's head and the set of tactile elements rests on his forehead.

When any photocell is light-stimulated, its corresponding tactile element vibrates at about 10 cps with an amplitude directly proportional to the strength of the light radiation. Thus, the blind person receives a spatial distribution of the tactile stimuli on the forehead that corresponds to the distribution and strength of lights and shades of the surrounding objects.

In tests, a congentially blind subject was able to localize correctly, point to large white objects against a dark background and recognize the shapes of some moving simple objects such as vertical or horizontal lines.

Defects in the first model included: the germanium photodiodes responded mainly to infrared, the transistors deteriorated, and the device was too heavy.

Silicon photodiodes will be used in a new 120-channel Elektroftalm under construction. Television techniques will permit the larger number of channels and enable a blind person to recognize more details. Mounting on the chest will make it easier to carry, and also accommodate the larger number of tactile receptors.

Sonar and Tv Are Robot's Eyes

REMOTELY CONTROLLED handling system for underwater exploration, salvage and maintenance tasks reportedly will be in operation at the end of the year. Sonar, dual video cameras, hydrophone, attitude and other sensors aid control of the system, called an underwater Mobot.

The free-swimming system will operate at depths beyond a mile without a pressure hull. Created by Hughes Aircraft, it is an underwater version of a design originally produced for nuclear handling applications.

Modular construction allows several combinations of working arms and electronic sensors. One or two closed-circuit tv cameras on movable arms with high intensity lights are employed. With two cameras, stereo or arbitrary perspective views of work in progress can be watched on the surface. A console on the mother ship's deck provides control of all functions through a cable.

POSITIONING SONAR — Sonar mounted in the head of the Mobot, with a range up to 1,000 feet, depending on vehicle application, is used for position information. A hydrophone provides listening capability for search and other tasks. Distance to bottom is determined by a fathometer.

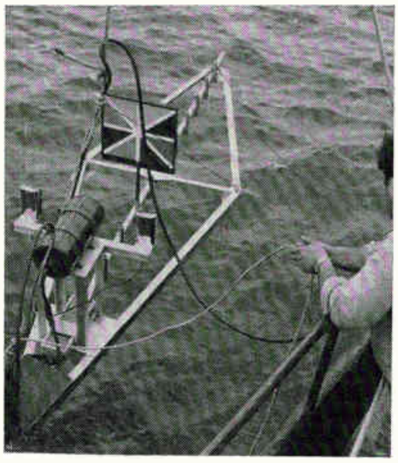
The Mobot is nearly six feet tall. Total underwater lifting power is 500 pounds. A single arm can lift 50 pounds. The vehicle can operate drills, torches and other tools with its hydraulically actuated arms.

The firm claims the underwater Mobot can do anything a human diver can and is capable of more arm positions than a human. Standard operating depth is 6,000 feet, with models able to operate to 32,000 feet considered possible. Propellers mounted in a frame which can be rotated on a lateral axis permit underwater "swimming" at speeds up to 5 knots over a radius of 1,000 feet. Attitude and current sensing devices transmit position information to the operator on the surface.

VISIBILITY TESTS—Underwater visibility checks to determine video performance in water of varying clarity, turbidity, refraction and absorption are being performed by Hughes.

Contrast, color sensitivity and other parameters are being studied under both natural and artificial lighting. High intensity mercury-vapor underwater lamps, selected for their high blue-green spectral content are employed. A transistor vidicon camera, mounted on a frame with the lights and a target placard, is lowered to depths up to 1,000 feet.

The placards used include standard tv raster patterns and contrasting colors.



VIDICON CAMERA *and eight-color target pattern are lowered for tests of underwater visibility and other parameters*

UNDERWATER MOBOT, *as the artist visualizes it at work. System is a variation of one used on land for nuclear handling*

LAFTA nations have 85 percent of Latin America's population and 75 percent of the region's production

Latin American Free Trade Area Plans Cooperation In Vacuum Tube Production

Program gets start at meeting in Montevideo. Radio, television may be next

By THOMAS EMMA
Associate Editor

LATIN AMERICA may give much more attention to electronics production and trade as a result of meetings in Montevideo this month. The talks, more economic than technical, were held under the auspices of the Latin American Free Trade Area (LAFTA).

VACUUM TUBES—Aim of the talks was to lay the groundwork for a system of manufacturing complementation that would allow the combined industrial facilities of the nations to produce a greater variety of vacuum tubes. To affect this, representatives from Argentina, Brazil, Chile, Mexico and Uruguay exchanged facts and figures.

Similar meetings will be held in the future on radios, television receivers and phonographs. Meetings on other components are also being considered.

Although no firm agreements have yet been concluded, some representatives hope for treaties that will benefit the LAFTA concept.

One Mexican commentator pointed out that there are, all told, seven plants in Mexico, Brazil, Argentina and Chile. Although a market exists for more than a hundred different tube types in LAFTA nations, each factory now produces only about 25 types representing the immediate demands of their local markets. Each turns out pretty much the same product line.

The eventual aim of a complementation program would be to produce more types and free-trade them throughout LAFTA.

Brazil and Mexico are the prime movers in the complementation concept. Both nations have strong positions in Latin American electronics.

TRADE OBSTACLES — Despite optimism in the wake of the Montevideo meeting, observers see many obstacles to overcome. Laws governing international trade, geographic difficulties and national attitudes must all receive more attention, it is said. Unless these conditions are moderated, Latin America will continue to depend on outside suppliers.

Growth of the electronics industry has suffered from confinement to small national markets, says one observer. The only nations with any sizeable production are Brazil, Mexico, Argentina and Chile, in about that order. None of these are even near self-sufficiency.

Considering the many components and products needed, the prospect of complementation between these nations is considered good. However, to attain maximum benefit from exchange programs and tariff reductions improvements in transportation and more international cooperation are required.

A Chilean spokesman says that this will come in time and that eventually companies in nations outside LAFTA will establish plants to compete in LAFTA, as is being done in the European Common Market.

EQUIPMENT MARKETS — At present, electronics products in Latin America center on consumer products. It is estimated that there are nearly 5 million television receivers in use, most of local manufacture. Many are priced at about $400 or more.

Studies indicate that while the tv market is becoming saturated in some larger cities, urban and suburban regions still represent a considerable future market. In these poorer areas, two or three families may pool their resources to buy a tv set.

There are about 150 television stations. Most large city areas have three or four channels, most stations use imported equipment.

Radios are more commonly available and are widely used.

Future market developments will probably center around communications equipment. In a part of the

LAFTA ORGANIZATION

Argentina, Brazil, Chile, Columbia, Ecuador, Mexico, Paraguay, Peru and Uruguay now comprise the Latin American Free Trade Area.

LAFTA holds about 85 percent of Central and South America's population and accounts for about 75 percent of total production of goods and services.

The countries in LAFTA have formed a loose federation aimed at lowering tariffs on products now being traded between them and on some products that will be traded in the future. The LAFTA nations hope to accomplish this over a 12-year period.

The organization is headquartered in Montevideo, Uruguay world noted for its balky telephone facilities, oil companies, mining concerns and other large industrial organizations are turning to their own communications systems. Besides these short-distance networks, it is likely that the next few years will see a growth in international microwave systems. South America's mountainous west coast, and the continent's vast jungles and swamps are considered by most communications engineers as conquerable only by microwave.

Railroad Will Use New Message-Handling System

DALLAS — Plans to put Collins Radio's Data Central communications system into operation on the 10,300-mile New York Central Railroad were announced last week. The computer-like system handles messages and data according to priority and channel availability. The railroad will initially use 67 circuits, each capable of handling 144,000 words daily. The system is equipped with 105 two-way circuits and can be expanded to 256.

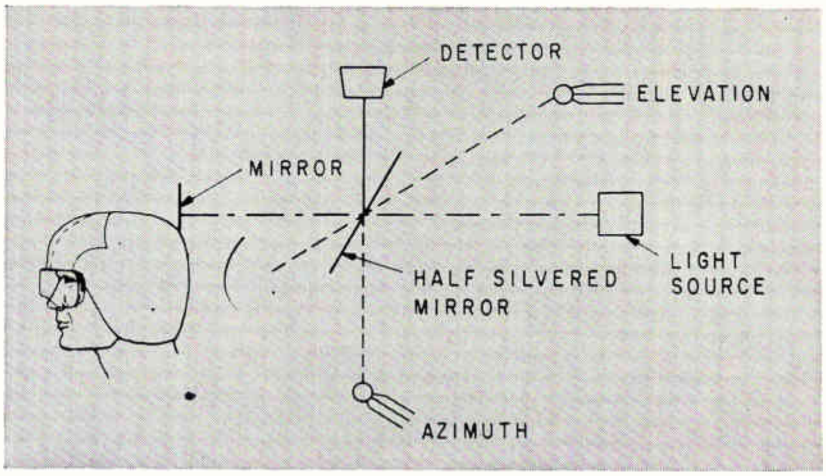
Coolants and Foam Coat Keep Antennas Accurate

BOSTON—MIT Lincoln Laboratory is developing isothermal reflectors for tracking, communications, radio astronomy and space probe applications at high-microwave and millimeter-wave frequencies.

Techniques to obtain dimensional tolerances to 23 mils by preventing unequal thermal loading were described at a Society of Plastics engineers meeting by C. A. Pappas and E. B. Murphy.

Foamed materials are applied to the aluminum framework to isolate short-term temperature changes. A fluid circulating system positively maintains the antenna at a uniform temperature.

A 62-inch foam-encapsulated dish for 39-Gc operation has passed electrical tests. Tests in an operating environment with an antenna with a circulating system are planned. The developers say the techniques can be used in larger antennas.



OPTICAL PICKOFF *arrangement proposed for helmet gunsight*

Pilot's Helmet Tracks Targets

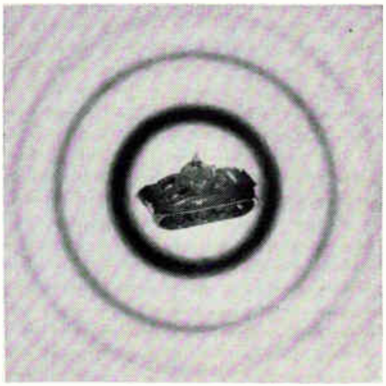
TARGET ACQUISITION and tracking system that enables a helicopter pilot to aim his weapons by merely looking at the target through a small lens in his helmet visor was disclosed last week at the Sixth National Convention on Military Electronics in Washington.

Called a Helmet Integrated System, it was reported by Everett Shockley and Henry Shapiro, of Sperry Gyroscope's Air Armaments division. Helicopter pilots must maintain constant control of their aircraft. The helmet control uses head and neck muscles, rather than hands or feet, for tracking and servo equipment control.

A standard helmet is modified by placing a ring sight in the visor and by adding a helmet position pickoff. The dime-sized sight is made up of light polarizing filters and a uniaxial crystal. The target is seen in a pattern of concentric interference rings.

To sight a target the pilot must move his head, like a person wearing bifocal glasses. The motion of the helmet can be measured optically, mechanically or magnetically. An optical pickoff promises more accuracy at lower weight.

An optical system would consist of an optical source, a receiver, a modulator and a measuring device. The source may be ultraviolet or infrared. A typical receiver may be either null seeking, proportional distance measuring or angle measuring. To modulate the light beam, a polarizing or refractive method is suggested. For angular measurement, the device may be amplitude or frequency sensing.



PILOT SEES TARGET *in pattern of concentric rings*

To determine the feasibility of the system, an electromechanical pickoff was tried. Flight tests showed that target acquisition time was less than two seconds and that the target could be tracked throughout all phases of acquisition, track and attack.

Skybolt Guidance System Passes Its Flight Trial

OPERATIONAL configuration of the guidance system for the Skybolt missile has been successfully demonstrated in flight in a C-131 aircraft, reports Northrop's Nortronics division. The astro-inertial system includes a star tracker aboard the missile and a ballistic digital computer and support equipment aboard the mother plane.

MEETINGS AHEAD

RADIO PROPAGATION COURSE, National Bureau of Standards and University of Colorado; National Bureau of Standards Boulder Laboratories, Boulder, Colo., **July 16-Aug. 3.**

RELIABILITY TRAINING CONFERENCE, IRE, ASQC; Princeton Inn, Princeton, N. J., **July 9-13.**

LUNAR MISSIONS MEETING, American Rocket Society, Pick-Carter and Statler-Hilton Hotel, Cleveland, Ohio, **July 17-19.**

MEDICINE & BIOLOGY DATA ACQUISITION AND PROCESSING, IRE-PGME, AIEE, ISA; Strong Memorial Hosp., Rochester, N. Y., **July 18-19.**

ENERGY CONVERSION PACIFIC CONFERENCE, AIEE; Fairmount Hotel, San Francisco, Calif., **Aug. 13-16.**

PRECISION ELECTRONIC MEASUREMENTS INTERNATIONAL CONFERENCE, IRE-PGI, NBS, AIEE, NBS Boulder Labs, Boulder, Colo., **Aug. 14-16.**

CRYOGENIC ENGINEERING CONFERENCE, University of California; UCLA, Los Angeles, Calif., **Aug. 14-16.**

ELECTRONIC CIRCUIT PACKAGING SYMPOSIUM, U. of Colorado, at U. of Colorado, Boulder, Colo., **Aug. 15-17.**

AIRCRAFT & MISSILES JOINT WESTERN REGIONAL CONFERENCE, ASQC; Benjamin Franklin Hotel, Seattle, Wash., **Aug. 16-18.**

APPLICATIONS & RELIABILITY SYMPOSIUM, Precision Potentiometer Manufacturer's Assoc.; Statler-Hilton Hotel, Los Angeles, **Aug. 20.**

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., **Aug. 21-24.**

MAINTAINABILITY OF ELECTRONIC EQUIPMENT, EIA Engineering Dept. & Dept. of Defense; U. of Colorado, Boulder, Colo., **Aug. 28-30.**

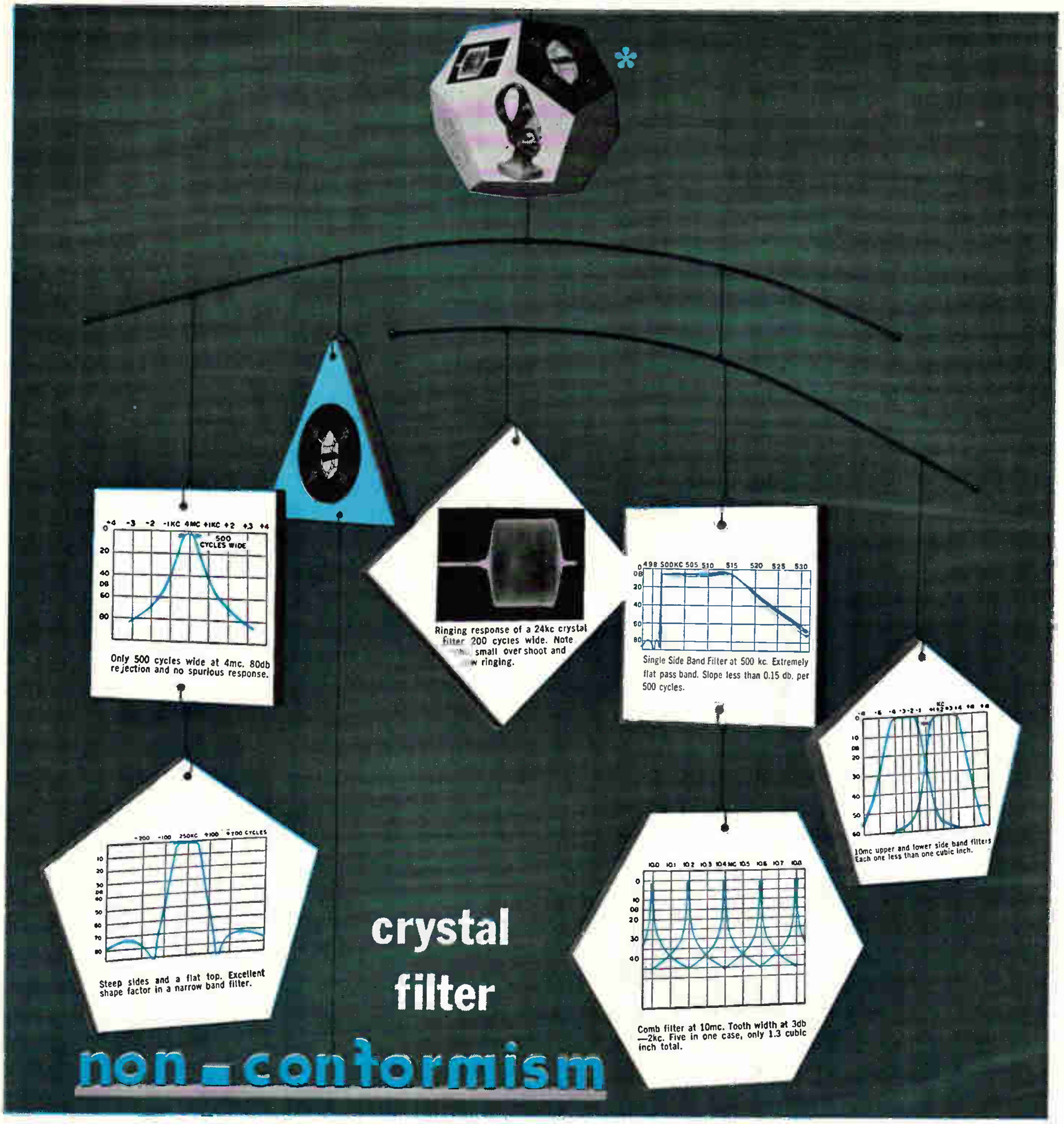
METALLURGY OF SEMICONDUCTOR MATERIALS CONFERENCE; the American Institute of Mining, et al; Ben Franklin Hotel, Philadelphia, Pa., **Aug. 27-29.**

BALLISTIC MISSILE & SPACE TECHNOLOGY SYMPOSIUM, US Air Force and Aerospace Corp., Statler Hilton Hotel, Los Angeles, **August 27-29.**

INFORMATION PROCESSING CONFERENCE, IRE-PGEC, IFIPS, AIFPS; Munich, Germany, **Aug. 29-Sept. 1.**

ADVANCE REPORT

RELIABILITY IN SPACE VEHICLES SEMINAR, IRE-PGCP, PGED, PGRQC; Rodger Young Auditorium, Los Angeles, Oct. 26. Aug. 1 is the deadline for submitting 400 word abstracts to the following for the designated interest areas: component parts—Ray France, Autonetics Division of NAA, Dept. 3241-2, Building 6, Downey, Calif.; electron devices— Jan Black, Hoffman Electronics, 4501 N. Arden Drive, El Monte, Calif.; systems or subsystems—Charles A. Wiley, Hughes Aircraft Company, Culver City, Calif.



Those *non-conformists* at Burnell's engineering laboratory aren't satisfied with just producing the broadest range of crystal filters, toroids and communication networks: through their constant efforts to satisfy tomorrow's space age electronics problems, they have developed a whole new family of sophisticated crystal filters, with exceptional and unusual characteristics, contributing to increased circuit flexibility as graphically demonstrated above.

Those same *non-conformists* have also made considerable progress solving other electronics/space age problems. A typical example of this has been their work with the application of Time Domain Synthesis; producing an unlimited inventory of wave forms for new applications, and resulting in substantial reductions of size and weight, eliminating the need for complex active circuitry for its support.

*Join the *non-conformists*—write today for your free ***Non-Conformist*** paper weight and Crystal Filter Catalog XT-455. Yes! Your circuits *can* profit today from tomorrow's research.

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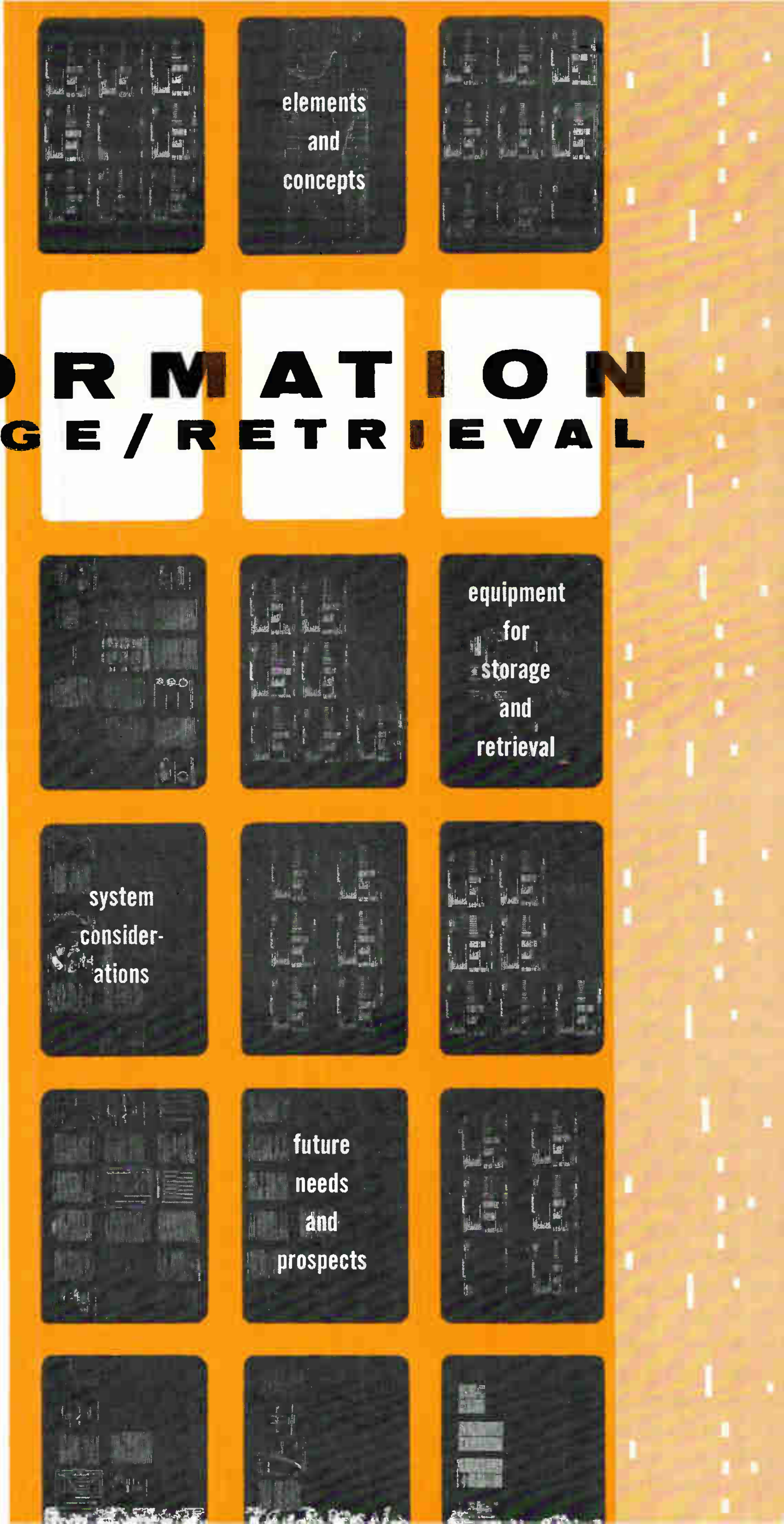
INFORMATION STORAGE/RETRIEVAL

By WILLIAM E. BUSHOR

Senior Associate Editor



INTRODUCTION

"A record, if it is to be useful to science

Recording Media—Old and New

Back in 1947 discovery of the Dead Sea Scrolls, some 40,000 fragments of ancient Biblical writings in Hebrew, Aramaic and Nabatean, dramatically made world headlines. However, obscurity of the language and deterioration from years of burial made scholarly interpretation virtually impossible. Through use of punch-card systems and large-scale information processing techniques, IBM has restored the text to the original form and meaning intended by the author.

Modern storage techniques are exemplified by Microcard Corporation's positive microfilm card. As shown above at actual size, 40 pages of **electronics** are contained on the front, and another 40 pages (not shown) are on the back side. Enlarged page-size images for reading are obtained from a special viewer

THE INFORMATION CRISIS?

RECORDED KNOWLEDGE has been thought of by some as today's dinosaur. Dinosaurs are extinct—and this has been partially attributed to the fact they grew so big their brain couldn't control the unwieldy body. A collection of information can also become so huge that efficient use cannot be made of its parts.

But does this condition constitute an information crisis? Published articles in many media assert we now have a document buildup of imposing proportions because of the exponential growth in literature generated by ever increasing numbers of engineers and scientists. Many prominent men in government and industry alike attest to the inadequacy of existing methods of searching a document store that doubles in size every eight or ten years.

If these are the criteria of an information crisis, then we've been having one since soon after 1900 when the Universal Decimal Classification system was developed. Library literature of those days showed a similar concern for the survival of man in a

ELEMENTS

INFORMATION ACCUMULATORS generally resort to some type of filing or card indexing technique to avoid searching through piles of unrelated material for a particular document. Sometimes this is a workable system; but often it is either an entirely inadequate or an inefficient compromise between available methods and actual needs.

Attempts have been made in recent years to expedite information recall with various mechanical, electromechanical and electronic contrivances. Relationships between elements of these systems and the basic concepts of how to use machines to retrieve information have been derived from trial-and-error empirical methods applied to specific or restricted problems. This condition is symptomatic of a basic lack—no general or complete theory of information retrieval exists. Thus, each system must be viewed in terms of the information it has been designed to handle on an individual basis.

INFORMATION AND DATA—But what of the relationship between information and data? The differentiamust be continuously extended, it must be stored and above all, it must be consulted." **Dr. Vannevar Bush**

flood of paper. Perhaps the tremendous recent interest in the documentation problem results from the impulse to apply our considerable machine capabilities to the old, perplexing and intriguing library problem and not from an explosion of printed words.

Man has survived his self-made document deluge, at least in the scientific and technological fields, by specialization. On the average, areas of interest in 1962 are only half as wide as those of eight years ago and the width will be halved again by 1970.

This contention is supported by an expert logician who argues that older published information is consulted at a rate roughly inversely proportional to its age; thus literature more than 10 years old is hardly used.[1] A well-known executive in the electronics industry, however, has written that every problem these days seems to be related to dozens of associated problems.[2] Therefore, as communication among specialists becomes more difficult, the isolation of specialized knowledge will limit progress toward developing the interdisciplinary approaches often required to solve more complex problems.

Various estimates of how much inadequate retrieval is costing the U. S. extend upwards to a billion dollars for this year alone![3] However, dollar waste is not the most critical factor. The rate at which scientific developments can proceed frequently depends on the facility, speed and accuracy with which technical information can be procured and disseminated. Here the time dimension is all important, particularly with relation to national defense activities.

At least one authority on the information sciences subscribes to the theory that retrieval systems have been made to work successfully, but the fatal element has been the drudgery pursuant to reading, analyzing and interpreting documents—the necessary first step in providing input to the system.[4] This human factor problem of the information processor must be given top priority in developing future retrieval concepts and devices. Another high-priority human factor—the user's psychology and needs—must be more actively investigated; the alternative is to continue scurrying about designing systems no one can or wants to use.

Automation of the retrieval process not only is theoretically feasible and economical, but has already been applied operationally in making bibliographic searches, indexes and vocabularies and, to limited extent, selective recall of abstracts and whole documents. These piecemeal solutions to rather special problems have considerable utility, but a much more significant contribution would be development of an overall balanced solution to much more general problems.

Many knowledgeable retrieval people question whether machines available in the past have been suitable for or capable of non-numerical problems of sorting and selecting ideas. Since these are the very qualities required for information retrieval, it is particularly important and germane to ask: will machines presently being planned suffer the same shortcomings? If by some chance they are built for information retrieval applications, should they merely implement old and constrained ideas of documentation?

Engineers and scientists who are part of the electronics industry should be doubly concerned with how these questions are answered.

AND CONCEPTS

tion stipulated in a paper given at last year's annual meeting of the American Documentation Institute was:[5]

Data are numerical or quantitative notations. Data concepts are mutually exclusive and have finite limits. Data are easily subjected to machine manipulation.

Information is recorded knowledge concerned with qualitative concepts or ideas. Information concepts are not mutually exclusive and do not have finite limits. The concepts interact and overlap. Usability is dependent upon the effectiveness of the creator and the astuteness of the reviewer. Information includes data. Information is not as easily subjected to machine manipulation as data.

We are concerned in this report with information exclusive of data.

What is information retrieval? By generally accepted definition, information retrieval is the science and technology of recovering desired portions of previously coded and stored information. In practice, this field involves the study and development of methods for acquiring, translating (if necessary), analyzing, selecting, codifying, reading in, storing, searching, displaying and disseminating information.

Information retrieval does *not* mean orderly cataloging and storing of the media—libraries handle this job adequately. It is, rather, a mechanization of the library staff and its user with the system interposed to talk about the documents for them.[6]

An information retrieval system must be looked on as an entity not merely as a summation of its many parts. For convenience, all elements that could contribute to the system complex are discussed separately; bear in mind, however, that many of these are extremely interdependent.

ACQUISITION—You cannot retrieve information you do not have. If this sounds both obvious and ridiculous, consider this often overlooked fact: not only does no one library in the U. S. now receive at least one copy of every significant scientific publication in the world, but not even all the U. S. libraries together receive one copy of everything reports the director of the Midwest Inter-

Авиационный двигатель

Typist copies an issue of Pravda on a special IBM electric typewriter which converts the Russian letters to punched holes in a paper tape. The tape is then read electronically and compared to Russian-English dictionary words stored on a ten-inch glass disk memory

Library Center.[7] For this reason, much attention should be given to *active* acquisition of information in the areas of interest.

Acquisition takes various forms. It can be an entirely arbitrary picking up of documents on a mathematical selection basis, where only items of interest to the user are acquired. Or it can be a total collection related to a given subject, from certain sources. It is not possible to achieve completeness in acquisition, either because it is too expensive to seek out the last small percent of missing documents or because there is no way of knowing when everything published in a particular field has been acquired. However, information centers have developed powerful and effective acquisition techniques.[8]

Typical high-utility information is in the form of company reports, experiment and test results, technical publications, house organs, patents, published and unpublished papers, doctorate dissertations, new books, publications of government agencies or military organizations, and the like. Updating requirements and storage limitations vary considerably from collection to collection. Information is conveyed in a variety of ways—the written word, mathematical and chemical symbology, drawings, photographs—and can be carried on paper, photographic film and sometimes magnetic tape, or punched cards.

These matters of makeup are important in processing information in any way, but particularly when using mechanized approaches. Optical character recognition and automatic language translators are vitally affected by type characters, print media and binding.

LANGUAGE TRANSLATION—The language barrier has been somewhat removed within the last few years through programs established by the National Science Foundation, the Atomic Energy Commission and the National Institutes of Health, disseminating translated Russian research information. Also, at least three firms are publishing over forty scientific journals of translated Russian scientific papers. Earlier this year, the first operational machine language translator was experimentally proven out by Machine Translations, Inc.

SELECTION—Although all information of a specific type is acquired, it should not be thrown into the system regardless of merit. This weighing procedure is admittedly a difficult task, but certainly the system can't be any better than the quality of its input, which is inherently uncontrolled and subject to much variance in this regard. There are instances where the peculiar nature of the retrieval required imposes a mass acceptance of incoming data. The Armed Services Technical Information Agency (ASTIA) for example, receives copies of reports prepared in connection with military contracts and is obliged to include them all in their system. Whether weighed or not, the document should be given thorough scrutiny by qualified personnel.

The information processor must ask himself what it is in the document that will probably be of interest to the ultimate user. This point is of the utmost importance. Without proper evaluation, the next steps—abstraction and document description—become pointless.

ANALYSIS—Before it is possible to reduce an article to a series of representative code marks, it is necessary to understand what is being read. Unfortunately, linguistic and semantic problems rear their ugly heads. How do we know that the author has been interpreted correctly, especially when he is a poor, ambiguous, or evasive writer? And, if we do, how can we unambiguously transfer the essence of the document's content into machine language?

The general problem is how to describe a document now so that its description will be useful for as long as possible in the future. Also how to make the descriptions amenable to and efficient for machine operations.[6]

The question is how to come to grips with the semantic aspects in a symbolic or mathematic fashion. The first step is to find where semantics can be excluded—and it can be excluded over a surprising range of bibliographic activities.[9] This is demonstrated by the actual operation of mechanical information retrieval systems.

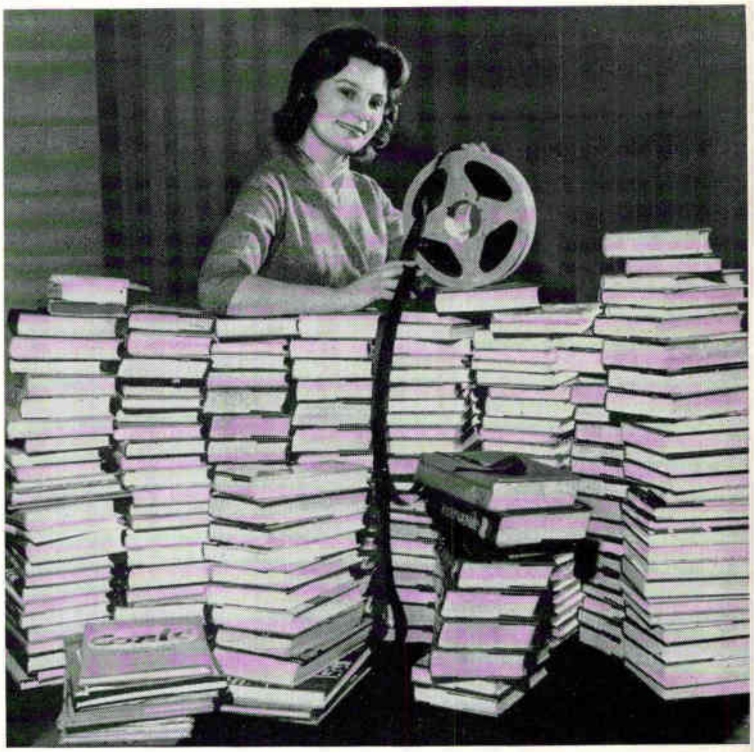
However, many situations demand the problem be faced squarely. Unfortunately the "semantic block" has been used more often as an excuse than the explanation for giving up attempts to develop retrieval systems.

Физические свойства почвы

Indexing is the basic difficulty as well as the costliest bottleneck of information retrieval. The problem is that most often the required information is not asked for by the proper name, address or function, but by description, relevance or application, foreseen or unforeseen. Thus, it is imperative that the codifier be able to recognize what he wants, know how he recognizes it, and then determine in what way to tell the automaton how to recognize it. But it must be remembered that it is manifestly impossible to devise a perfect technique because the language is amorphous.

The kinds of requests to be satisfied should be the key to describing documents. Abstracts must be prepared differently for different interest groups.

Programs and techniques for abstracting the intelligence from text—which will permit automatic evaluation and indexing of materials—have been devised. Here techniques are statistical count methods and the elimination of trivial words and participles, but many of the methods are highly specialized; no valid generalized solution has evolved.



One-hundred-ninety 300-page volumes of information can be recorded by Potter Instrument's high-density recording system on a 10½-inch reel of tape

INDEXING—In documentation, the indexing function indicates whether or not a document is available and, if so, where to find it. An index system may also include a separately maintained abstract file. Arrangement of document descriptions so that location requires only a few to be examined is called strategy of localization of search. Despite growth of the collection, the arrangement of document descriptions must keep their power to localize searches.[10]

Two basic techniques for indexing presently in use are classification and coordinate indexing. These include traditional hierarchial subject classification schemes such as the Dewey Decimal and alphabetical subject index systems. Unfortunately, it is not clear how to establish a hierarchy of classes which will make much search localization possible.

Two other traditional methods are alphabetically arranged lists of document descriptors and alphabetically arranged card catalogs of subject headings. Large collections make these methods time-consuming and discouraging. Also, the methods lead to incompleteness of retrieval, often give insufficient document descriptions for retrieval purposes, and require patient, time-consuming complexity of the structured retrieval requests. These sequential access systems have been mechanized through using punched card data processing equipment.

Indirect retrieval of stored items by concept coordination indexing is the basis of most effective systems today. This approach is based on the premise that it is easier to get general agreement on the precise definition of terms in a document than on the meaning of the document as a whole. Systems designed around this technique store reference to information by indexing items with their terms. In one form of concept coordination, for each of these terms the item is listed and references are retrieved by the coordination or matching of items which discuss the concepts in question.

Terms are stored references to information and are of two types whose nature is often misunderstood. Uniterms, keywords and the like are *exact* words extracted directly from the title or text of the document. Descriptors are arbitrarily labeled idea units (usually mnenonic words or phrases), derived through analysis of their meaning in the text.

Both types of terms can be used with either manual or machine procedures to retrieve documents. But with a considerable volume of new entries and inquiries, machine methods are indicated for greater accuracy, speed, and overall efficiency.

Marking of items to represent all queries that may arise, past, present, or future, is as fantastic as it is impossible, but it is often attempted in various complicated disguises. What changes with time is not the text but the language used in asking for the information. Therefore, it is not the marks, but the rules for translating requests into marks, that must be changed as time goes on.[6]

Scores of research projects throughout the world are attempting to index mechanically through statistical, syntactic, or semantic analysis of language. The idea here is to automatically select the pertinent pieces of information the requestor is likely to need.

One line of attack is to use the entire text of a document, and find rules for determining whether it is what you want just from the things a machine can detect, such as the kinds of words used, how often, and in what context. American and British workers are attacking this, but both are hampered by the scarcity of texts that can be read by machine, and the great cost of transcribing them into machine form. In Britain the National Physical Laboratory is studying natural language abstracts on physics, and the Cambridge Language Research Unit explores word incidence and word clumping in a specialist field.

Another technique is IBM's KWIC (keyword-in-context) system, a new method of indexing that utilizes electronic data processing systems. A program enables a computer to select significant words from the titles of articles, arrange these keywords alphabetically, and print them out with several words preceding and following them in the original title at 600 lines a minute ready for reproduction.

CODIFICATION—After analysis, an identifying name (usually a number for brevity) must be associated with the terms describing the document. Result of a search would then be a list of document numbers, although a bibliographic citation, abstract or a full copy of the document can be obtained.

Advantage of just carrying along number names is the saving in storage space and search time, but then the documents themselves must be separately sought out. If output of document numbers is small, the system is not prohibitive from the time standpoint.

Advantage of carrying along an image or representation of entire pages is that the user immediately receives either a view or a copy of the document. However, this could also be done in retrieval systems which only carry document numbers by having the number selected actuate an external file containing copies of each document.[10]

STORAGE MODES—Upon receipt, the coded terms describing the document are placed in storage (a word preferred to memory in this case). Indexing is independent of all storage techniques and devices, although the techniques and devices are not independent of the indexing used. However, regardless of whether classification or coordinate indexing is used, two basic storge modes are available: (a) *random access,* in which the storage location is approached directly without reference to any other location which precedes or follows. It is typified by various card files in manual systems, and disk files such as IBM Ramac for mechanized systems. (b) *Sequential* access in which storage location is approached only after proceeding from another location which precedes or follows. Examples are systems using reels of computer tape or rolls of microfilm.

Within each of the above, records can be in item reference order, term reference order, or can be the storage of the items themselves.[5]

STORAGE MEDIA—Information retrieval systems have used many types of storage media including mechanical position types, such as: punched cards, edge-notched cards and optical coincidence cards or sheets; magnetic media such as: cards and tape; photographic devices such as: microfilm reels, strips and chips, aperture cards and microphotos or glass sheets.

Major advantage of punched cards lies in flexibility of the card handling machinery. Disadvantages are that only a small amount of information can be stored on a card and the cards must be handled serially.

Edge-notched cards are advantageous in that they can be used to store a useful abstract and/or photographs. They also yield to parallel sort with fairly high speed (as exhibited by the Zator system). This medium is in increasing use but primarily for compilation of indices, bibliographies, charge systems and fact files. Some initial application has been made in the classical documentation area, but there have been no new developments in the last several years. Work needs to be done to improve the flexibility and permit fully automatic operation.

Punched and edge-notched cards are document-oriented; that is, each card contains the terms describing one particular document. Optical coincidence cards and sheets are term-oriented; that is, each card represents a term. Holes punched in a matrix form indicate the documents involving the term. The selected term cards desired for a search are superimposed against a light source. Coinciding holes that show light indicate which document was indexed by all the terms. This technique is popularly known as the Peek-a-boo system.

Magnetic tape has several advantages over photographic film. First of all, it is durable. Secondly, it requires no developing process. And, thirdly, it can be erased and used over and over. However, magnetic tape suffers from the fact that information must be stored serially in time, the number of parallel channels available being limited. In a search, therefore, both code information and abstract material must be scanned serially even though the code is all that is being checked. The most efficient system would store, in addition to code designations, only a document number; abstracts arranged by number would be filed elsewhere.

Magnetic storage of information on plastic cards has the advantage that these can be searched at the remarkable speed of 100 cards a second. This speed compares favorably with the search rate possible with magnetic tape, and it has the added advantage that a new piece of information can be slipped anywhere into the existing file when required.

Microfilm reels, where an indexing code is photographically imprinted next to a microphoto of the original document, (once thought to be the solution to the high-density storage problem) have been found inadequate because of their inflexibility. Once a film is made it cannot be changed unless the whole strip is remade. Consequently it is difficult to add new information to the system or to rearrange old information already on the film. Other defects inherent in the system are: the need for a photographic development process, the difficulty of filing and sorting microfilm, and the difficulty of comparing references when one is at the beginning and the other at the end of a film.

Microfilm strips on which the document images (at a 35 to 1 reduction) are recorded on short (15 in.) lengths of special film, are also used with a separate magnetic indexing system to determine which images contain the desired information. With this approach, access time is reduced, and image revision costs and complications are eliminated.

Another approach is to use discrete chips of film carrying the text of each item. With these, individual records can be sorted more easily, without sequential search. Codes can be carried right along with the film. They can be searched optically by patterns on the film, as in the Eastman Kodak Minicard, the Ramo Wooldridge Metri-

The 35-mm microfilm image of an engineering drawing is mounted in a tabulating aperture card. This is the storage medium for Minnesota Mining and Mfg Co's Filmsort system

Experimental IBM memory uses electronic readout from punched cards. Presence of a hole is detected by change in capacitance at any point where conductors cross

card and the French Filmorex systems.

Microfilm chips attached over the opening in a punched card form a so-called aperture card. These are indexed with punched holes and can be searched mechanically with conventional sorting equipment. Frequently, however, to cut down wear and tear on aperture cards, the index to the documents is also recorded on standard IBM cards, which are searched mechanically. The desired aperture cards are then pulled from the file manually. The images on the aperture cards are examined by using special equipment for viewing or automatic printing.

By using microphotographic techniques on a glass plate an extreme minification system that reproduces 10,000 document pages on a glass plate only a foot square can be achieved. Ten such plates, holding 100,000 pages, are handled by a device that will pick out any page on command in a few seconds, and in a few more seconds produce an enlarged copy of it. A guide or index to the contents of the 100,000 pages must be provided through some means external to the device itself—that is, an index in book form.

SEARCH—Search is nothing more than a review of the index, or abstract file, to determine the availability, location and content of a desired document. Searches of the store are initiated to answer a question or to find particular information; thus the inquiry must be analyzed and transformed into the language of the system. Search strategy is used to get the best out of the storage mode and medium used.

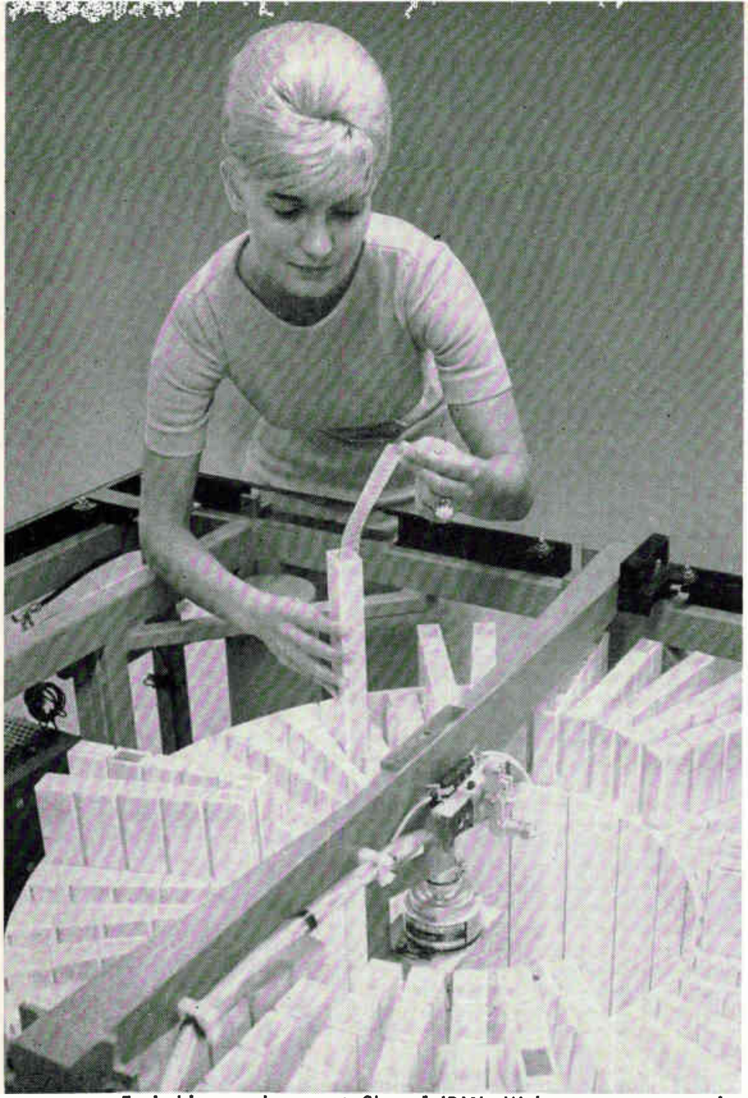
PRESENTATION—Great contribution of document selector systems is that they quickly give the inquirer the material form, if not the content, of what he wants. These systems cannot of themselves give the right type of document—that depends on external agents—but they do give a readable document, not just strings of reference numbers. A retrieval system must produce at some time the documents (or replicas or relevant abstracts); high-speed searching is expensive uselessness, if subsequent access to the results of the search are astronomically slower.[6] The proper presentation and display of information to a customer may play an important role in the palatability and digestibility of retrieval information.

REPRODUCTION—Creation of copies of the stored document either manually or automatically is an important aspect of a total system. Cheap throwaway duplicates are highly desirable.

DISSEMINATION—Merely because information is resurrected does not mean the job is done. Often this information must be actively disseminated to others because of its high degree of relevance to their work. Various forms of communication also come into play where the questioner is at some remote location. Thus, communication nets will be as important to information retrieval as they are to central computer-satellite operations in our space effort.

More attention should be paid to active dissemination of scientific information rather than the passive interment in libraries where the resurrection of information requires initiative and ingenuity on the part of the customer. The information must be directed to a person who has not yet asked a question, but who does have a need for the answer.[5] Dissemination of indices is just as important and just as complex as dissemination of documents.

Intracorporate dissemination systems will become increasingly important. An interesting present-day example is IBM's experimental application wherein computers channel publications and other current information selectively to the people in an organization who are most interested in this information.



Each bin, or document file, of IBM's Walnut system contains 200 plastic cells loaded with film strips containing images equivalent to about 3,000 average-sized books

"There are nine and sixty ways of constructing tribal

SYSTEM

INFORMATION RETRIEVAL as a field has gone through a 17-year gestation period, but only discordinate, fragmentary efforts have been made in the direction of system design, even in specialized fields. To date, only very special solutions to particular problems have evolved.

Unfortunately, most approaches have not followed the logical procedure of first defining system operating policy and philosophy, and *then* considering the need and justification for mechanization. Often times those who most want to automate are those who need it least, while those who most need a mechanized system want it least.

Many authorities propose a systems approach wherein the first consideration is the searching strategy to be employed. To accomplish this end it is necessary to couple systems analysis techniques with a knowledge of available equipment, human factors, and a clear understanding of the real problem at hand. Most probably a multitude of systems will evolve and in all likelihood, this is the desirable solution. Much time has already been wasted on looking for *the* system.[11]

WHY AUTOMATED SYSTEMS? Despite existing gaps between theory and practice, automated information retrieval is both a recognized practical necessity (because of the urgency created by decreasing permissable retrieval times) and a partial reality. Compromises must be and have been made between what is desirable and what works. Ideal systems would give immediate presentation of the exact information which would answer any question or satisfy any request, while simultaneously operating efficiently on an ever-multiplying volume of information whose future growth is essentially limitless.[12] (See Fig. 1).

Automated machine systems offer the hope of reproducing all the humanly conceived functions necessary to obtain meaningful information and do so at such speeds that retrieval time can be eliminated as a problem, even in a real-time system. The fact must be faced, however, that we will always have with us one insoluble problem: incomplete, ambiguous, misleading, poorly-written documents which form an uncontrollable input.

Speeds and capacities of electronic machines (particularly computers) appear to be attractive qualities when used as replacements for or supplements to the traditional manual library and bibliographic cataloging techniques. Despite the fact that many systems have been devised for this purpose, machines are not able to handle all such problems. An example is the recent estimate indicating that 8,000 electronic computers of the UNIVAC type would be required to replace the present

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I BELIEVE that all present systems of information retrieval are based on some form of codes, descriptions, indexes or the like. These are almost always incomplete, out of date, and biased. One of the wonderful things about the human brain is that it can relive past experiences and, in doing so, can extract any of the information that has been stored in it without a prior knowledge of its importance at the time of storage. It is dangerous and sometimes foolish to try to design machines to simulate the action of the human brain, but occasionally it may pay to try. Because of the fact that most of the information that the human race has stored so far is in the form of printed text, it appears that the ability to examine all of it is what is really needed. The reading machine make this possible for the first time. A reading machine coupled to a high-powered data processor can now recognize words, groups of words, and, at some future time, concepts. The ability of reading machines to read original, unedited, text makes information retrieval ready to go to town.

JACOB RABINOW, President,
Rabinow Engineering Co.

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lays, and every single one of them is right" . . . . **Rudyard Kipling**

CONSIDERATIONS

card catalog at the Library of Congress.[6]

A recent survey by Systems Development Corp. has attempted to provide a base from which the function of an automated retrieval system can be analyzed.[12] This thinking is important because mechanization of functions must be evaluated in the light of a complete system.

PRIMARY PROBLEM—Preparation of the information for machine handling—in other words the basic machine input—is the major difficulty encountered in designing systems. Merely increasing the speed of search, while helpful over all, will not solve this problem.

No completely automated information retrieval system exists today, nor could one be put together from existing equipment. This is because to be complete such a system must have automatic indexing and abstracting and analysis, and no radically new hardware has been developed to handle the problem. Essentially, specific needs have forced development of special purpose equipment with rather narrowly defined scope having a great many limitations for general purpose applications.

Basic approach has been to set up multiple indexing systems—and this scheme not only works in many cases, but is a completely adequate solution to certain problems. Here, documents are indexed very specifically by conventional library designations such as author, subject, topic words, date or issuing agency. They are then codified and stored. Searches are based on exact matches of request and indexed terms.

In all systems, an intellectual decision of system organization determines whether concept coordination or classification is used. Access to the information depends upon the selected mode of storage which is dependent upon system requirements and economics.[5] Approaches vary widely; each have advantages and disadvantages and certain characteristics can be compared.

Human beings operating through keypunch machines and the like still provide much of the input to information retrieval systems. For example, in Russian machine translation all functional systems involve keypunching the Russian characters of a document. Considerable effort is being expended, however, in developing various types of character and pattern recognition devices. These activities are detailed in an excellent state-of-the-art report on automatic character recognition.[13]

A fundamental question in designing an information retrieval system is whether it is sufficient to give only a reference to the document's location for later manual retrieval, actually drag the document along with the index and display or copy it immediately when found,

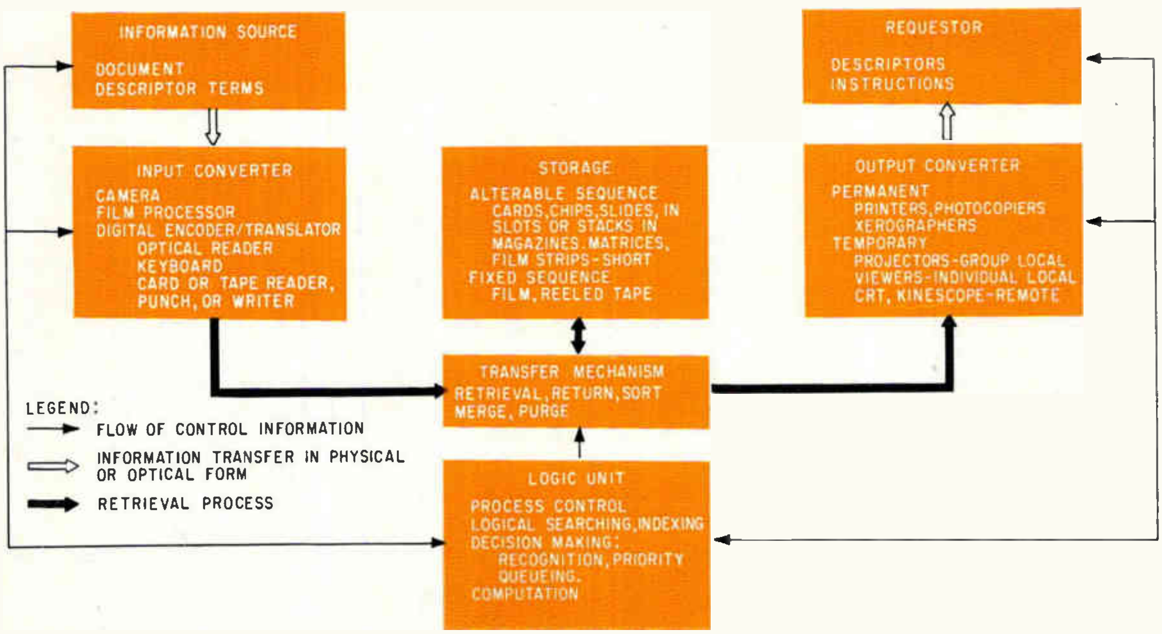


FIG. 1—Block diagram of generalized information retrieval system as conceived by System Development Corp.

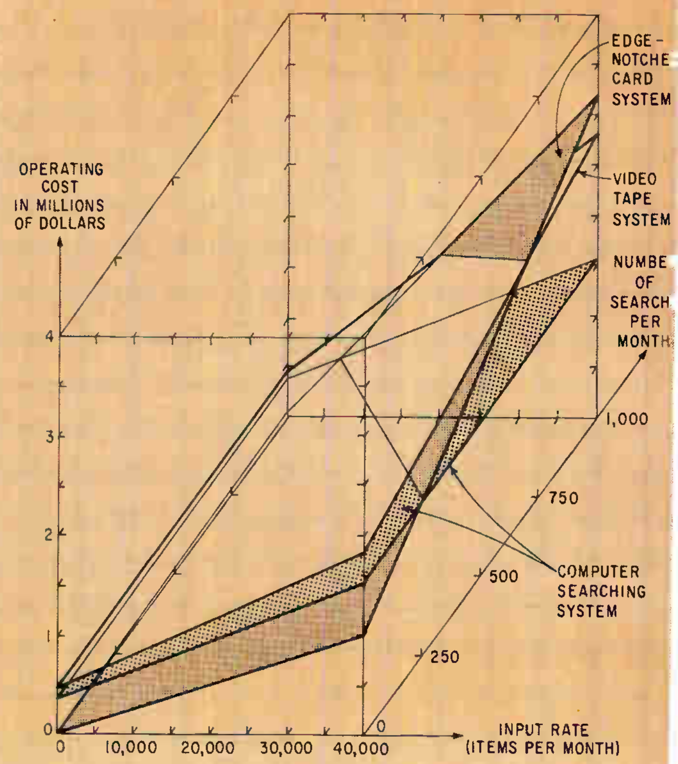


FIG. 2—Annual costs of operating three storage and retrieval systems in study prepared by Stanford Research institute.

or to search only the index but follow up with automatic retrieval and display or copying of the document.

With separate index systems, the index can be rearranged and updated without affecting the document image store. Also, the system complexity, at least in terms of the search aspect, is simpler and faster than the drag-along technique.

There are strong arguments, however, for retrieving the actual document and not just an address, file number or bibliographic listing. Unfortunately, when the index codes are stored with the document image, everything must be brought along in performing a search. Thus, the system can become costly, slow and a bit unwieldy.

Perhaps the best solution is the approach taken with IBM's Walnut system, wherein modern equipment is used to perform the index search, and other automated hardware is brought into play to extract the document image from a separate store. Although an admirable solution, costs are staggering and only the most needful and well-financed users could afford them as presently conceived. Perhaps, as was wrily observed by a prominent information retrieval expert, what is needed is not a Walnut but a Peanut system![14]

USER NEEDS—Three approaches can be used to determine or measure user's information requirements: study users' information environment, study the present information resources (really a special part of the information environment), and study the user.

Environmental factors such as economic and time pressure or practical constraints limit the usable information resources. Present information resources should be seriously considered before entertaining thoughts of getting a new retrieval system. There should be assurance that it will give at least as much service and value as the system it is intended to replace.

Although the user is often influenced by the information tools and facilities that he is familiar with, he usually cannot discriminate between his actual needs and his way of performing work. In a recent study made by Stanford Research Institute at IBM Laboratories, Sylvania, and Lockheed (all in California) engineers and scientists in fields of applied electronics research were asked about the last search they made by conventional methods.[15] Some of the comments were:

"The search was a little bit out of my field, which made it harder."

"I've subscribed to IRE since 1949, so had my own source."

"I was fortunate enough to meet a man at a Berkeley meeting who knew just where to look."

Two interesting comments were made with regard to advising young engineers how to proceed:

"Have as much information as you can on the subject before you start."

"Talk to people who are familiar with this area of investigation."

Most important system consideration to these people was that it should take a minimum of time to obtain the major group of relevant references. Although the group was generally uncertain about and in disagreement on the relative importance of other factors, the order of final placement was: minimum relevant material overlooked by the search, certainty that specified sources over certain period of time were searched (certainty that 100 percent of the source was searched, certainty that 90 percent was searched but 10 percent may not have been searched, etc.), references retrieved arrive in preferred form (complete document, abstract, citation or document number), assurance that documents on a given subject do exist, minimum of effort required to communicate request for a search, and minimum of irrelevant material produced by the search.

WHO ARE THE USERS?—A recent National Science Foundation report lists 52 organizations that use nonconventional technical information systems for storing information and preparing indices. Only three organizations listed electronics as one of their subject fields; two more listed broad interests which by implication includes electronics. However, over half of the total were involved with chemistry or biochemistry.

SYSTEM COSTS—Three representative information retrieval systems were evaluated by Stanford Research Institute in the survey mentioned previously.[15] Direct comparison of the economies of these systems over wide ranges in operating parameters is shown in Fig. 2. Although accuracy of the basic time and cost data is somewhat suspect, the evaluation procedures developed are capable of producing good results.

Annual costs of information retrieval systems include: salary, power requirements, material costs, translating costs (where documents are preprocessed before they are entered into the file), and document enlarging and duplicating costs. Initial costs include: purchase price of system equipment, building construction, system installation, duplicating and photographic equipment, and the initial establishment of the basic collection.

Engineer examines one of 750 printed-circuit, logic-component pluggable cards in GE 225 computer at Western Reserve University's Center for Documentation and Communications Research. Each reel of magnetic tape in upper left of console stores the equivalent of approximately 2,500 documents

SCIENTIFIC INFORMATION is transmitted and stored in a number of different ways—in books, technical journals, reports, notebooks, card files, and on the backs of old envelopes. Now that electronic computers and data-processing systems have become available, how well will they be able to meet the "information explosion" that is imposing a staggering load on the traditional means of scientific communication?

The mechanized systems are superb at doing what they are designed to do. But just because a very large volume of material can be handled with great speed does not necessarily mean that a scientist has rapid access to any piece of information he wants. The utility of an information retrieval system must be measured by drawing a balance between the cost and effort that the user must expend and the completeness and correctness of the information that he gets as well as the convenience and speed with which he gets it. Thus, the usefulness of a retrieval system is determined not only by the speed at which it can treat a large volume of material but on the efficiency of organization of the material, the validity and permanence of the material, and the form of the intended output. In deciding on the appropriateness of using a mechanized system, these factors should be borne in mind. For instance, a telephone directory is very well organized for a user to get at the intended output, and very few users require formal training in its use. There is, therefore, no particular urgency in mechanizing this means of information retrieval for the general user. However, machines do provide a current capability of searching large quantities of properly organized data for desired information. Moreover, the result of using machines is not just a quantitative difference due to expanded capacity but a qualitative one resulting from new capabilities of comparing and correlating data.

Apart from their extended capacity, a great potential advantage of automated systems is that it is possible to alter material in the system without disrupting the whole system. This makes it possible to store and retrieve current values of a set of variable quantities. When such variable quantities are interrelated, an automated system provides an entirely new capability in that a change in one quantity can automatically cause updating of all others depending on it or derived from it, or an alarm can be given that inconsistencies have been introduced. This type of system would eliminate much tedious labor and many possibilities for error in maintaining files of physical data, such as thermodynamic and kinetic data, in any such inventory-like operation.

At present, the speed of computers permits the processing of such large quantities of properly organized material that searches can be made that could not even be attempted manually. In order to enjoy this advantage of automation, the material handled must be machine-readable and organized and coded for rapid and efficient processing and retrieval. Advances have been made in mechanizing these input and organizing processes.

GIRARD L. ORDWAY, Research Physicist,
Operations Research Inc.

EQUIPMENT FOR

"I must create a system, or be enslav'd by another man's. I will not

FULL OR PARTIAL mechanization of operations involved with information retrieval systems has been in progress for the last 12 years, but only during the last three or four has considerable attention been given to more complete automation. This new attitude results from the enthusiasm shown by equipment manufacturers with long-range market development plans, military agencies with dollars to support research in particular problem areas (particularly the U.S. Air Force), and the National Science Foundation and Council on Library Resources with grants for studying general-interest documentation problems.

Both users and manufacturers have been trying with great perseverance (and some ingenuity) to apply their existing gear to the problem of retrieval. Classification and indexing techniques used have been those developed originally for manual systems, but are now widely employed in electronic accounting machine and computer systems.

MANUAL SYSTEMS—Non-conventional clerical methods of retrieval usually involve hand-manipulated edge-notched or optical-coincidence (peek-a-boo) cards. These techniques are generally cheaper and faster than punched cards which are searched on electronic equipment. However, when volume of the store and rate of requests builds up to any appreciable amount, these systems tend to become unwieldy.

Jonkers Business Machines is marketing a system utilizing the peek-a-boo card which searches at high speed with relatively low-cost equipment. Output is the serial or code number of the document being sought.

Each item of information is given a serial number. Cards are dedicated to the characteristics of terms, thus there is one card for every term in the vocabulary of terms developed from the information collection. Each system usually has a few hundred to a few thousand of these cards. Data are entered by punching the serial number of items into the term cards. Search is made by simply superimposing the cards, turning on a light source and reading out hole positions in the matrix through which the light shines.

PUNCHED CARD SYSTEMS—Many of these systems are in existence, but in most cases the equipment was obtained for other purposes and has been used for information retrieval. Despite the unsophisticated aspect of these devices, they will be used extensively for arranging such things as catalogs and indexes for printing. Unlike notched cards, there have been new developments in electronic accounting machines in recent years, notably IBM's 9900 Special Index Analyzer, 9310 Universal Card Scanner and the 101 with Row-by-Row Scanning Attachment.

Because they read and do something about each card, punched card machines must not have diluted collections. Applications include listing and marshalling of collections whose order and composition is not known.[6] Many punched card systems have been developed using sorters and collators, particularly in the chemical industry.

COMPUTER SYSTEMS—Purchase of electronic accounting machines—much less computers—solely for information retrieval is seldom justified. However, computers are often given retrieval problems, even if only for experimental purposes. Almost all the original work done with computers has been by the users and distributors of technical information—both commercial and governmental.

INDEX AND SEARCH

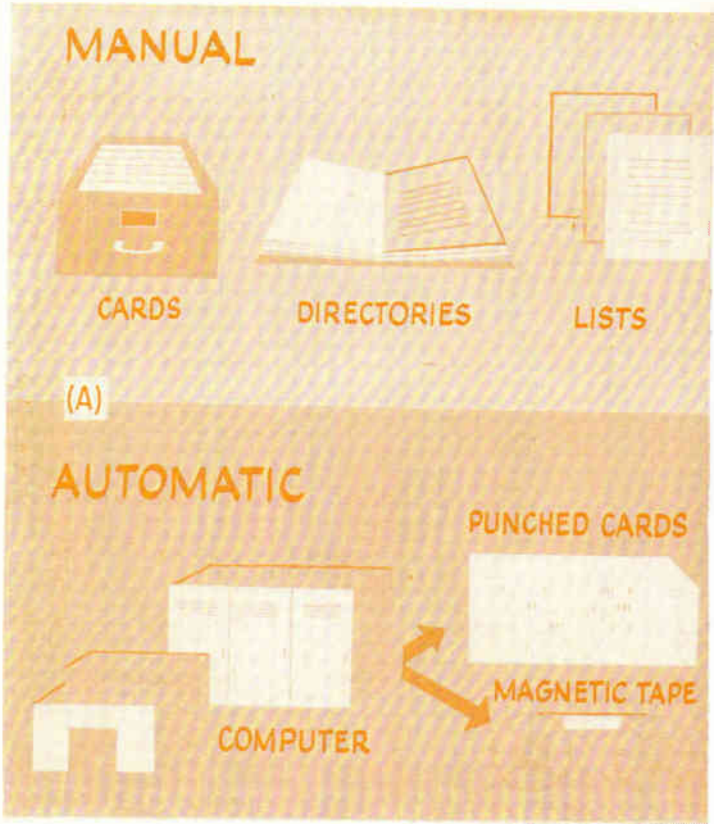


FIG. 1—Modern techniques of information indexing, index searching and communications are exemplified by Information Retrieval Corporation's CRIS (Command Retrieval Information System). This system-oriented approach precludes obsolescence.

STORAGE AND RETRIEVAL

son or compare: my business is to create . . . **William Blake**

Coordinated indexed material is the usual computer input although straight classification indexes are used for a few patent and chemical problems. Other document-type applications for which computers are being used include preparation of indexes and catalogs used in manual systems; automatic routing or dissemination of material to potential interested parties; development of abstracts from straight textual material; and generation of key index word lists and permutation of keyword-in-context (KWIC) indexes.

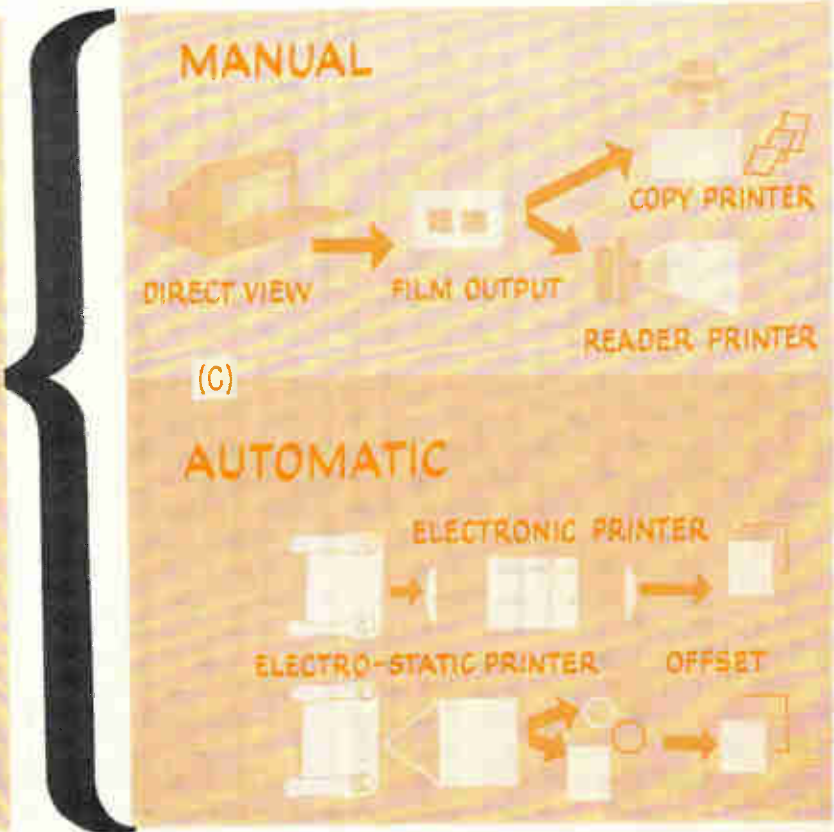
Digital computers are extremely flexible, in that they operate from internally stored programs. This situation is ideal for computing, but not for information retrieval since the need to refer to the stored program for each step makes the operation too slow.

MAGNETIC TAPE SEARCHERS—File-searching devices based on magnetic tape systems are designed to do the same information retrieval job that a computer does, but cheaper. However, most of these equipments are too high-priced to compete with several moderately priced computers. Some of the systems under development are: *Logic Processor* (Aeronutronics), *Index Searcher* (Computer Control Co.), *Univac Tape Searchwriter* (Remington Rand); *Findafact* (Rese Engineering Co.), *GE-250 Information Searching Selector* (GE Co.) and *Tape Searcher* (Herner & Co.).

Fully automated systems are divided in two classes—document (wherein document image and index are handled simultaneously) and aspect (wherein a separate index is used to locate a stored image).

LOOK-UP

REPRODUCTION AND TRANSMISSION



and facilitates integration of existing hardware, while attaining the ultimate in flexibility. Queries generated at remote points can be transmitted to an information center for electronic processing of the index search, the computer output fed directly to a CRIS unit, and the required documents immediately retrieved and transmitted by electronic facsimile methods to the requestor. This particular system has an average retrieval time under 20 seconds

RAPID SELECTOR—NBS has developed a system of mechanized searching based on Vannevar Bush's original Rapid Selector principles.[16, 17] Index terms are encoded on punched cards which are then photographed onto 35-mm reels of microfilm in form of black and white dots representing bits (maximum of 240 bits), with indexed document immediately following. Documents are retrieved by means of a punched interrogation card and a patch panel which specifies the search criteria and logical relationships required. The information store is then moved past photoelectric cells in a comparator circuit at about 300 feet a minute, or the equivalent of about 3,000 document pages a minute.

Whenever the scanner identifies the desired preselected code, a copy circuit is activated which automatically produces microfilm copies of the selected documents without slowing down the film. Average search time reported by users, including processing, is 12 minutes. System is now being used to locate and duplicate parts or entire volume of ships information books and ships allowance lists for the Publications and Information Retrieval Branch of the Navy's Bureau of Ships.

FLIP—Benson-Lehner's FLIP (Film Library Instantaneous Presentation) is a viewer system with no printout facility and limited photographic index code. System automatically locates frames within the film role by means of coded frame numbers. Instructions are accepted by means of a keyboard or any machine source such as punched cards or punched tape.

FILE SEARCH—FMA's FileSearch system is similar to FLIP but has added features. (See photo at right.) Three-part basic arrangement consists of a recording unit, a retrieval unit and a modified Flexowriter. The recording unit produces a reel of coded film by photographing information about the document. The retrieval unit accepts a request in the form of a punched card, electronically scans the coded film, compares the code on the film with that on the request card, and locates the document or documents. The modified Flexowriter is used for punching both the index and request cards. The system permits requestors to retrieve documents as an image on a screen (for browsing), a hard copy print, or a duplicate film copy (for file expansion or reproduction).

FileSearch automatically searches 1,000-foot reel of microfilm containing 32,000 document pages at a rate of 6,400 pages a minute. Documents are indexed with up to 392 code bits by an analyst who uses a set of words or numbers to describe the contents.

First commercial unit was installed at the Bureau of Ships to store and retrieve technical reports, contract documents, and correspondence.

RAPID ACCESS LOOK-UP—Ferranti-Packard's Rapid Access Look-up system was developed as a quick catalog look-up system with printout facility available if desired. Each frame in loop of 16 mm film contains catalog page and alphanumeric code for page identification. Selection is done with a control keyboard. Film automatically stops when proper frame is reached and requested page is projected on a screen. Average selection time is about 1½ seconds. Any electrically operated keyboard can be used for input and can be adapted to key punch equipment (entry via tape, card, Flexowriter or card punch).

FILMSORT—Filmsort system of Minnesota Mining and Manufacturing Co. uses chips of film containing image of document inserted into aperture created in conventional punched cards. Thus, searching can be done on standard sorting and collating equipment. Three methods of printout can be used: two are card-to-paper systems, one has continuous automatic electrostatic printer for making copies in quantity, the other a reader-printer for first viewing and then making copies of desired document, and the third is a card-to-card system for reducing the library store. The U.S. Army Rocket and Guided Missile Agency (ARGMA) at Redstone Arsenal uses the system for retrieving drawings from a file of over 2 million items.

MAGNAVUE—Magnavox has developed several systems based on the concept of the unit document. Earliest of these was the Magnacard System. Basic storage medium is 1 × 3-in. Mylar card which contains coded indexing information but no image of original document. Each card retains up to about 5,000 code bits (1,000 decimal digits or 600 alphanumeric characters) and can be scanned at 5,400 cards a minute. Large-scale processing of file items and random access to individual cards are obtainable using small-scale general purpose computer.

The more recent Magnavue System (which grew out of Magnacard) also uses a 1 × 3-in. Mylar card with magnetically coded index, but includes a photographic image of original document. The microfilm image takes up one third the card; the code, which can go up to 3,000 bits, takes the rest. Minimum operating life of cards, 200,000 passes; capacity 450 characters in addition to graphic image. The cards are scanned magnetically to separate out desired cards whose microfilm images are then projected on a screen for reading. They can be viewed remotely by closed-circuit tv, or used to make full-size hard copies. Information transfer rate between cards and computer is 90,000 characters/sec. This system also is computer controlled.

The Magnavue system combines advantages of high-speed electronic processing, high-capacity magnetic recording, and the ability of photographs to compress graphic information, with the ease of handling inherent in the use of individual records.

MINICARD—Eastman Kodak's Minicard system uses film sliced into 16 × 32-mm pieces which can be handled like tiny cards. Since documents are discrete pieces of film, their select time is slowed down if searched serially; however, the retriever can speed the operation by going directly to a particular group of cards if he knows the identity of the document. Also, cards can be filed under as many headings as desired by instructing machine to make extra copies of each Minicard master. One problem is how to handle and read these miniature cards at high speeds. The system can now search at 1,000 cards a minute. Some 11 million document pages fit on 900,000 Minicards. (See Fig. 2.)

FMA's FileSearch system scans documents at more than 100 pages per second, selects those desired, and presents them, one at a time, either on a screen for viewing, or in a hard copy for further use or leisurely study. Hard copy is available in seconds, emerging from the slot above the viewing screen

System operates as follows: Minicard film uses black and white dots for indexing code. Up to twelve pages of legal-size documents can be exposed on a single film record with 49 code characters or the full area may be used for 455 indexing characters with the document images to follow on other film records in sequence.

Next, the code data are converted to punched paper tape on a Flexowriter. This tape is fed through a reader which electronically converts the indexing to the dot code pattern on the film. Then the related graphic material is microfilmed at a reduction of 60 to 1. Film rolls are 16 mm and 200 feet long; each of the 2,000 frames contained therein becoming a Minicard.

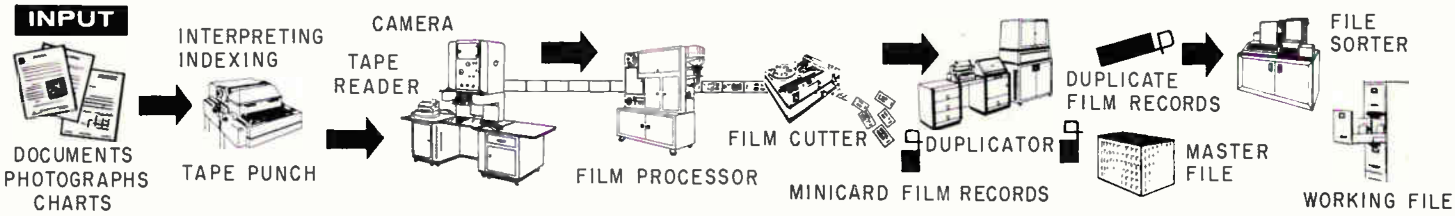
Next the exposed roll is rapidly developed in an automatic, continuous processor and is cut into frames to form each Minicard. Individual cards are stacked into a receiving magazine by the cutting machine where they slide onto a steel handling-stick, capable of holding 2,000 cards.

Duplicate copies of these master records are then produced to form the working file. At the sorter, the cards are scanned electronically at a rate of 1,000 a minute and relayed automatically to their respective magazines in accordance with filing concept.

Requests are coded and punched into tape to form the inquiry. A control panel is wired to establish logic conditions for an output selection and is used in conjunction with the tape in the selector. A magazine of cards covering at least one of the terms in the inquiry is removed from the working file and inserted into selector. Tape and control panel together set up the conditions of single search information retrieval. All cards are scanned electronically; those desired for answering the inquiry are deposited in a magazine fixed on the selector, and finally are duplicated, processed, inspected, cut, stacked onto smaller sticks for easier handling and delivered to inquirer. He can study with table model viewer or make hard copies. Record cards obtained can be thrown away after use or kept for future reference.

MEDIA—A low-cost system developed by Magnavox called MEDIA (Magnovox Electronic Data Image Apparatus) utilizes 16 × 32-mm film cards containing up to 17 visually readable numbers, a machine-readable binary-coded counterpart of those numbers and two or more pages of information reference by numbers. Special 10-position keyboard is used. Numbers, code and pages are simultaneously photographed by a single exposure cycle. Film is then developed, cut into 32-mm lengths and filed in small capsules containing up to 200 cards.

Retrieval from files is based on number of the document, which serves to locate the particular capsule. Then the capsule is removed from file, inserted into selector-reproducer, desired document number keyed in at selector-reproducer, and MEDIA cards searched at a rate of 15 per second for those matching the required document



Actual size of the Minicard film record. It contains six pages of graphic information and 1,554 bits, or 259 characters, of alpha-numeric code information

FIG. 2—Input and output flow charts of the Minicard system

number. When matching takes place, the stored data on the card are enlarged and reproduced onto hard copy. Any two-page document can be retrieved from a file of 10 million documents within approximately one minute.

ASPECT SYSTEMS

VERAC—Avco Corporation's Electronics and Ordnance Division has built a feasibility model of a fully automated system which uses photographic medium to provide direct random access to designated microphotographic fields of information. Known as Verac, the equipment was originally company sponsored, but is now partially funded by the Council of Library Resources, Inc.

Document images are recorded on sheets of film, rather than on either small pieces of film or reels. This system takes advantage of the almost fantastic reductions that can be made photographically. Using reductions of 140 to one, it can record images of as many as 10,000 document pages on a single 10×10-in. film sheet. Verac retrieval equipment can store up to 100 film sheets, equivalent to a million document pages. A separate manual index or computer is used to determine which images contain the needed information. Once this is known, the Verac unit can locate any image within two seconds. It can then produce a 35-mm film strip of the selected images or full-size hard copy. The images may also be viewed remotely.

System scans the stored microimage electronically and produces full-size high-resolution hard copy at a remote location by a newly developed electrostatic printing process. Indexing and searching techniques are under

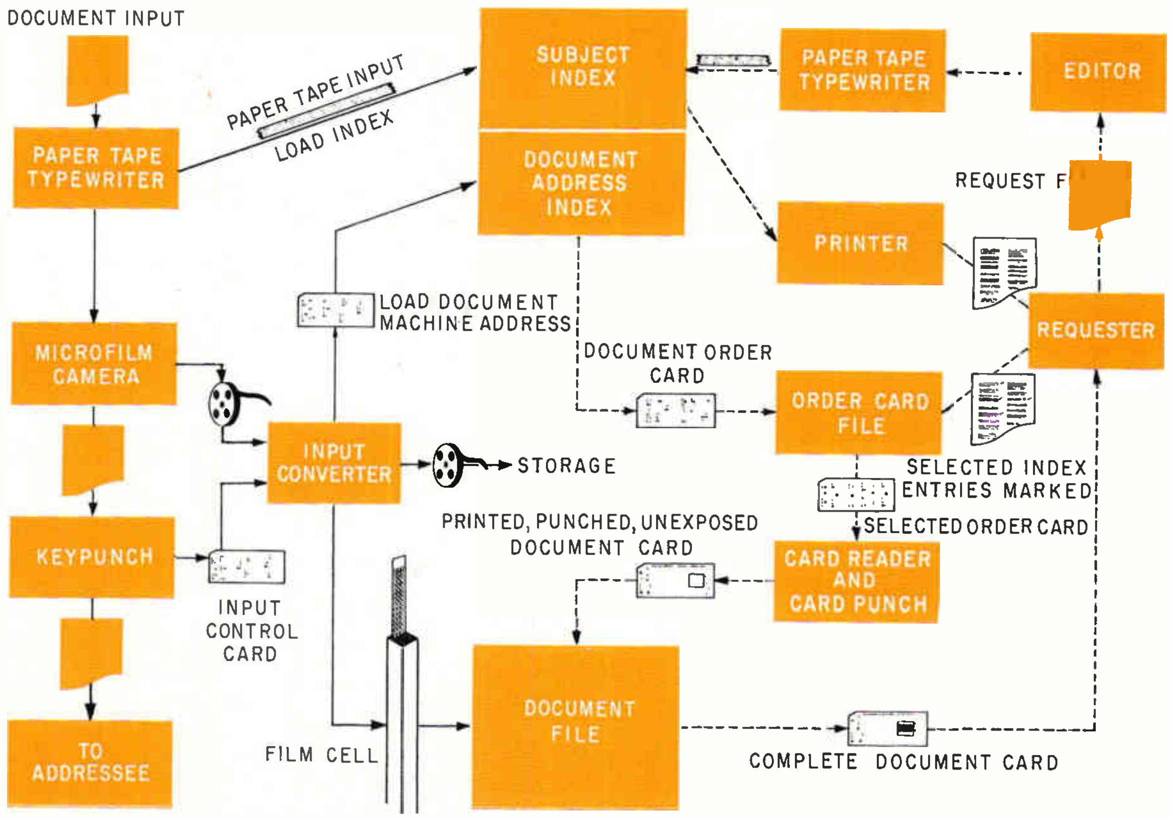
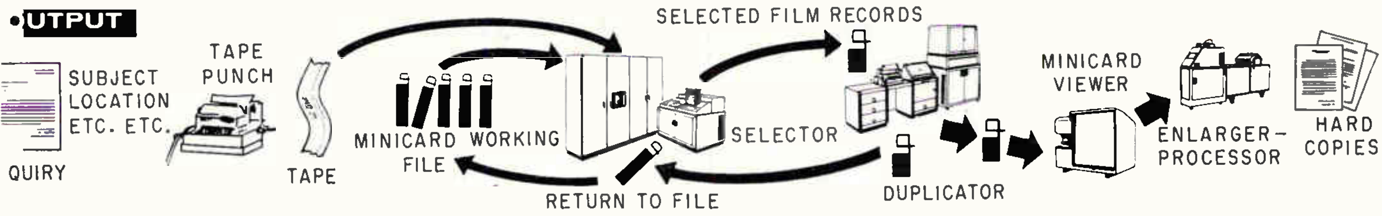


FIG. 3—Most elaborate information retrieval system built to date is IBM's WALNUT. Each image-file module stores 990,000 document pages, and modules can be added to extend capacity indefinitely. High-speed high-capacity random access magnetic index provides great flexibility in recording or searching records of documents in 1 to 2 sec; large-capacity, random access document image files provide for reproducing any desired document in 5 to 10 sec



f information storage and rapid mechanical retrieval by electronic machines

study to make system flexible enough for both special scientific applications and general library applications.

Four functional units make up the Verac system. These are the step-and-repeat camera for recording the information on film, the storage and retrieval unit which carefully files each film and uses a code to relocate any position on the film, an optical or television unit for viewing any selected page from the Verac file, and, finally, a "hard copy" reproduction machine. The four units have not been demonstrated as a single system, but they may be adapted to each other in any desired combination of functions to form a system.

WALNUT—IBM's WALNUT is a photographic-electronic system able to retrieve any one of millions of printed or typed pages or photographs from a file center within five seconds. This is a prototype information system being developed by the IBM Advanced Systems Development Division for the Central Intelligence Agency. There are no plans to market this system commercially primarily because of cost. (See Fig. 3.)

A tiny image of the document is photographically transferred to an IBM card so the document can be viewed on a screen or printed out without removing it from storage. Immediate access to any of the images stored in the bins is faster than locating information which must be searched serially. Information from the magnetic index immediately pinpoints location of the image in the file so that within seconds the document is ready for viewing or photographic reproduction.

The operation of WALNUT is comparable to that of a library—a dynamic type of library serving users almost instantaneously with information. Its catalog, or index, is a magnetic file. Its "shelves" are bins, each automatically loaded with photographic images of documents that have been reduced to about 1/1000th of their original area.

First, documents are microfilmed. Then, the 35-mm microfilm is placed in an image converter, which further optically reduces the image and transfers it to strips of film, each strip containing 99 images. As an image is transferred from microfilm to film strip, control cards are automatically punched to record its location in the file.

Each bin, or document file, contains 200 plastic cells of 50 film strips each, a total of 990,000 images. This is roughly equivalent to about 3,000 average-size books. The total WALNUT system can accommodate more than 100 document files.

A user starts his search for information by writing key search words on a form—words such as "Smith", "computer", or "creativity". Punched paper tape made from the form is placed in the machine, and a magnetic index is searched electronically. A list of index entries corresponding to the documents found by the key words is printed and returned to the user.

The user checks his choices on the list. Punched cards corresponding to the selected documents are pulled from a file of cards prepared when the document or abstract list was printed. From this file, pertinent data such as image location of the desired document and identification of the requestor are automatically punched in an aperture card containing a blank film insert.

The unexposed aperture cards are inserted into the document file which reads the location from the punched holes and brings the film strip containing the document image into lens position. The card's film insert with up to four images is automatically exposed by ultraviolet light and developed immediately by a dry heat process in about one-half second for each operation.

The card is then returned to the user, who may enlarge the images to original document size for printing or for viewing with a projection device.

CRIS—Information Retrieval Corp. has developed a system with mass microimage storage with rapid automatic retrieval capabilities called CRIS (Command Retrieval Information System).[18] The CRIS system is based on the original patents of Emik Avakian, as well as improvements developed by Information Retrieval Corporation. It is being manufactured by Litton Systems, Inc., of College Park, Md. (See Fig. 1.)

This system divides the retrieval problem up into three functional areas: index and search, storage and retrieval, and reproduction and transmission. The system is designed for compact, economical storage of millions of document images and for their rapid automatic retrieval. Microimages of any printed or pictorial matter are stored on a scroll contained in a cartridge which is inserted in the CRIS unit. Upon entry of a CRIS location number corresponding to the desired image, the unit automatically positions the image for display or reproduction.

The CRIS System is a combined 16mm and 35mm microfilm storage system. Because of the unique mapping of the scroll, it is possible to incorporate at random both 16mm and 35 mm microimages in the scroll. Each scroll may contain over 500,000 images of 8½ in. × 11 in. pages, or over 28,000 large drawings, or any combination of the two formats. The basic format is a frame of

1¼ in. × 1¾ in. which can be used for large drawings or maps. This frame may be further divided into nine subframes each containing two 8½ in. × 11 in. page images. Average automatic retrieval time to any desired image, selected at random, is under 20 seconds. Sequential selection is proportionally much faster.

The document image selection number or address, entered via a manual keyboard, corresponds to the physical image location on the scroll. This address is independent of the image content and therefore is fully compatible with any existing index. A cross-reference from an existing index to the CRIS address will be made available as a by-product of the scroll preparation procedure.

A dual lens system, controlled by the image address, projects either the subframe or the full frame on the 18 in. × 24 in. display screen. A sequential scanning key permits rapid scanning of frames or subframes. Accordingly, it is possible to scan or reproduce up to 18 pages as a unit. In addition to the visual display, a microimage contact print may be made from the selected frame or subframe. This film card, capable of con-

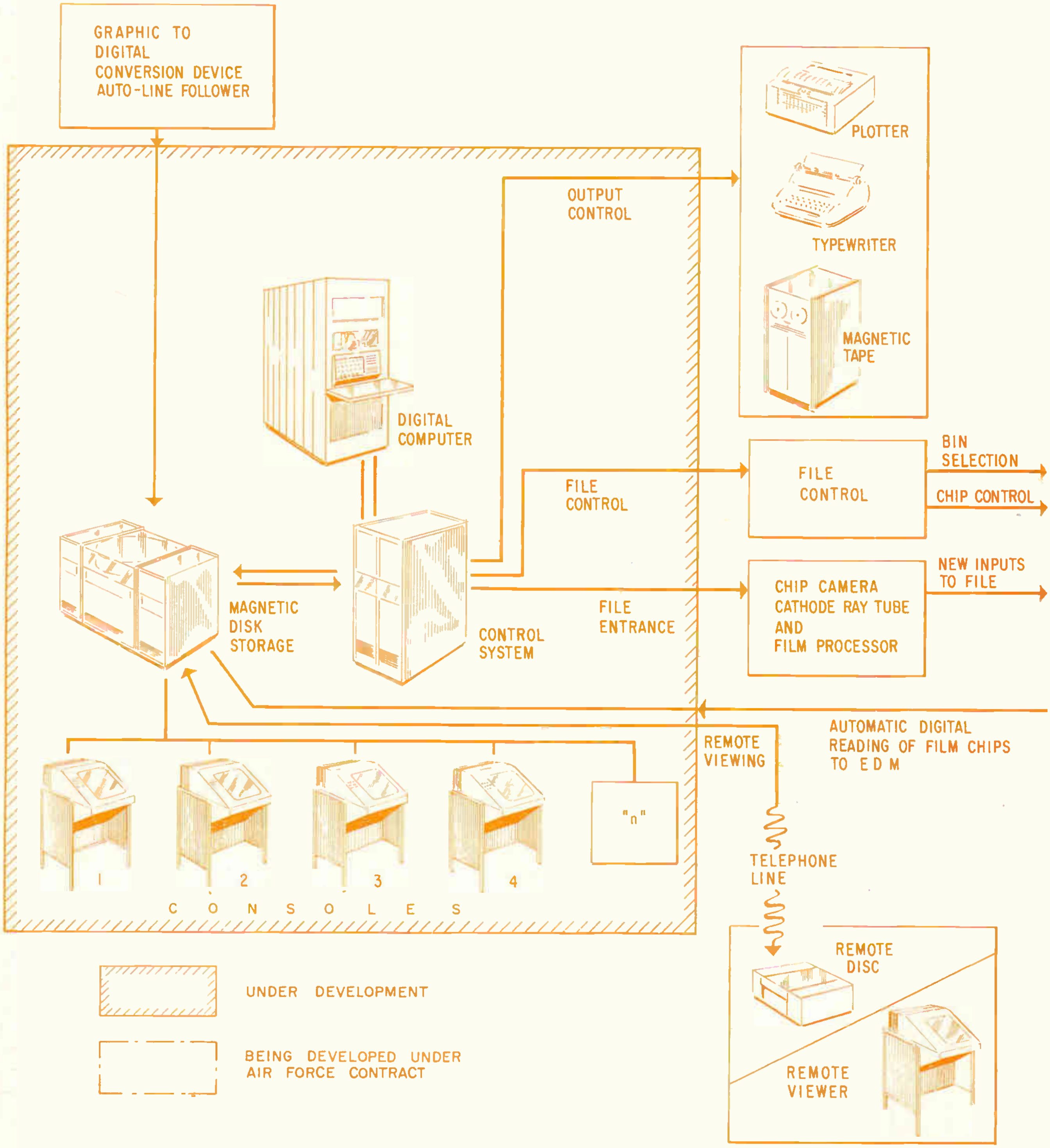


FIG. 4—A fully-integrated digital-graphic information retrieval system is Itek's EDM (Electronic Drafting Machine). A digital computer generates or recalls any of the stored signals on request. An operator at the console can then use a light pen and control buttons to erase, measure, move about, enlarge or reduce graphic images presented on the crt display

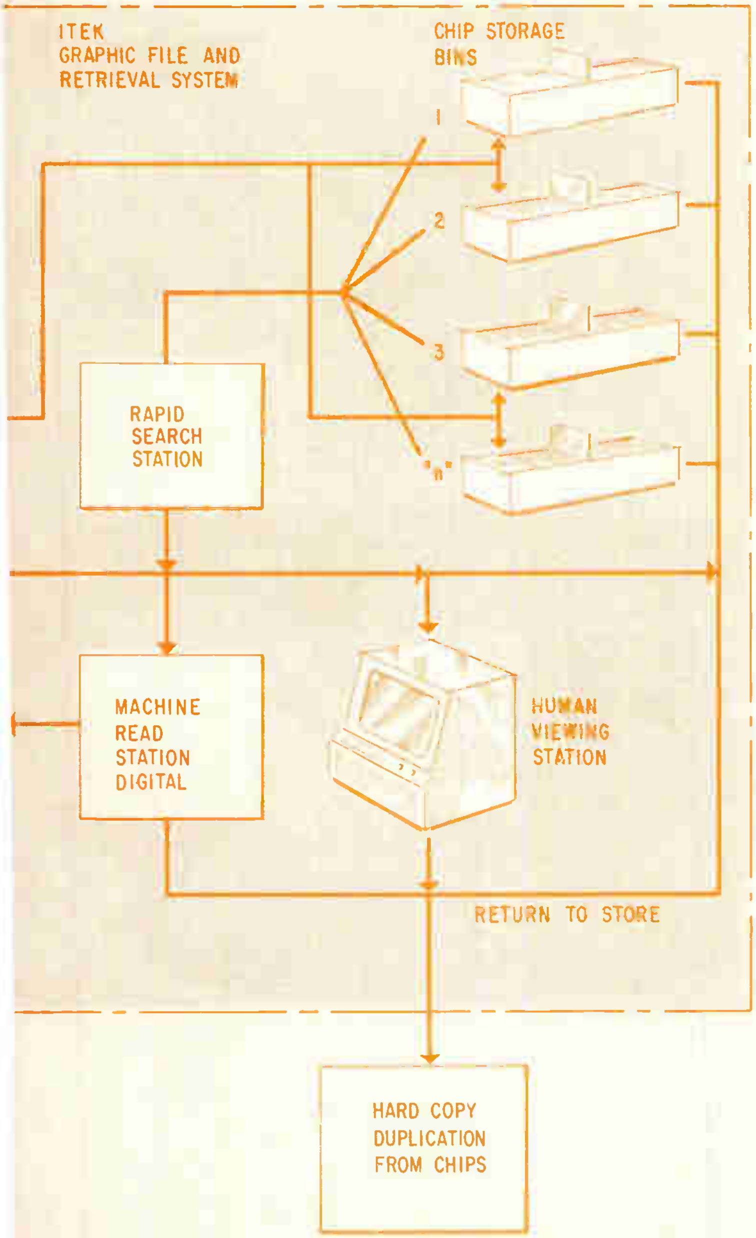
taining as many as 36 page images of 8½ in. × 11 in. may be used in conventional microfilm viewers and printers.

CRAM—National Cash Register's new Card Random Access Memory (CRAM), developed for use with NCR's 315 computer system, employs a removable cartridge containing 256 magnetic cards on which information can be stored in any order and selected and read in a fraction of a second. High-speed accessibility and large-capacity storage of the unit makes it possible to sort data, update records on either a random or sequential basis, make random inquiry, and store report data through the use of a single unit.

The magnetic cards used with CRAM are 14 inches long and 3¼ inches wide, and will hold 10,850 words. A deck of 256 cards is suspended from 8 two-position rods which turn in such a combination that the selected card is released onto a rotating drum, where data are read or written at a rate of 100,000 characters or 150,000 digits a second. A deck of CRAM cards, which can be replaced in about 15 seconds, stores over 8,332,800 decimal digits of information. Up to 16 CRAM units can be used with a 315 computer system.

As with all magnetic card storage systems, information can be stored or transferred in either a random or sequential manner. When used as a random storage medium, access time is 14 milliseconds and is time-shareable wherein the next card is selected and actually dropped while processing of the card already on the drum is completed.

When used as a sequential storage medium, a sort can be made on one CRAM unit. A full sort with two-way merge capabilities can be performed for up to 138,750 ten-word items on a single CRAM unit—a feat that requires four handlers using magnetic tape units.



MAGNACARD—(See Magnavue)

MICROCITE—NBS is also developing a system which uses 15 × 15-in. sheets, each of which can record the images of 18,000 document pages or abstracts.[19] The subjects are indexed by a set of peek-a-boo cards. When the illuminated holes in a set of peek-a-boo cards are intersected by a pair of coordinates, the appropriate image is positioned for projecting. This differs from the usual peek-a-boo system (where the position of a hole is interpreted as a document serial number) in that the searcher views a description of the document at each hole position. The description is on microfilm and is projected and enlarged on a screen.

Modification to permit accommodation of additional sets is being investigated. The first multiple-set magazine will accommodate abstracts of approximately 200,000 documents and be capable of enlargement without appreciable modification. The magazine will carry one microimage matrix for each set of 18,000 documents. The appropriate matrix will be selected automatically by insertion of the peek-a-boo cards being searched.

Provisions for furnishing photocopies of selected abstract cards are almost complete as are provisions for coded electrical output of selected-document serial numbers. The latter will be available for feeding into accessory equipment to print out lists of document numbers or to furnish complete documents, as desired. Work is continuing on problems of duplicating peek-a-boo cards and on development of simple techniques for making searches involving logical sum and logical difference.

This prototype system is in experimental use as a search tool for the instrumentation reference collection at NBS' Basic Instrumentation Section.

The research and development department of the U. S. Patent Office is also interested in the NBS photo-drum viewer and peek-a-boo card indexing system for searching transistor technology drawings. F. & W. Co. studied the NBS experimental machine and has made a preliminary design and estimate of the equipment modifications needed to adapt a precision Microfile camera, vacuum contact printing frame, and special light source for making a 20 × 22-in. film sheet containing up to 18,000 drawings, each 6 × 9 in.

Also F. & W. has designed a 72X projection system which could be used to check individual images on the first sheet. The elements of this projector would later be used on the prototype photo-drum viewer to be made in the Census Bureau shops for the Patent Office.

L-3000 SYSTEM—A computer—mass memory combination (the L-3000) proposed by General Precision's Librascope division will abstract each document into a short list (16 words) of the most frequently used words in the document.[20] These will be listed alphabetically and stored in a 126-word block in the mass memory along with an eight character key which is assigned by an information retrieval technician and which describes the general category under which the document should be stored.

If several such different categories are pertinent, the abstracted key words are repeated under each of these categories in different blocks in the file. The fixed address location of those blocks in the mass memory, along with the file position and the mass memory console address, become the cross-reference code number for the original document which is stored on microfilm under the code.

On the microfilm unit, the documents can be retrieved by that code and examined on a viewer or reproduced. Further, the mass memory can access a line printer to print out the sorted abstracts as the results of a search, or just print out the list of code address with a relevancy number.

One Librascope mass memory, with a capacity of about 85,000,000 characters, will hold and search the abstracts of the equivalent of 42,000 *Electronics* magazine articles.

Since the average access time on the Librascope mass memory will be about 45 milliseconds, including disk latency and head positioning, the first abstract should be ready for printout on a line printer within that time.

The sequence of retrieval would be as follows: an inquirer (possibly at a remote point) would describe the imaginary document he wishes to retrieve by listing possible general categories (from a list of general categories and examples supplied to him), and by listing the key words which he requires or which he would like to see in the document.

This information is then passed on to the technician who checks it for accuracy of spelling (the technician's help may have been used in preparing the query), lists the mandatory key words alphabetically, followed by the non-mandatory key words listed alphabetically, and then enters the query into the computer via a remote i/o typewriter, small computer, or via punched cards and magnetic tape. The computer prepares the file unit for search, and the remainder of the mass memory operation is off-line or in parallel with other computer operations.

With the search key in the file's mask register, the file logic begins comparison on the file data to find the general category keys. Whenever one is found, the logic takes the first character of the first key word and looks for comparison within that block. When this is found, the next letters in sequence must compare with the next letters of that key word. If no comparison is found in all mandatory key words by the end of the block, the search is repeated on subsequent blocks.

When the first mandatory key word has been compared, the first character of the next key word is brought up and when it coincides with a character in the block, then comparison on subsequent characters of the word is required, and so on through all of the mandatory key words. As comparison on a block is made, it is read into the key register portion of the core buffer register, and if successful comparison on all mandatory words is made, then the block is rechecked in the register to determine how many of the non-mandatory key words compare. A count is generated which demonstrates the degree of comparison, thus automatically giving relevancy criteria.

All three or any combination of the abstract, the coded cross-reference number for the microfilm, and the relevancy number may be printed out on the line printer, headed up with the original search criteria as a title. This listing can be sent to the inquirer and provides a comprehensive list of all pertinent documents and, because of the relevancy numbers, also provides depth to the list in that the records with the highest relevancy numbers are closer to being the imaginary document for which the search was conducted.

The inquirer, upon looking over the abstracts, will be able to reject many as being unsatisfactory, and will then request the actual documents via the code numbers of the relevant abstracts. The micro-films of these documents can be viewed at one of several viewing centers for further refinement of selection before reproduction, or the whole transaction can be handled from a remote point, and the requested documents will be reproduced and sent to the inquirer.

SPECIAL SYSTEMS—Itek Corp. has just introduced a fully integrated digital-graphic processor for reading and writing geometric patterns.[21] This system allows high-speed storage and retrieval of drawings and fast introduction of changes without destruction of the original.

A drawing is stored in both digital and graphic form on film chips. A compact, digital description of a drawing can be transmitted long distances over telephone lines at a fraction of the cost of facsimile and with no degradation in drawing quality. The receiving unit maintains a clear image on a crt without the need for repeating the transmission periodically as in television.

The graphic file and retrieval system (Fig. 4) is an open-end storage system designed for large installations where the use of magnetic tape is limited by sheer volume of data to be handled. Chips or cards are 35 mm, 70 mm or 3 in. by 5 in. size and mounted in a rapid handling transport mechanism. Chip handling is accomplished by blowing air behind each chip.

As the chips pass through a series of search stations, a code is read from the edge of the chip by a new method of magnetic reading. Retrieval time is a matter of seconds. When the desired chip passes through the search station, it is switched off-line to a reading station where it can be read by either of two methods: human viewing by optical enlargement of the chip image, or machine reading by electronic scanning of digital data recorded on the chip as opaque or clear spots.

The index of the graphic file is programmed in the computer and can be addressed from the console or from the File Control Station.

"Man may become the polymorphic switch in the man-machine system, the link with the continuing unclear outside world" . . . **Simon Ramo**

FUTURE NEEDS AND PROSPECTS

Woven screen memory under development at Thompson Ramo Wooldridge may reach cost of one cent a bit

OPTIMAL INFORMATION retrieval systems can never be developed, primarily because they are open-ended and will require continuous refinement. When integrated with information centers, however, the continual feedback inherent in such operations will stimulate further development and discoveries.

Ten years from now, no library will attempt to handle information by the present manual methods. Because they will be mechanized, at least in part, there will be a trend toward development of more and more information centers.

SCIENTIFIC INFORMATION CENTERS—Mechanized handling of technical and scientific literature has quite naturally led to the centralization of information processing for automatic search. These centers have been set up primarily to acquire, organize, search, and disseminate recorded information on specialized subjects to give the user maximum accessibility and utilization of the published works in his field.[21]

Scientific information centers are defined differently by people from dissimilar disciplines. Most important center, however, to a volatile technology/science like electronics is that which exists for the primary purpose of preparing authoritative, timely and specialized reports of the evaluative, analytical, monographic, or state-of-the-art type. Many centers are presently established in the electronics field with more likely in the future.[22]

Contract for the largest computer oriented, completely integrated technical information center in the world was recently let by NASA to Documentation, Inc. To be known as the Scientific and Technical Information Facility and dealing in the space and aeronautical sciences, it will use the latest in communication equipment, an IBM 1401 tape system with a random access memory and 100 information specialists. Facility location is Bethseda, Md.

PERSONNEL—Historically, information specialists considered their function to be accumulation and organization of knowledge to support creative work in the disciplines. As has been emphasized throughout this report, changes are rapidly taking place in the information sciences which are now and will continue to affect both the creators and processors of documents. Electronics, like all other highly competitive industries, is going to be motivated toward tackling the problem by the desire to survive—a condition dependent largely on time use of technological, scientific and management information.

But where is industry going to get the all-important connecting link, the modern science information specialist? Today, no distinct organized profession of science information exists![23] Those who have been working in the fields are of many professional types: mathematicians, logicians, linguists, philosophers, computermen, librarians, intelligence experts, documentalists, publishers and industrial management people.

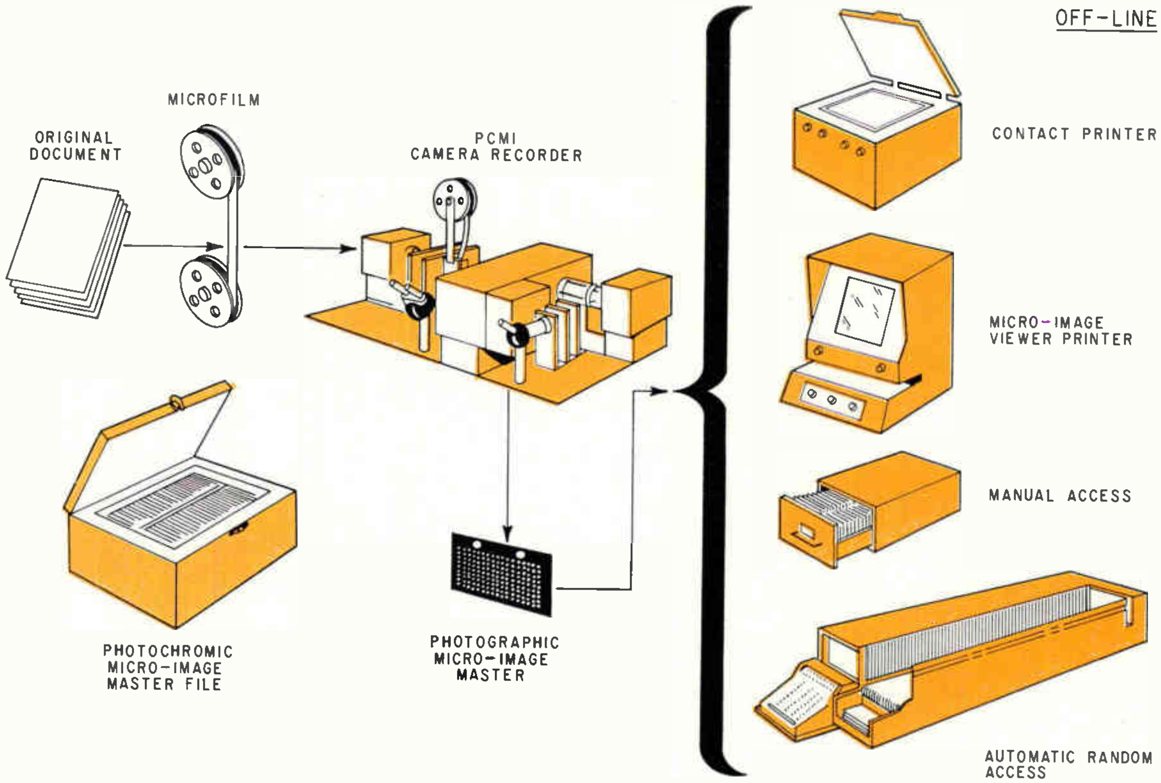
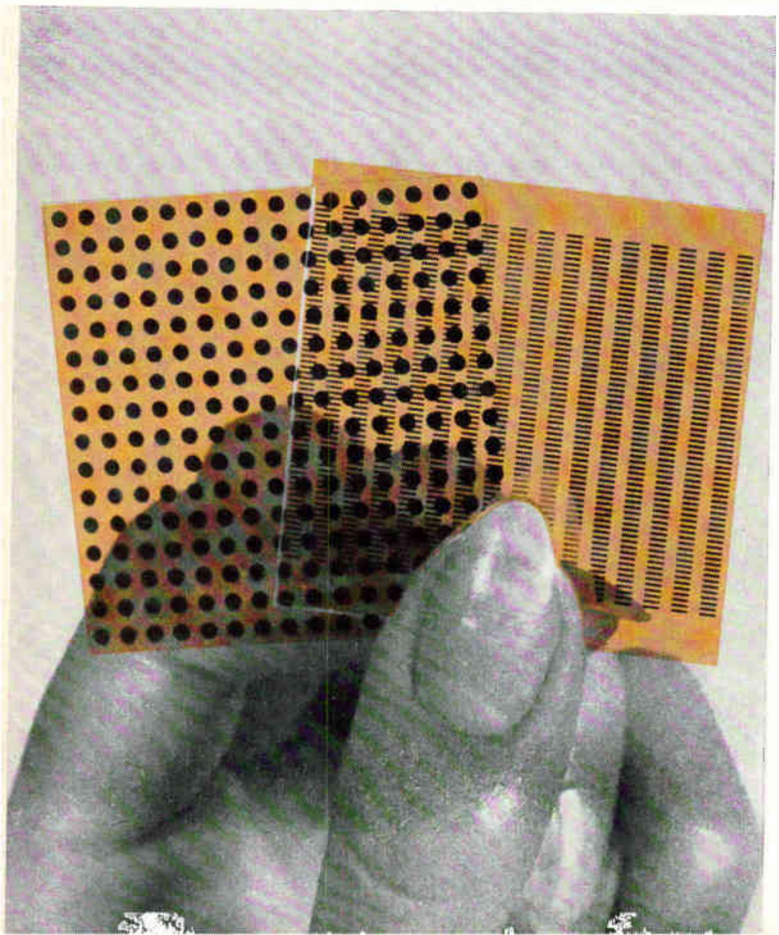


FIG. 1—In National Cash Register's photochromic micro-images system, near-ultraviolet light is directed through transparent microfilm of original material and into the micro-image lenses to form a miniature image on the photochromic coating

Thin magnetic film with rectangular spots is used in FX-1 computer in operation at MIT Lincoln Laboratory. Initial memory has capacity of 256 13-bit words, with a read-write cycle time of about 0.2 microsecond



Most important task of the science information specialist of tomorrow will be developing information systems, investigating machine applications, interpreting information, researching with information, and actively scouting out information. He will also be involved with: administering science centers; locating, selecting and acquiring material; descriptive cataloging; indexing, abstracting and annotating; performing reference work; literature searching and bibliography preparation; translating and converting information to machinable form. Besides subject knowledge, information specialists probably will be required to have one of four other qualifications: knowledge of information systems and instrumentation, administrative ability or experience, foreign language proficiency, or professional library education and experience.

INPUT NEEDS—Providing input to a system in machine language is not only a difficult technological problem, but involves prohibitive cost when done manually; thus, savings must be made by cutting down the excessive input effort (in terms of time and money) now required.

New indexing techniques will probably be evolved which offer special advantages for machine operation. Techniques being investigated now include prime number and superimposed coding, and abbreviated spelling. Also, vocabulary control, possibly through the use of thesauri, should be investigated to cut down some of the language barriers.

Character recognition devices capable of accurately reading a variety of typed characters under high noise conditions should be developed to provide automatic input capability. Short term, these devices may not have too much application because if some prophesies come true, all input to retrieval machines of the future will be in machine translatable language to start with. However, recognition devices will be needed for automatic machine translation where input is uncontrolled.

Several severe problems must be investigated vigorously. How can response failures resulting from inadequacy in phrasing a question be minimized? How can increasing amounts of duplicate, repetitious or junk-type information be controlled and culled out? How can mechanical procedures synthesize information so that new relationships not apparent from any single document can be determined?

In the near future, at least, the major effort will be further development and refinement of storage systems of both image and special digital types. Also general-purpose digital computers will utilize more thorough sophisticated programming techniques. However, most important is the development of new high-capacity storage devices. These microstorage techniques should be low-cost enough so that they can be economically exchanged between information centers or cooperating groups.

FUTURE MASS STORAGE DEVICES—Magnetic drums, disks and cards will probably become the main computer storage media for information retrieval systems during the next five to ten years. However, these techniques may be displaced in the interim by thin film or woven screen memories, if predicted costs are realistic, or the photochromism approach.[24]

Drums and disks are expected to have track densities up to 500 to 1,000 tpi and pulse densities up to 3,000 ppi within a few years. This improvement would mean storage of from 10 to 100 billion bits—a capacity more than adequate for many retrieval systems. However, prohibitive costs in achieving lookup times better than a few tenths of a millisecond may be a limiting factor.

Low cost, high volumetric efficiency and inherent open-end flexibility make magnetic cards a sure bet to gain increased popularity. Probably systems utilizing this media will have to tolerate random access times higher than obtainable with drum or disk storage.

Switching speeds in the nanosecond range make magnetic thin film memories attractive. Problems of noise and low density recording (few thousand bits per square in.) together with high drive requirements are severe, but solutions are being actively sought in many laboratories.

Superconductive thin film memories are a distinct possibility because of the rapid refinement that has taken place in cryogenic techniques and recent sharp drop in cost of liquid helium. Large memories are anticipated with extremely fast switching speeds.

Superconductive tunnel diode thin film memories may actually be the dark horse entry. Microwatt power requirements are predicted with switching speed in the nanosecond range.[24]

WOVEN SCREEN MEMORY—Woven screen memories have been under development at RW Division of Thompson Ramo Wooldridge for a considerable time. What is hoped for is a very large, fast, random access, inexpensive memory that will be superior to anything possible in conventional magnetic core memories.

By large is meant well over 100,000 words or—to be specific—a million-word memory having at least 36 bits per word. Achievable speed is under 10 microseconds. and RW feels the memory cost can be reduced to about one cent a bit. For comparison, the present cost of core

LIBRARY OF TOMORROW

THE BOOK will be with us for a long time; it is too good a piece of human engineering to be discarded easily. Likewise, users will demand full-size copies of other documents, even though the image may be stored in microform. Thus, I expect the retrieval selector machines to move into the background, to be used only in special situations. Instead, I propose a wholly different solution to the problems of internal library operations.

Heart of the system would be a "reactive typewriter". This I conceive as a special kind of computer connected typewriter capable of reacting by automatically typing back modified versions of the information that had just previously been typed in. A program-language called TRAC (acronym for "text" reckoning and comply system) that could be used to control computer operation is now being designed. TRAC allows for intermixing of text and programming statements, programming statements to be treated as text, naming any of the entities, storing them and recovering them by name, and handling recursive statements, definitions and nested definitions. Also, it is especially capable in performing substitutions, rearrangements and decisions.

One application of a reactive typewriter system would be in the maintenance of card catalogs—not only typing and filing the cards, but also replacing them when they deteriorate or wear out. An example of how the reactor typewriter system might be used is in preparing a stack of new cards, loading the remote computer with a procedural description of the desired catalog card format and a description of the permutation on the data that we wish to have typed out. Next, the required master information for each book or document is typed in. When the "go" signal button is pressed, the remote computer with its catalog format program takes over and types card sets desired.

For other applications, electronically compiled lattice indexes or their equivalent could be used. Lattice indexing is a technique for stringing descriptors together by machine to systematically generate sets of consistent subject headings and index entries for printed index.

The big change coming is the disappearance of the card catalog. It will be replaced by book-form catalogs compiled periodically and brought up to date by electronic machines. Current high-speed printout machines for computers print from 36,000 to 60,000 lines of double column text (two pages at once) in an hour, with the material arranged in the most useful fashion.

These are only hints of the capabilities of the reactive typewriter. It is my prediction that it—in some version—will soon be with us, and will create a revolution in office clerical procedures—
CALVIN N. MOOERS, Zator Company[4]

memories is about 15 cents per bit. Extensions in the state of the art could bring this down to five cents per bit.

Functionally, a woven screen memory has the attributes of a magnetic core memory. In the RW approach, individual memory elements are formed by weaving strands of 30-gauge bare copper wire into a screen mesh, thereby forming the equivalent of a magnetic core at each mesh point. The screen is then plated with a permanently magnetic material. Read and write leads are brought to each mesh point to control or sense the state of magnetization.

RW has demonstrated the feasibility of the woven screen technique, using a six-microsecond switching speed. Actually, switching is not a limiting factor—they have operated at speeds well under two microseconds.

THERMOPLASTIC STORAGE—Thermoplastic recording (TPR) combines the processing speed and much of the versatility of magnetic recording and the storage capacity of photography, and it offers some advantages over both these recording systems. Invented at GE's Research Laboratory, the process can concentrate 100 times as much information in a given space as can magnetic recording, and has the potential of still greater concentration. Like photography, TPR has the advantage of almost instantaneous recording and will produce pictures either in black and white, or color, but does not require chemical processing and can be erased. Density of 40 million bits per square in. is possible.

PHOTOCHROMISM—The National Cash Register Company has developed a new storage technique, called photochromic micro-images (PCMI), which makes high-density document storage feasible at linear reductions of 200 to 1, representing an area reduction of 40,000 to 1. Using this technique, it would be possible to record a 300-page book within a square inch of film. (See Fig. 1).

By definition, photochromic compounds exhibit reversible spectral absorption effects (or color changes) resulting from exposure to radiant energy in the visible, or near visible, portions of the spectrum.[25] One class of photochromic materials consist of light-sensitive organic dyes. The NCR photochromic coatings consist of a molecular dispersion of these dyes in a suitable coating material. These coatings can be made to retain two-dimensional patterns which are optically transferred to their surface.

Mechanization of the NCR PCMI process involves transferring the original document to high-quality conventional microfilm. Properly filtered, near-ultraviolet radiation then is directed through the transparent microfilm and into the micro-image optics. This forms a miniature image on the photochromic coating. The size of each micro-image would be 0.042 × 0.055 inch, and a matrix with up to 2,625 micro-images could be placed on each 3 × 5 plate. Now the entire contents of the photochromic plate are transferred in one step as micro-images to a high-resolution photographic film by contact printing. The photographic film is then developed under highly controlled conditions, and the result is a 3 × 5 photographic micro-image master plate.

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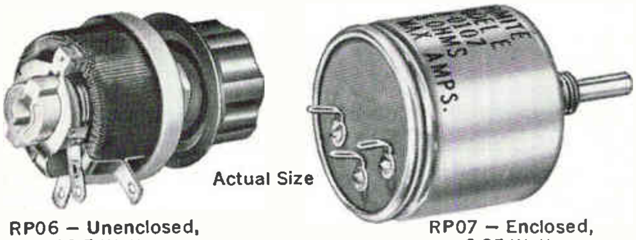
Frontispiece shows section of 400-foot long, 17-in. wide microfilm scroll capable of storing over ½ million printed pages which is used in Information Retrieval Corporation's CRIS system (p 55). Although illustration carries only three horizontal rows of frames, actual film has eleven horizontal rows.

Cover based on a sketch submitted by Documentation, Inc

New Revision "B" Brings Small Rheostat into the Specification



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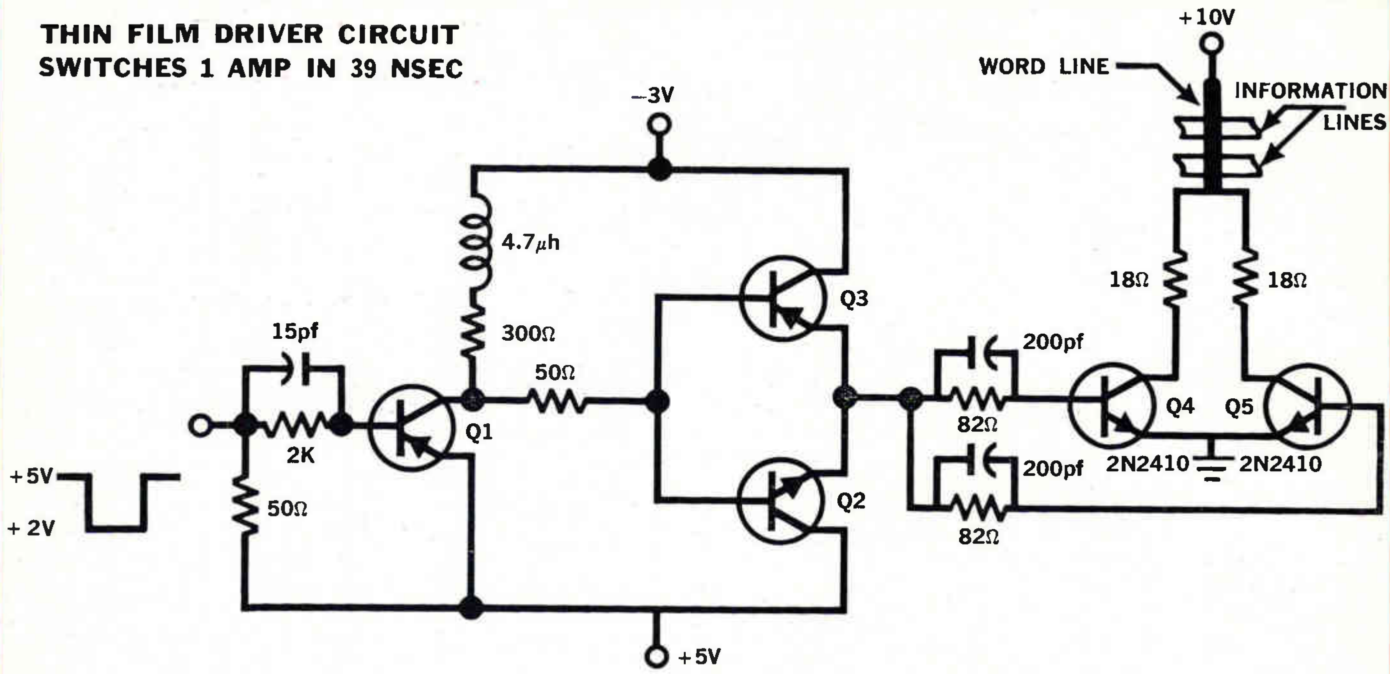

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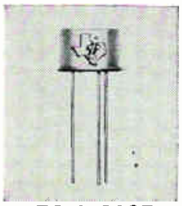

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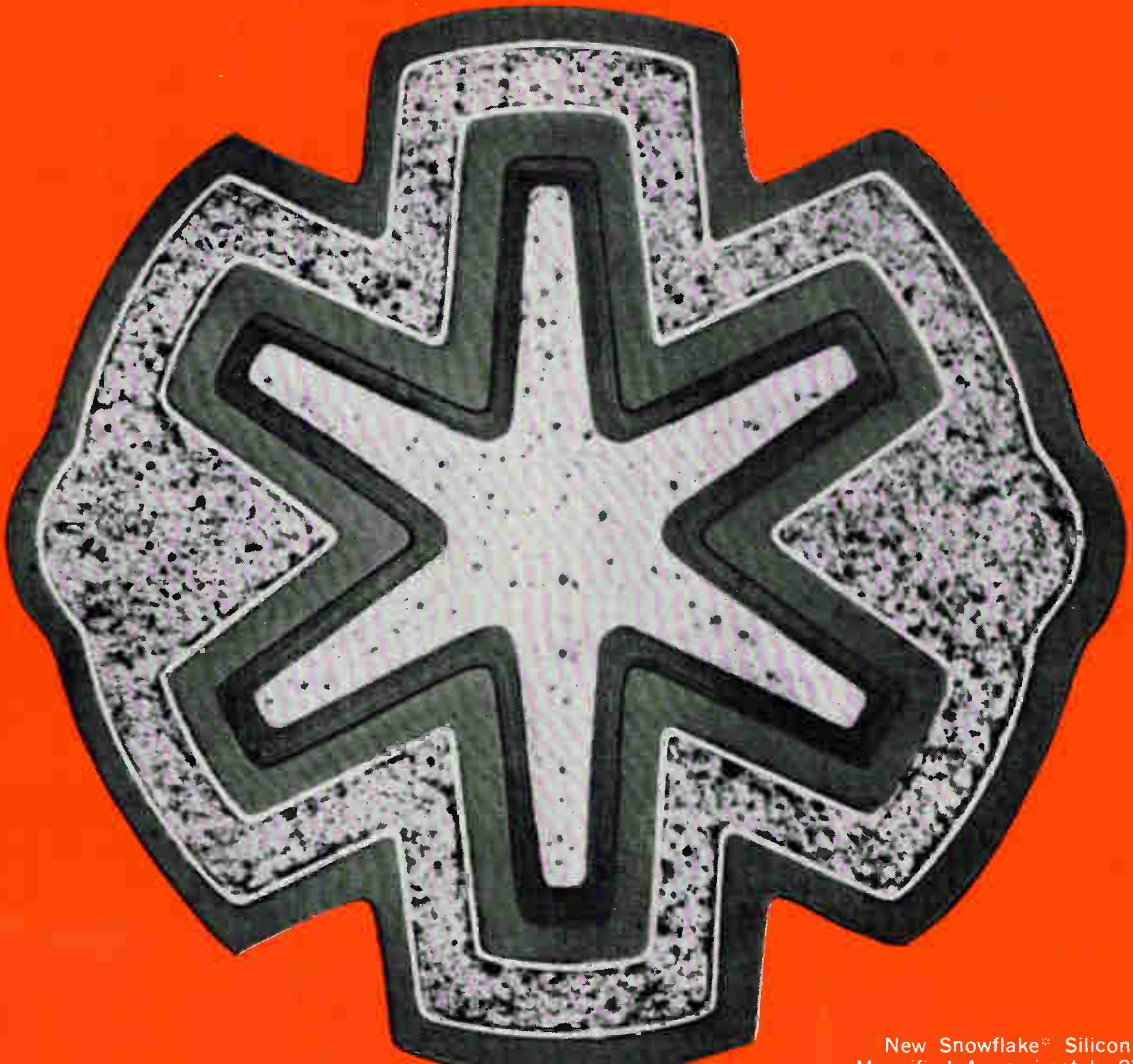

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TI 2N2410 "SNOWFLAKE" SPECIFICATIONS

Parameter	Test Conditions	Min	Typ	Max
BV_{CBO}	$I_C = 100\ \mu a$, $I_E = 0$	60 v		
h_{FE}	$V_{CE} = 10$ v, $I_C = 10$ ma	30	75	120
h_{FE}	$V_{CE} = 10$ v, $I_C = 150$ ma	30	75	120
h_{FE}	$V_{CE} = 10$ v, $I_C = 500$ ma	25	60	100
$V_{CE(sat)}$	$I_B = 15$ ma, $I_C = 150$ ma		0.35 v	0.45 v
$\|h_{fe}\|$	$V_{CE} = 10$ v, $I_C = 50$ ma, f = 100 mc	2.0	3.0	
t_{on}	$I_C = 150$ ma, $I_{B(1)} = 15$ ma, $I_{B(2)} = -15$ ma		35 nsec	65 nsec
t_{off}	$V_{BE(off)} = -2.75$ v, $R_L = 40\Omega$		40 nsec	55 nsec
t_{on}	$I_C = 500$ ma, $I_{B(1)} = 50$ ma, $I_{B(2)} = -50$ ma		40 nsec	65 nsec
t_{off}	$V_{BE(off)} = -3.50$ v, $R_L = 40\Omega$		45 nsec	65 nsec

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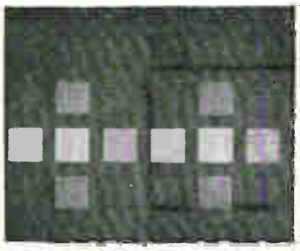
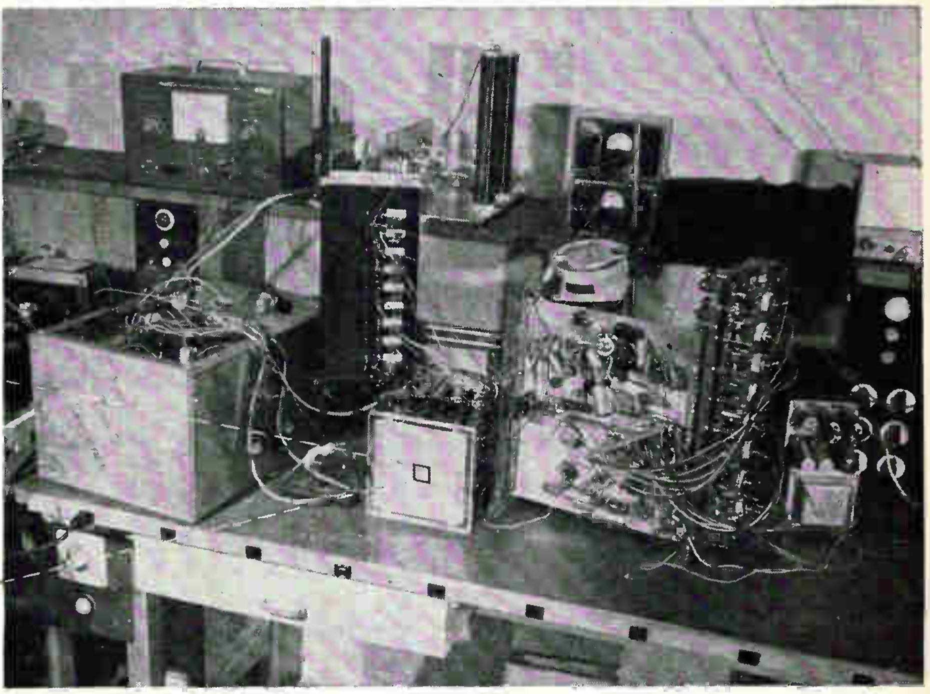
SEQUENTIAL *and simultaneous display panel in operation showing electronically generated dot pattern*





SOLID-STATE PANELS:

Will They Bring Flat-Display Tv?

This ferroelectric-electroluminescent display panel uses a combination sequential and simultaneous excitation procedure to achieve tv frame repetition rate. System is capable of high resolution

By B. BINGGELI
ENNIO FATUZZO
RCA Laboratories Ltd.,
Zurich, Switzerland

MUCH EFFORT has gone into producing panel-type display devices[1-4] that can be used in flat display boards handling information, air traffic control and general memory display, but resolution and speed of these displays are usually low. What is desired is a display working at television speeds and television resolution. Many approaches to flat panel displays are possible.

One approach uses a ferroelectric-electroluminescent (FE-EL) system, mainly because the impedance match between the electroluminescent and the ferroelectric cell is good as compared, for instance, with the impedance match between an electroluminescent and a ferromagnetic element. Both ferroelectric and electroluminescent cells have high impedance.

Another FE-EL combination, by A. Sack[5], uses the static nonlinear properties of ferroelectrics to control the voltage across the electroluminescent cell and thus its light output. A scheme by Coopermann[6] uses the dynamic properties of a ferroelectric to control the electroluminescent output.

This last system, based on a sequential type of display, has some serious practical disadvantages. Because of the limited switching speed of the ferroelectric crystals and the relatively long excitation time needed for the phosphor, a certain scanning speed cannot be surpassed unless impractically high voltages are used, or unless the number of picture elements is greatly reduced. Even if a long persistence phosphor and hence slow scanning speeds could be used, the bandwidth of the video signal would have to be limited and a change of picture information could be accomplished only slowly.

NEW SYSTEM—Proposed here is a system that avoids these shortcomings, while making use of the FE-EL combination and of the dynamic properties of ferroelectrics. This system (Fig. 1) is based on a combination of a sequential and a simultaneous display.

A ferroelectric is a dielectric in which the relation between the electric displacement and the applied electric field is given by a hysteresis loop. The ferroelectric has two equilibrium states for $E = 0$. With an electric field, it can be switched from one state to the other. Several investigators[7-9] found a considerable increase in the dielectric constant when it is being switched. It is this effect which is exploited in our device. The increase in dielectric constant of the FE capacitor yields a corresponding decrease in the reactance of the capacitor. Thus, the FE capacitor can be used as a FE gate, which is open while the FE is being switched, and closed the rest of the time.

The screen is an electroluminescent phosphor layer sandwiched between two conducting surfaces. One of them is transparent to allow the generated light to be observed, while the other carries 225 evaporated opaque metal dots representing the picture elements. These dots are arranged in a square having 15 dots on each side. In the circuit the 225 dots are arranged in 25 subgroups (5 × 5) of 9 (3 × 3) dots each (see Fig. 3A). The rows of the matrix are capital *A*, *B*, *C*, *D*, *E* and the columns are lower-case *a*, *b*, *c*, *d*, *e*. Thus each subgroup can be identified by two letters (for example, *Bd*): each dot in each group can be identified by a number from 1 to 9, so that each dot in the panel can be labeled by two letters and one number (for example, *Bd*3). Based on the principle of the FE gate, a scanning system brings the exciting a-c voltage sequentially to the subgroups (from *Aa* to *Ab* to *Ac* and so on).

Each subgroup receives the information for the 9 dots simultaneously through 9 different carriers ranging from 22 to 38 Kc.

In Fig. 3A, the dots consist of EL cells, excited by a-c voltages of about 80 v rms and frequencies ranging from 22 to 38 Kc. The path for the a-c excitation current leads from one a-c generator of arbitrary phase 0 deg through an FE gate, then through the EL cell and through a second FE gate to another a-c generator of 180 deg phase as in Fig. 2A. Two a-c generators, each supplying half the excitation voltage for the EL cells, are used for two reasons. First, two sweep amplifiers are needed for horizontal and vertical sweep; since these amplifiers are also used for the amplification of the excitation voltage, it is convenient to divide the excitation power between them. Second, since the excitation voltage appears superimposed on the sweep voltage, there is a noticeable increase of ON time of the ferroelectric crystals due to the additional switching effect caused by excitation voltage. Therefore, the ratio of sweep voltage to excitation voltage should be kept as high as possible. Thus, one set of ferroelectric condensers is placed on the horizontal axis of the EL cell matrix, the other set operates on the vertical axis (Fig. 1).

The group of dots receiving information at one particular time is selected by the opening of two FE gates; one gate chooses the column, the other the row. The scanning sequence is (Fig. 3A): *Aa, Ab, Ac, Ad, Ae, Be, Bd, Bc, Bb, Ba, Ca, Cb, Cc, Cd, Ce, De, Dd, Dc, Db, Da, Ea, Eb, Ec, Ed, Ee*.

Coopermann's system is used to scan the matrix.[6] The FE gate controlling a horizontal line remains open, while the gates controlling a column close one after the other. After one row is scanned, the gate controlling it closes and the gate controlling the next row opens. This sequential opening of gates is achieved by biasing each FE crystal with a d-c voltage. All FE capacitors on one axis gating a 9-dot group have the same bias; the ferroelectrics gating different groups

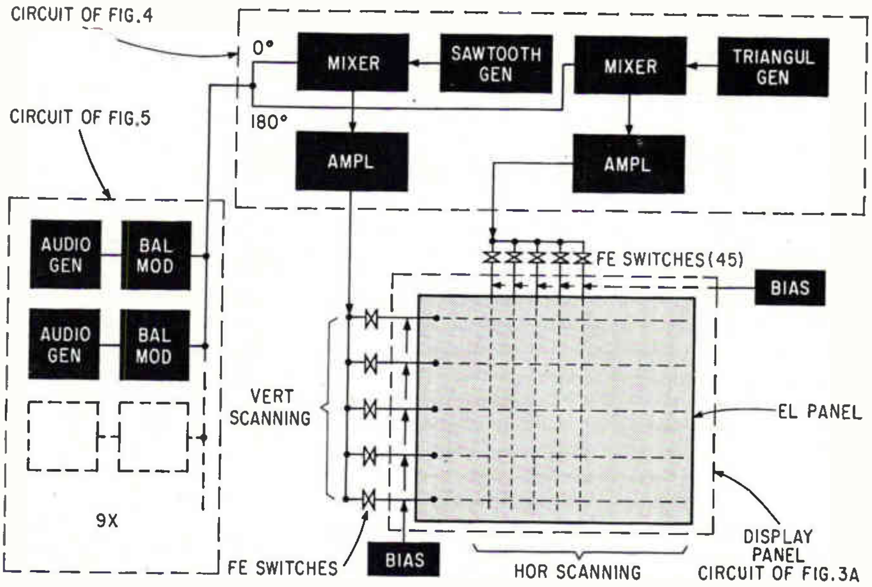
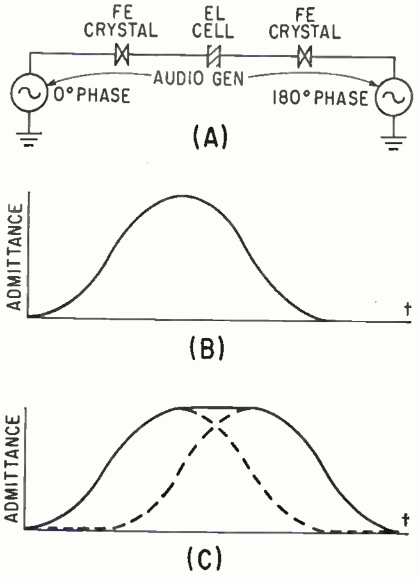
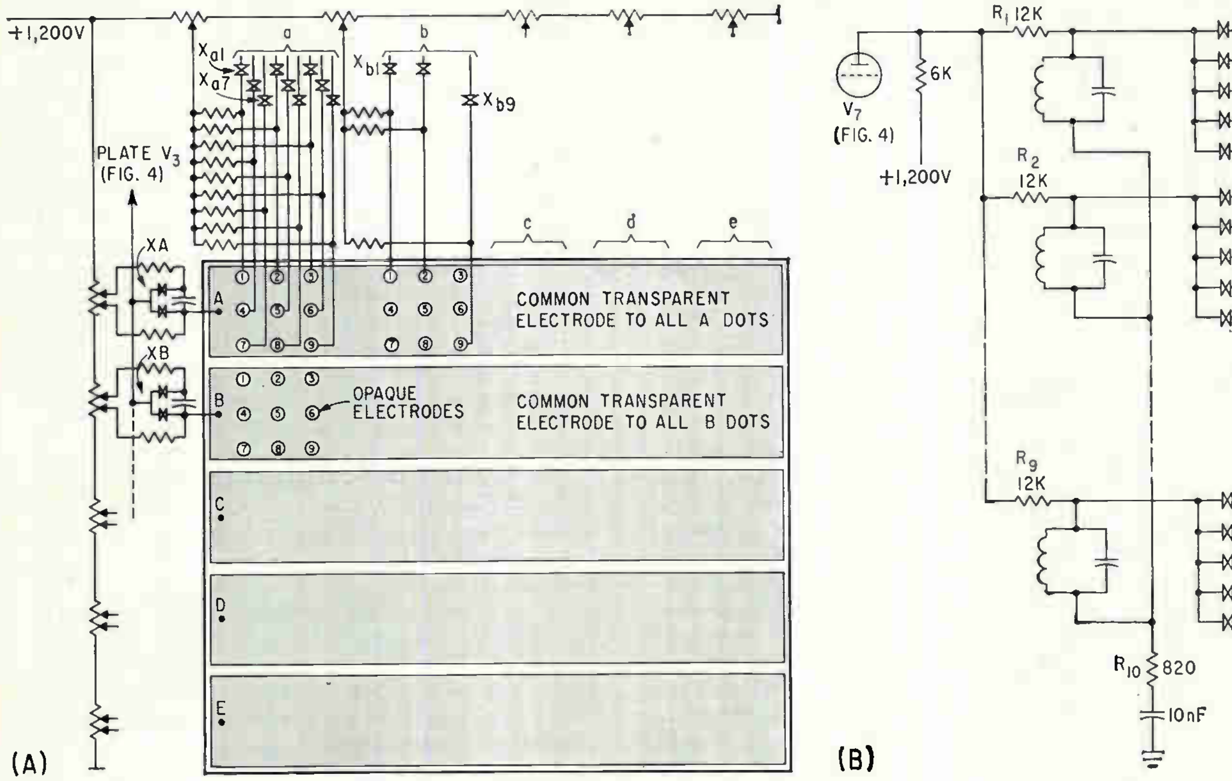


DIAGRAM *of the ferroelectric-electroluminescent display system—Fig. 1*



BASIC CIRCUIT *uses two generators (A). Switching characteristics of single FE crystal (B) and crystal pair (C)—Fig 2*



ARRANGEMENT *of ferroelectric gates (A), and filter circuit (B)—Fig. 3*

have a different bias.

A triangular wave of 125 cps is applied to the vertical axis of the matrix, while a sawtooth voltage of 50 cps is used on the horizontal axis. The ferroelectrics switch when the sawtooth or the triangular voltage increases over the bias voltage. Since the ferroelectrics are biased in a steplike sequence they will switch sequentially. The bias for the FE crystals is supplied from a voltage divider through insulating resistors of 33,000 ohms. These resistors prevent the excitation voltage from being shorted to ground and keep a d-c path open for the d-c charge reversal of the FE crystals.

The FE gate controlling a horizontal line must remain open while the row is scanned, then this gate must be closed rapidly and the one controlling the next line has to be opened. This requirement calls for a switching characteristic short rise time, long duration) that cannot be obtained with one FE crystal. The problem can be solved by using two crystals in parallel, to which a slightly different bias voltage is applied. Figure 2B shows the admittance increase of a single crystal during switching and Fig. 2C the admittance characteristic of a pair of crystals in parallel with slightly different bias; the slopes remain as steep as those of a single crystal—a desirable switching characteristic. The crystals X_A to X_E, in Fig. 3A, represent a combination of two capacitors with slightly different bias.

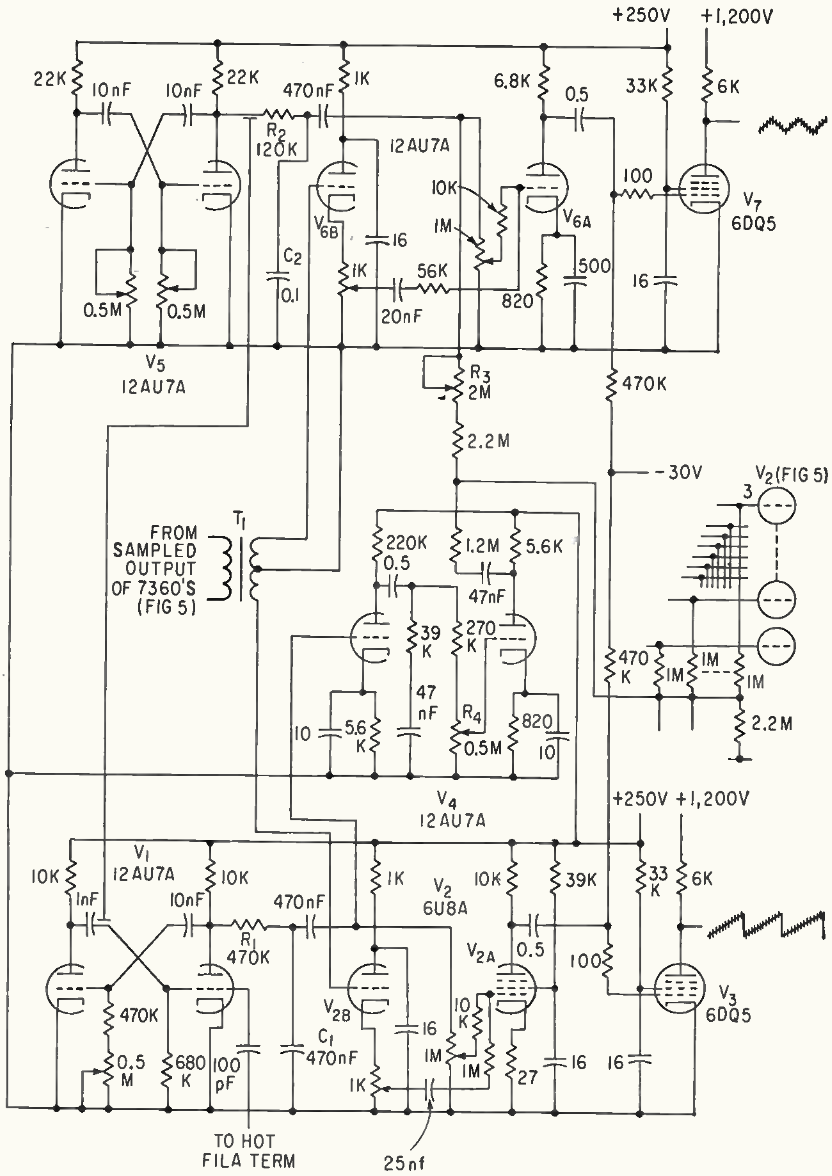
FILTER OPERATION—The simultaneous distribution of the brightness information to the 9 dots of each group is accomplished by filters as follows: The a-c excitation applied to the matrix consists of 9 different carrier frequencies, each modulated with the proper information for the corresponding picture element. Across each picture element there is a parallel L-C network with its resonant frequency adjusted to one of the 9 carriers. The lowest carrier is placed at 22 Kc, the highest at 38 Kc. Only the carrier corresponding to the resonant frequency of the L-C filter develops sufficient excitation voltage for the EL cell. The other 8 carriers, although present, meet only a small impedance.

Since all 9 filters receive their signals from a single output terminal at the excitation amplifier, provisions must be made to prevent one filter from shorting the remaining 8 carriers. This is done by inserting 9 insulating resistors R_1 to R_9 (see Fig. 3B). Resistor R_{10} increases the load resistance for proper matching to the excitation amplifier. This resistor reduces the selective action of the filters but the nonlinear excitation voltage vs. light output characteristic of the EL-cells allows a 2:1 ratio in excitation voltage to control fully the brightness of the EL cell.

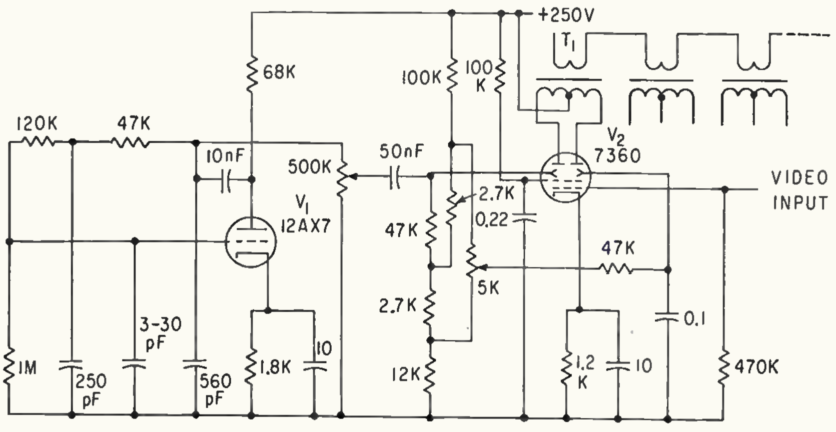
Figure 4 shows the sawtooth and triangular wave generators.

Figure 5 shows one of the 9 generator-modulator units. Tube V_1 operates as an R-C generator on one of the 9 carrier frequencies. The output signal is fed to the deflection plate of a beam deflection tube V_2 and after amplification sampled in transformer T_1. The modulation from a camera, containing the brightness information, is fed to grid 1 of V_2 and modulates the excitation carrier. At the secondary of transformer T_1 only the carrier and its modulation sidebands are present, while the modulating signal is cancelled in the transformer primary. The relatively small tubes V_3 and V_7 (Fig. 4), used as final amplifiers, are driven beyond linear operation, thereby causing the a-c excitation signal to increase its amplitude from beginning to end of sweep. This causes an undesirable non-uniform background brightness throughout the display panel. To avoid this shortcoming, corrective signals are derived from the circuit of Fig. 4 as follows:

A sawtooth signal is branched off at the integrator network following tube V_1 and fed to tube V_4 where amplification and shaping takes place. The output of V_4 renders the proper waveshape which then is fed to the control grid of the 9 modulator tubes V_2 of Fig. 5. Furthermore, at the integrator network following tube V_5, the triangular wave is taken off, shaped in an R-C network and combined with the sawtooth correcting voltage. Through adjustment of controls R_3 and R_4, an exact compensation of the nonuniform background brightness can be achieved.



SCANNING CIRCUIT: *the sawtooth generator (V_1 through V_3) and the triangular wave generator (V_5 through V_7)—Fig. 4*



AUDIO GENERATOR *and balanced modulator circuit—Fig. 5*

SYNCHRONIZATION—The scanning sequence requires that the 50-cps sawtooth and the 125-cps triangular wave are interlocked. This synchronization is achieved simply. A capacitive coupling of a few pf between a plate of the triangular wave generator and a grid of the sawtooth generator provides just enough interlocking action for operation over a limited temperature range, providing supply voltages are well stabilized.

With this sequential and simultaneous display, a satisfactory performance at tv frame repetition rate has been achieved.

The experimental panel was built to prove the principle, and performance is by no means optimum. Brightness was 2 foot-lamberts. Contrast between bright and dark spots was about 15:1. The resolution is given by the number of dots —225. Higher brightness can be achieved by improving filter design. It is estimated that contrasts greater than 100:1 can be obtained. The system is capable of controlling 10^4 dots (not yet a tv resolution) by using 100 groups containing 100 dots each, arranged in a matrix of 10 groups per side. The 100 dots in each group would receive the information through 100 carriers.

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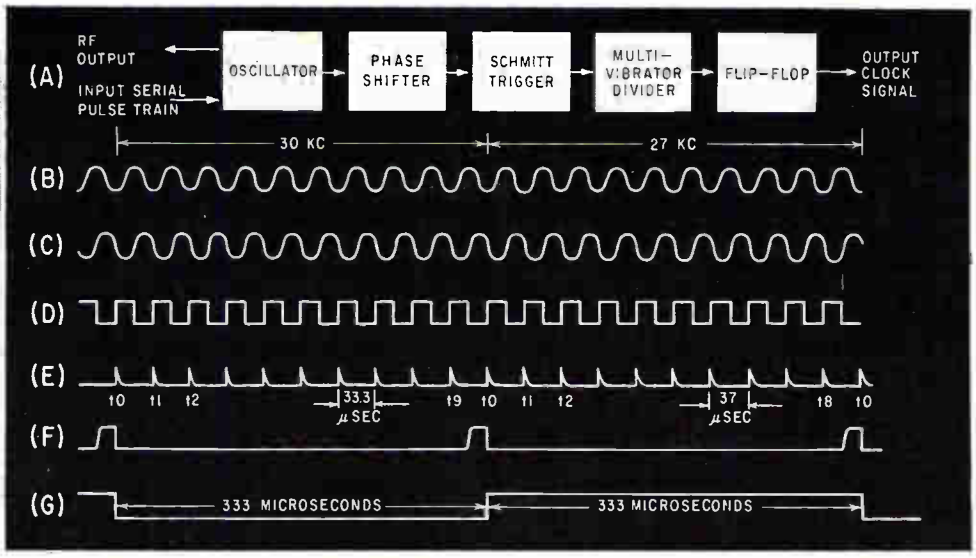


COMPONENTS OF THE SYSTEM *(A), oscillator output waveform (B), oscillator output shifted 90 degrees at output of phase shifter (C), Schmitt trigger output (D), waveform (D) differentiated and negatively clipped as applied to multivibrator-divider (E), output of multivibrator-divider (F), and flip-flop output at 1.5 Kc (G)—Fig. 1*

NEW COHERENT KEYER Simplifies Pulse-Code Telemetry

Telemetry keying system provides reference clock frequency by dividing down from subcarrier frequency

By R. C. ONSTAD

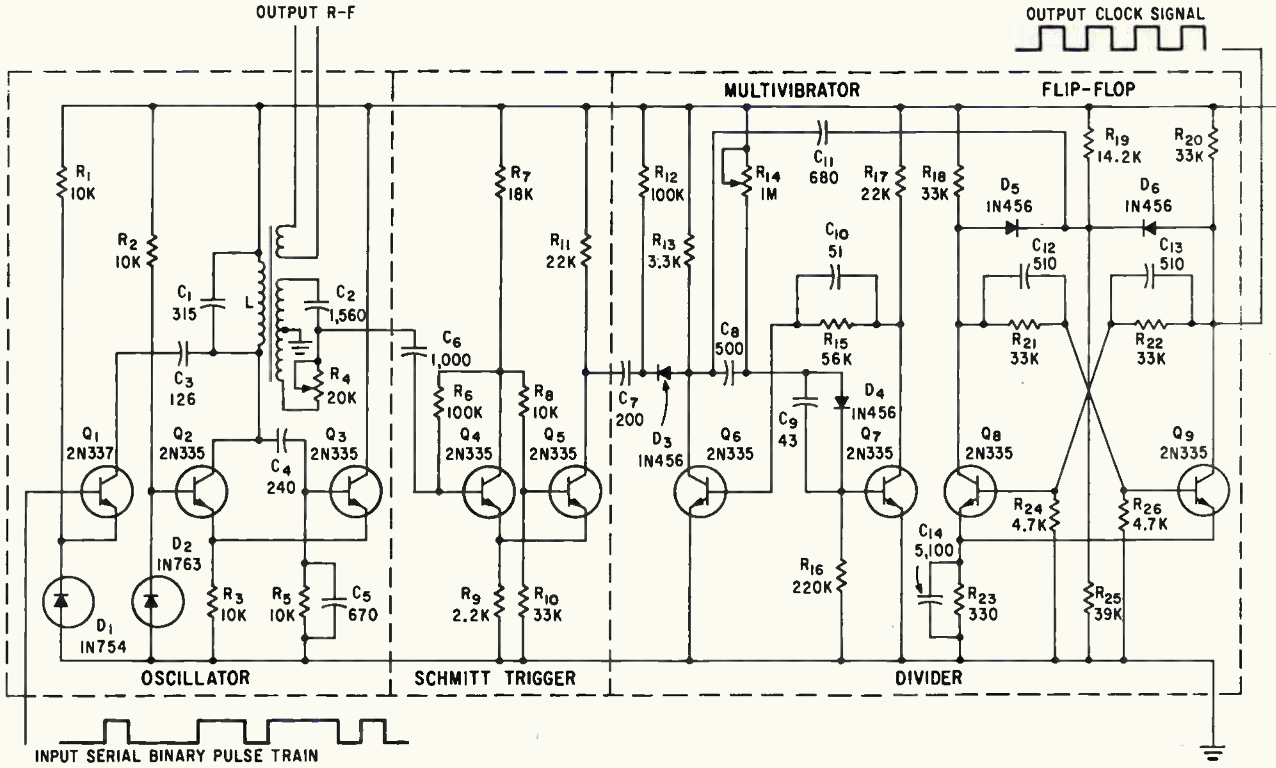
General Dynamics/Astronautics, San Diego, California

COHERENTLY SWITCHED oscillator, a 90-degree phase shifter, a Schmitt trigger and a frequency divider make up a system, Fig. 1A, for modulating a subcarrier of an f-m/f-m telemetry system with pcm data. The system provides a reference frequency for the pcm system; coherent frequency shift keying of a subcarrier oscillator with negligible switching transients; means by which on-ground recovery of the pcm data bit rate can be extracted directly from the subcarrier oscillator signal.

KEYER INPUT—This is a serial binary pulse train from a pcm coder that goes directly to the switching oscillator as shown in Fig. 1A. The keyer provides two outputs—one is a square-wave reference or clock frequency to the pcm coder and the other is the frequency shift keyed r-f output from the oscillator. This second output is mixed with the outputs of other subcarrier oscillators for modulation of the telemetry transmitter.

Frequency-shift keying of an oscillator usually produces switching transients causing undesirable sideband components. By selection of the time at which the oscillator is switched, these effects can be made negligible thus greatly reducing crosstalk on other subcarrier channels. Elimination of transients reduces the frequency transition time, permitting a higher keying rate.

Conventional means of maintaining time synchronism between a missile-borne pcm coder and a ground data processing station require a highly stable oscillator to provide timing for the pcm coder, and another stable oscillator at the



MULTIVIBRATOR *and flip-flop (right) make up the frequency divider—Fig. 2*

receiver kept in synchronism by receiving information describing the transmitted frequency characteristics. This is usually accomplished by inserting synchronization bits in the pcm serial pulse train. By using a keyer as described here, a reference clock frequency can be extracted from the demodulated subcarrier allowing perfect time synchronism in spite of instabilities in the subcarrier oscillator.

Oscillator frequency, Fig. 1, is switched to the lower frequency each time the input pulse train swings positive and the oscillator is switched to the higher frequency coincident with the negative swing of the input pulse train. The transition of the serial non-return-to-zero pulse train coincides with the negative swing of the oscillator voltage waveform. To provide coherent switching of the oscillator, the 90-degree phase shifter, Schmitt trigger and frequency divider are required. The Schmitt trigger converts the phase shifted sinusoidal output of the oscillator to a square wave with leading and trailing edges occurring at the zero crossings, Fig. 1D. The 90-degree phase shift places the square wave leading and trailing edges at the positive and negative peaks of the oscillator tank voltage.

The frequency divider consists of a monostable multivibrator followed by a flip-flop. The multivibrator operates as a synchronous frequency divider by its ability to remain insensitive to input pulses while in its unstable state. It responds to the first input pulse following transition to its stable state. Output frequency of the multivibrator is divided by two and an output square wave provides a clock to control timing in a pcm encoder.

DIGITAL DATA—It is supplied by a pcm encoder whose output is a serial nrz pulse train at a rate of 3,000 bits per second. Desirable objectives were to confine the data to the lowest frequency Interrange Instrumentation Group (IRIG) subcarrier practicable, to minimize synchronization requirements and to provide compatibility with existing ground equipment.

Using the subcarrier oscillator as a clock source and coherently keying the oscillator allows the subcarrier to convey bit by bit synchronization to the ground data processor. Frequency shift keying is compatible with existing ground station discriminators but the bit rate normally changes with the shift in oscillator frequency. By selection of IRIG channel B with a 30-Kc center frequency for the subcarrier and shifting this subcarrier between 30 Kc and 27 Kc, a constant output clock frequency of 1.5 Kc is obtained. When the oscillator is at 30 Kc, the multivibrator divider divides by 10 to produce a 3 Kc output. This was accomplished by designing the multivibrator time constant to remain in its unstable state for a period midway between that corresponding to a 9 to 1 and 10 to 1 division ratio or 315 microseconds. When the oscillator frequency is at 27 Kc, a 315-microsecond period is between that corresponding to a division ratio of 8 to 1 and 9 to 1.

The multivibrator divider automatically divides the 30 Kc frequency by 10 and the 27 Kc by 9 to yield a constant output of 3 Kc from the multivibrator divider when the oscillator is switching between 30 Kc and 27 Kc. The output flip-flop then yields a 1.5-Kc clock frequency.

Keying of the oscillator occurs exactly at the negative peak of the oscillator voltage waveform, Fig. 1. This is the optimum point in the oscillator cycle for switching. In Fig. 2. the tank circuit LC determines oscillator frequency. Sufficient positive feedback to sustain oscillations is provided by coupling the collector of Q_2 to the base of Q_3 (an emitter follower) and connecting the emitters of Q_2 and Q_3 to a common load. Oscillator frequency is lowered by switching capacitor C_3 into the tank circuit by Q_1. Switching was made as free of transients as possible. This was necessary to reduce adjacent channel interference.

When capacitor C_3 is switched into the circuit it effectively parallels the tank capacitor C_1. In a conventional LC oscillator tank circuit, energy alternatively is transferred between the inductor and the capacitor. When the energy in the capacitor is zero, voltage across it is minimum and current in the tank is maximum.

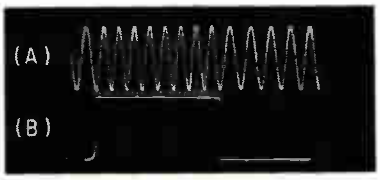
If a zero-charge capacitor is placed across the tank capacitor at the point in the cycle when the voltage across the capacitor is minimum. transients associated with the switching should also be a minimum. Transistor switch Q_1 is closed or opened only at the negative peak of the voltage waveform as measured at the lower end of the tank inductor.

WAVEFORMS — Figure 3 shows the oscillator waveform for this condition. Switching transients and amplitude modulation resulting from the frequency shift keying are negligible. A slight change in the period each time the frequency is shifted is the only change noted when the oscillator is keyed.

Two secondaries are provided on the oscillator tank transformer, Fig. 2. One winding provides an r-f output to the subcarrier mixing amplifier. The second winding provides an output to the 90-degree phase-shift network. This is a resistance-reactance phase shifter requiring a center-tapped secondary winding, resistor and capacitor. This bistable circuit converts the sine wave to a square wave by changing between its stable states at each crossing of the sine wave.

SCHMITT TRIGGER OUTPUT—It is differentiated and the negative pulses steered to the multivibrator frequency divider. This divider circuit is a one-shot multivibrator and in its stable state has transistors Q_6 cut-off and Q_7 saturated. The first negative pulse applied to the collector of Q_6 causes the multivibrator to change states so that Q_6 is saturated and Q_7 is held cut off by the charge on capacitor C_8. While the one-shot is in this state it is isolated from input pulses. This is because the differentiated output of the Schmitt trigger is referenced to +28 volts and therefore there is now about 28 volts reverse bias across diode D_3. The time constant provided by C_8 and R_{11} holds the one-shot in its unstable state for 315 microseconds. The first input negative pulse to Q_6 following the return of the one-shot to its stable state will again cause the one shot to flip.

Diode D_4 improves stability of the circuit. It becomes reverse-biased when the one-shot flips to its unstable state and thus eliminates the base of Q_7 as a discharge path for C_8. The capacitor across D_4 speeds switching action. The output at the collector of Q_6 is a positive pulse (Fig. 1F). The trailing edge of this pulse is coincident with every tenth input pulse when the input pulse repetition frequency is 30 Kc and is coincident with every ninth pulse when the input prf is 27 Kc. Thus the output prf from the divider is at a constant 3 Kc under these input conditions. The output of the divider is differentiated and drives an output flip-flop that produces a 1.5-Kc square wave.



RELATION OF WAVEFORM *at oscillator tank (A) to the input square wave at the switching transistor Q_1 (B). Switching transients are negligible Fig. 3*

The r-f spectrum generated by the subcarrier oscillator consists of line spectra at two discrete frequencies of 27 Kc and 30 Kc plus side-current pairs every 1.5 Kc above and below the two discrete subcarrier frequencies. Adjacent channel splatter and crosstalk caused by the side-current pairs is reduced to a negligible value by using a standard channel B telemetry band pass filter at the output of the oscillator.

To derive a constant-frequency square wave from the frequency shifted subcarrier oscillator for the clock, it is necessary to select two uniquely related frequencies to be generated by the frequency shift keyer. The resulting frequency deviation is of course not optimum. As in frequency modulation, the higher the ratio of deviation to modulation frequency the greater is the amount of r-f energy that is concentrated in higher order sidebands. To accommodate a higher bit rate on this same IRIG channel using frequency shift keying would necessitate less separation between the two discrete frequencies to concentrate most of the sideband energy within the subcarrier band and prevent adjacent channel splatter and interference. If it is desirable to incorporate coherent keying along with this higher bit rate, the clock frequency will shift slightly each time the subcarrier frequency is shifted. However, since both the missileborne encoding and the ground decoding equipment are slaved to this clock a slight variation in clock frequency will not affect timing of the system.

To recover pcm data at the receiver, it is necessary to generate a clock frequency synchronized with the clock at the transmitter. This is accomplished by passing the detected and separated subcarrier through the same type of circuits associated with the oscillator-keyer. By duplicating the phase shifter, Schmitt trigger and divider, a clock frequency is derived that is synchronous with the keyer generated clock.

This keyer simplifies problems in providing a pcm channel on an fm-fm telemeter to make more digital measurements possible.

Design Idea: Unijunction Transistor

Addition of unijunction transistor to a conventional monostable multivibrator expands the time delay by two orders of magnitude

By M. P. HUMBLET, Mobiltel Division, Lenkurt Electric Company, San Carlos, California

A TIME DELAY circuit giving a delay 100 times longer than a conventional monostable multivibrator using the same value of timing capacitor is described. The circuit is simple and economical, and operates over a wide range of temperature with both fast recovery time and sharp transitions.

Several difficulties occur when a conventional transistor monostable multivibrator (Fig. 1A) is to be used for time delays of one second and above. The value of the resistance R_T used is limited by the amount of base current I_b necessary to saturate the on transistor and also by the transistor's stability versus temperature characteristic. The value of capacitor C_T is limited by size, cost, and leakage.

In a monostable multivibrator there are two sets of conditions that must be fulfilled in choosing timing resistor R_T

$$I_b > \frac{I_c}{\beta} \text{ which gives}$$

Conditions *A*

$$R_T < \frac{(E - V_{bon})\, R_2\, \beta}{E}$$

or using the design values $B_{min} = 20$ and $I_{comax} = 100\ \mu a$, plus component values in Fig. 1

$$R_T < 23{,}500$$

Conditions *B* $\quad \frac{E}{R_T} \gg I_{co}$ for temperature stability

$$R_T \ll 120{,}000$$

To satisfy those two requirements a value of 12,000 ohms for R_T is chosen. The length of the output pulse for this circuit is given by

$$T \approx 0.7\, R_T\, C_T \qquad (1)$$
$$T \approx 8.4 \times 10^3\, C_T$$

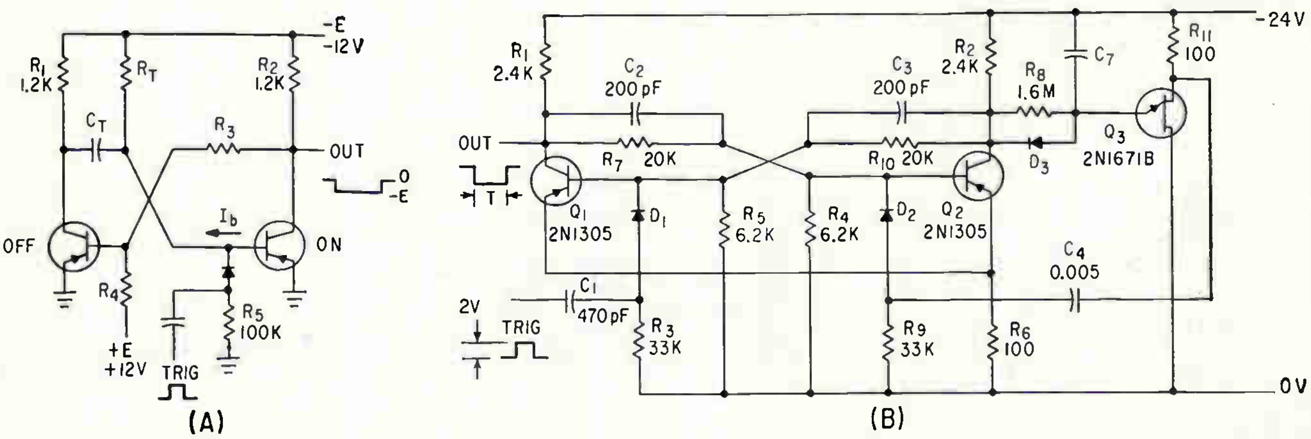
A 1 μf capacitor gives an output pulse 8.4 msec long.

NEW MONOSTABLE CIRCUIT—(Fig. 1B) uses flip-flop plus delayed reset circuit based on a silicon unijunction transistor. In the quiescent state Q_1 is conducting, Q_2 is cut-off. A positive triggering pulse applied at the input will switch Q_1 off and Q_2 on. Transistor Q_3 remains cut-off. Capacitor C_T charges through R_8 until the emitter firing potential of Q_3 is reached. At this point Q_3 conducts abruptly, causing a positive pulse to appear at base 1 of Q_3 and causing capacitor C_T to discharge through the emitter to base 1 junction and R_{11}. This positive pulse going also through C_4 and D_2 turns Q_2 off resetting the flip-flop to its initial state. When C_T is almost discharged, Q_3 extinguishes and C_T is then further discharged rapidly through D_3 and R_2.

The cycle is completed and the circuit is ready for another triggering pulse. The length of the output pulse is function of R_8, C_T, the characteristics of the unijunction transistor, and the voltage swing at the collector of Q_2.

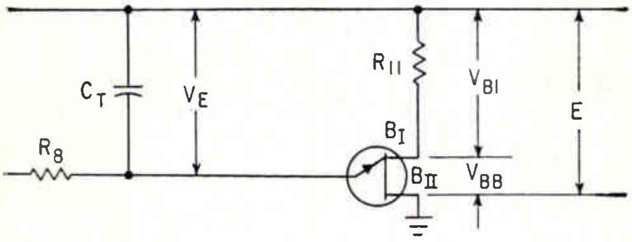
An analysis of the circuit gives the following

$$T = R_8\, C_T \ln\left(\frac{R_{BB} + R_{11}}{R_{BB}\,(1 - \eta)}\right) \qquad (2)$$

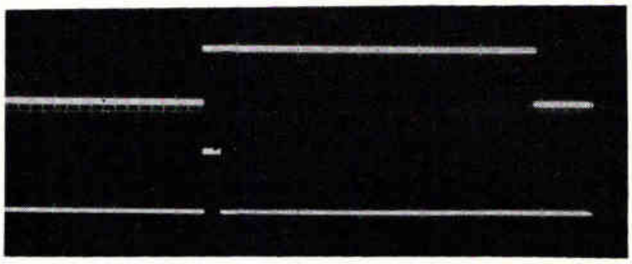


MONOSTABLE CIRCUIT *(A) with time delay defined by C_T and R_T; monostable circuit using unijunction transistor (B) has time delay of just over one second. Same timing capacitor produces 8.4ms pulsewidth in conventional circuit—Fig. 1*

Multiplies Monostable's Pulsewidth



UNIJUNCTION *transistor voltages used in the analysis—fig. 2*



WAVEFORM *illustrates the high mark-space ratio of unijunction circuit*

where η is the intrinsic stand-off ratio of the unijunction transistor and R_{BB} is its base to base resistance with emitter open.

The flip-flop design is conventional and does not present any special problem. Components R_8 and C_T determine the length of the delay; R_8 is optimized to take full advantage of this circuit.

Two conditions given by Eq. 3 and Eq. 4 must be fulfilled to fire the unijunction transistor. Taking the negative terminal of the supply as reference

$$V_E \geqq V_{B1} + \eta V_{BB} \quad (3)$$

and

$$I_E \geqq I_p \quad (4)$$

where V_{BB} is the base to base potential and I_p is the peak emitter current at firing point for a given V_{BB}

$$V_{B1} = \frac{E \times R_{11}}{R_{11} + R_{BB}} \quad (5)$$

where E is the supply voltage and R_{BB} is the base-to-base resistance

Since

$$V_{BB} = E - V_{B1} \quad (6)$$

then from Eq. 3

$$V_E \geqq V_{B1} + \eta (E - V_{B1})$$

replacing V_{B1} and V_{BB} by Eq. 5 and Eq. 6 gives

$$V_E \geqq E\left[\frac{R_{11}(1-\eta)}{R_{11} + R_{BB}} + \eta\right] \quad (7)$$

$$V_E = VCQ_2 - I_p R_8 \text{ at firing} \quad (8)$$

with VCQ_2 = on collector voltage for Q_2

To satisfy 7 we must limit R_8 to

$$R_8 \leqq \frac{VCQ_2 - V_E}{I_p}$$

If the collector to emitter voltage drop is neglected for the on transistor

$$VCQ_2 \approx \frac{E \times R_2}{(R_2 + R_6)} \quad (9)$$

Which gives

$$R_8 \leqq \frac{E}{I_p}\left[\frac{R_2}{R_2 + R_6} - \frac{R_{11}(1-\eta)}{R_{11} + R_{BB}} + \eta\right] \quad (10)$$

This is an expression for the maximum value of R_8. Typical values for η, I_p and R_{BB} can be found in the manufacturer's specifications. For the worst-case condition the maximum values for η, I_p and the minimum value of R_{BB} should be taken.

NUMERICAL EXAMPLE—Using a supply of 24 v, component values of Fig. 2 and the unijunction transistor parameters (Table) for the worst-case condition From Eq. 10

UNIJUNCTION 2N1671B TRANSISTOR PARAMETERS

	Min.	Max.
Interbase resistance R_{BB} (V_{BB}=3 v, I_E=0	4.7K	9.1K
Peak point emitter current (V_{BB}=25 v)	—	6 μa
Intrinsic stand-off ratio (V_{BB}=10 v)	0.47	0.62

$$R_8 \leqq \frac{24}{6 \times 10^{-6}}\left[\frac{2.4}{2.5} - \left(\frac{100\ (0.38)}{4800} + 0.62\right)\right]$$

$R_8 \leqq 2.04$ megohms

To take care of component tolerances and variations in supply voltage a safe value of 1.6 megohms is used for R_8.

The maximum time delay is then given by Eq. 2

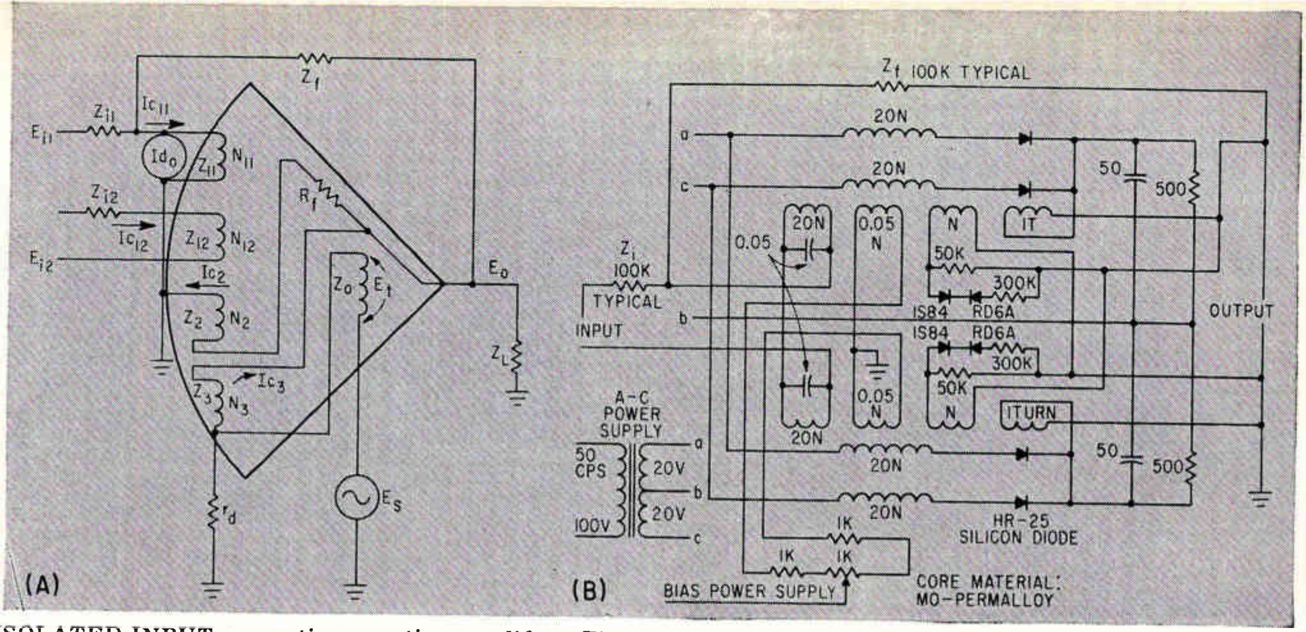
$$T = 1.6 \times 10^6 \cdot C_T \ln 2.68 = 1.6 \times 10^6 C_T$$

If a 1-μf capacitor is used for C_T, a delay of 1.6 seconds is obtained. In Fig 1 the same 1-μf capacitor used in a conventional monostable multivibrator gave a maximum delay of only 8.4 msec; the unijunction transistor has therefore increased the delay 190 times. With a unijunction transistor having parameters at the opposite extreme from the one used in the last example, that is R_{BB} = 9,100 ohms, $I_p = 6\mu a$, and $\eta = 0.47$, the circuit would give a minimum delay of $T = 1.6 \times 10^6 \times C_T \times 0.69 = 1.1 \times 10^6 C_T$. With most of the unijunction transistors a time delay between $1.1 \times 10^6 C_T$ and $1.6 \times 10^6 C_T$ is obtained for R_8 = 1.6 megohms.

The reset time is given by $T_R \approx 3 R_2 C_T$ which is less than 1 percent of the duration of the output.

Parameter R_{BB} is the only parameter of the unijunction transistor that changes significantly with temperature to influence the length of the output pulse. At 25 degrees C, R_{BB} has an average temperature coefficient of 0.7 percent per degree C which causes R_{BB} to increase almost linearly up to about 85 degrees C.

The effect of temperature on the output pulse can be calculated from Eq. 2 where R_{BB} at 25 degrees C is replaced by the value of R_{BB} at another temperature, keeping all the other terms constant. Assuming that R_8 and C_T do not change, a temperature increase from 25 degrees C to 75 degrees C will cause the output pulse to vary about 5 percent in the worst case.



ISOLATED-INPUT ***magnetic computing amplifier—Fig. 1***

Reliable Magnetic Amplifier

Using one magnetic operational amplifier, this half-square multiplier is suitable as squaring function generator, quarter-wave multiplier or two multipliers

By TAKEO MIURA
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ANALOG COMPUTERS are widely used as both computers and simulators for solving problems in fields such as automatic control systems and vibrating systems. Lately, analog techniques are also being used experimentally in on-line automatic control systems for process control, electric power system control, and electric motor control. The most important requirement placed on analog computers used on-line is high reliability. The magnetic operational amplifier has been developed to fill this requirement.

In developing this magnetic amplifier, it was decided to adopt a voltage-feedback amplifier using high computing impedances, for the following reasons: It is easy to realize a real-time computer. It is easy to obtain high accuracy. Also, it is easy to use the same techniques used with vacuum-tube amplifiers.

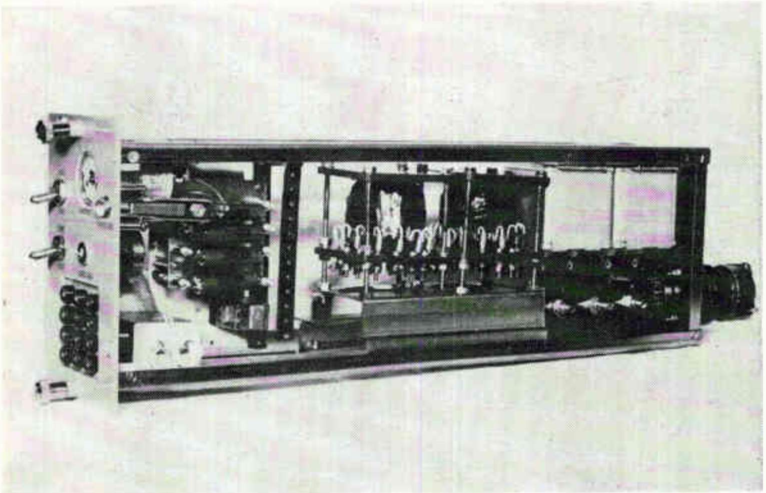
In this article the transfer function of the magnetic operational amplifier is derived. The effects of the various parameters and the computing error are theoretically considered, special care being taken to clarify difficult points. Next, an experimental function generator and an experimental multiplier, which were built using the experimental operational amplifier as the basic element, are discussed. The newly developed multiplier, which should be called the one-half square type, is a comparatively simple apparatus of high reliability.

One feature of a magnetic computing amplifier is that the input signals are computed not only electrically but also magnetically. Therefore, signals can be added or subtracted by addition or subtraction of ampereturns with input windings, and output circuits are easily isolated from the input.

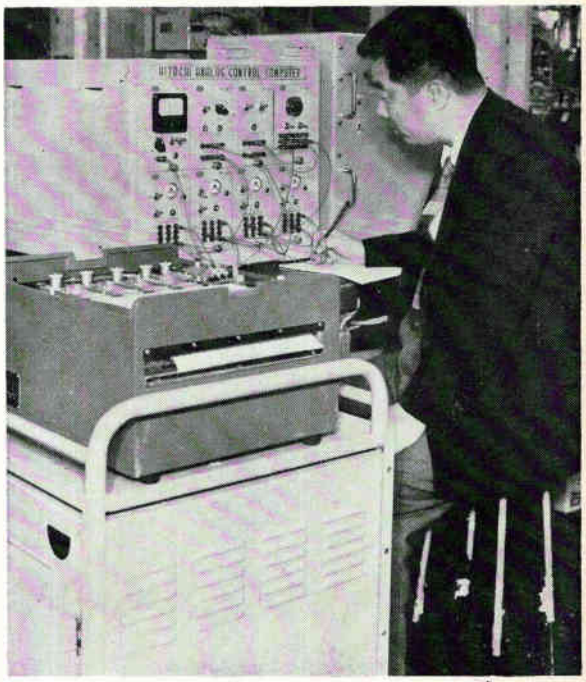
Figure 1 shows the block diagram of an isolated-input type computing amplifier. An amplifier

CHARACTERISTICS OF EXPERIMENTAL COMPUTING ELEMENTS—TABLE I.

	Standard Ampl	Booster Ampl	High-Power Ampl
Output Voltage	±10 v max. load 3,000 ohms	±10 v max. load 1,500 ohms	±10 v max. load 300 ohms
Precision	better than 0.2%	better than 0.2%	less than 0.2%
Frequency Response	15 cps (−3 db)	6 cps (−3 db)	6 cps (−3 db)
Power Supply	100 v ± 10 v (50 cps) 10 v d-c ± 1v	100 v ± 10 v (50 cps) 10 v d-c ± 1v	100 v ± 10 v (50 cps) 10 v d-c ± 1v
Power Consumption	1 watt	2 watts	10 watts
Standard Computing Impedances	100,000 ohms, 10μf	100,000 ohms, 10μf	100,000 ohms, 10μf



COMPUTING UNIT *designed as an on-line analog computer amplifier*



AUTHOR MIURA *operating analog control computer using four amplifiers*

Improves Multiplier

with two isolated inputs as shown is considered. The voltages and currents for this circuit are

$$\left.\begin{aligned} I_{c11} &= \frac{E_{i1} - I_{c11}Z_{11}}{Z_{i1}} + \frac{E_o - I_{c11}Z_{11}}{Z_f} + I_{do} \\ I_{c12} &= \frac{E_{i2}}{Z_{i2} + Z_{12}} \\ I_{c2} &= \frac{E_o}{R_f + Z_2} \\ I_{c3} + \frac{I_{c3}Z_L'}{r_d} &= \frac{(E_S - E_R) - I_{c3}Z_i}{r_o} \\ E_R &= R_A(I_{c11}N_{11} + I_{c12}N_{12} - I_{c2}N_2 - I_{c3}N_3) \\ E_o &= I_{c3}Z_L' \end{aligned}\right\} \quad (1)$$

where $Z_L' \cong \dfrac{1}{\dfrac{1}{Z_L} + \dfrac{1}{Z_2 + Z_f} + \dfrac{1}{Z_f}}, \quad Z_3 \cong 0$

LONG-TIME DRIFT WITH VARIOUS COMPUTING IMPEDANCES—TABLE II

Computing Impedance		Drift/8h
Z_i	Z_f	
10,000 ohms 1 Meg	10,000 ohms	100 μv 50 μv
1,111,000 ohms 10,000 ohms 100,000 ohms 1 Meg ∞	100,000 ohms	1.5 mv 0.6 mv 0.5 mv 0.5 mv 1 mv
10,000 ohms 1 Meg	1 Meg	2.5 mv 2.3 mv

AMPLIFICATION CONSTANT—Constant R_A is the amplification constant of the magnetic amplifier whose magnitude corresponds to the output voltage increment when a control current of one ampere is supplied to a control winding of one turn. The larger R_A, the larger the amplification. The parameters that contribute to R_A are the core materials, the core dimensions and the number of turns of the gate winding. The drift current I_{do} at an amplifier input winding is defined as a source of output drift voltage.

The actual amplifiers are connected in push-pull, so that the effect of the power supply voltage E_s is canceled. Therefore, Eq. 2 may be obtained from Eq. 1 by the substitution of $E_s = 0$ in Eq. 1.

$$E_o = \frac{-\left[\dfrac{Z_f}{Z_{i1}}E_{i1} + \dfrac{Z_f}{Z_{i2}+Z_{12}}\left(1 + \dfrac{Z_{11}}{Z_{i1}} + \dfrac{Z_{11}}{Z_f}\right)\dfrac{N_{12}}{N_{11}}E_{i2} + I_{do}Z_f\right]}{\left[1 + \dfrac{Z_f}{N_{11}R_A}\left(1 + \dfrac{Z_{11}}{Z_{i1}} + \dfrac{Z_{11}}{Z_f}\right)\right]\left(1 + \dfrac{r_o}{r_d} - \dfrac{N_2R_A}{Z_2 + R_f} + \dfrac{r_o - N_3R_A}{Z_L'}\right)} \quad (2)$$

Equation 2 is the transfer function of an isolated-input computing amplifier. It is desirable that the second term of the denominator be small to obtain high static accuracy. The accuracy is higher if N_{11}, N_{22} and R_A are large, and Z_{11} and Z_{12} are small. Especially, it must be noticed that in contradistinction to vacuum-tube type amplifiers, magnetic computing amplifiers give higher accuracy with lower circuit impedance.

To realize ideal characteristics as a computing amplifier, positive-feedback current compensating winding N_3, which reduces the output impedance, and a positive-feedback, gain-compensating winding N_2 are chosen to satisfy the compensation conditions of Eq. 3; and Eq. 4 obtains. But the effect of I_{do} still remains

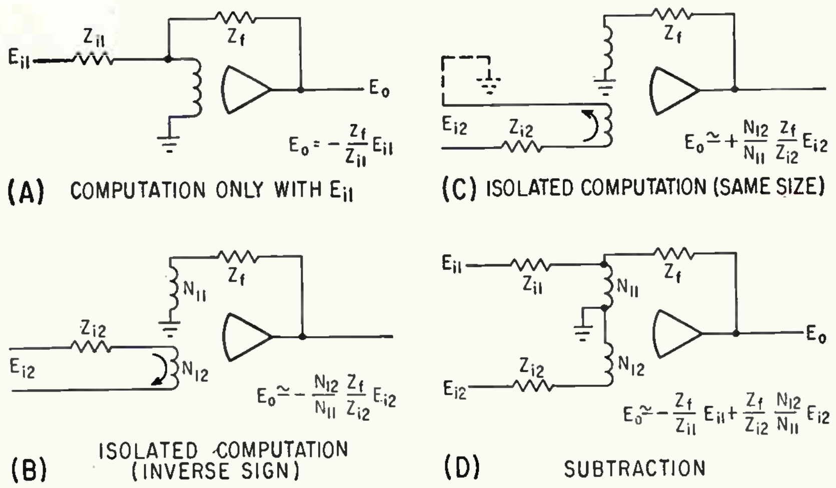
$$\left.\begin{aligned} 1 + \frac{r_o}{r_d} &= \frac{N_2R_A}{R_f + Z_2} \\ r_o &= N_3R_A \end{aligned}\right\} \quad (3)$$

$$E_o = -\frac{Z_f}{Z_{i1}}E_{i1} - \frac{Z_f}{Z_{i2}}\frac{N_{12}}{N_{11}}E_{12} - Z_fI_{do} \quad (4)$$

where $Z_{i1} \gg Z_{11}$, $Z_{i2} \gg Z_{12}$, $Z_f \gg Z_{11}$

The transfer functions for several circuit configurations, computed from Eq. 4, are shown in Fig. 2.

Under the perfect compensation conditions of Eq. 3, the error is zero except for the effect of drift current. However, even with d-c input, R_A is not uniform over the entire range of input levels because of the nonlinear amplification characteristic of the magnetic amplifier. Therefore, Eq. 3 does not hold



COMPUTING CIRCUITS *with isolated-input operational amplifiers, and their transfer functions—Fig. 2*

over the entire range. Besides, R_A changes with change of the waveform of the supply voltage. Moreover, with a-c input, in addition to the above effects, the imaginary part of each impedance constrains Eq. 3 so that the compensation condition cannot be maintained—except at one particular frequency—and computing errors occur.

If the error voltage and the exact output voltage are defined as dE_o and $[E_o]$ respectively, the relative error $dE_o/[E_o]$ is

$$\frac{dE_o}{E_o} = K_o + K_1 \frac{dR_A}{R_A} \quad (5)$$

where K_o, the error coefficient, occurs when the denominator of Eq. 2 is assumed to be unity and K_1 is the error coefficient due to dR_A.

For simplicity, assuming that $E_{i2} = 0$ in Eq. 2, K_o and K_1 are calculated

$$K_o = 0$$

$$K_1 = \frac{Z_f}{N_{11} R_A}\left(1 + \frac{Z_{11}}{Z_{i1}} + \frac{Z_{11}}{Z_f}\right)\left(1 + \frac{r_o}{r_d} + \frac{r_o}{Z_L'}\right) \quad (6)$$

On the other hand, considering the dead time τ of the magnetic amplifiers to R_A, these equations are obtained

$$\left.\begin{aligned} R_A &= R_{Ao} e^{-p\tau} \\ \frac{dR_A}{R_A} &\simeq \frac{dR_{Ao}}{R_{Ao}} - p^{\tau} \end{aligned}\right\} \quad (7)$$

From Eq. 5, 6 and 7, the error voltage of the magnetic computing element considering is obtained. For example, the relative error of integrators in holding condition is

$$\epsilon = -\frac{t}{CR} e_{off} + \frac{1}{N_{11} R_{Ao} C} \left\{\left(1 + \frac{r_o}{r_d}\right) t \frac{dR_{Ao}}{R_{Ao}} - \left(1 + \frac{r_o}{r_d}\right) \tau\right\} \quad (8)$$

where C and R are the computing impedances of the integrator, and e_{off} denotes the offset voltage.

The characteristics of the experimental computing amplifier are tabulated in Table I. With the exception of frequency response, this amplifier is in no way inferior to vacuum-tube amplifiers; it completely fulfills all requirements for applications such as process control with low input frequency.

A computing unit designed as a convenient on-line analog computer amplifier is shown in the photograph.

The placement of parts in the experimental computing unit is shown in the photographs. The magnetic operational amplifier is in the center, computing impedances in the front, and the control circuit and the filter capacitors in the rear of the unit.

The measured static error of the experimental amplifier was less than 0.2 percent. Moreover, the static error is reduced to less than 0.1 percent when the nonlinear positive feedback of the output voltage is used as plotted in Fig. 3.

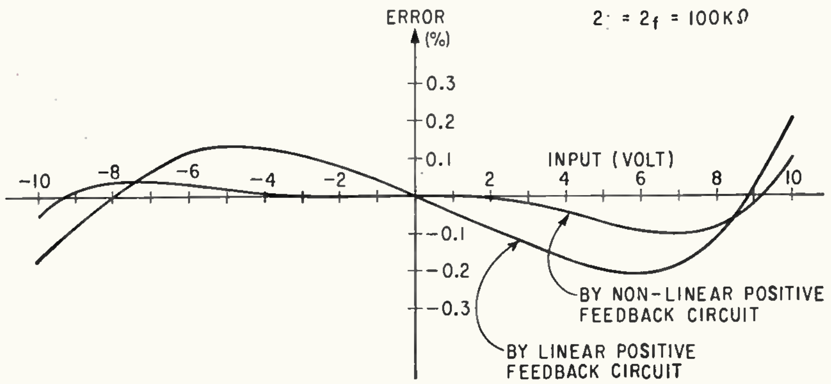
OPERATING ERRORS—The errors caused by operating conditions can be summarized as follows. The error for a ±10 percent fluctuation in power-supply voltage is less than 0.5 percent. Since linearity of transfer impedance R_A is degraded by power-supply voltage change, the error increases. The waveform of the power supply results in an error of less than 0.25 percent when the form factor changes by 0.01. The influence of temperature is also measured; the error between 0 and 70 deg C is less than 0.25 percent. These characteristics make the amplifier suitable for on-line use.

The output drift depends mostly on Z_f, as was shown in Eq. 5. Output drift for various combinations of Z_f and Z_i is shown in Table II.

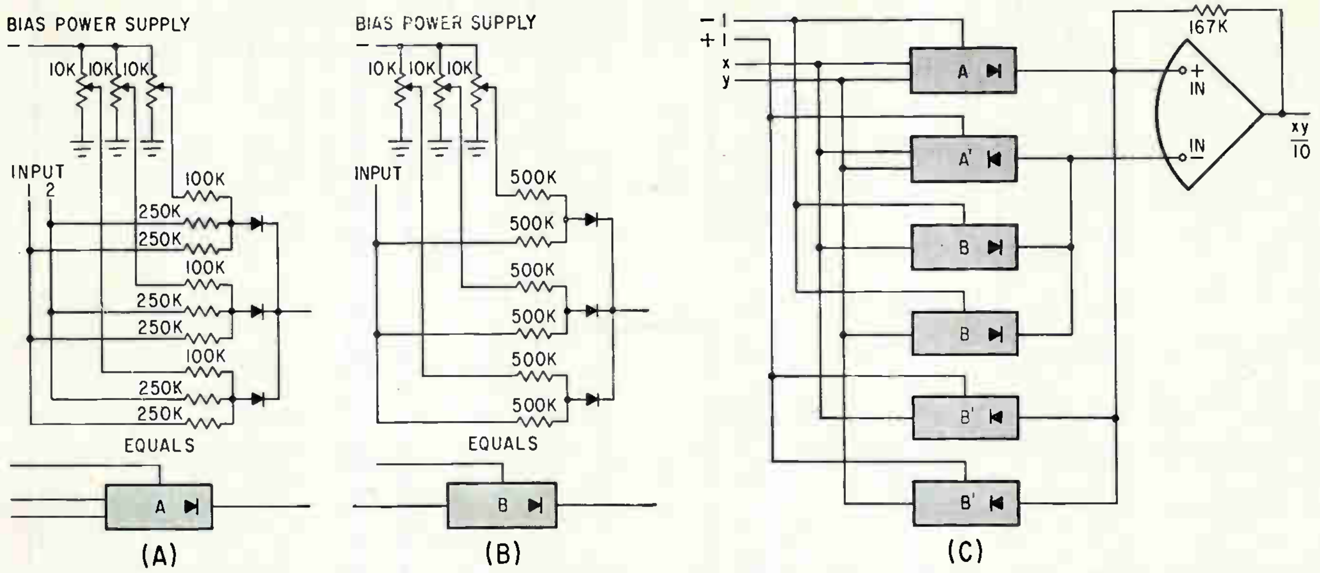
The holding characteristics of the integrator are shown by example. After 10 minutes, an integrator with a 50-mf metallized-paper capacitor showed an error of approximately 10 percent. This result shows good agreement with the computation.

A function generator and a multiplier consisting of nonlinear diode networks and experimental computing amplifiers were assembled and their characteristics investigated. The desired characteristics were obtained.

The magnetic operational amplifier is also suitable for use with a biased-diode function generator in a manner similar to vacuum-tube circuits, because of its voltage analog configuration. The differences



STATIC ERROR *of constant multiplier: comparison of linear positive feedback with nonlinear positive feedback—Fig. 3*



HALF-SQUARE MULTIPLIER. *Circuits (A) and (B) are connected as shown in (C); A' and B' resemble A and B except that diode and biasing polarities are reversed—Fig. 4*

from the vacuum-tube case are as follows:

(1) The triangular ripple wave superimposed on the output makes the breakpoint round. If the superimposed wave is a perfect triangular wave, it can be proved that the output curve is quadratic. The input range over which roundness is observed is equal to the peak-to-peak voltage of the superimposed ripple.

(2) The operational amplifier has a subtracting terminal, and the subtraction of several inputs is possible.

The first feature is advantageous when a smooth curved function is intended, but a sharp curvature cannot easily be followed. The second feature simplifies the circuit configuration of the function generators.

A new multiplier configuration, which can be called the half-square multiplier, using this function generator was developed by the authors. The principle of the multiplier is based on

$$xy = \tfrac{1}{2}\{(x + y)^2 - x^2 - y^2\} \qquad (9)$$

Advantages of this configuration for use with the magnetic computing amplifier are:

(1) It has no moving parts, hence its life expectancy is long.

(2) The squaring curve in the neighborhood of the break points.

(3) The configuration for the half-square multiplier becomes comparatively simple because of the subtracting ability incorporated in the magnetic amplifier.

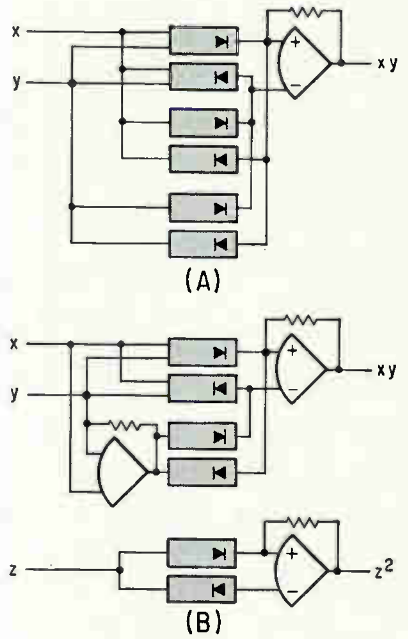
The entire circuit configuration is illustrated in Fig. 4. The squaring networks consist of resistors and semiconductor diodes only. No active elements are used. This characteristic is realized with three break points for each polarity. The maximum error of this network in forming x^2 or y^2 is less than 0.5 percent, the error for $(x + y)^2$ is less than 1 percent. Maximum experimental error for four-quadrant multiplication is less than 2 percent.

Further advantages of the half-square multiplier are:

(1) It needs only one operational amplifier.

(2) For single-polarity input, the number of elements in the squaring circuits is cut down to one-half those required for both polarities; but the quarter square multiplier requires $\frac{3}{4}$ times the number of elements because both polarities are possible for $(x - y)$.

(3) It is extremely flexible, as illustrated in Fig. 5. A multiplier is often used only for squaring. In such a case only the squaring circuit is used. The circuit is even commonly used as both a squaring function generator and a quarter-square multiplier simultaneously. Furthermore, after dividing into two multipliers for single polarity, by making the input single polarity (dividing by 2 after adding 1), it can be used as two multipliers. If the multiplier is used in a computing circuit, the operational amplifier of the next stage can be substituted for the multiplier operational amplifiers; hence only the computing impedances are needed for a multiplier.



FLEXIBILITY *of the multiplier showing different possible interconnections—Fig. 5*

This work was carried out under the supervision of Dr. Tadano and Dr. Abe of Hitachi Central Research Laboratory. The authors express their appreciation to S. Izumi of the Hitachi Works, Hitachi Ltd., and to J. Iwata of Showa Denshi Ltd., for their cooperation in the development of the amplifiers.

Simplify UHF Amplifiers With

Capacitive tuning of transmission lines at uhf frequencies offers advantages over shorting-type cavities. This article discusses these advantages and presents equations for calculating the design parameters

By STANLEY TULGAN, Manson Laboratories Inc., A Subsidiary of The Hallicrafters Co., Stamford, Conn.

SHORTED QUARTER-WAVE reentrant cavities as tank-circuit elements for uhf are well known and often used. Advantages of shorted cavities include maximum L/C ratio over the entire tuning range; high transfer efficiency $= (Q_u - Q_L)/Q_u$ because of high unloaded Q and low loaded Q; low circulating tank currents.

Some disadvantages are that finger stock at short is susceptible to breakage and corrosion, and dirt causes intermittent operation; high-current point occurs at the short, causing burning at the fingers; in frequency-determining circuits, the frequency stability is critical with respect to the shorted section and the stability is degraded due to damaged finger stock. In addition, cavity tuning requires complex mechanisms and if linear tuning is required, the cavity use specially cut lead screws. Generally, the input and output loading must move as the frequency is changed, and the tuning unit tends to be large.

One approach to this problem is capacitively tuned parallel-plate transmission lines. A half-wave parallel-plate transmission line, capacitively loaded at the far end, makes tuning simple. Use of parallel plate lines in push-pull amplifiers reduces the minimum capacitance and improves the L/C ratio.

FREQUENCY LIMITS—Lengths of line, tube output capacitance and the minimum tuning capacitance determine the high-frequency limit, while the tube output capacitance and the length of line determine the lowest frequency that can be tuned. This because the capacitive reactance of tuning capacitor C_T approaches a short as the capacitance is increased. Therefore, the line will approach a quarter-wave length and will be resonant at its lowest frequency.

A method for increasing the resonant tuning range is the use of an additional capacitor across the lines at the voltage null point when tuned to the high end of the band. This capacitor has no effect on tuning at the top end of the band.

Since the voltage is zero and the current is maximum at this point, the capacitor appears across an electrical short. However, as the main tuning capacitor increases, the null moves towards the end of the line and the fixed capacitor then loads the line. Thus, the additional loading will electrically increase the length of the line and allow the tuning range to go much lower than the mechanical length of the line would indicate.

With this approach, tuning becomes simple. A capacitor with a 100-to-1 antibacklash worm-and-wheel gearing tunes the lines. This is simple and mechanically rugged. Tracking is simplified because the capacitor plates can be shaped to any curve and mechanically reproduced. The loading point cannot move far along the line since it is restrained by the tuning capacitor and the null capacitor. This allows the loop coupling to be stationary and tuning becomes simple.

This approach, however, has the disadvantage of a low L/C ratio. Since $Q_L = R_p \omega C$, Q_L will be high. Since Eff $= (Q_u - Q_L)/Q_u$ the efficiency will not be as good as the cavity tank circuit.

One other loss is due to radiation. A cavity due to its closed construction is superior in this respect to open lines. However, well-balanced lines and a well-shielded low-loss wrap-around will keep the radiation loss to a minimum. Therefore, mechanical simplicity, ease in tuning, fewer tuning controls and the ability to track and linearize for automatic tuning are advantages brought about by foregoing the smaller power supply and more efficient cavity with its attendant disadvantages.

To calculate the physical size of the 225 to 400-Mc parallel-plate transmission line and the capacitors for tuning, note that at 400 Mc (Fig. 1A) the vsw appears on the line up to the voltage null *B-B*. To tune down to 225 Mc, the line must be electrically lengthened. Add another section as shown in Fig. 1B. Section L_2 must be resonant at 400 Mc so the line at *B-B* appears to terminate in a short.

Section L_1 can be calculated by using $X_L = Z_0 (Z_T \cos BL + j Z_0 \sin BL)/(Z_0 \cos BL + j Z_T \sin BL)$ where X_L is the inductive reactance of the line looking into terminals *A-A*, Z_0 is the characteristic impedance in ohms of the line and Z_T is the terminating load in ohms appearing at the end of the section. At *B-B*, $Z_t = 0_t$ and the expression for $X_L = Z_0 (j Z_0 \sin BL)$ $Z_0 \cos BL = j Z_0 \tan BL$, where $B = 360°/\lambda$ and L = length of line.

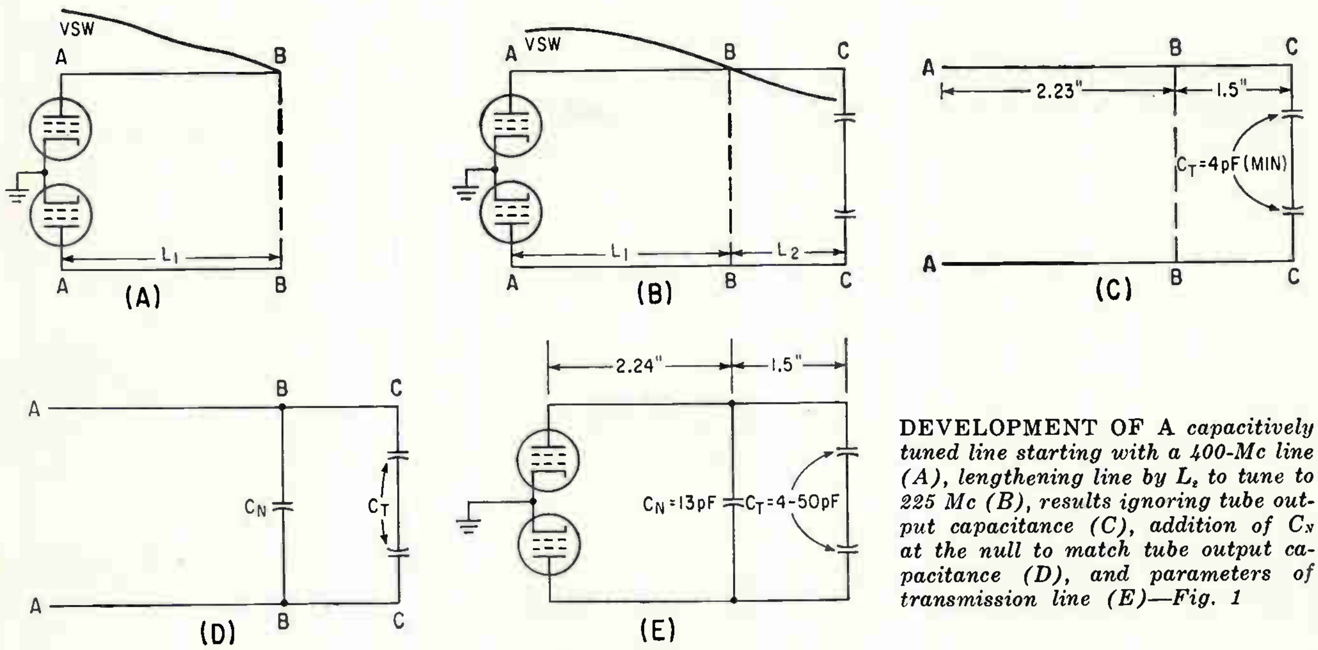
The inductive reactance of the line must resonate with the capacitive reactance of the tubes. The output capacitance of each tube is 5 Pf. In push-pull the output capacitance is therefore 2.5 Pf. Then $X_c = -j155$ ohms, where X_c is the capacitive reactance of 2.5 Pf at 400 Mc. Therefore, $X_L = +j155$ ohms $= j Z_o \tan BL$.

Z_o for a parallel-plate transmission line is approximately equal to

$\sqrt{u/e} \cdot (a/b)$, where a is the distance between the plates and b is their height.

This approximation is true only when $a<b$. In this example the physical size does not conform exactly to the approximation. In practice physical modification is required after the circuit is constructed be-

Transmission Line Tuned Circuits



DEVELOPMENT OF A *capacitively tuned line starting with a 400-Mc line (A), lengthening line by L_2 to tune to 225 Mc (B), results ignoring tube output capacitance (C), addition of C_N at the null to match tube output capacitance (D), and parameters of transmission line (E)—Fig. 1*

cause of capacitive effects of the walls of the enclosure and variations in tube reactance. The design calculation is a good approximation so that an intelligent start can be made.

Because of physical size limitations and past experience the dimensions of the lines chosen are $a = 0.5$ in. and $b = 0.625$ in.

$$Z_0 = \sqrt{u/e} \cdot (a/b) = \sqrt{(4 \times 10^{-7})/(1/36 \times 10^{-9})}\ (0.5/0.625) = 302 \text{ ohms}$$

Now the length of line can be calculated.

$$X_L = +j\ 155 = j\ 302 \tan BL$$
$$\tan BL = 0.513$$
$$B = 360°/\lambda = 360°/29.5''$$
$$BL = 27.16°$$
$$L = 2.23''$$

To calculate L_2, use the same approach as in the L_1 calculation. The minimum value of C_2 determines the length of line. A well-designed split-stator capacitor has about 4 pf minimum capacitance. The line section L_2 must resonate with C_2 at 400 Mc.

Since the line appears as an electrical short at *B-B*, the formula $X_2 = jZ_o \text{ Tan } BL$ can be used. The spacing of the line remains constant and therefore Z_o = 302 ohms.

$X_c = -j\ 100$ ohms (at 400 mc), thus $X = +j\ 100$ ohms, $\tan BL = 100/302 = 0.331$ and $BL = 18.3$ degrees. Then $L = 18.3/360\ (29.5) = 1.5$ inches.

LINE LENGTH—To determine if the line is long enough to resonate with the tube output capacitance at 225 Mc without additional loading, calculate X_{in} for the total length $L = 3.73$ inches. The input reactance must be equal to or greater than $+j280$ ohms.

$X_L = Z_0\ (Z_t \cos BL + j\ Z_0 \sin BL)\ (Z_0 \cos BL + j\ Z_T \sin BL)$ at section *A-A*.
Assume C_T max (Fig. 1C) approaches infinite capacitance. Therefore $X_t = Z_T \rightarrow 0$
$X_L = j\ Z_0 \tan BL = j\ 144.35$ ohms at section *A-A*.

The line is not long enough physically and must be loaded electrically. This is accomplished by placing a capacitor C_N at point *B-B* on the line as indicated in Fig. 1D.

To determine the value of C_N two things must be known. First, the value of the impedance that must appear across *B-B* which will cause an inductive reactance to appear at *A-A* equal in magnitude to the output impedance of the tubes, and second, the impedance of the line looking from *B-B* towards C_T. Knowing these two items, a parallel resonant circuit is computed in which the parallel impedance is equal to the value calculated above and consists of the impedance of the line in parallel with the reactance of C_N. Then

$Z_{A\text{-}A} = Z_0\ (Z_{B\text{-}B} \cos BL + j\ Z_0 \sin BL)/(Z_0 \cos BL + j\ Z_{B\text{-}B} \sin BL)$ or,
$280 = 302\ (Z_{B\text{-}B} \cos 15.35 + j\ 302 \sin 15.35)/(302 \cos 15.35 + j\ Z_{B\text{-}B} \sin 15.35)$ and
$Z_{B\text{-}B} = +j\ 159.51$ ohms. This is the impedance required at point $_{B\text{-}B}$ to tune the line with the output capacitance of the tubes.

The impedance presented by the line looking from *B-B* towards C_T is determined by the maximum value of C_T. A reasonable value for C_T maximum = 50 pf. The reactance of C_T at 225 Mc is $-\ j\ 14$.

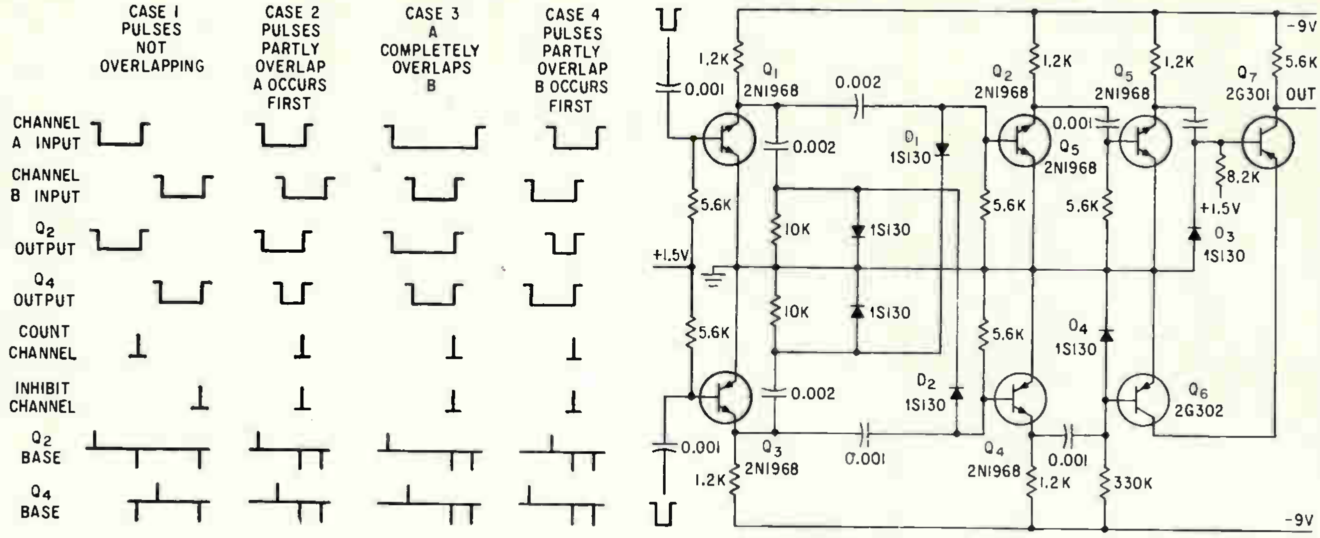
$Z_{B\text{-}B} = 302\ (-j\ 14 \cos 10.28 + j\ 302 \sin 10.28)/(302 \cos 10.28 + j\ (-j\ 14) \sin 10.28)$ and
$Z_{B\text{-}B} = +j\ 40.3$ ohms.

The capacitive reactance X_N to be loaded across *B-B* to transform the reactance to $+j159.5$ ohms is

$j\ 159.5 = (-j\ X_c)\ (j\ 40.3)/(-j\ X_c + j\ 40.3)$
$X_N = -j\ 53.8$ at 225 Mc, and therefore $C = 13$ pf.

The transmission line with its various tuning and loading capacitors and line lengths has been completely calculated and appears in Fig. 1E.

After construction, some modification may be necessary, but all values are reasonably close to the final physical sizes.



POSSIBLE PULSE COMBINATIONS *and the anticoincidence circuit*

Novel Anticoincidence Circuit Detects Pulse Overlap

Permits counting of pulses occurring in one channel that do not overlap those generated in another channel. Circuit is useful in statistical analyses

By K. R. WHITTINGTON and G. ROBSON
Tube Investments Research Laboratories, Hinxton Hall, Nr. Saffron Walden, Essex, England

THIS CIRCUIT detects coincidences between pulses of random length and spacing occurring in two separate channels.

POSSIBLE COMBINATIONS — Note from sketch that in all cases where overlap occurs, the pulses from the two bistable circuits finish at the same time. Thus, if the trailing edges of pulses from the two binary circuits are used to generate output pulses in two channels, one of these can be used to activate a counter, and the other to inhibit it. Only in cases where the input pulses do not overlap, will a count be obtained.

Buffer stages Q_1 and Q_3 isolate the input and give pulses of consistent amplitude and rise time. They consist of *pnpn* switching transistors triggered by alternate negative- and positive-going pulses. The pulses appearing at the collectors of Q_1 and Q_3 are differentiated and applied to the bases of Q_2 and Q_4 respectively. In addition, the negative-going (trailing-edge) spike from Q_1 is applied, through D_2, to the base of Q_4, and the negative-going spike from Q_3 is applied through D_1 to Q_2. Thus, the base of each of these two transistors sees, for each pair of overlapping input pulses, one positive and two negative spikes. The negative spikes on each base will be coincident with those on the other base, but the positive spikes will not necessarily be coincident. Transistors Q_2 and Q_4 will be switched off by the positive-going spike and on by the first negative-going spike. The second negative spike will have no effect on the circuit.

The net result is that if the input pulses overlap, as shown by cases 2, 3 and 4, the pulses from Q_2 and Q_4 terminate at the same time. If, as in case 1, they do not overlap, then the output pulses from Q_2 and Q_4 are merely replicas of the input.

The output of Q_2 and Q_4 are again differentiated, and in the case of Q_2, inverted by Q_5. The waveforms are applied to the bases of Q_6 and Q_7. These transistors, which make up the anti-coincidence circuit proper, are connected in series with Q_6 biased on, and Q_7 biased off. Thus, a negative-going input to Q_7 will normally cause a positive-going output to appear at its collector. However, if the base of Q_6 is simultaneously taken positive, Q_6 will cut off and prevent current flowing through Q_7, so that no output will appear. The negative and positive inputs referred to are the spikes obtained by differentiation from the trailing edges of Q_5 and Q_4 outputs. The spikes of opposite polarity appearing on their leading edges should produce no output from Q_7, but in practice small spikes do appear at Q_7 collector, diodes D_3 and D_4 eliminate these.

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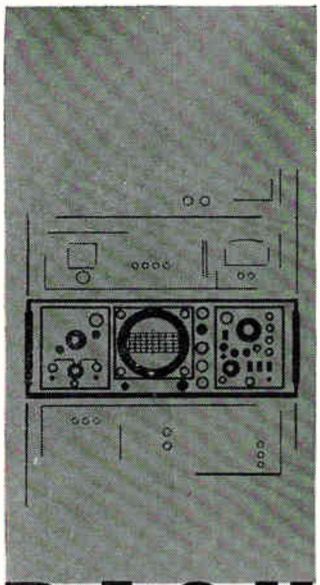

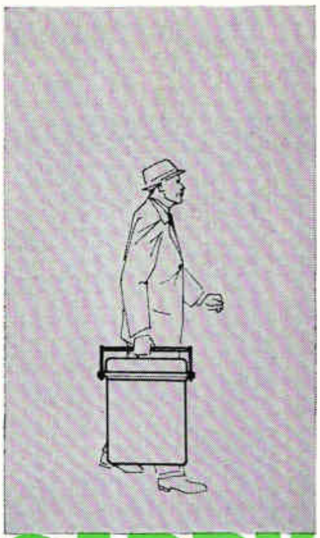

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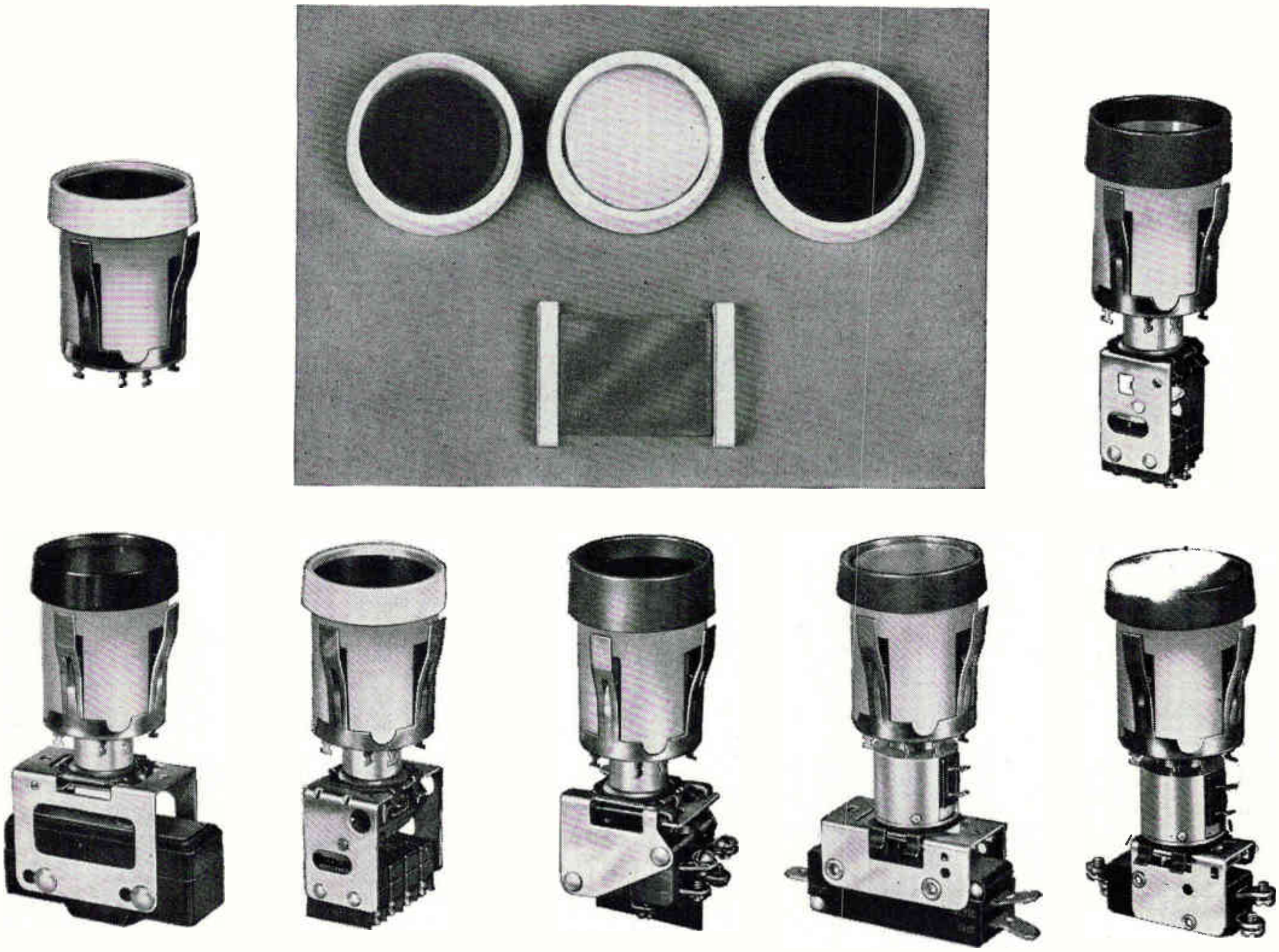

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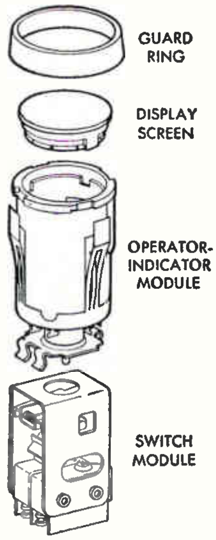

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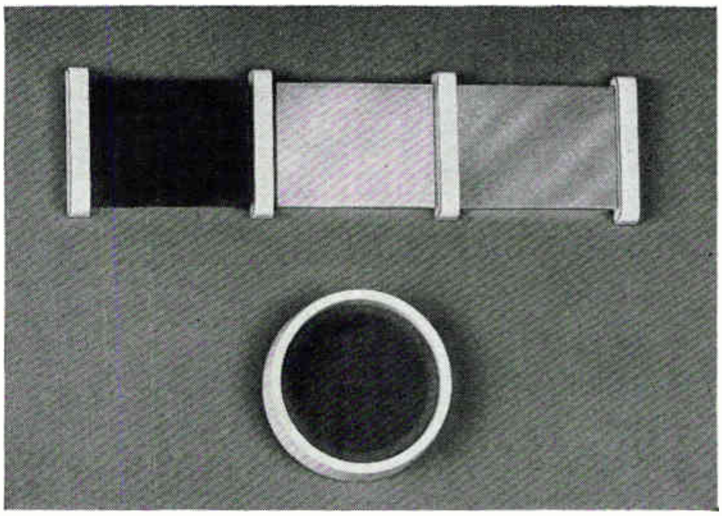

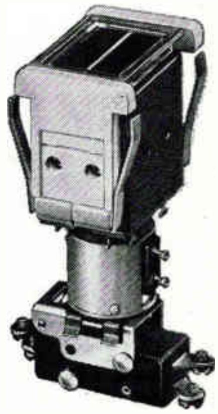

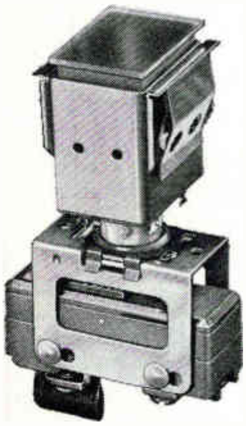

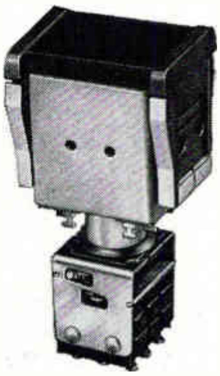

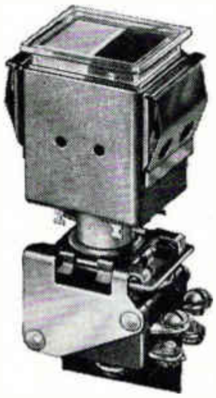

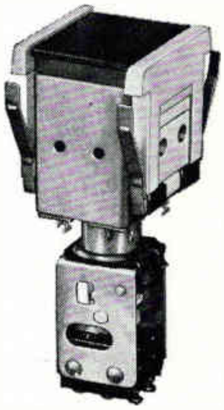

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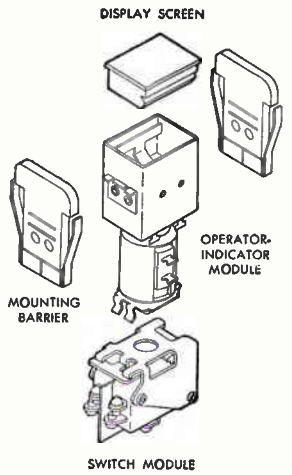

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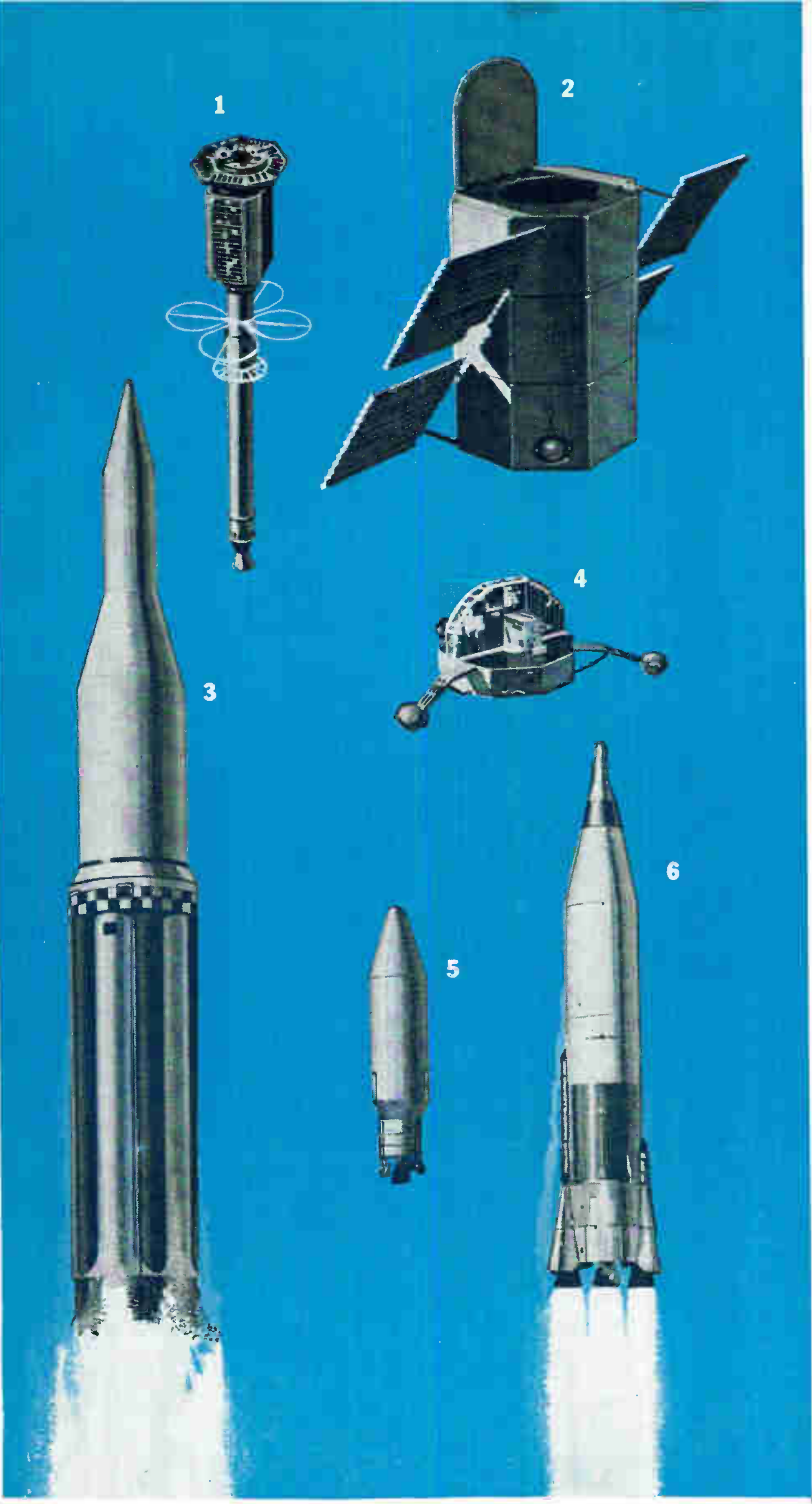

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4. **Orbiting Solar Observatory.** The OSO, developed for NASA by Ball Bros., took into orbit a combination of Avco's Satellite Receivers and Decoders on March 7, 1962.
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Realistic Simulator Displays Radar Shadows

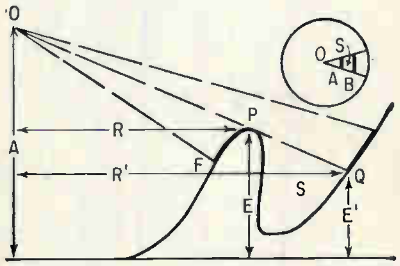
Dual transparencies provide analog data for creating shadow effects

By VICTOR G. HAJEK
Naval Training Device Center
Port Washington, New York

CHANGES in the presentation of an airborne radar as land masses are traversed in flight are provided in a simulated display. The dual-transparency display simulator was developed to train operators to interpret radar presentations rapidly and accurately.

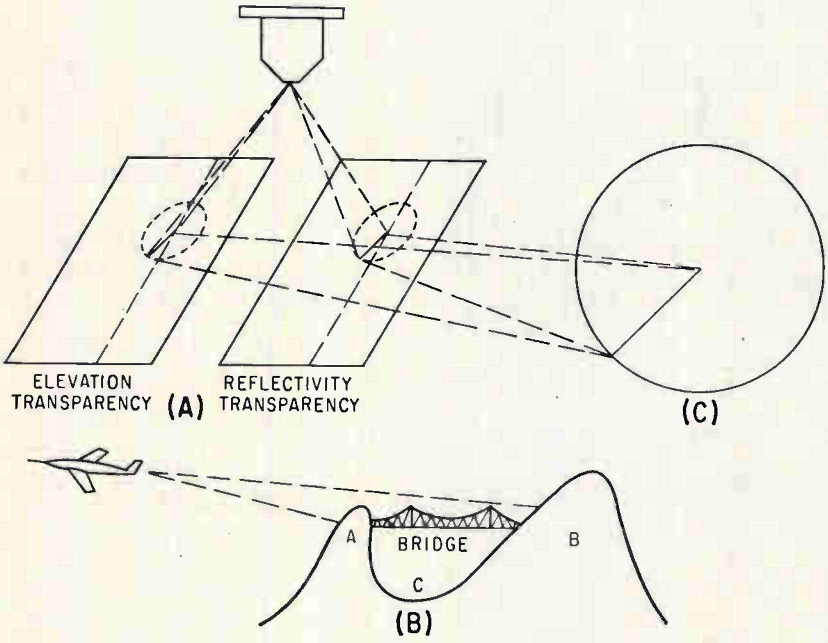
The new system was evolved in a program that began in 1957 at the Naval Training Device Center, Port Washington, N. Y. In addition to generating shadow effects, advantages over earlier simulators include smaller size, less complex optics and lower cost. The dual-transparency system can also simulate low-altitude flights.

Two transparencies about 5 by 10 inches each provide information about a geographical area at a scale of 5,000,000 to 1. They are precisely

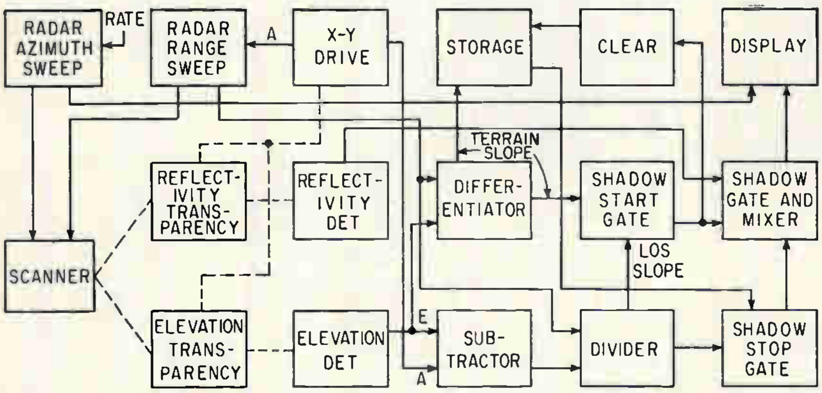


SHADOW REGION *between mountains is simulated by using geometrical relationships between terrain and radar line of sight—Fig. 3*

mounted and simultaneously scanned by a split-beam optical scanner. The two transparencies in Fig. 1A contain information about the terrain at B and are used to provide the display at C.



SPLIT-BEAM *scanner (A) extracts information from transparencies about terrain (B) for simulated display (C) of land masses—Fig. 1*



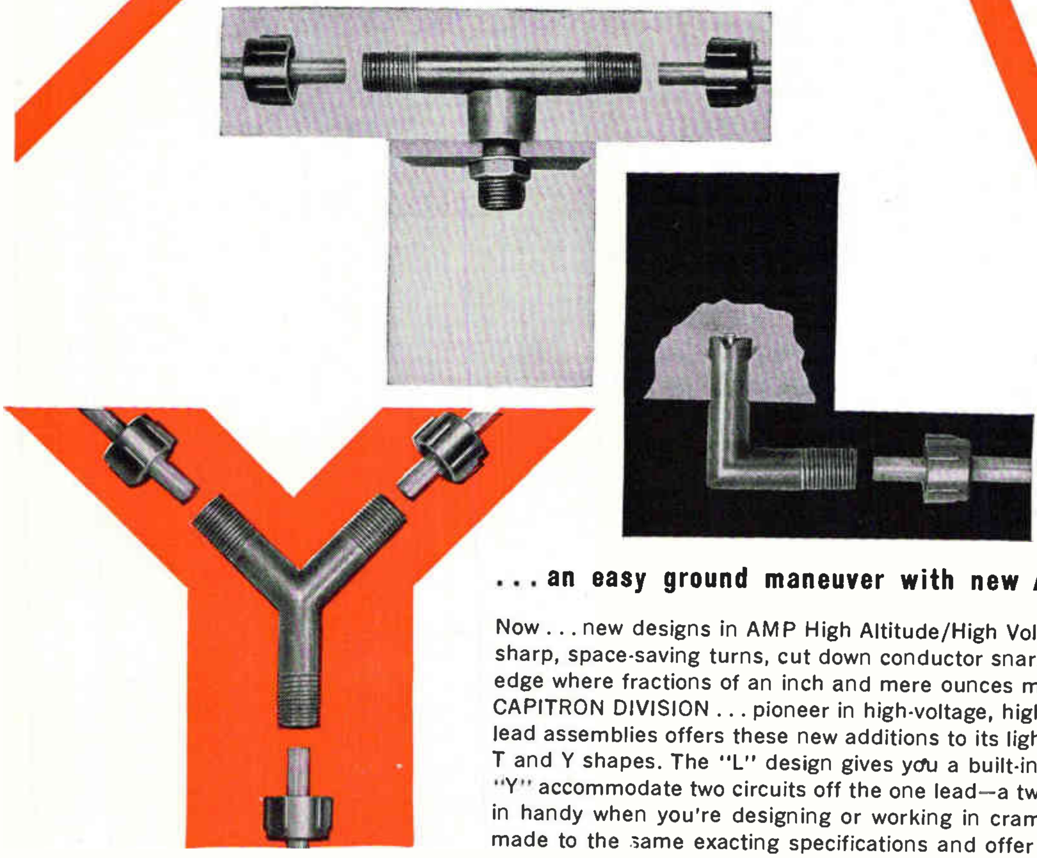
ANALOG TECHNIQUES *use information obtained by synchronized scanner to generate start and stop shadow-effect signals—Fig. 2*

Density of the elevation transparency is a function of altitude, and the light beam passing through it would indicate objects like hills A and B and valley C. The reflectivity transparency provides terrain details that would result in differences in signal strength of radar echoes. The beam passing through it would indicate objects like the bridge in Fig. 1 as well as the type of terrain. The scanner is synchronized with the radar sweep, and all times are equal to the comparable radar characteristics.

A multiplier phototube senses the amount of light passed by the reflectivity transparency, which is directly proportional to terrain characteristics. The signal is used essentially unmodified in the simulated display in Fig. 2. A second multiplier phototube detects the amount of light passed by the elevation transparency, providing a signal that is a function of altitude. These signals are also used for generating shadow effects, which are needed to simulate realistically radar displays of land masses.

GENERATING SHADOWS—Shadow area *S* in Fig. 3 would not be seen by radar at *O*, resulting in blank area shown in display. To

a tight turn at 70,000 feet?



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simulate this effect, start and stop shadow signals must be generated. As the scanner sweeps from point F toward point P, changes in altitude (elevation transparency density) relative to horizontal range R are detected by a differential circuit. At point P, line-of-sight slope $(A - E)/R$ becomes tangent to terrain slope obtained from the elevation information, and a signal is generated to initiate the shadow effect. For use in generating shadow stop signals, the values of terrain slope that are tangent to line-of-sight slope are stored electronically for each simulated radar pulse.

When simulated range increases so that point Q is reached by the scanner, the shadow stop signal is generated. This point is established when $(A - E')/R'$ is equal to $(A - E)/R$. In the system in Fig. 2, A is a voltage analog of altitude above sea level, analogs E and E' are obtained from the elevation transparency, and R and R' are obtained from the scanner sweep circuits.

To simulate aircraft movement, the transparencies are positioned by an x-y drive. Radar ranges are simulated by controlling the rate and distance scanned.

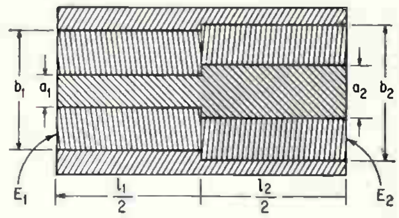
In the photograph of a simulated radar display, mountain ridges are represented by the light areas. To their right, the simulated shadow effect can be seen.

Tolerances in Coaxial Low-Pass Filters

By RICHARD M. KURZROK
Surface Communications Systems Laboratory
Radio Corporation of America,
New York, N. Y.

MECHANICAL TOLERANCES can be prescribed on the physical dimensions of coaxial low-pass filters. An equation has been derived that relates small changes in dimensions of these filters to the resulting changes in cutoff frequency.

Cutoff frequency, which is usually the most significant performance characteristic of a low-pass filter, is considered in relation to dimensions for the varying-impedance type coaxial low-pass filter. Structure of this filter shown in the figure is popular because of its physical form factor (no shunt stubs) and its ease of fabrication.



HALF-SECTIONAL *view of low-pass coaxial filter shows physical dimensions that are related to cutoff frequency in equation*

Characteristic impedance of the high-impedance subsection is $Z_{o1} = 138/E_1^{\frac{1}{2}} \log_{10} (b_1/a_1)$ and of the low-impedance subsection is $Z_{o2} = 138/E_2^{\frac{1}{2}} \log_{10} (b_2/a_2)$, where E_1 and E_2 are relative dielectric constants of the different impedance subsections, b_1 and b_2 are inner diameters of the outer coaxial conductors and a_1 and a_2 are outer diameters of the inner coaxial conductors. In the figure, l_1 is physical length of the high-impedance subsection and l_2 of the low-impedance subsection.

At cutoff frequency for the principal passband (but not spurious passbands), $\rho = \cot (\theta_1/2)/\tan (\theta_2/2)$, which is the filter cutoff equation in which $\rho = Z_{o1}/Z_{o2}$. Electrical length of the high-impedance half-section at cutoff frequency is $\theta_1/2 = \pi l_1/\lambda_c$ and for the low-impedances half-section is $\theta_2/2 = \pi l_2/\lambda_c$, where λ_c is free-space wavelength at filter cutoff frequency.

Small changes in filter physical dimensions can be approximated by differentials. By differentiating the filter cutoff equation and obtaining total differentials of all partial differentials, an equation can be obtained in which the overall percentage change in filter cut of frequency can be related to the percentage changes in all filter physical dimensions.

It can be shown that $\Delta f_c/f_c = (1/D) \{(2\rho \tan \theta_2/2) [(1/\ln_e b_2/a_2) (\Delta b_2/b_2 - \Delta a_2/a_2) - \frac{1}{2} (\Delta E_2/E_2)] + (2\rho \tan \theta_2/2) [(1/\ln_e b_1/a_1) (\Delta a_1/a_1 - \Delta b_1/b_1) + \frac{1}{2} (\Delta E_1/E_1)] - (\theta_1 \csc^2 \theta_1/2) (\Delta l_1/l_1) - (\rho\theta_2 \sec^2 \theta_2/^2) (\Delta l_2/l_2)\}$ and $D = (\rho\theta_2 \sec^2 \theta_2/2) + (\theta_1 \csc^2 \theta_1/2)$,

where Δf_c is overall change in filter cutoff frequency, f_c is nominal filter

cutoff frequency, $\Delta f_c/f_c \times 100$ is percentage change in filter cutoff frequency, and Δa_1, Δa_2, Δb_1, Δb_2, ΔE_1, ΔE_2, Δl_1 and Δl_2 are the changes or tolerances of the various filter dimensions. It has been assumed that all changes in filter dimensions are less than 5 percent.

Although the validity of this tolerance study has not been experimentally verified, computations of $\Delta f_c/f_c$ for practical mechanical tolerances on a typical coaxial low-pass filter have yielded reasonable quantitative results. A spot qualitative check of the equations reveals that the direction of the change in frequency for positive or negative tolerances is correct for all filter dimensions.

The study did not take into account the effects of the discontinuity capacitance resulting from the steps in the inner and outer coaxial conductors. Although these discontinuity capacitances often shift f_c as much as 5 percent, the change in f_c from the changes in discontinuity capacitances should not be significant for most coaxial low-pass filter designs.

A similar study has been made of corrugated waveguide bandpass filters[1] and one could be made for the strip transmission line low-pass filter.

REFERENCE

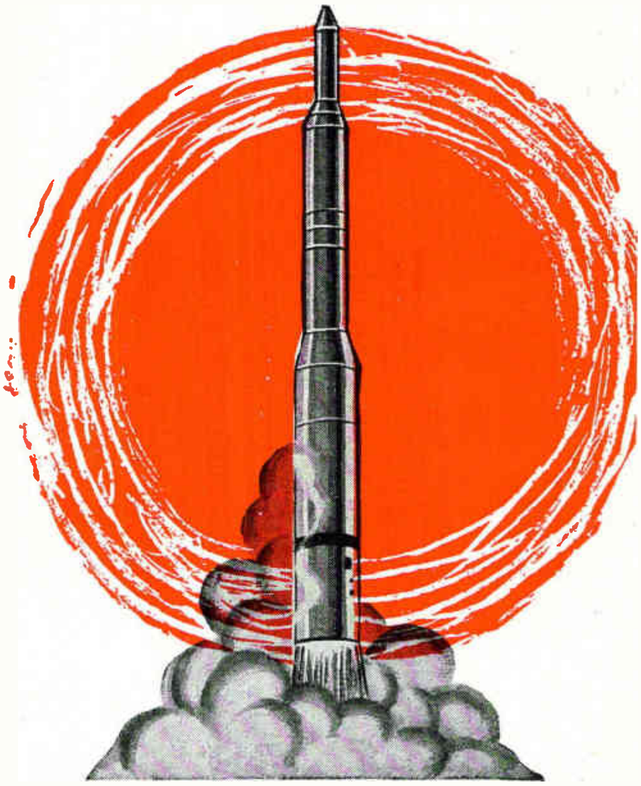
(1) Richard M. Hurzrok, Corrugated Waveguide Bandpass Filters, Thesis for degree of Master of Electrical Engineering at the Polytechnic Institute of Brooklyn, p 20, 74, June 1956.

Superconductor Observed Reversing Magnetic Field

EXPERIMENTAL EVIDENCE has verified that a magnetic field reverses its direction as it passes through a superconducting thin film. This reversal was first predicted by Professor A. Pippard at Cambridge University in 1953. Now scientists at International Business Machines have actually observed the change.

The observation was made during an experiment designed to determine how magnetic fields penetrate superconducting thin films. When a strong enough magnetic field is applied to superconducting metals, they revert to their normal condition. A number of theoretical explanations of this phenomenon have

SELECTED BY RCA FOR A HIGH RELIABILITY *PROJECT



Here is MEASURED RELIABILITY!

Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no** failures of any type occurred*

The accumulated 22 x 10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than .00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

**The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

**A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than ±2% and whose capacitance did not fall within the original tolerance of ±5%.
3. A part whose final dissipation factor exceeded .002.
4. A part whose final insulation resistance measured less than 100,000 megohms.

Write for a copy of our "Reliability Study of Silvered Mica Capacitors".

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MANUFACTURERS OF
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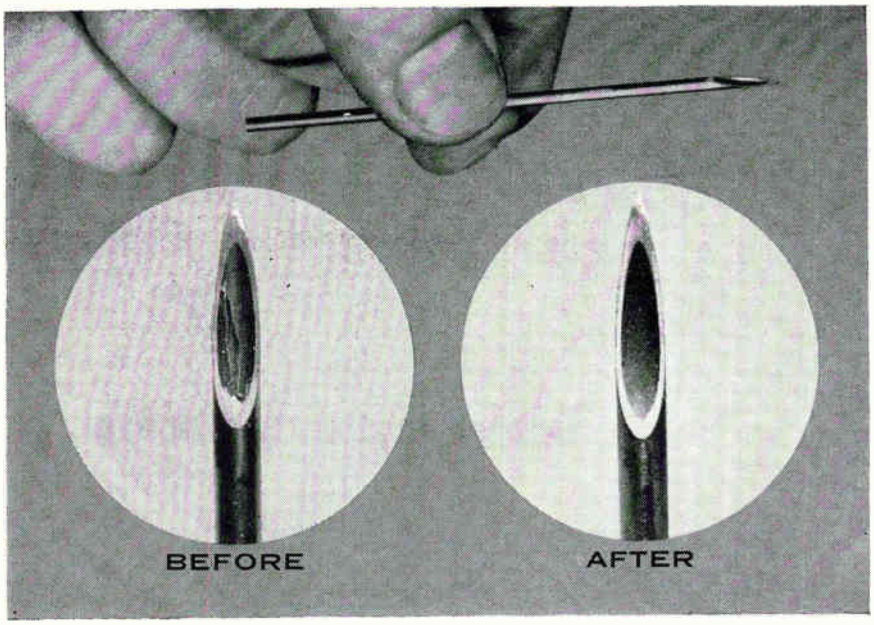
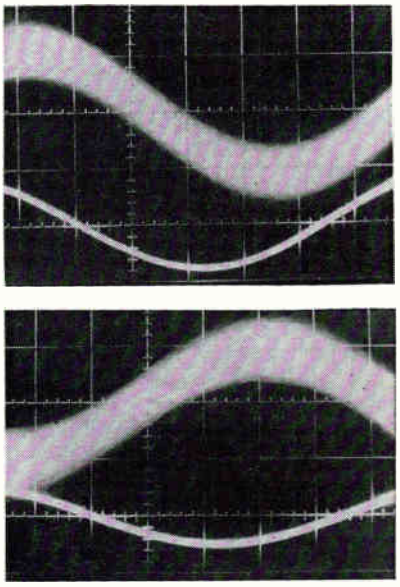


been advanced. However, only in the past five years has the Bardeen, Cooper, Schrieffer Theory evolved, which explains most of the phenomena. While much experimental evidence has been accumulated to support this theory, observing the sign reversal is the first direct physical evidence that certain relatively unexplored predictions of the theory are valid.

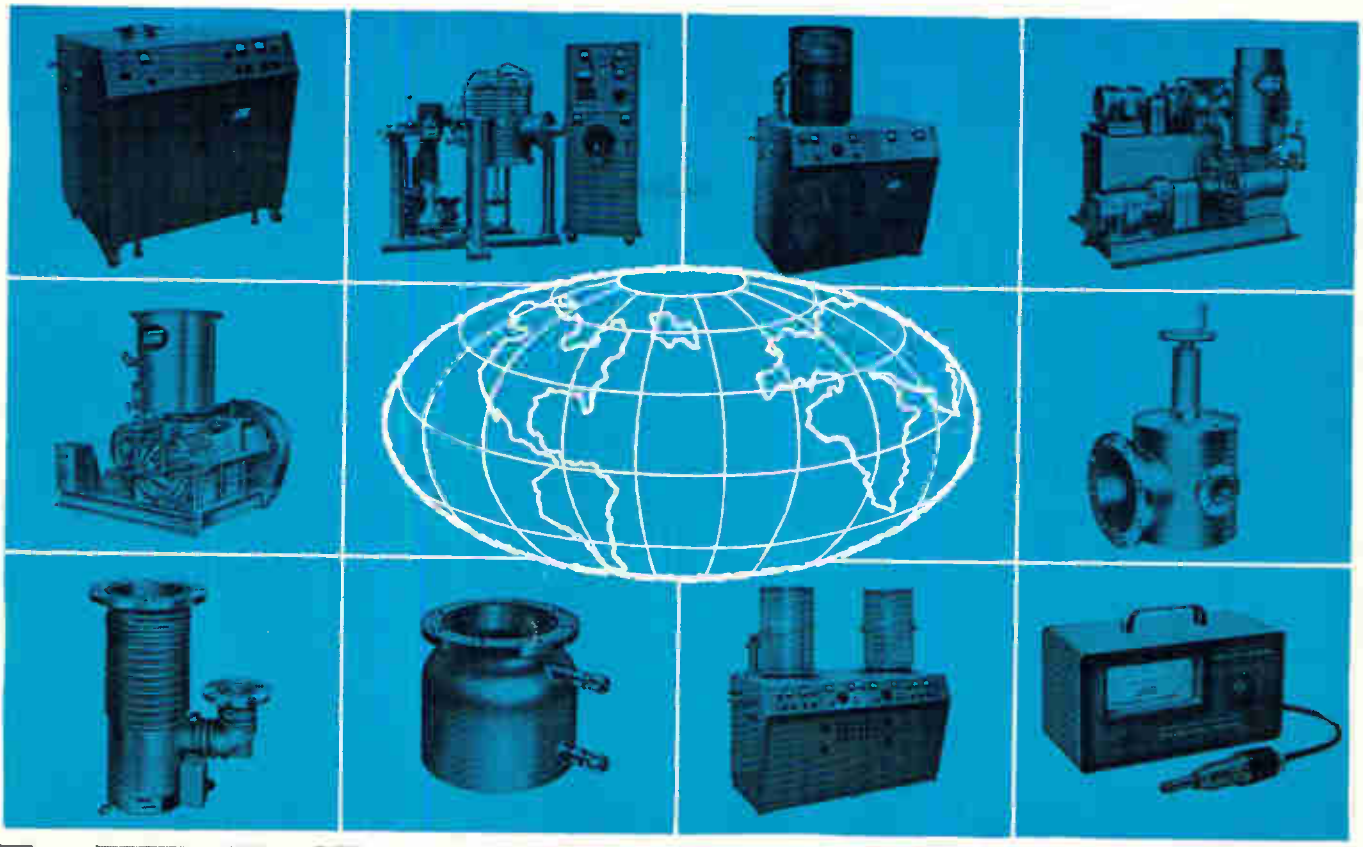
To perform the experiment, tin films were evaporated on the outside surface of a rotating glass substrate. The cylinders formed were 0.8 inch in diameter, 6 inches long and had walls 0.007 inch thick. A pickup coil was placed inside the cylinder, and a second coil was wound around the outside of the cylinder.

By applying alternating current from a signal generator to the outside coil, a magnetic field of up to 30 oersteds was available to create a small field inside the cylinder. The



HEAVY TRACE *shows reversal of phase in induced signal compared to reference as superconducting temperature is reached*

highly attenuated field that penetrated the superconducting film was detected by the pickup coil inside. This signal, tuned with an external capacitor and amplified in a tune amplifier, was compared with drive current in the exciting coil on a dual-beam cathode-ray oscilloscope with external triggering. This setup enabled comparison of both the amplitudes and phases of the two voltages. When temperature was lowered below a certain level, reversal



in the direction of the field was clearly visible as a change in phase between the internal and external signals.

During the experiments, the earth's magnetic field was compensated to better than 10^{-3} oersted to reduce the effects of trapped flux.

Isolated Dog Behavior To Be Studied by Telemetry

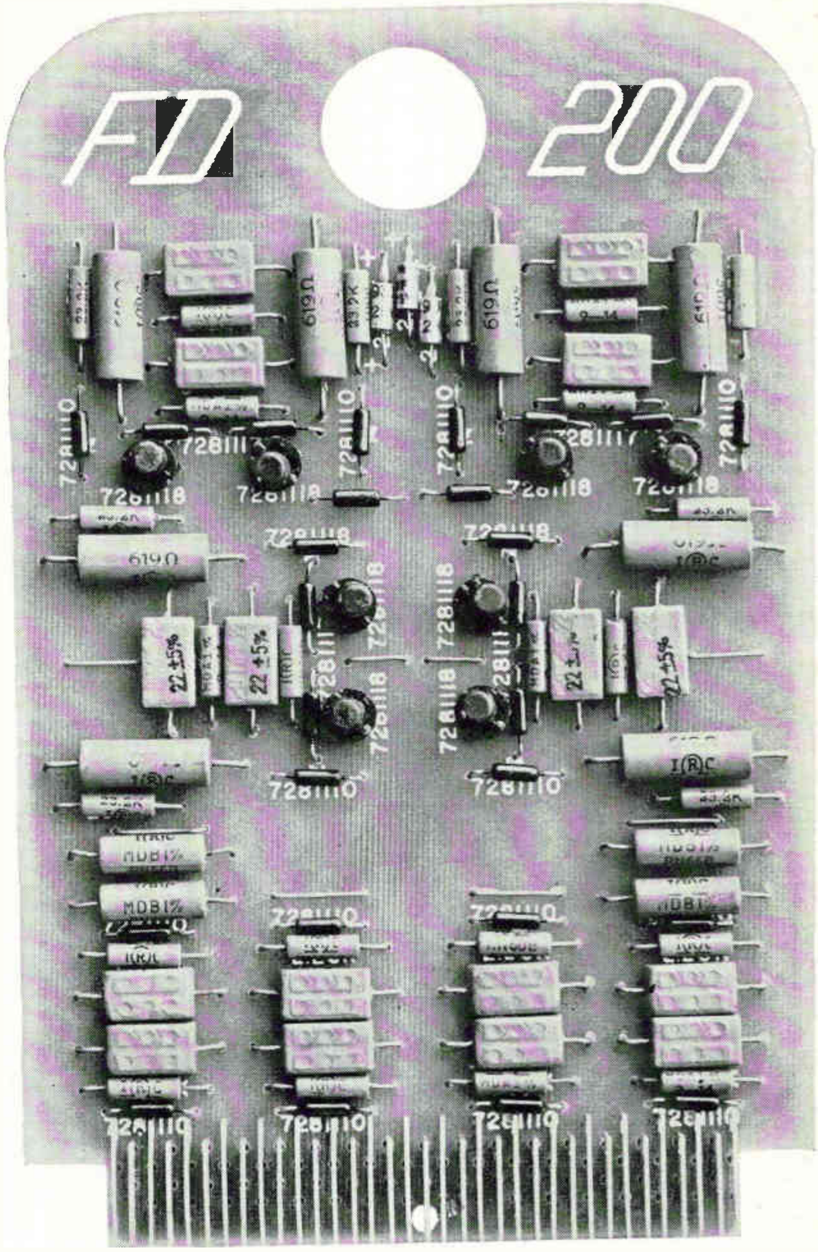
PERMANENT ELECTRODES and temperature sensors will be implanted in the brains of dogs in an effort to find out more about the source of abnormal behavior. Information from the transducers will be telemetered and monitored for its general psychological significance and its possible application to human behavior problems arising from an environment of restricted sensory inputs.

The investigation is part of a study of the effects of isolation on man and on the lower vertebrates. Working on a grant from the Air Force Office of Scientific Research, Dr. R. Melzack, MIT, is studying the effects of isolating young animals on the development of their behavior.

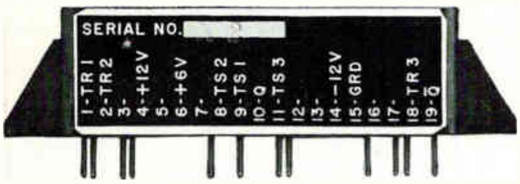
Three litters of beagles were divided at three weeks of age into two groups. Eight pups were shut up in individual boxes and six grew to maturity normally on a farm. Behavior of the dogs shut away for six months was infantile, erratic, bumbling and excitable. They also had an unusual disregard for pain, excitedly bumping their heads into objects and even poking their noses into flames. They did not seem to learn from these experiences or to be disturbed by them. The isolated animals ignored other dogs and were unresponsive to being petted by humans.

The litter mates raised on the farm were significantly more successful in psychological tests of learning and discrimination. One dog raised on the farm, however, underwent a marked change. Moving him from the farm to a cage in the laboratory resulted in behavior like the isolated dogs.

The electronic equipment will provide additional data for use in examining the many theoretical questions about behavior, learning and pattern recognition.



both 10mc

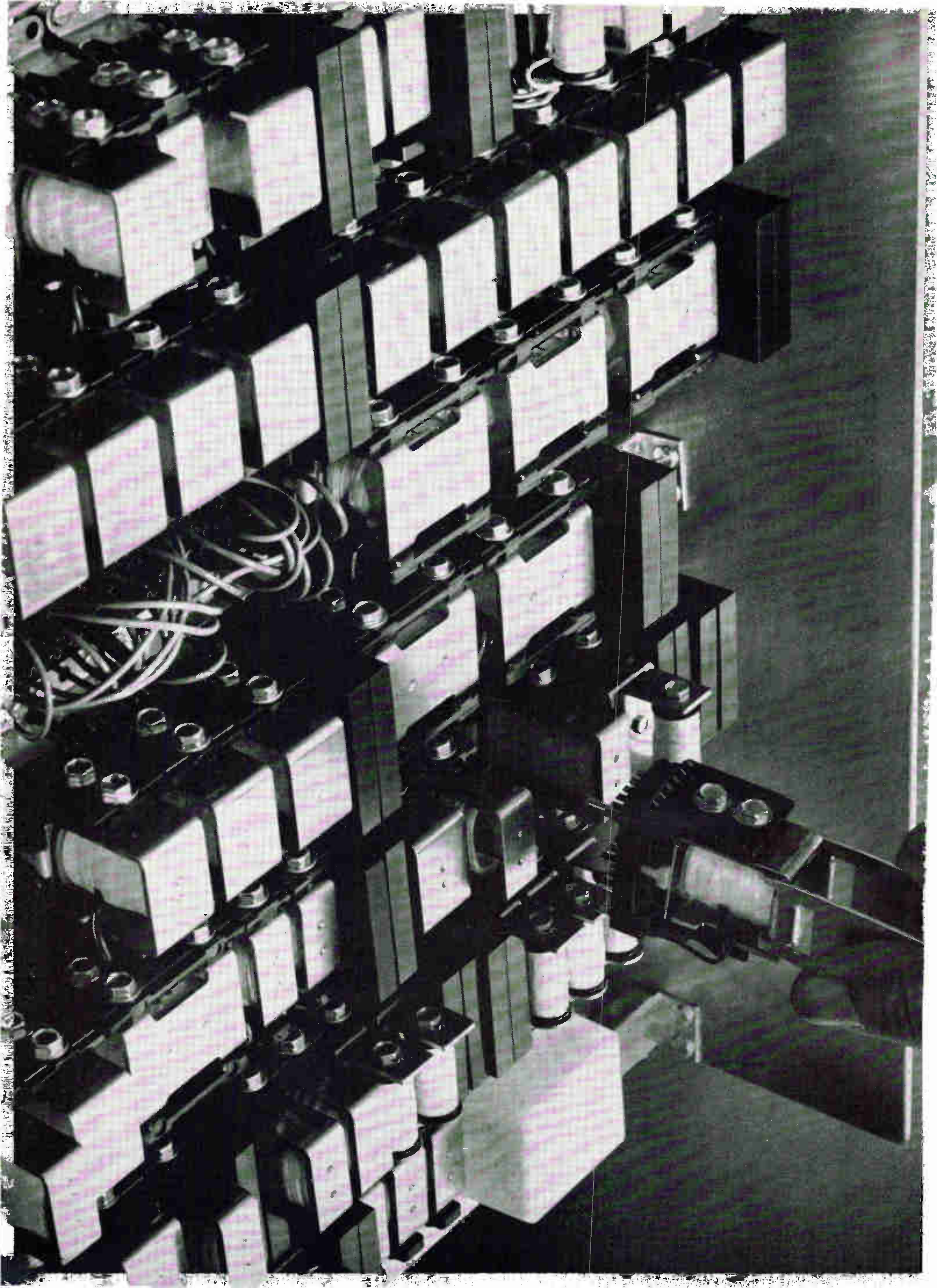


ONE FOR THE BIRD ONE FOR THE BLOCKHOUSE

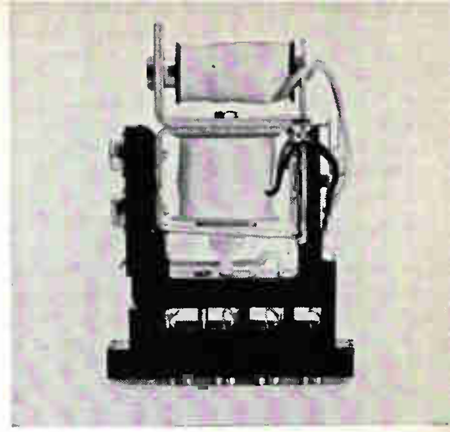
Tested, proved, ready for work . . . Delco's new 10 mc Silicon Digital Modules are available in either building block or plug-in card. Both circuits are *exactly* the same electrically. Either way, these modules meet or exceed all MIL-E-5272D (ASG) environmental requirements. In the blockhouse, the plug-in card package offers extreme accuracy and reliability with a gate-switch speed of 40 nanoseconds. The building block package and the card offer the same high speed at temperatures of −55°C to +100°C. Ideally suited to airborne guidance and control, the building block package is environmentally proved to: *Shock*, 1,000G's in all planes; *Vibration*, 15G's at 10 to 2,000 cps.; *Humidity*, 95% at max. temp.; *Storage and Sterilization Temp.*, −65°C to +125°C; *Acceleration*, 20G's. Both building block and plug-in card modules are designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Delco Radio can offer both 10 mc module packages off-the-shelf or can supply circuits to meet your specific needs. Write Delco Radio Military Sales Department, Kokomo, Indiana.

DELCO RADIO
Dependability Reliability

Division of General Motors • Kokomo, Indiana

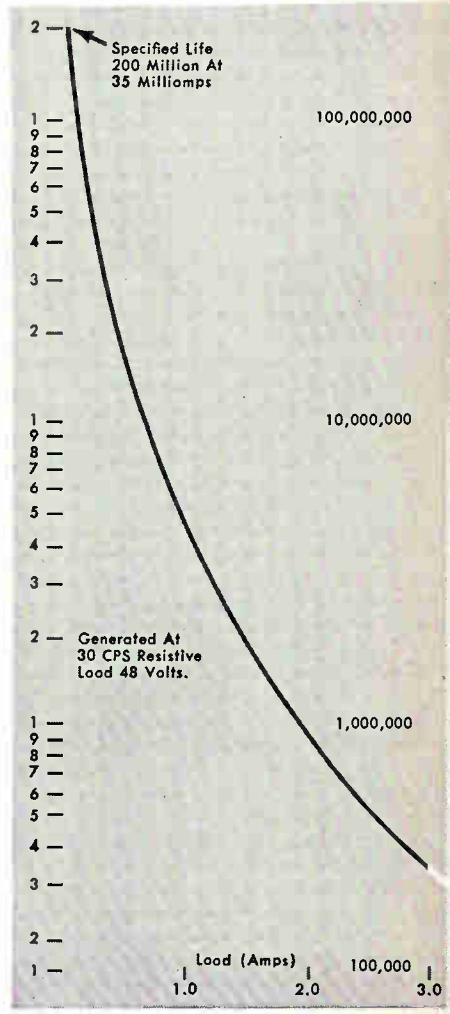


Time Tested
IBM Wire Contact Relays



The mechanical latch type wire contact relay for low cost memory

Prices start at $3.40 for a single relay. And, there's one low price regardless of quantity. Standard 4, 6, and 12 pole relays range from $3.40 to $6.15. Latching relays with 4 and 6 poles range from $8.45 to $9.35. All prices are f.o.b. Essex Junction, Vermont. Shipments of production relays can be made *within 24 hours of receipt of order when requested.*



Life vs Load

Time Tested Performance

Life: 50 to 200 million minimum

Operate Speed: 4 to 8 ms including bounce

Release: 5 ms maximum including bounce

Contact Rating: Vary with life requirements (See Chart)

Reliability: 1 error per over 400 million contact closures at 48 VDC

Coil Voltages: Up to 100 VDC

Integrated Package. Solderless connections and multiple coil designs coupled with compactness, standardized mounting hardware and racks offer *manufacturing savings and lower product costs.*

Applications. Wire contact relays are ideal for counting, logic switching, shift registers, flip-flop and timing circuits for such applications as numerical control, communications, test equipment, process control, data processing, supervisory control systems, and many others.

New Catalog. Get the complete story of the wire contact relay—applications, circuits, 15 years of field performance data, electrical characteristics, mounting hardware, and, of course, prices. Here's everything you need to determine a price/performance ratio.

Write direct to: IBM, Commercial Sales, Relays, Essex Junction, Vermont.

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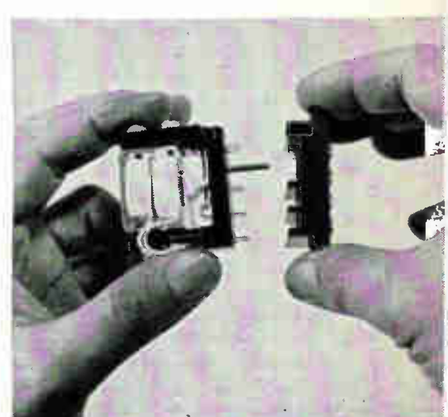


Pluggability simplifies installation, reduces inventory cycle

CIRCLE 99 ON READER SERVICE CARD

Interscience Center Spawns New Devices

Work is coordinated in solid-state, infrared and other new fields

INTERTWINING DISCIPLINES of materials science and electronics at Massachusetts Institute of Technology points to an increased interdependence between the fields of electronics, chemical and solid-state physics, molecular science and engineering, and materials engineering. Responsible authorities agree that important advances in electronic devices will come from coordinated programs that bridge the gap across from one of these subdivisions to another.

The best definition of the proposed new Materials Center at MIT is a consolidation of separate organizations which have had independent existence in the past into one entity. Although each group will continue to maintain its independence, advances in one group will be correlated with work carried on in another group.

The present program at MIT has special significance. MIT spokesmen claim that it will provide leadership for the industry in a formal program that will lead to device advances in broad areas of electronics.

The Materials Center at M.I.T. is conceived as a federation of many individual projects, knit in teams. These individual projects are essentially autonomous and will determine their own programs, and to a large extent handling their own business. But the center is a coordinated body whose main function is to pass information back and forth, as well as to supply the convenience of central facilities which are too large for any one project to handle by itself.

Here is a rundown on some work now being conducted in a few of the areas.

FUNCTIONAL BLOCKS—Workers are mastering oxide-masking and etching techniques used for the control of geometry of silicon blocks. Prototypes of device designs will not only be constructed, workers will study problems in the fabrication steps, serious interactions between diffusants, and control of critical device dimensions. They are beginning to look at device characteristics of insulators that support space-charge limited currents, now receiving considerable attention in industry; microwave applications of semiconductors; superregenerative varactor amplifiers; and high-power ferromagnetic resonance. One group is now investigating thin-film thermoelements.

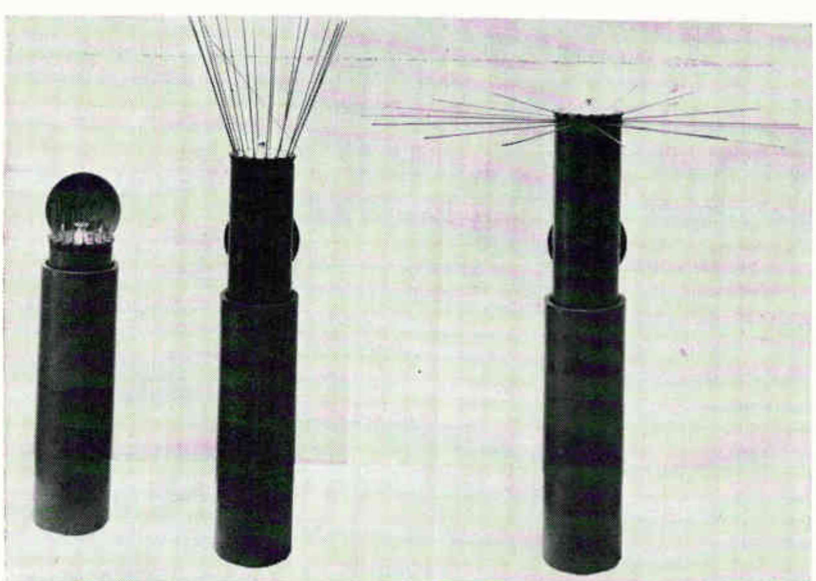
THIN FILMS — Systems - oriented components activities in thin films exploit properties of materials used, and techniques for depositing thin, vacuum evaporated films. Work has been conducted in the areas of magneto-optic effects on magnetic film surfaces, i-f noise in thin metallic films, conduction in metallic and semiconducting films, and deposition of photoelectric and electroluminescent films.

Two-terminal devices have been constructed of aluminum and aluminum oxide, where the oxide is formed by electrolytic anodization. Conduction through the oxide has been examined as a function of oxide thickness, temperature, and voltage applied across the oxide. The theory of conduction for such devices will be worked out.

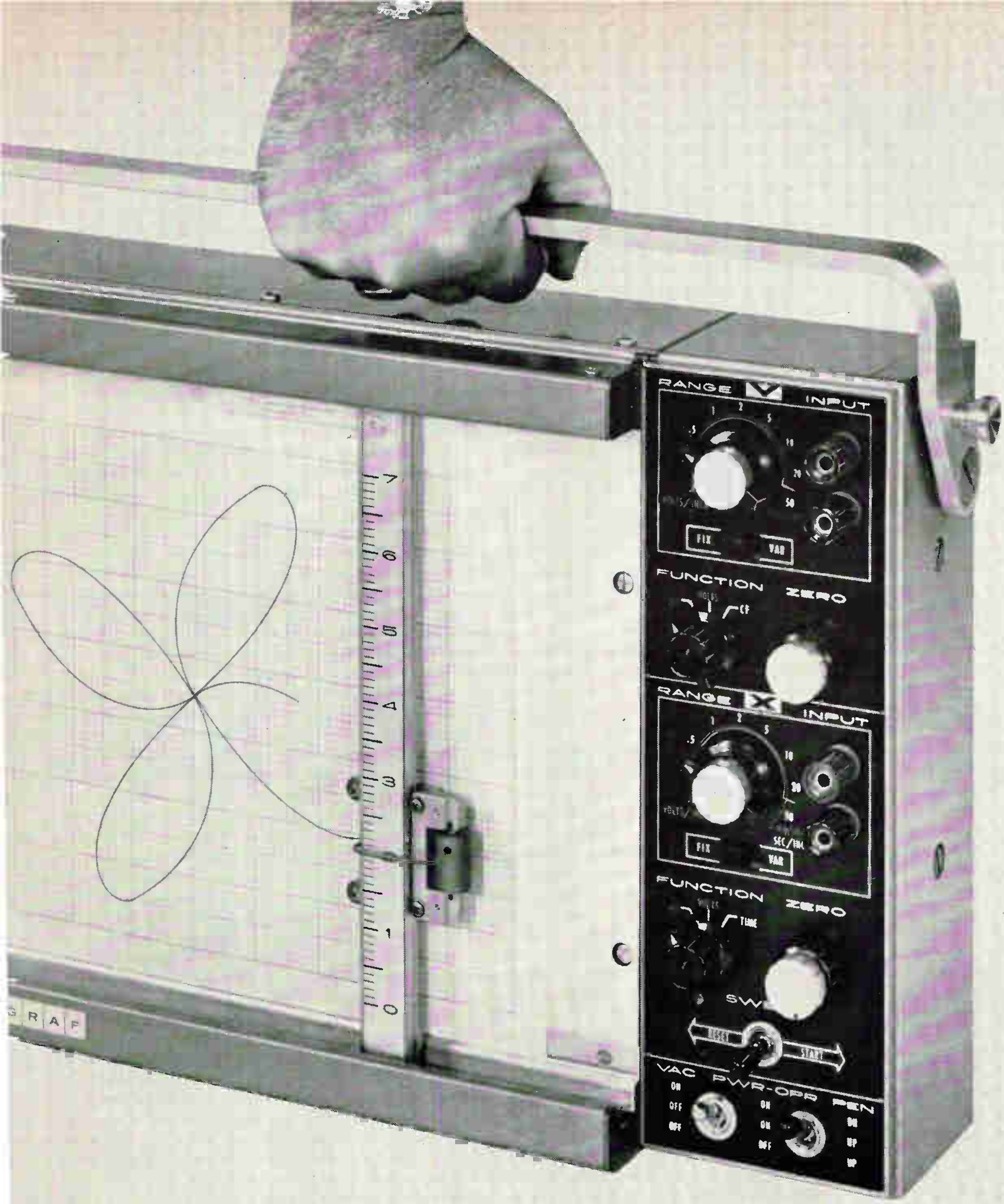
Other work has been conducted to develop satisfactory techniques for deposition of tantalum films, and to study conduction in a tantalum-tantalum oxide system. An electron bombardment system has been developed for directly evaporating aluminum oxide to determine if aluminum-aluminum oxide diodes can be formed by vacuum deposition.

INTERMETALLICS — Investiga-

Antenna Survives Nuclear Blast



POPUP ANTENNA *would be buried in the ground in its silo sheath. Upon command following a nuclear blast, it would rise some 12 feet above ground and spread to a 24-foot diameter to restore communications. Performance is equivalent to a 120-foot-high conventional antenna. Developed by Sylvania, it can be scaled to operate over a wide range of frequencies*


RANGE Y INPUT
FIX
VAR
FUNCTION ZERO
RANGE X INPUT
FIX
VAR
FUNCTION ZERO
VAC PWR-OPR PEN
GRAF

tion of structure and properties of Nb_3Sn reveal that this compound has a high T_c and is one of the most promising materials now available for making superconductive solenoids capable of producing fields of 100,000 gauss or more. Another intermetallic, Nb_3Al also with a high T_c, has been made in the form of a wire with a Nb jacket. Very high purity niobium single crystals have been made by floating-zone electron beam technique, and resistivity data is being compiled for these crystals.

New emitter materials are under investigation at MIT Department of Metallurgy. Efficiency of thermionic converters can be improved by employing mixtures of refractory metals with rare earths.

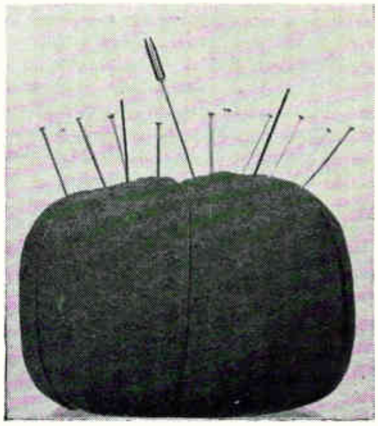
INFRARED—An image tube designed at MIT's Lincoln Laboratory, is sensitive in the spectral region of one to 40 microns. Photoconductor is zinc-doped germanium, sensitive to 40 microns in series with a photoemitting surface sensitive to and excited by visible light. Proposed tube has all of the advantages of a vidicon. Construction has been undertaken by another group in the laboratory.

An all-solid-state-infrared-to-visible converter has been built which consists of a photoconductor of copper-doped germanium in series with an electroluminescent layer, sandwiched between two transparent copper electrodes. Units have been fabricated which transform images at 3.8 microns when operated at 150 deg K. Other units are capable of producing the conversion out to 29 microns when operated at 17 deg K. The converter should be able to produce recognizable image transformations of objects whose temperature differs by one deg K from a background at 300 deg K. Preliminary units, however, have a temperature difference of 50 deg C to produce recognizable conversion. Irrespective of sensitivity, the converter should prove useful in transforming thermal scenes into visual pictures because of its simplicity, ruggedness, low cost and fast speed of response.

MASERS—Cyclotron resonance masers are now feasible, according to theoretical calculations. Magnetic fields of 100,000 gauss and an optical maser are required as the pump source. The latter induces an allowed direct interband transition between magnetic levels for inverting the population. Stimulated emission is downward by an intraband cyclotron resonance transition. The maser is tunable by the magnetic field and should provide coherent radiation in the far infrared region of the spectrum. Instrumentation is now being built at Lincoln Laboratory for a preliminary experiment.

ELECTRONIC MATERIALS — Programs center around the development of special techniques to produce crystals of high perfection and purity, the preparation of new materials, and basic studies to characterize the physical and chemical properties of these materials. A typical defect-type intermetallic, SnTe, has been prepared in single crystal form for electrical studies. Single crystals of SnO_2 have been produced by vapor deposition, and electrical resistivity measurements show temperature regions of intrinsic and extrinsic conduction. Sinble crystal of silicon, highly doped with tellurium, have been produced by a new vapor deposition method using the tellurium impurity as the

Latest Neutron Detector Weighs One-Tenth Gram



RADIATION TATTLETALE, *for space systems, made of titanium, is the latest and smallest in a complete line of nuclear instruments developed by General Electric's Nuclear Electronics Products Section, San Jose. Other devices include picoammeters, count rate meters, flux amplifiers, power supplies, logic and calibration units, trip actuators and pulse amplifiers*

RAYTHEON 1N3728 CUTS DIODE COSTS IN HALF

New high reliability 1N3728 (formerly Rheem RD250) is direct replacement for more than 250 general purpose and high voltage silicon diodes.

Now you can reduce qualification and specification expenses, lower inventory costs, and obtain higher reliability with the Raytheon/Rheem 1N3728 *Universal* silicon diode. It is priced at less than one-half the average of manufacturer's published prices for the diodes it replaces, and meets or exceeds all tests and specifications for these units.

The 1N3728 features very high voltage with very low leakage. Reverse leakage is specified at nine points, forward current at ten. Replacement of standard 100 and 200 volt diodes with the low cost 550-volt 1N3728 greatly increases the safety margin of the reverse characteristic, substantially reducing the major point of diode failure. Dependable performance is assured by more than two years of testing and field use.

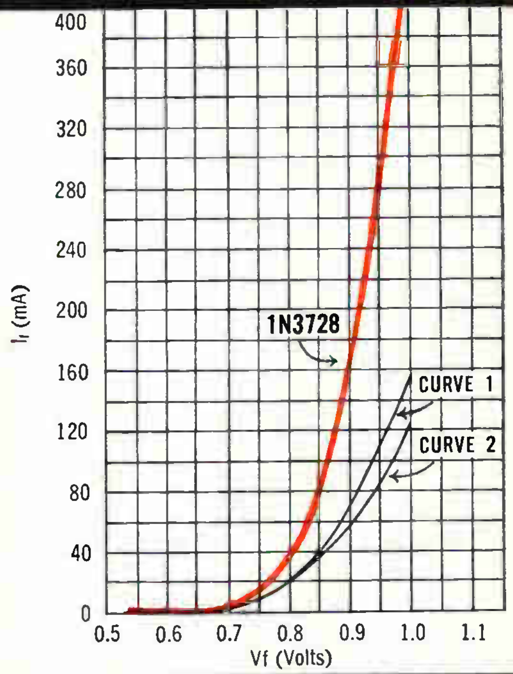
For complete data of the 1N3728, please contact the Raytheon Field Office nearest you, or write Semiconductor Division, 900 Chelmsford Street, Lowell, Massachusetts.

MAXIMUM RATINGS @ 25°C		1N3728	UNIT
Peak rectified current	I_F	650	mA
Average rectified current	I_O	200	mA
Surge current (1 sec.)	I_F (surge)	1000	mA
Pulse current (2µsec. 1% duty cycle)	i_F (pulse)	2000	mA
Power dissipation (derate 1.4 mw/°C)	P_t	250	mW
Operating temperature	T_A	−65 to +200	°C
Storage temperature	T_{stg}	−65 to +200	°C

SPECIFICATIONS	MIN.	TYP.	MAX.	UNIT
Forward Voltage @ 1 mAdc	.61	.64	.68	V
@ 10 mAdc	.72	.75	.80	V
@ 100 mAdc	.84	.87	.98	V
@ 200 mAdc	.88	.92	1.09	V
@ 400 mAdc	.92	.98	1.20	V
Reverse Current @ 20 Vdc				
@ 25°C		.0005	.005	µAdc
@ 100°C		.050	.100	µAdc
@ 150°C		1.00	2.0	µAdc
Reverse Current @ 175 Vdc				
@ 25°C		.010	.025	µAdc
@ 100°C		.150	.500	µAdc
@ 150°C		2.0	5.0	µAdc
Reverse Current @ 400 Vdc				
@ 25°C		.085	.100	µAdc
@ 100°C		.500	1.00	µAdc
@ 150°C		4.0	10.0	µAdc
Saturation Voltage −65°C to +200°C @ 100 µA	500	—	—	Vdc
Saturation Voltage @ 25°C @ 100 µA	550	650	—	Vdc

(SHOWN ACTUAL SIZE)

TYPICAL DIODE FORWARD CHARACTERISTICS



TYPES REPLACED BY 1N3728

Some of the currently-used types replaced by the 1N3728/RD250 are such general purpose, high voltage silicon diodes as:

Type	*Curve*	*Type*	*Curve*	*Type*	*Curve*	*Type*	*Curve*
1N456	2	1N461	2	1N482	1	1N485	1
1N456A	1	1N461A	1	1N482A	1	1N485A	1
1N457	2	1N462	2	1N482B	1	1N485B	1
1N457A	1	1N462A	1	1N483	1	1N486	1
1N458	2	1N463	2	1N483A	1	1N486A	1
1N458A	1	1N463A	1	1N483B	1	1N487	1
1N459	2	1N464	2	1N484	1	1N487A	1
1N459A	1	1N464A	1	1N484A	1	1N488	1
				1N484B	1	1N488A	1

SEMICONDUCTOR DIVISION

RAYTHEON

LOWELL, MASSACHUSETTS

vapor transport agent. Optical properties (infrared region) are being studied.

UHF TRANSISTORS—Both mesa and electrochemical high-speed switching transistors are being studied at MIT's Lincoln Laboratory with the aid of subcontracts from Texas Instruments and Philco. It is hoped that these devices will have current gain bandwidths $G_t \Delta f$ of the order of 5 Gc at collector currents of the order of 50 ma.

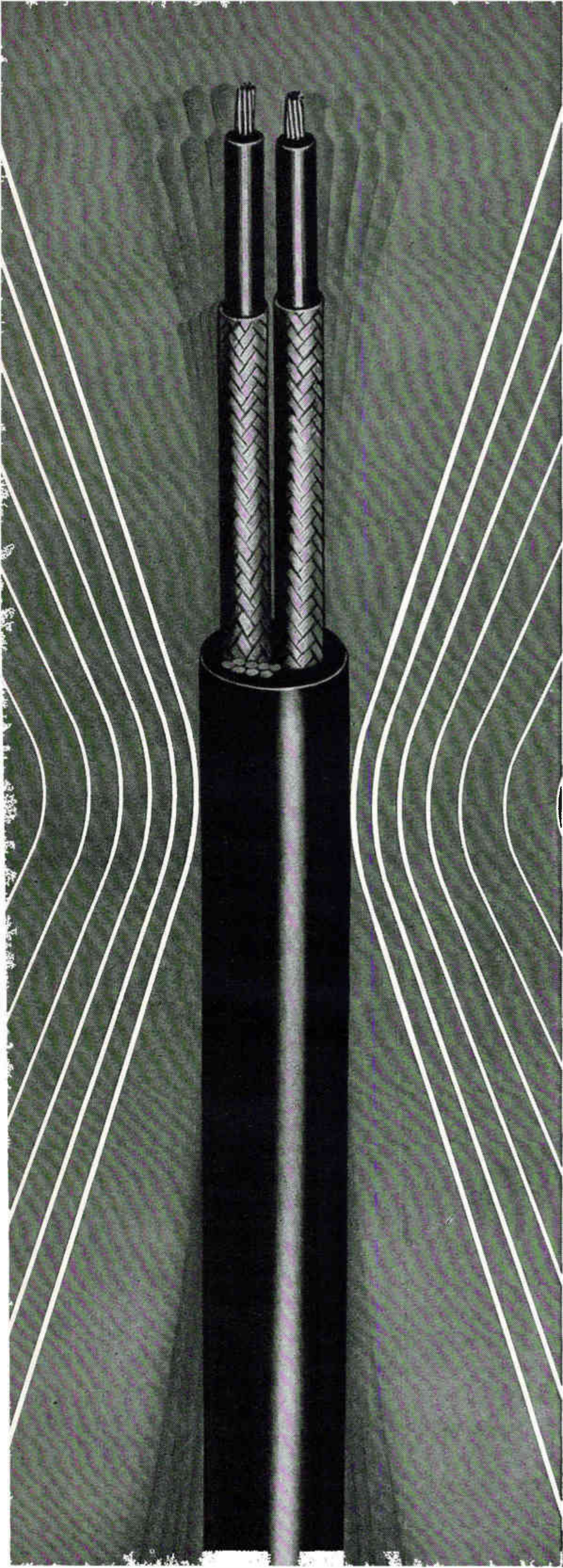
Base widths of the order of 2,000 angstroms are required and have been obtained. Specific problems of base resistance and base widening at high current appear to be solvable. Achievement of even higher gain bandwidth in future transistors does not seem possible since the collector depletion layer is also of the order of several thousand angstroms wide and contributes to the effective base width.

WELDED COMPONENTS—Work in development of optimum resistance welding reliability through study of welding parameters was carried on during the design of an inertial guidance system, and contributed directly to the greatly reduced size and weights of one system presently under development. This work has resulted in a definition of material and other variables, determination of their effect on the weld junction, and progress in control of the welding process ensuring the reliability of the electronics.

Statistical and metallurgical correlation has been obtained between welding parameters, namely electrode force, configuration and materials, power as defined by current and voltage as a function of time, and the effect of change in work resistance as a function of time on the generation of heat.

Results of this study led to adoption of a more fundamental statistical technique for determining welding parameters.

ENCAPSULANTS—New encapsulation materials have been developed in form of soft glass foam potting compound inside of a hard shell of epoxy. The foam consists of tiny hollow spheres of glass mixed with a binder and a solvent. The idea of



Simplex Electronic Cables...

Reduce Low-Level Signal Noise
Protect Hard Site Communications
Facilitate Ocean Implantment

Typical of designs within the Simplex family of electronic cables is an antimicrophonic construction which reduces externally caused noise to a level of 2 millivolts as compared with a level of 60 millivolts in a typical RG 8/U cable subjected to identical testing.

Simplex can incorporate this long-lasting antimicrophonic design feature into any special cable construction, and high demand items such as 2 conductor #18 and single conductor #16 are stocked for immediate delivery.

Many critical installations require cables that are both pliable and strong. Cables, armored by Simplex with extra heavy corrugated metallic sheaths, provide protection for vital communications at hardened missile sites.

This cable provides power and instrumentation circuits plus tensile strength for lowering and retrieving complicated electronic equipment in ocean depths of several miles. These Simplex cables are of "balanced-torque" construction minimizing residual torque of the armor wires.

The Simplex family of electronic cables offers designs to meet the demands of most applications — plus unusual capabilities in the development and construction of special cables to solve specific problems. For further details write to Department 365, Simplex Wire & Cable Co., Cambridge, Mass.

Simplex

WIRE & CABLE CO.

EXECUTIVE OFFICES: Cambridge, Mass.

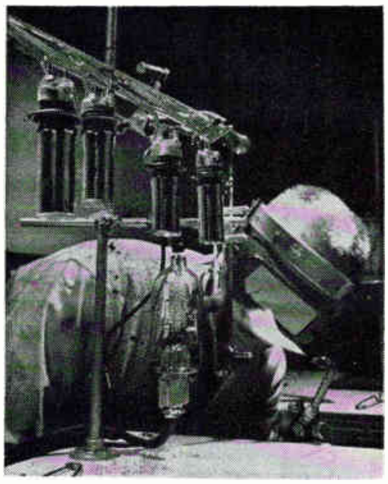
Plants at Cambridge, Mass., Portsmouth, N.H.,

Westbury, L.I., Monrovia, Calif.

CIRCLE 105 ON READER SERVICE CARD

using foams of various types for potting is not a new one, but previous techniques employed foam resins or else mixed fillers with the resin. In this new method, a slurry of the glass foam material is poured over a module in a mold and cured. A shell is cast around the foam. The glass foam protects against shock and vibration, yet repairs are easily made. A hole is cut through the epoxy shell and the foam is quickly integrated by immersing the module in a solvent for the foam. Damage to components is no more than during potting itself.

Infrared Detector Response To Millionth of a Microwatt



FAST RESPONSE of an indium antimonide sensitive element in a rugged infrared detector tube makes it particularly valuable for airborne terrain mapping. The device is sensitive to the intermediate region of the spectrum extending from one to five and a half microns. It delivers a signal of 1,000 volts per watt of 500 deg K black body radiation.

Since the detectors bias current can be varied, signal and noise voltage outputs can be made large by comparison with noise generated in the associated amplifiers. The detector is designed for operation at 77 deg K, and for maximum ease of cooling is being manufactured in a variety of Dewar design configurations.

The tube is being produced by Honeywell's electro-optical facility in Los Angeles. Photo shows worker sealing tubes.

microwave signal generators

1953
MSG-1 and 2
950 to 4600 mc

1962
MSG-1R and 2R
950 to 4600 mc

9 years apart... exactly what are the differences?

As you can obviously see, the modern version has had a bit of face-lifting; but that's not all—the main differences lie in improved modulation capabilities; now—the best in the business. For example, internal square wave was 40-4,000 pps, *now* 10-10,000 pps; pulse width was 0.5-10, *now* 0.3-10 μ sec.; pulse repetition rate was 40-4,000 pps; *now* 10-10,000 pps; pulse delay was 2.5-300, *now* 2-2,000 μ sec. But oddly enough, we're proud of both the changes and the lack of changes. The changes have certainly made the MSG-1R and 2R a more sophisticated instrument—a better buy than ever. But the lack of really basic change means the 9-year-old version is far from obsolete – it's still a highly competitive unit – it still possesses unusually high stability and accuracy; its direct-reading frequency and power, UNI-DIAL® control and other convenience features save important time and insure accuracy in either the lab or the field. Moreover, the fundamental retention of the *essential* design, after eight years, means that these instruments are the most *tried and proven* design that ever came down the pike. Concrete proof of Polarad's policy of "features for the future." **Write for a copy of Notes on Microwave Measurements.**

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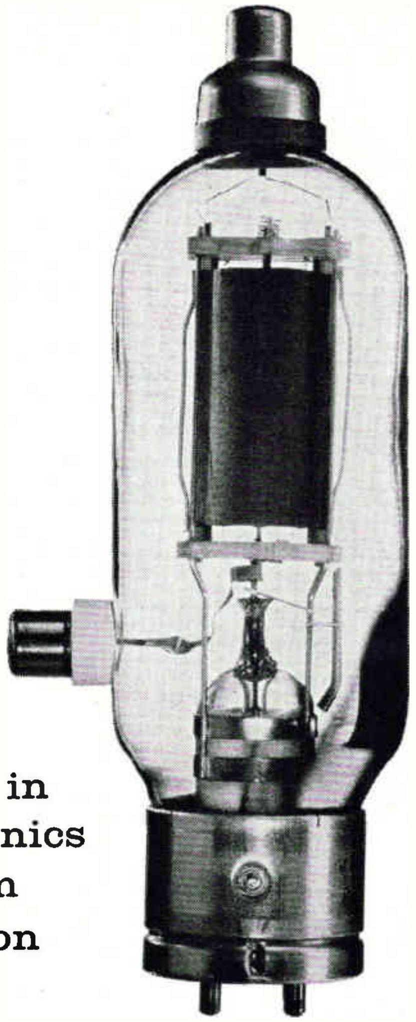

Ideas in Electronics from Norton

The electronics industry became a giant before it became a baby.

This outstanding growth has been largely due to the development of new materials — *refractory* materials with a great range of electrical properties. The prime source of these *idea refractories* is Norton Company.

For example, refractory fused alumina has high constant resistivity, to assure minimum leakage between elements in TV, radio and radar tubes. The same material is a recent innovation for transistor potting. Norton silicon carbide is an essential component in lightning arrestors and other non-linear resistors because of its variable voltage-current relationship. Silicon carbide is also finding new uses in microwave absorption, and as single crystals in high temperature rectifiers and transistors.

Fused magnesium oxide, used in most heating elements for electric ranges, has gained acceptance in such areas as advanced thermocouple design and infrared transmission.

Norton offers a wide choice of super-refined refractories, including oxides, borides, nitrides and carbides, and is ready to work with you in engineering materials to meet your needs. But above all, Norton offers ideas in every field in which refractory materials play a part.

Write NORTON COMPANY, Refractories Division, 685 New Bond Street, Worcester, Massachusetts.

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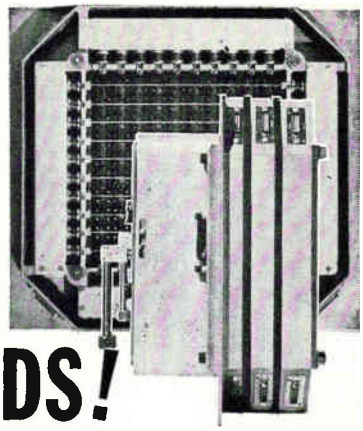

IF YOU ARE NOW USING CROSSBAR, RELAY OR STEPPING SWITCHES, 99 TO 1 YOU CAN USE THE NEW McKEE MULTI-SELECTOR CROSSBAR SWITCH.

This unique 400-position unit combines switching matrix and connector into one integral unit; the connector becomes a part of the switch. Unlike other crossbar, stepping, and relay switches, this design eliminates wiring from the connector to the unit since the switching element makes direct contact with the connector pin.

CAPABILITIES—

- Contact "Make and Break" within 30 milliseconds. X-Y parameters simultaneously energized.
- High voltage capacity in excess of 3000V AC and 4200 V DC.
- Millions of maintenance free operations . . . Servicing performed by your own technicians.
- Minimal capacitance at 20.0 mmf with contact resistance 10.0 milliohms; variation not greater than 5 milliohms.
- Rugged 19 inch frame for panel mount or 17½ inch for framing.
- Controlled internal atmospheric condition optional.

Connector with elongated connector pins permits modularization of two or more matrixes on a common connector. A single 400-position matrix may be used one to ten positions at a time as one to ten pole switch. Addition of matrix units to a common connector multiply these factors.

The switch lends itself to programming by tape, card, pushbutton among others.

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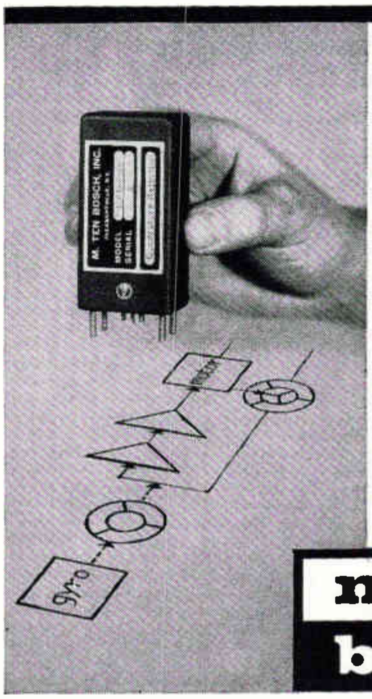

INPUT IMPEDANCE	500,000 ohms (A wide range of input values may be made available to suit source impedance requirements.)
LOAD IMPEDANCE	500 ohms
POWER GAIN	30 Db.
VOLTAGE GAIN	Unity
PHASE SHIFT	Zero
CARRIER FREQUENCY	380 to 420 c.p.s.
OUTPUT	450 millivolts minimum saturated signal at 500 ohm output impedance
INPUT-POWER REQUIREMENTS	28 V.D.C. at 12 ma.; 115 V. 400 c.p.s., 1 ma.

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For detailed QUADRATURE REJECTION AMPLIFIER SPECS, MODEL 1805-0500
Write to Dept.TR-30, M. Ten Bosch Inc., Pleasantville, New York

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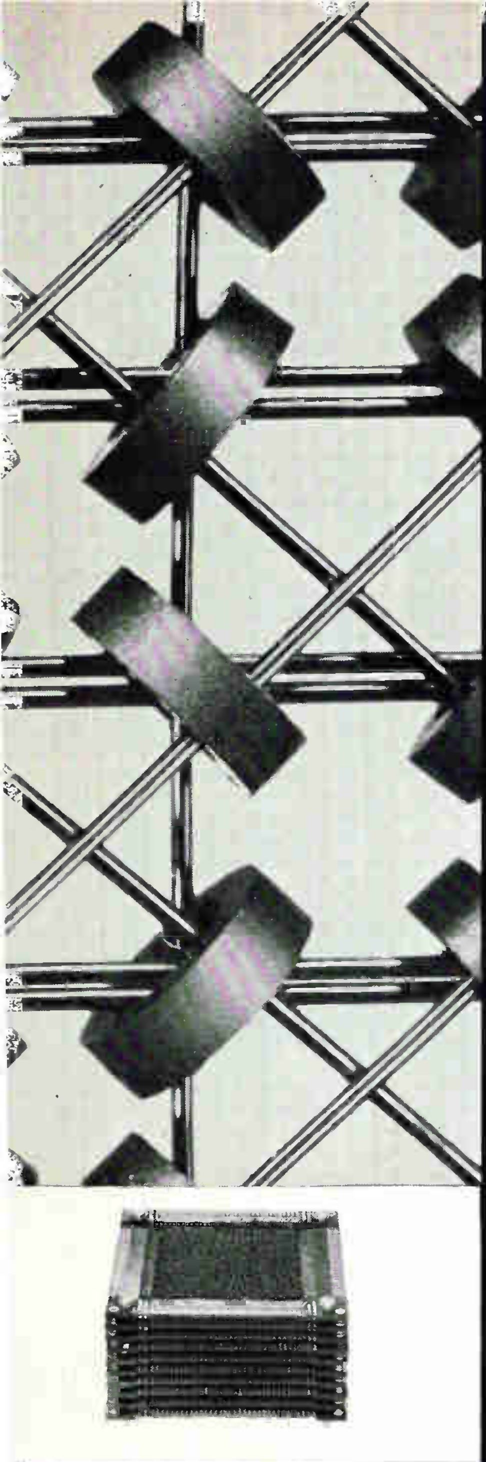

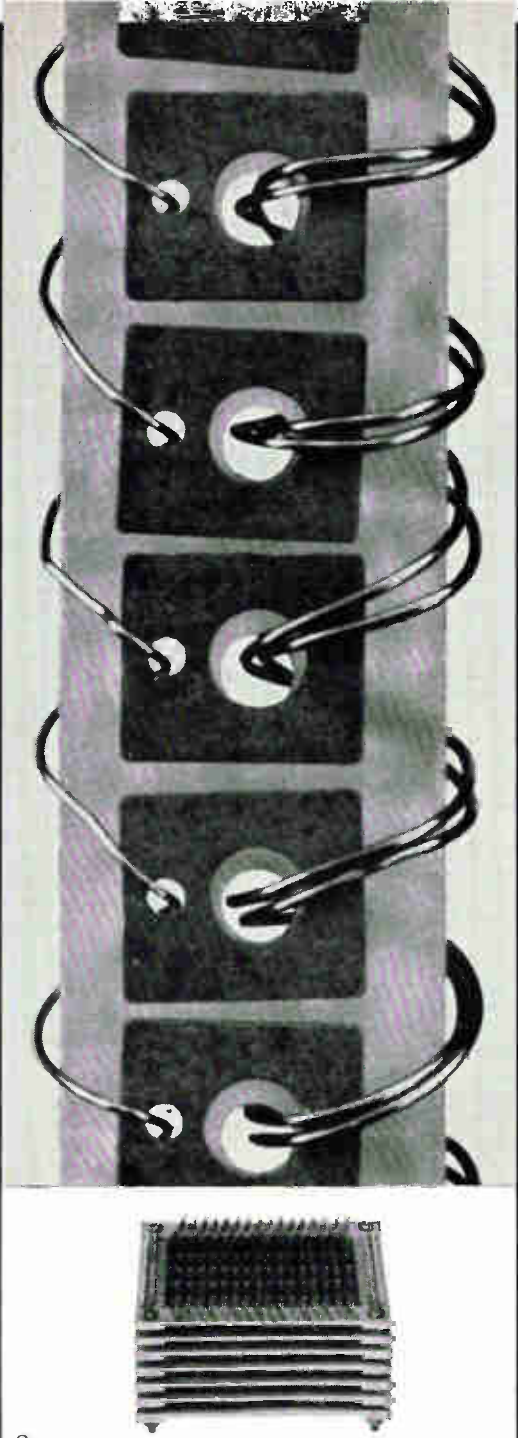

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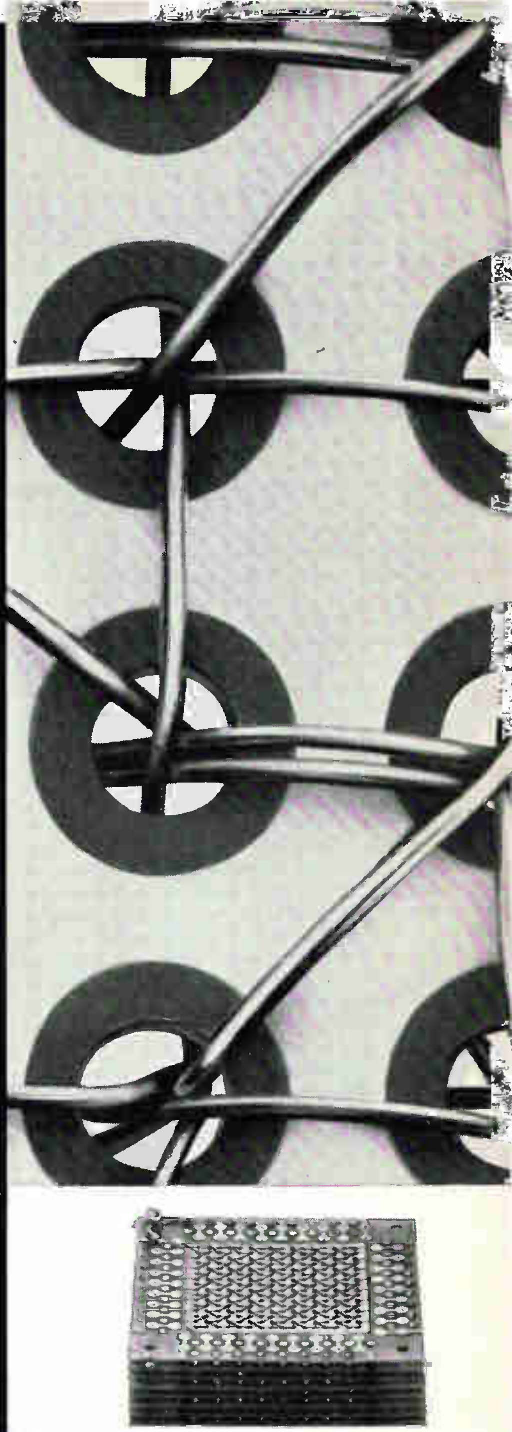

3.

PRODUCTS PHOTOMACROGRAPHED APPROXIMATELY 30 TIMES ACTUAL SIZE

close-up of maximum reliability

Lockheed Electronics' in-house capability produces ferrite cores, multi-aperture devices, printed circuit boards, memory planes and stacks, plug-in circuit modules, and fabricated metal casings. Every step from design through test is under one management to assure maximum quality control and minimum cost.

The enlarged photos above show three of the many types of memory plane assemblies produced by Lockheed Electronics.

1. Standard commercial open frame ferrite core memory plane utilizing either coincident current or linear select wiring.

2. Lockheed designed memory array using multi-aperture cores to provide non-destructive readout. This unique method of mounting and wiring provides the necessary rigidity for severe environmental applications.

3. Memory plane with conventional ferrite cores using imbedded assembly and wiring techniques to meet exceptionally high environmental shock and vibration requirements of military specifications.

For further information on Lockheed cores, memory planes and stacks, or printed circuitry to fill your particular requirements, write: Lockheed Electronics Company, 6201 East Randolph Street, Los Angeles 22, California.

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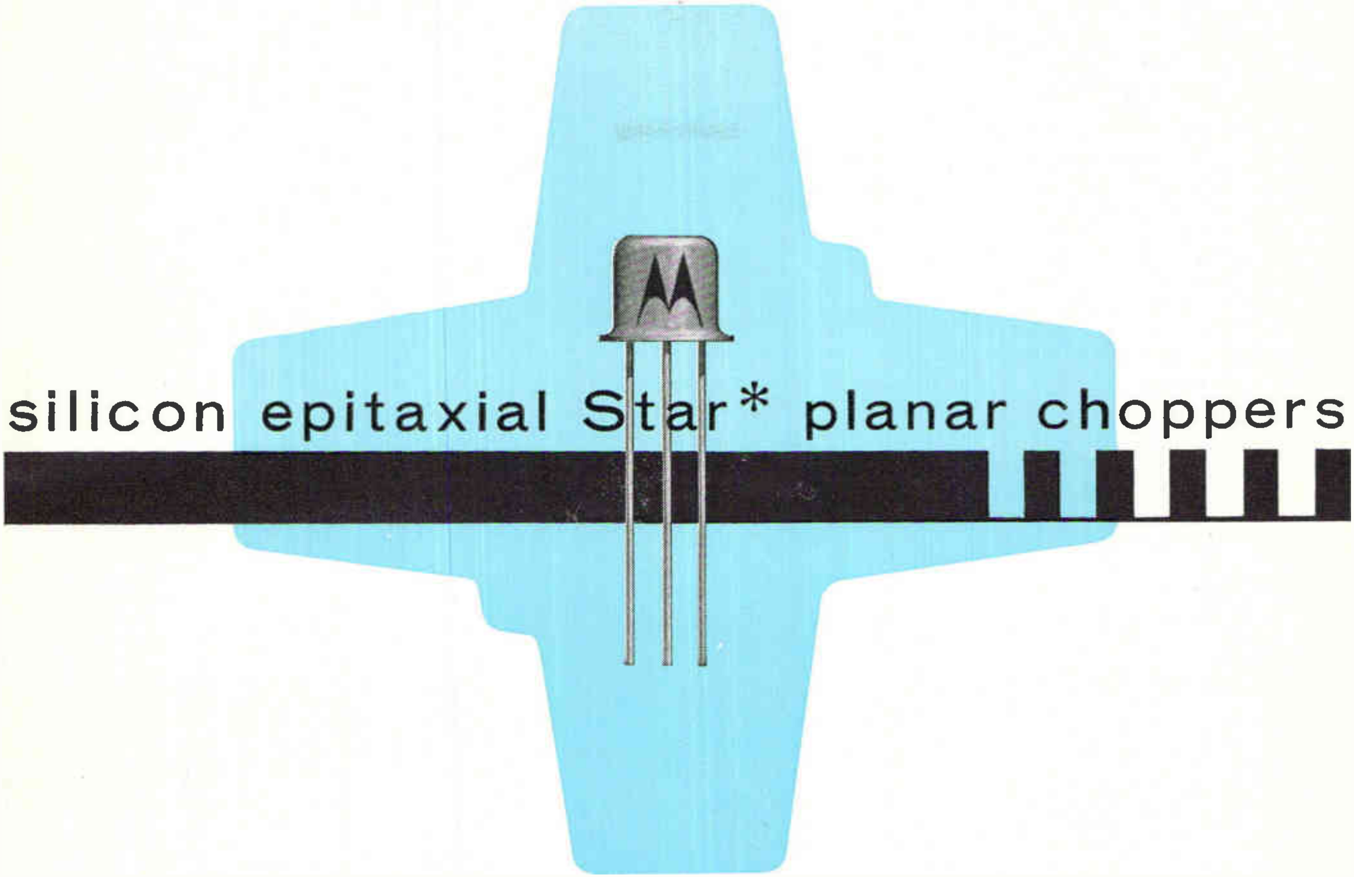
another Si ⊕ from **MOTOROLA...**



silicon epitaxial Star* planar choppers

with parameters virtually insensitive to temperature from +25°C to +85°C

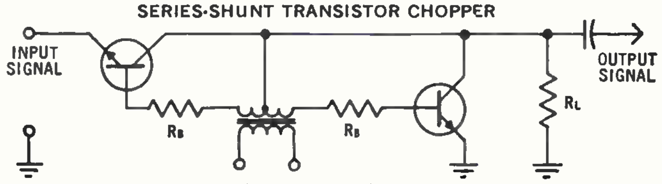
The lowest available offset voltage and offset current, combined with extremely low inverse saturation and the highest frequency response of all choppers available today, are yours with the new Motorola 2N2330 (TO-5 package) and 2N2331 (TO-18 package) Star planar choppers. And, you can use these units without resorting to elaborate temperature precautions because they are virtually insensitive to temperature variations from +25°C up to +85°C.

Designed especially for high-speed DC-AC chopping in low-level saturated switching applications, these new devices are ideal for use in telemetry, multi-channel communications, analog computers, and other low-level data handling applications.

Matched pairs of each type are available on special request for "quasi" push-pull chopper circuit applications. Pairs can be matched with respect to offset voltage, (V_{off}), to within 50 or 100 microvolts.

*STAR is a trademark of Motorola Inc.

SERIES-SHUNT TRANSISTOR CHOPPER



2N2330 (TO-5) $P_D = 0.8$ Watts

2N2331 (TO-18) $P_D = 0.5$ Watts

Characteristics*	Symbol	Min.	Typ.	Max.	Unit
Offset Voltage ($I_B = 200\ \mu$Adc, $I_E = 0$)	$V_{(off)}$	—	0.3	0.75	mVdc
Inverse Saturation Voltage ($I_B = 200\ \mu$Adc, $I_E = 50\ \mu$Adc)	$V_{EC(SAT)}$	—	1.0	3.0	mVdc
Small Signal Forward Current Transfer Ratio ($I_C = 1$mAdc, $V_{CE} = 1$ Vdc, f = 100 mc)	h_{fe}	1	1.5	—	—
Offset Current ($V_{BC} = 2.0$ Vdc, $V_{CE} = 0$, $T_A = 25$°C)	$I_{(off)}$	—	0.1	1	nAdc
Offset Current ($V_{BC} = 2.0$ Vdc, $V_{CE} = 0$, $T_A = 85$°C)	$I_{(off)}$	—	1	10	nAdc
Emitter Diode Recovery Time ($I_B = 1.5$ mA nominal)	t_{fe}	—	3.5	—	μsec

*All values at 25°C ambient unless otherwise indicated.

Production quantities are available now.

To obtain either type, or if you would like additional technical information, contact your local Motorola District Office or Distributor.

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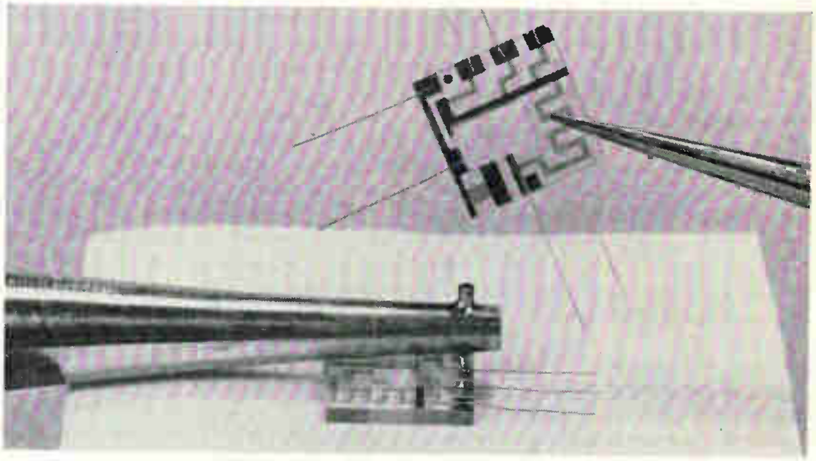
Electronic Applications of Ultrasonic Welding

Makes connections to thin films of many types on various substrates

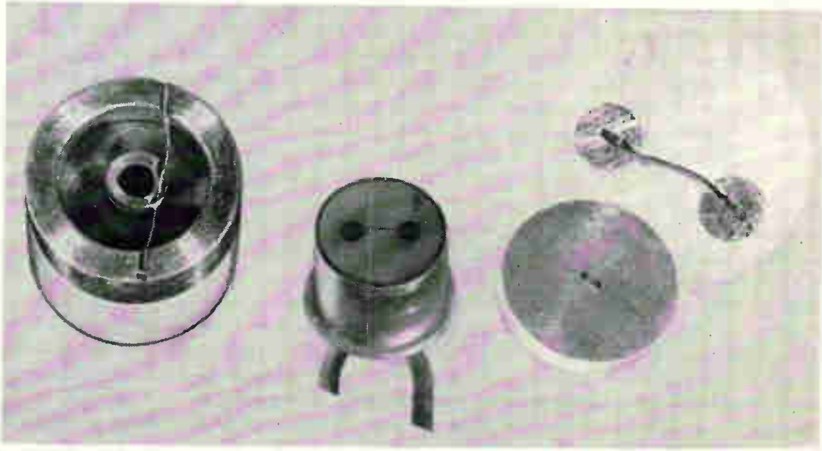
By J. M. PETERSON
Sonobond Corp., West Chester, Pa.,
H. L. McKAIG
C. F. DePRISCO
Aeroprojects Inc., West Chester, Pa.

SINCE ultrasonic welding can create bonds between a wide variety of materials (ELECTRONICS, p 62, June 8, 1962) it is particularly well suited for making connections to thin-film circuits. Several other characteristics of ultrasonic welding are favorable to this application: the ability to join thin sections to either thin or thick sections allows films to be welded to wires and ribbons; since heat as such is not used in the process, and since the parent metals do not reach melting temperatures in most cases, the actual joining operation causes only slight changes in the characteristics of the films and conductors joined. Close dimensional tolerances can be maintained since thermal distortion does not occur.

Some of the many types of films on various substrates that have been successfully welded are shown in the table. Though aluminum wires are the most versatile conductor elements, the process can also be used with gold, copper and nickel conductors. One of the photographs shows a thin film circuit with aluminum wire welded to gold film. The process is entirely mechanical so there is no problem of electric currents flowing through the films or circuit elements.



ALUMINUM WIRE, *0.005 inch diameter, is ultrasonically welded to 2,000-A thick gold film in thin-film circuit application*



FINE WIRES *are welded to relatively heavy terminals in bridgewire assemblies, which are used to initiate chemical reactions*

SEMICONDUCTOR BONDING—Another important application is making connections to semiconductor materials. Gold and aluminum wires, from 0.0005 to 0.025 inch diameter, have been bonded to silicon and germanium, both plain and metallized. The technique is being used by General Electric Co., Auburn, N. Y. to attach wires to silicon in their C-5, C-10, C-35, C-50 and C-204 silicon rectifiers. One of the photographs shows a typical application, in which two 0.01 inch diameter aluminum wires have been bonded to silicon.

Ultrasonic welding is being considered as a method of joining lead wires to semiconductor materials in transistors. There are both economic and technical reasons why the process may be superior to other methods now generally in use.

The yield in bonding gold wires to semiconductor elements ultrasonically can often be made 100 percent, provided the welding installation and set-up are properly established and maintained. This kind of yield has been obtained in pilot runs, and production experience at General Electric, Auburn, N. Y. indicates that it can be at least approached in routine production.

A technical reason for considering ultrasonic welding for attaching leads to semiconductor materials is the formation of a purple stain in the vicinity of gold wires that have been bonded to aluminum-silicon eutectic p-n junctions, such as are found in planar transistors. The purple stain is $AuAl_2$, a brittle, porous compound that ap-


Search for Survival

pears to increase mechanical failures of the connections. One way to eliminate the purple staining is to eliminate the gold wires from this region and ultrasonically weld aluminum wire directly to the aluminized silicon stripe. Even when $AuAl_2$ is not formed in the usual bonding operation, some investigators report that it will form later by diffusion mechanisms and alter mechanical and electrical properties.

Using aluminum instead of gold wires for transistor leads also improves the shock and vibration characteristics of the devices. The lower density of the aluminum wire reduces the mechanical forces on the wire-to-silicon bond, with the result that shock resistance increases from something less than 10,000 g to about 20,000 g.

Ignitor devices using thin, high resistance bridgewire elements to initiate explosions and other chemical reactions have been successfully manufactured using ultrasonic welding. Filament wires 0.001 inch diameter of nickel-chromium and tungsten-platinum have been joined to terminal posts of copper, iron, phosphor-bronze and other metals, as one of the photographs shows. Combustible materials, such as Pyrofuse, which are difficult to

METALLIZED FILMS ON VARIOUS SUBSTRATES TO WHICH CONDUCTORS HAVE BEEN ULTRASONICALLY WELDED

Film	Conductor	(thickness in inches)
I—On Glass Substrate		
Aluminum	Aluminum wire	0.002 to 0.01
	Gold wire	0.003
Nickel	Aluminum wire	0.002 to 0.02
	Gold wire	0.002 to 0.003
Copper	Aluminum wire	0.002 to 0.01
Gold	Aluminum wire	0.002 to 0.01
	Gold wire	0.003
Tantalum	Aluminum wire	0.002 to 0.02
Chromel	Aluminum wire	0.002 to 0.01
	Gold wire	0.003
Nichrome	Aluminum wire	0.0025 to 0.02
Gold—4, 7, and 12 microinch	Aluminum wire	0.010
Platinum—1 microinch	Aluminum wire	0.01
Gold-Platinum—9 microinch	Aluminum wire	0.01
Palladium—8 microinch	Aluminum wire	0.01
Silver—8 and 100 microinch	Aluminum wire	0.01
Copper—electroplated on silver	Copper ribbon	0.028
II—On Alumina Substrate		
Molybdenum	Aluminum ribbon	0.003 and 0.005
Gold-Platinum—7 microinch	Aluminum wire	0.01
Molybdenum-lithium metallized—Gold plated	Nickel ribbon	0.002
Copper plated	Nickel ribbon	0.002
Molybdenum-manganese metallized—Silver plated	Nickel ribbon	0.002
III—On Silicon Substrate		
Aluminum	Aluminum wire	0.01 to 0.02
	Gold wire	0.002
IV—On Ceramic Substrate		
Silver	Aluminum wire	0.01
Copper electroplated on molybdenum, metallized with manganese	Copper foil	—
V—On RCA Alumina Modules Substrate		
Copper electroplated on screened silver	Copper wire, bare, #44	—

MNEW FROM MNEMOTRON!*

We are silent about the "M" in Mnemotron but not about our new 700 Series Data Recorder. With good reason. For one, it brings the size and cost of data recording systems down to sensible proportions if your data is analog voltage from DC to 5000 cycles per second. And its features would not embarrass even the costliest instrumentation recorder. Here are a few:

COMPACTNESS. A complete 7 channel record/reproduce system uses less than two feet of rack space. A 14 channel system adds less than seven inches more.

ACCURACY. Input-output characteristic is linear within 0.2 per cent with Mnemotron unique Pulse Frequency Modulation (PFM) data conversion technique.

FLEXIBILITY. As many data channels as you need with a choice of channel format. For greatest operating economy, choose up to 7 channels on ¼ inch magnetic tape, 14 channels on ½ inch tape, standard IRIG spacing and track width of 7 channels on ½ inch tape.

INTEGRATED RECORD/REPRODUCE MODULES. A single solid-state PFM Data Converter has all the record/reproduce electronics for each channel. Simple rotary switching lets you select data conversion for 3 tape speeds. No additional plug-ins needed.

ISOLATED INPUT CIRCUITS. Input terminals of each channel are isolated from all the others to readily accept data from floating, unbalanced or differential sources.

VERSATILITY. 700 Series plug-in accessories expand instrumentation capability. Typical: Electrocardiogram and electroencephalograph preamplifiers for recording these variables directly from electrodes. Sync-pulse plug-in module for recording trigger pulses, time markers, or stimulus pulses in medical research . . .

PRICE. 7 Channel System from $6,495

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* To answer the many inquiries, Mnemotron comes from Mnemosyne, Greek Goddess of Memory.

MNEMOTRON CORPORATION

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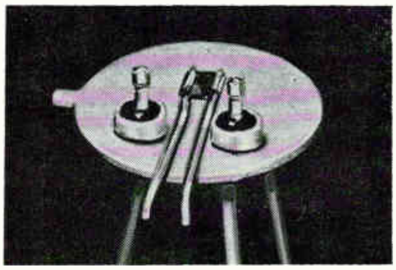
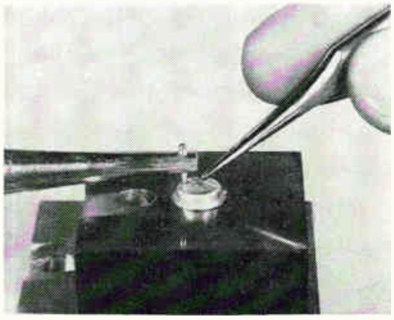
Subsidiary of Technical Measurement Corporation, North Haven, Conn.

bond with resistance welding because of low ignition temperature, have been bonded ultrasonically.

Many types of thermocouples can be attached to aluminum, steel, copper and other metals ultrasonically. Tungsten-rhenium couples for measuring temperatures to 4,500 F have been formed ultrasonically by Martin-Marietta Co., Denver, Colorado; the same organization has used ultrasonic bonding to attach stainless steel and ceramic sheathed thermocouples to test structures.



SILICON RECTIFIER *with two 0.01 inch diameter aluminum wires ultrasonically attached*

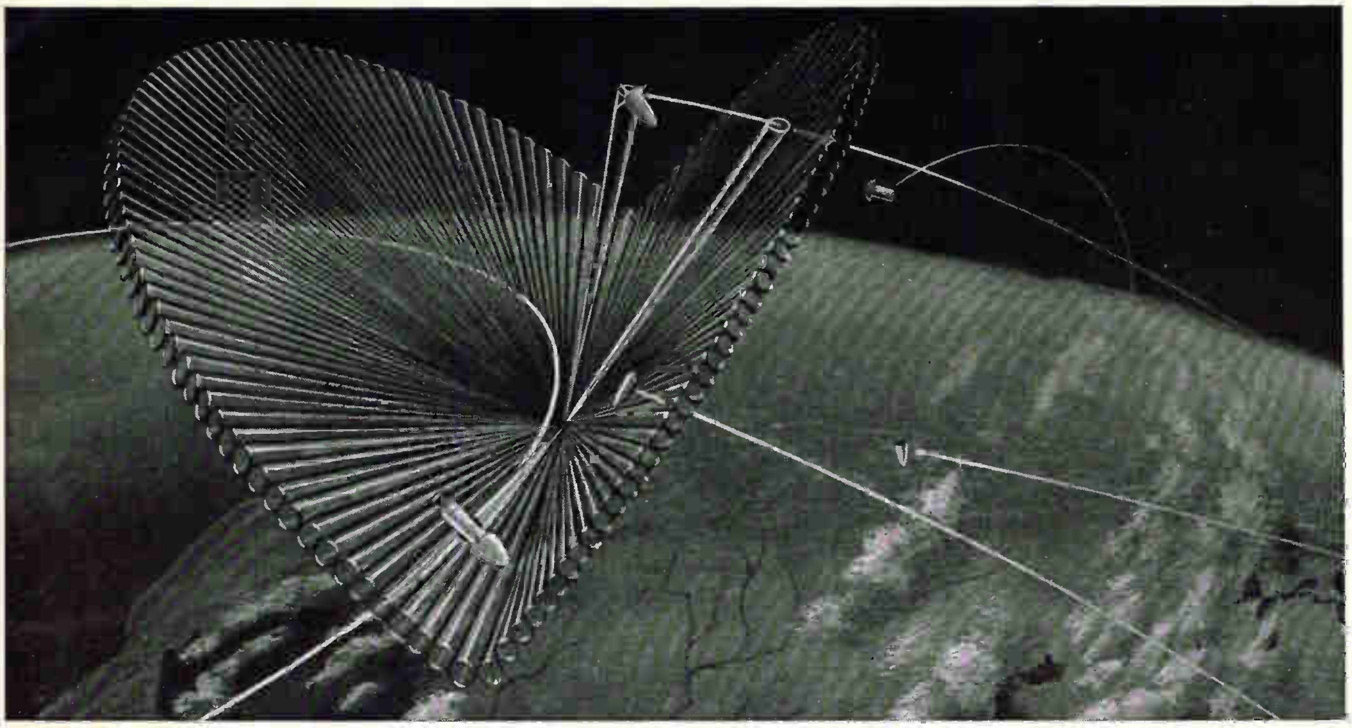


PLANAR TRANSISTOR *with wires welded to aluminized silicon stripes and gold-plated Kovar posts*

In many cases it is possible to weld thermocouple junctions to ceramics and other non-metallics.

Copper foil leads can be attached to plastic coated aluminum coil windings, giving connections that are reliable and that can be readily adapted to automated manufacture. Precious metal contacts of silver, gold, palladium, and platinum can be directly bonded to various spring metals for switches and relays, thus eliminating the sandwich construction often needed with other techniques.

Attaching leads to tantalum electrolytic capacitors is successfully accomplished ultrasonically and solves some problems inherent in other methods. Only one relatively large joint is created; the connection has good mechanical properties



and embrittlement of leads and foils does not occur; the ultrasonic process is insensitive to oil and oxide films and other surface contaminants and thus consistent and uniform welds are made.

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Filtered Air Flow For Clean Areas

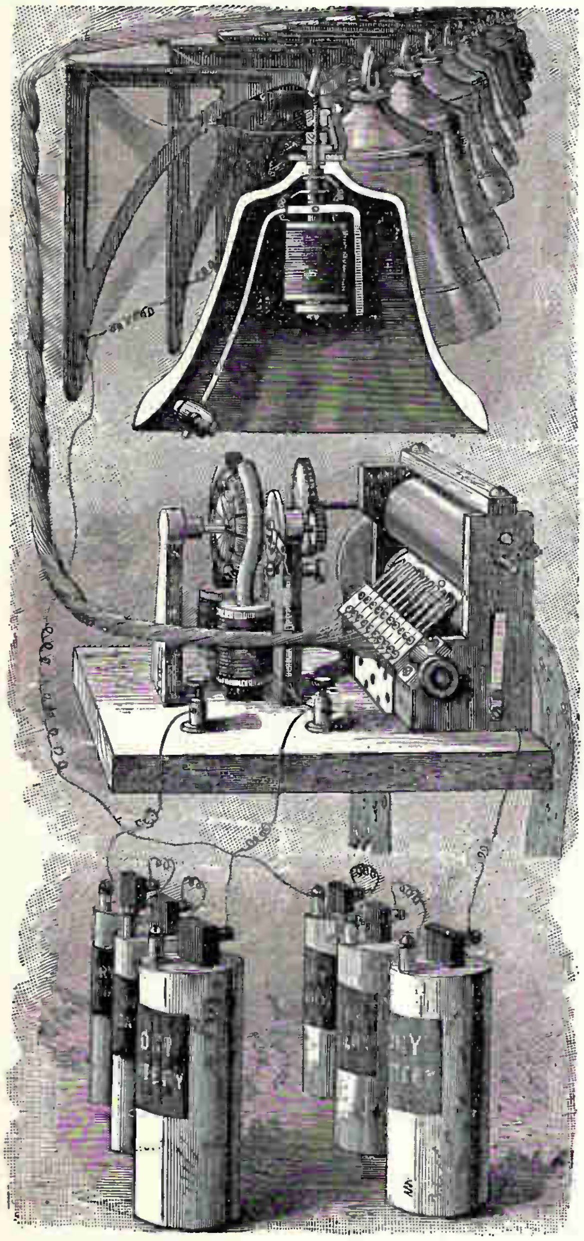
A NEW ultra-clean work bench said to provide an atmosphere cleaner by better than 500 to 1 over conventional dust control hoods has been developed by Agnew-Higgins Inc., Stanton, Calif.

The bench supplies a flow of highly filtered air that sweeps down and over the 2x2x6 ft. work area and keeps dust out by positive pressure. For many applications, the requirements on clothing, smoking and eating at the work station can be substantially reduced.

Over an 8-hour working day test program, the bench eliminated 0.5 micron particles from the filtered air flow to the work space completely, and reduced 0.3 micron particles to less than 1,000 per cubic foot. The average range for dust control hoods now in general use is 500,000 particles per cubic foot.

Benches of almost any size can be set up end to end to provide a continuous assembly line without separations or partitions.

The same cleaning principle has been applied to an ultra-clean room at the Sandia Corp. in Albuquerque. Air, with an average of less than 750 particles larger than 0.3 micron, washes down over the work and out of the room through gratings in the floor.



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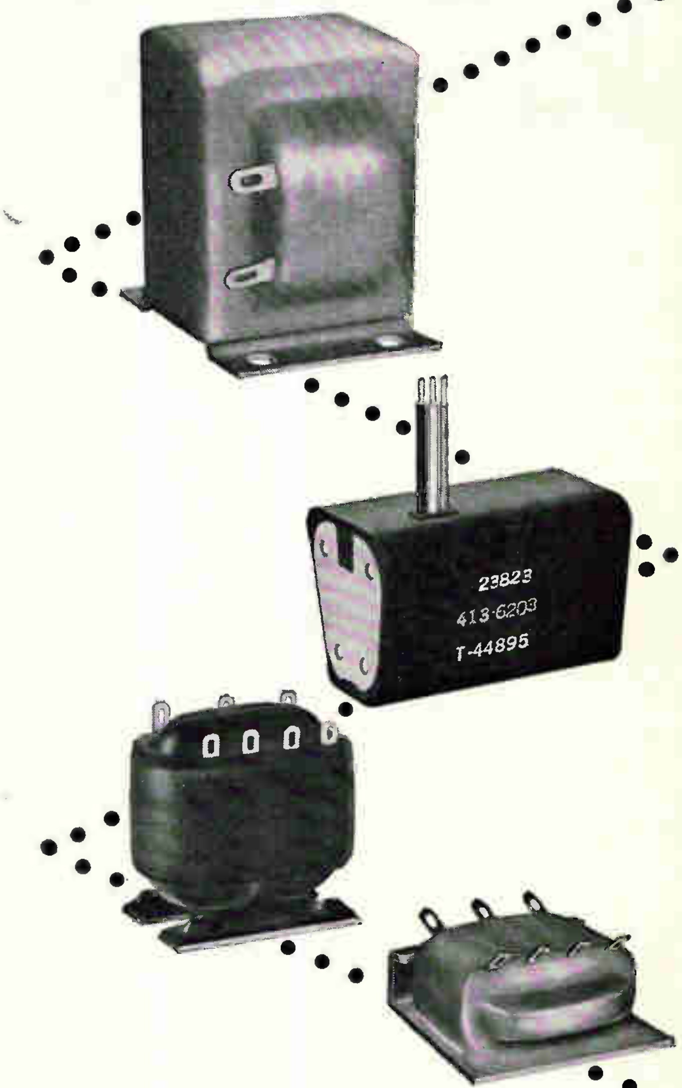
How to Design ENCAPSULATED TRANSFORMERS

For certain applications, encapsulated transformers have distinct advantages over conventional designs. Physical design need not be limited to enclosing cases, thus engineering innovations can often be incorporated to improve performance, weight and size. Knowing how to take advantage of these factors, plus many years of experience in creating and producing hundreds of encapsulated transformers, is the service we offer to any new or present customer.



ACME ELECTRIC CORPORATION

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A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SERIES

Modernizing U.S. Industry

The Tremendous Job Ahead and a Key Requirement for Success

Over the past four years American industry has made remarkable progress in modernizing its plant and equipment. But an enormous job of modernization remains to be done in order to provide the efficient productive facilities that are crucial to economic growth and prosperity in the USA. To have a reasonably good chance of doing the job, industry must have relief from the profits squeeze in which it is now caught.

These facts about modernization come from the *15th Annual McGraw-Hill Survey of Business' Plans for New Plants and Equipment*, conducted by our Department of Economics.

How Modern Is American Industry?

Since 1957, when McGraw-Hill last checked the age of American industry's producing facilities, the obsolete and antiquated share has been substantially reduced. In 1957 about 50% of our industrial capacity was over 12 years old — for most of it that meant thoroughly antiquated. Now the latest McGraw-Hill survey has found that the proportion of comparably ancient equipment has been reduced to 40%. This is real progress, often made under difficult circumstances.

But the facts provided by the survey also underline the tremendous modernization job that remains to be done. This is indicated by the table in the next column, which shows not only that 40% of our plant and equipment dates back to before 1951, but that 24% goes back to World War II or even before that. This segment deserves a place in Washington's Smithsonian Institution alongside Lindbergh's *Spirit of St. Louis.*

The 40% of industrial facilities dating back more than a decade is the average of U.S. industry as a whole. Some industries are in far better, or worse, shape than others.

AGE OF U.S. PLANT AND EQUIPMENT, DECEMBER 1961

INDUSTRY	Percent Installed Before 1957	Before 1951	Before 1946
Iron & Steel	66%	37%	27%
Nonferrous Metals	65	34	21
Machinery	68	41	24
Electrical Machinery	55	30	18
Autos, Trucks & Parts	71	21	8
Aircraft	56	28	17
Other Trans. Equipment	74	56	43
Fabricated Metals & Instruments	67	38	25
Chemicals	67	36	21
Paper & Pulp	69	39	23
Rubber	68	40	23
Petroleum & Coal Products	62	32	20
Textiles	73	49	32
ALL MANUFACTURING	67	40	24
Mining	71	38	24
Railroads	71	58	39
Electric Utilities	65	36	23
ALL INDUSTRY*	67	40	24

*Does not include commercial business or gas utilities.

Source: *15th Annual Survey of Business' Plans for New Plants and Equipment*, McGraw-Hill Department of Economics.

As the table shows, the auto industry has only 21% of its facilities dating back to before the Korean War. The aircraft industry is not too far behind with 28% of its plant and equipment in that age category. The railroads, on the other hand, are burdened with huge amounts of antiquated facilities. So, too, are the textile, furniture and shipbuilding industries.

But the 40% of overage equipment is a good gauge of the magnitude of the modernization to be done if we, as a nation, are to meet the many challenges that confront us.

The Challenges

There is the challenge of overseas competition. Producers in the European Common Market countries and in Japan have put a large part of their industrial capacity into first-class shape over the past decade, and, on balance, their facilities are considerably more up-to-date than ours. This enables them to give us tougher competition in the world's markets than ever before.

There is the challenge of the scientific explosion. In the more relaxed days of just a few decades ago, the need to modernize would not have been so urgent. New ideas germinated more slowly, and the pressure to put them to industrial use was less intense. But how things have changed! Estimates are that 90% of all the scientists the world has ever known are alive today, and in the U.S. alone we spent more on research and development during the past decade than we had spent since the settlement of Jamestown in 1607. This means that new ideas for new products and new cost-cutting ways of making them are streaming from the world's laboratories at breathtaking speed. It's up to U.S. producers to put these new developments to work with new producing equipment.

And there is the Communist challenge. Premier Khrushchev threatens to "plow us under," to outproduce us in a contest of industrial strength. A crucial element in this all-out struggle is the relative efficiency of the industrial equipment of the contestants.

Some Help

Our business leaders have clearly recognized the critical need of modernizing their producing facilities and have been working hard to meet it. This is attested by the fact that McGraw-Hill surveys indicate that manufacturers alone spent nearly $34 billion, or about two-thirds of their total investment, on modernization in the years 1958-61. And manufacturers now report, through the latest survey, that they plan to raise the modernization share to nearly 70% during the years 1962-65, the highest figure planned in the last decade.

Increased allowances to offset the depreciation of its plant and equipment have helped American industry greatly in getting ahead with the modernization job. Annual depreciation allowances for corporations have increased from $13.5 billion in 1954 to $24.4 billion in 1961. Legislation passed in 1954 permitting some acceleration in depreciation charges has contributed to this increase. Some further liberalization of depreciation allowances is also promised soon. This, too, will give an important lift to the modernization job.

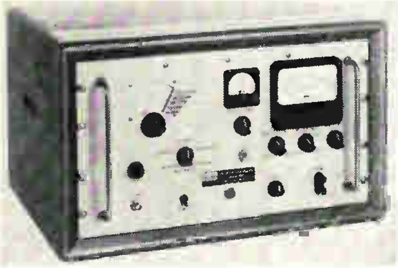
Getting The Job Done

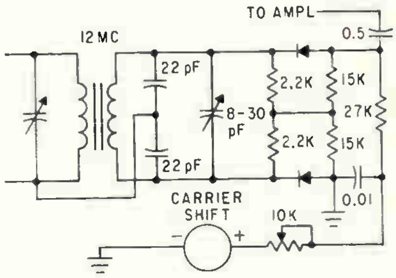
But to give a decisive boost to the tremendous task of putting America's industrial plant and equipment in tip-top condition, there is another key requirement. It is to relax the profits squeeze which now dulls both the incentive to modernize and cuts the capacity to do so. This incentive and capacity, as explained in the previous editorial in this series on *The Profits Squeeze*, is heavily dependent on business profits.

There are various ways of relaxing the profits squeeze. One, at which industry is hard at work, is to cut costs. Another is to raise prices. (President Kennedy battered down an attempt on the part of the steel industry to cope with the problem this way.) **A third, and in the present circumstances by far the best way to ease the squeeze on profits, is to cut the corporate income tax. Except for very small companies, this tax takes 52¢ of every dollar of business profit. A substantial cut in the corporate income tax is the surest way of insuring success in the enormous job of industrial modernization ahead, as well as giving a general infusion of new vitality to the American economy.**

Donald C McGraw
PRESIDENT
McGRAW-HILL PUBLISHING COMPANY

DESIGN AND APPLICATION



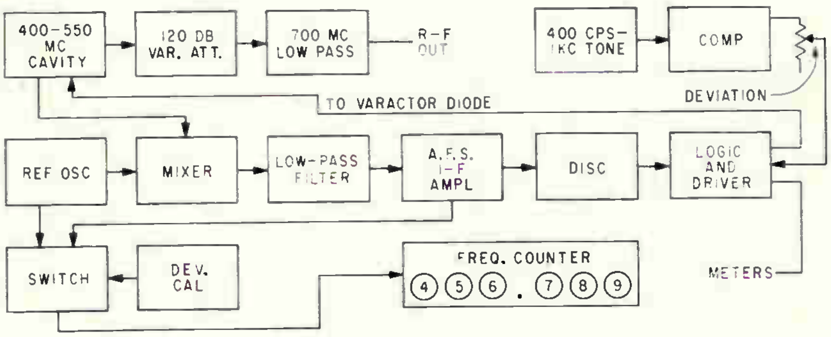


F-M Deviation Meter Has ±2% Accuracy

Ultra-linear discriminator with 3 Mc peak separation has very low drift

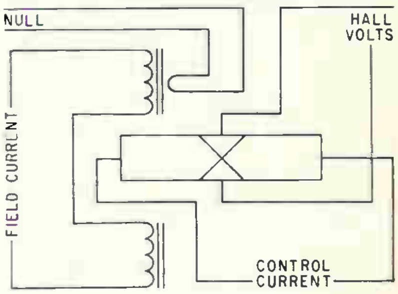
RECENTLY announced by Advanced Measurement Instruments Inc., 109 Dover St., Somerville, Mass., the model 400 f-m deviation meter accurately measures peak positive or negative deviations of composite waveshapes with an accuracy of better than 2 percent. Carrier frequency range is 20 to 1,000 Mc with calibration accuracy of 0.5 percent. Peak deviation measurement ranges are ±10, 30, 100, 300 and 1,000 Kc full scale ±2 percent, on all ranges for modulation frequencies between 20 cps and 120 Kc. R-f input is 10 mv to 1 v. Low-frequency modulation level is approximately 1 v at full scale with any deviation range at an impedance of 5,000 ohms. Distortion is less than 0.2 percent and noise is 55 db below 1 v relative to 10 Kc deviation. The device is essentially a broadband f-m receiver with a modified Foster-Seeley type discriminator (see sketch) and accurate readout. Carrier shift indications to ±250 Kc are provided. Local oscillator operates on fundamentals up to 500 Mc minimizing image responses. An internal calibration signal is provided. Price for cabinet mount is $1,850 and for rack mount $1,800.

CIRCLE 301, READER SERVICE CARD



F-M Signal Generator Displays Digital Frequency

MANUFACTURED by Microdot Inc., 220 Pasadena Ave., South Pasadena, Cal., the model 412 f-m signal generator features single-knob tuning and digital frequency display. Frequency range is 400 to 550 Mc with accuracy of 0.0003 percent and stability of 0.0005 percent per hour with output of 0.1 μv to 1 v accuracy ±1 db. Internal modulation is 400 cps and 1 Kc and deviation is 0 to 300 Kc. Distortion is less than 2 percent and the peak deviation constant ±3 percent for input voltage variations of 0.8 to 6 v. The r-f is generated in a stable tunable cavity (see sketch). A sample of r-f output and reference signal are applied to a mixer and frequency difference is amplified. Signal is discriminated and output is applied to automatic frequency stabilization (AFS) logic and driver. Driver output is fed to varactor reactance diode portion of the tunable cavity. If frequency starts to vary, correction voltage is generated to maintain frequency ±1 Kc. Applications for the device include command receiver checkout, bandwidth tests, discriminator and sensitivity measurements, receiver alignment and frequency search. (302)

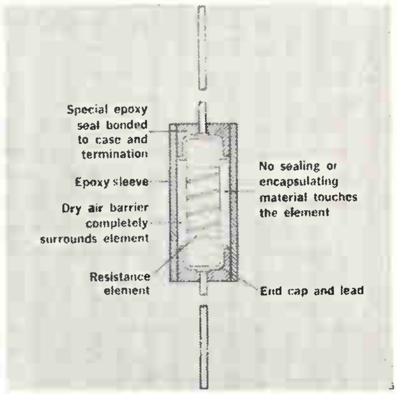


Hall Inverter Provides Linearity ±0.5%

ANNOUNCED by Kearfott Div., General Precision, Inc., Little Falls, N. J., the KXI-100 series inverter output is proportional to the product of an a-c magnetic field and a d-c control current input. The device can receive d-c control current variations of 10 to 40 ma and a-c current inputs up to 50 ma. Output is 25 mv with d-c control input of 20 ma and a-c field current of 18 ma, 60 cps at 65 F. Inverter linearity is less than ±0.5 percent. From 68 F to 140 F, temperature coefficient is less than 0.01

percent per degree F and from −10 F to 68 F, it is less than 0.035 percent per degree F. Inductive null voltage is less than 250 μv between −10 to 140 F and harmonic content is less than 2.5 percent (typical 1.5 percent). Control terminal input resistance is 200 ohms, output impedance is 80 ohms. Input resistance at 140 F is maximum 210 ohms. A-c input impedance is 750 ohms at 60 cps with phase shift between 84 and 90 degrees. The device has internal inductive null correction winding which may be used with external potentiometer and it also has an electrostatic shield about the Hall element.

CIRCLE 303, READER SERVICE CARD

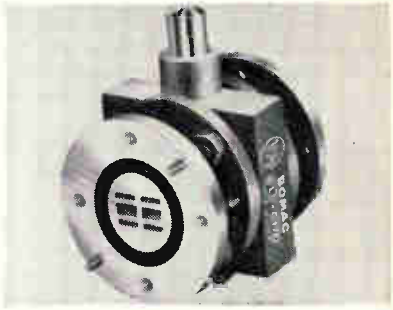


Precision Resistors Offer Air Barrier Design

MEPCO, INC., Morristown, N. J. Line of precision resistors incorporate design and manufacturing advances that provide positive, bonded atmospheric seals for carbon film and metal film resistors. The new techniques, combined with Airguard construction, provide film resistors with the characteristics of sealed types, at prices comparable to those of molded products. (304)

Trimmer Capacitors Are Ultralinear

VOLTRONICS, INC., 112 Magnolia Ave., Westbury, N. Y. Series TMV and TPV miniature telescoping Leedscrew VariTrims feature a non-rotating piston which has a capacity vs turns linearity of ½ of 1 percent. The capacitors are made in both panel mount and p-c types, with a choice of dielectric materials. Capacitance ranges up to 90 pf can be provided with resolution as fine as 0.50 pf per turn, resulting in micrometer setability. (305)

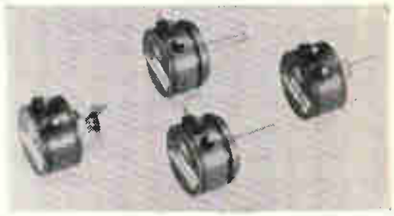


Gas Duplexer Operates from —40 to +85C

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. The BLP-017D is designed for 4.3 mm operation. The gas discharge duplexer operates from 68.75 to 70.75 Gc. It is operable at temperatures ranging from −40 C to +85 C in excess of 500 hr. It weighs less than 4 oz and occupies a volume of only 1.4 cu in. It switches 15 Kw peak power at a 0.0006 duty cycle. (306)

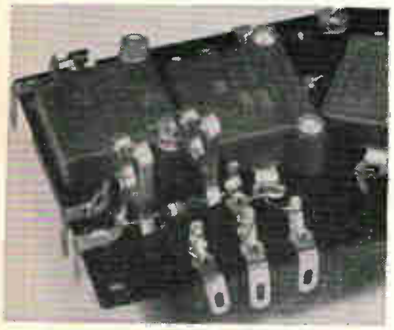
5-Kw Transmitter Covers 1 Kc to 3 Mc

WESTINGHOUSE ELECTRONICS DIV., P.O. Box 1897, Friendship Airport, Baltimore 3, Md. A 5-Kw transmitter has a frequency range of 1 Kc to 3 Mc. It can be used for either c-w or frequency shift-keyed operation. An external input connection permits use as an amplifier for externally generated c-w, frequency or phase shift-keyed signals. A feature of the unit is adaptability to higher power units, up to 150 Kw, with minor changes in control, protection and adjustment circuitry, and packaging. (307)



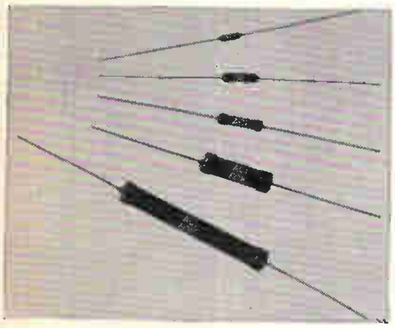
Precision Pots Measure ⅞ in. Diameter

CARTER MFG. CORP., 23 Washington St., Hudson, Mass. Model 118 series, incorporating new design features from rugged feed-through terminals to winding and mounting of resistance elements, provide extreme reliability, high linearity, high temperature operation, and excellent resolution. Resistance range is 100 ohms to 25,000 ohms. Standard resistance tolerance, ±5 percent. Temperature coefficient (wirewound): 0.002 percent per deg C. **(308)**



Heat Sink Made of Beryllium Copper

CLAUSS CUTLERY CO., Fremont, O., has developed a new heat sink tool design for the protection of parts during soldering operations. Made of lightly chrome plated beryllium copper alloy, the heat sinks give long tensile life, maximum thermal conductivity, and maximum positive contact without corrosive detraction. The tool is available in two sizes: 7/8 in. long with 1/8 in. wide points, and 1 in. long with 1/16 in. wide points. **(309)**



Metal Film Resistors Priced from $1.20 to $0.10

AMERICAN COMPONENTS, INC., 8th Ave. at Harry St., Conshohocken, Pa. The Noble-Met resistors cover wattage rating from 1/8 w to 2 w in 125 C ambient temperature, and resistance range from 25 ohms to 10 megohms. Standard temperature coefficient is 0 ± 150 ppm/deg C and standard tolerance is ± 1 percent, although ± ½, + 2, and ± 5 percent are also available. Prices—typical, $1.20 to $0.10 depending on quantity and wattage rating.

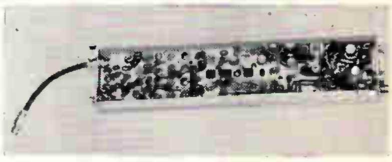
CIRCLE 310, READER SERVICE CARD

Transponder Operates at S-Band

AERO GEO ASTRO CORP., Alexandria, Va. The S/T model 303 operates over a frequency range of 2,700 to 3,000 Mc and is available with transmitter outputs of 500 to 2,500 w. Weight is 6.5 lb, and volume 115 cu in. The transponder uses a power input of 25 to 30 v d-c and has a d-c to d-c converter incorporated within the unit. It is pressurized and operates in typical missile environmental conditions. (311)

L-Band Duplexer Handles 6 Kw of Power

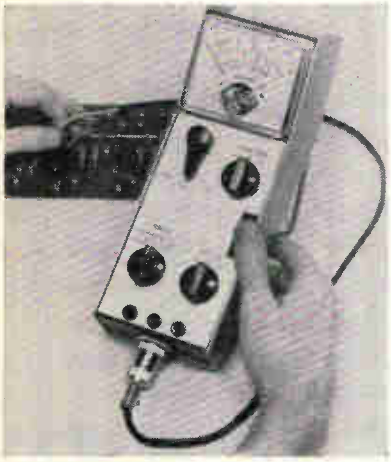
SPERRY MICROWAVE ELECTRONICS CO., P. O. Box 1828, Clearwater, Fla. Line of varactor duplexers for uhf and L band provide solid state reliability for missile application. The 1600 Mc unit features a high power insertion loss of less than 0.2 db, receiver isolation greater than 40 db and low level loss less than 0.7 db for a peak power handling ability of 6 Kw and a bandwidth of 100 Mc. (312)



I-F Amplifier Uses Transistors

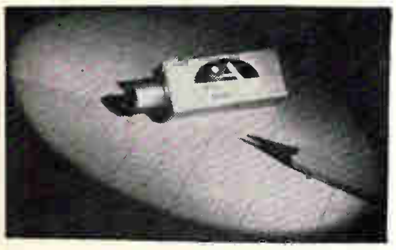
RS ELECTRONICS CORP., P. O. Box 11368, Station A, Palo Alto, Calif., offers a low noise i-f amplifier for airborne radar service. Model 83002 is 2 in. wide, 1 in. deep, and

9 in. long, and weighs 10 oz. When used with a single ended microwave mixer, the amplifier provides 112 db gain at 30 Mc, with a noise figure of 4 db. It has a bandwidth of 2 Mc at the 3 db points, and 10 Mc at the 60 db points. The output provides positive video pulses from an emitter follower. (313)



Transistor Tester Features Portability

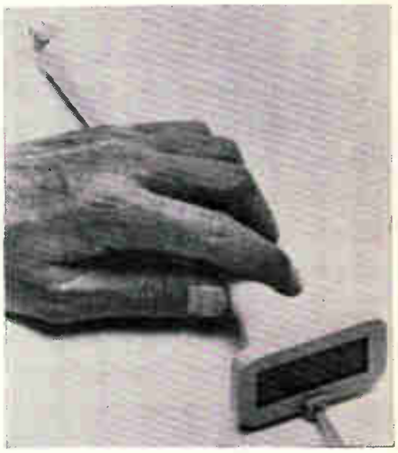
TEST EQUIPMENT CORP., P. O. Box 13185, Houston 19, Texas. Portable instrument tests semiconductors while installed in circuit. Circuit resistances down to 20 ohms may be balanced for evaluating low and high power transistors or diodes. Saturation or forward resistance is measured in circuit with 5 percent accuracy at 5, 50, or 500 ma by a simple, two-step sequence. Unit will also measure d-c current gain and leakage out-of-circuit with 3 percent accuracy. (314)



Balanced Mixers Have 1.2 W Max Signal Input

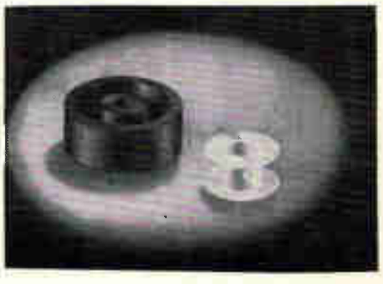
ANZAC ELECTRONICS, INC., 375 Fairfield Ave., Stamford, Conn. The KMC line approximates an ideal switch opening and closing at the l-o frequency. Signal and i-f connections are made to a common terminal on the mixer through a pair of filters which separate these two frequency components. Mixer is available with or without these filters. Line is divided into 3 groups: The KMC-1 through 3 gives octave band coverage up to 1,000 Mc. KMC-11 through 13 covers 110 to 1,100 Mc in 3 units featuring a 2.5 to 1 frequency range. KMC-20 covers (in one unit) the range from 10 to 1,000 Mc.

CIRCLE **315**, READER SERVICE CARD



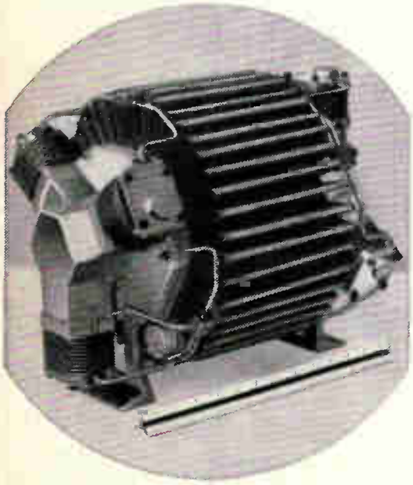
Miniature CRT Has High Resolution

LITTON INDUSTRIES, 960 Industrial Road, San Carlos, Calif. The C2A11A Micropix crt, when operated at an anode voltage of 15 Kv d-c, is capable of displaying a 0.0006 in. line width as measured by a collapsed tv raster. It has a geometrically efficient rectangular 2 in. by ¾ in. screen, which is normally supplied with a low noise, short persistence P11 phosphor. Tube also features a reduced ⅞ in. diameter neck, which provides higher deflection sensitivity. **(316)**

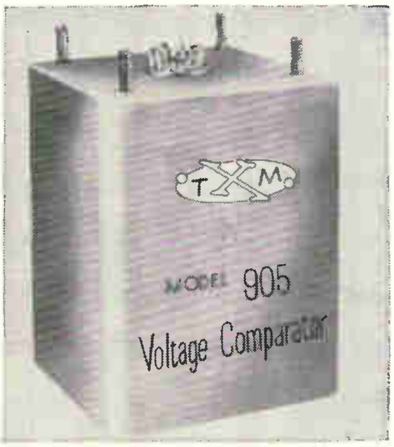


Ferrite Pot Cores Save Space

FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y., offers a complete line of inductive pot cores and accessories, providing the assembler

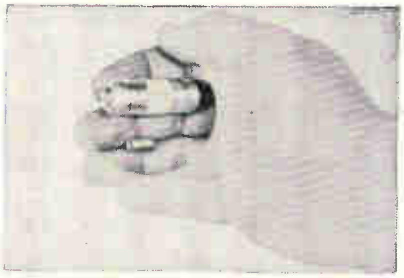


all necessary component parts except the wire for windings. The cores provide extremely low losses even at high frequencies, along with economies in assembly operations and space savings. Line includes non-adjustable 20 percent units, mechanically-adjusted 10 percent, electrically-adjusted 3 percent and tunable units that may be adjusted to within 0.02 percent accuracy. (317)



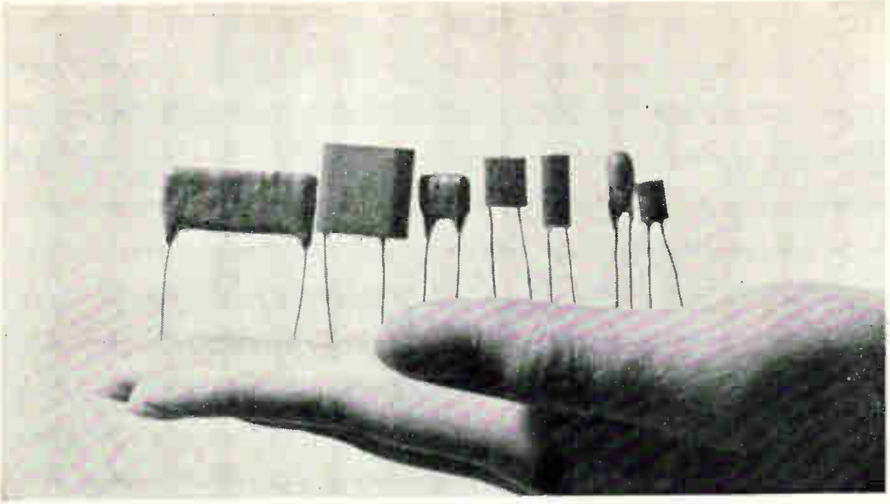
Voltage Comparator Meets MIL Specifications

TRANSMAGNETICS INC., 40-66 Lawrence St., Flushing 54, N. Y. Model 905 features a solid state comparator, with three isolated inputs, which furnishes 28 v, 200 ma power source switching on and off within ±1½ mv differential input stability over −55 to +85 C. Applications include failure warning, sensitive relay, and voltage comparison in automatic checkout. Each input is 1,000 ohms, accommodates better than 1,000 times overload. (318)



R-F Connectors Have Low VSWR

SCINTILLA DIVISION, The Bendix Corp., Sidney, N. Y. Series of miniature and microminiature r-f connectors have a max vswr less than

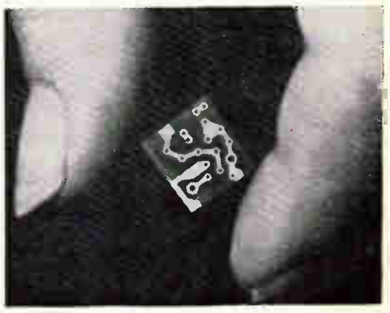


1.1:1 over the 1 to 10 Gc range. The environmental resistant connectors are designed to terminate 0.140 in. (BRM type) or 0.085 in. (BRMM type) semi-rigid coax cable by threading or by threading and soldering. The BRM, illustrated with the standard N type, is 1/28 the size and 1/38 the weight of the latter.

CIRCLE 319, READER SERVICE CARD

Encoder Translator Uses Transistors

DATEX CORP., 1307 S. Myrtle Ave., Monrovia, Calif. Compact unit will translate up to 14 bits of Gray code to binary code, producing at the same time not only the binary signal but its complement as well. The TR-702 features improved reliability at high encoder speeds. The encoder output is filtered and clipped. This eliminates the possibility of errors due to brush bounce. (320)

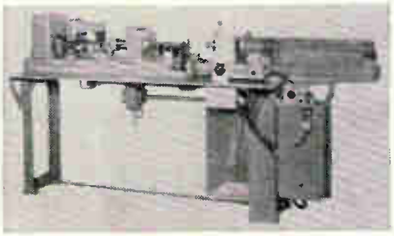


Miniature Circuits Meet MIL P-13949B

RG CIRCUITS CO., 15216 Mansel Ave., Lawndale, Calif. The Mintron model 60-2 miniature printed circuits are designed for installation in digital counters, miniature amplifiers and a wide variety of instrumentation equipment where space and reliability are critical factors. Printed on epoxy glass laminated material as thin as 0.004 in., the units may contain plated through holes, overlays of nickel, gold or tin, or, if required, be solder plated. **(321)**

Xenon Flash Tube Has 6 Inch Arc Length

EDGERTON, GERMESHAUSEN & GRIER, INC., 170 Brookline Ave., Boston, Mass. Model FX-45, a 2,000-w sec Xenon flash tube, has an arc length of 6 in. Light output is 7,500 horizontal candlepower sec. Capable of at least a thousand 1-millisec pulses at a flash rate of 1 per 35 sec, the FX-45 is priced at $95, and is available 45 days after receipt of order. **(322)**



Grid Winder Features High Speed

KAHLE ENGINEERING CO., 3322 Hudson Ave., Union City, N. J. No. 3766 automatic high speed grid winding machine has positioning devices and control cam for winding frame-grid strips. There are 9 frames per strip, for receiving tube frame-grids with variable pitch winding. The operator clamps the strip in the chucks, secures the grid filament wire and starts the machine. The rest is automatic. **(323)**

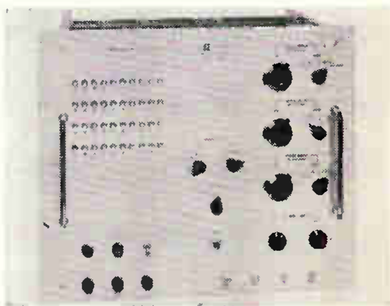
Readout Module Displays TOD and CDT

BINARY ELECTRONICS CO., 1161 E. Ash Ave., Fullerton, Calif. New concept in system modules displays time of day and count-down time directly from binary coded decimal (BCD) inputs. These modules are currently being used on the Polaris program. They are designed to take BCD inputs directly from a system, convert this code, and supply driving power to optical display of time of day and/or count-down time, either at remote locations or at the system console.

CIRCLE 324, READER SERVICE CARD

Step-Servo Module Sells for $1,830

AUTOMATION DEVELOPMENT CORP., 11824 W. Jefferson Blvd., Culver City, Calif. Model 821A combines step-servo components in an integrated plug-in digital servo module used for automatic missile system testing. Unit includes four rotary switches and two 350 deg pots driven by a step-servo through precision (P2) anti-backlash gearing utilizing stainless steel shafts and class 7 bearings. These components together with four trimming pots are mounted on steel plates in an aluminum housing. **(325)**



Word Generator Simulates Digital Inputs

RESE ENGINEERING INC., A & Courtland St., Philadelphia 20, Pa. Model 5140 digital word generator is designed to generate serial-binary information at bit rates to 1 Mc and word lengths up to 40 bits. Characterized by precision, continuous calibration—better than 1 percent accuracy—of all time related parameters (clock period, clock pulse delay and output pulse width) the unit provides output data in either discrete pulse or non-return to zero format. **(326)**

Molybdenum Foil

L. LIGHT AND CO. LTD., Poyle Colnbrook, Buckinghamshire, England, has available molybdenum foil for deep-drawing. Thicknesses range from 1 mm down to 0.1 mm. Rare earth metals can also be rolled down to 0.025 mm thick. **(327)**

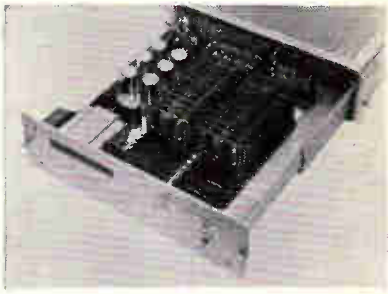
Rotary Switch Has 24 Positions

JANCO CORP., 3111 Winona Ave., Burbank, Calif. Series 6-1900, a 24-position rotary selector switch, features 15 deg indexing and is designed for ground and airborne electrical systems where execution of tap, transfer, and sequence functions is required. It exceeds MIL-S-6807A and MIL-S-3786A. Power handling capacity is up to 5 amp at 115 v a-c and 3 amp at 28 v d-c resistive, and 2 amp at 28 v d-c inductive, and is rated to make, break, and carry. **(328)**

D-C/D-C Converter Designed for Missile Use

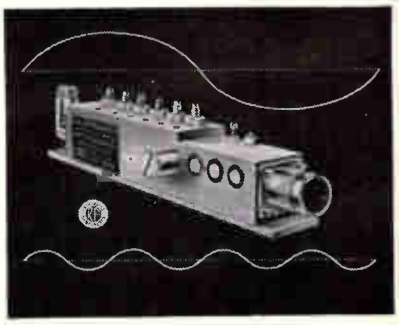
SPERRY ELECTRO DEVICES LABORATORY, 55 Denton Ave. South, New Hyde Park, N. Y., offers a ½ Kw d-c to d-c power converter for missile and space craft applications. Capable of converting 28 v battery power into regulated d-c output over a temperature range from −32 C to +115 C, it combines 65 percent efficiency with unlimited short circuit protection.

CIRCLE 329, READER SERVICE CARD



Multiplexer Switches 64 Channels

PACKARD BELL COMPUTER CORP., 1905 Armacost Ave., Los Angeles 25, Calif., announces a low cost solid state multiplexer for high speed data acquisition in computing systems. Available for switching from 4 to 64 channels, model EM3 operates with a basic settling time of 20 μsec and will switch a full complement of 64 channels in less than 50 μsec. Input and output limits are ±10 v with no inversion, and the unit will drive a stable load impedance of 25,000 ohms. **(330)**



S-Band Quadrupler Has 300 Mc Bandwidth

APPLIED RESEARCH INC., 76 S. Bayles Ave., Port Washington, N. Y. The VM-2350/300-4 is a passive quadrupler with an output of 100 mw available across the full 300 Mc bandwidth from 2,200 to 2,500 Mc. All spurious products are held more than 40 db below the desired signal. Spurious can be held 60 db down, if desired. The quadrupler is driven by 750 mw in the 550 to 625 Mc band. **(331)**

CONNECTORS AND WIRING HARNESS SETS custom molded. Tech Panel Co., Inc., 37 Milford St., Binghamton, N. Y. (332)

MASER CRYSTALS neodymium-doped. Linde Co., Division of Union Carbide Corp., 270 Park Ave., New York 17, N. Y. (333)

TRANSISTORIZED POTENTIOMETER TRANSMITTER millivolts to d-c. Taylor Instrument Companies, 95 Ames St., Rochester 1, N. Y. (334)

H-V RECTIFIER subminiature package. Solitron Devices, Inc., 500 Livingston St., Norwood, N. J. (335)

INORGANIC PLASTICS for sealed components. Molecular Dielectrics Inc., Clifton, N. J. (336)

HIGH VACUUM FURNACE rapid heat-up. Tri Metal Works Inc., 1600 Bannard St., East Riverton, N. J. (337)

PATCHCORD SYSTEM rack-mounted. AMP Inc., Harrisburg, Pa. (338)

MICROPHONE & EAR RECEIVER for space flights. Roanwell Corp., 180 Varick St., New York, N. Y. (339)

PRESSURE SWITCH Delrin housing and insulation. Perma Research and Development Co., 345 E. Washington, No. Attleboro, Mass. (340)

PHASE SENSITIVE VOLTMETER versatile instrument. Dytronics Co., Inc., 485 North High St., Columbus 14, Ohio (341)

COBALT MANGANESE FLUORIDE future maser material. Semi-Elements, Inc., Saxonburg Blvd., Saxonburg, Pa. (342)

FLUX RESIDUE REMOVER for printed circuits. Alloys Unlimited Solder, 21-01 43rd Ave., L.I.C. 1, N. Y. (343)

D-C GEARHEAD MOTOR miniaturized. Engineered Products Div., U. S. Industries, Inc., 6312 Hollister Ave., Goleta, Calif. (344)

CARTRIDGE TAPE uniform motion. Reeves Soundcraft Corp., Great Pasture Rd., Danbury, Conn. (345)

FILM ADHESIVE for bonding glass and metal assemblies. Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 1, Minn. (346)

P-C COIL FORMS silicone impregnated fiber glass collars. Cambridge Thermionic Corp., 145 Concord Ave., Cambridge 38, Mass. (347)

1-MC TRANSISTORIZED COUNTER 7 Nixie tubes for readout. Northeastern Engineering, Inc., Manchester, N. H. (348)

OVERLAY AND NAMEPLATE KIT for relay rack panels. Halmar Electronics, Inc., 1550 W. Mound St., Columbus 23, O. (349)

SYNCHRO-RESOLVER STANDARD ±2 arc sec accuracy. Kearfott Div., GPI, 1150 McBride Ave., Little Falls, N. J. (350)

TANTALUM FOIL CAPACITORS 200, 250 and 300 v. Mallory Capacitor Co., Indianapolis 6, Ind. (351)

SOLAR CELL radiation resistant. Amelco, Inc., 341 Moffett Blvd., Mountain View, Calif. (352)

SPECTRUM ANALYZER 100 Mc window. Lavoie Laboratories, Morganville, N. J. (353)

COAXIAL THERMAL VOLTMETER for measurements to 30 Mc. Filmohm Corp., 48 W. 25th St., New York 10, N. Y. (354)

PHOTOELECTRIC SWITCH all solid state. Invac Corp., 26 Fox Road, Waltham 54, Mass. (355)

MINIATURE FORCE TRANSDUCERS versatile series. Sanborn Co., 175 Wyman St., Waltham, Mass. (356)

BUFFER/MEMORY UNITS modularized. Albert L. Gibney, Inc., 100 Chestnut St., Springfield, Mass. (357)

MOVING COIL MECHANISM with astatic Pancake torque-tube. Ammon Instruments, Inc., 345 Kelley St., Manchester, N. H. (358)

THREE-GEAR DIFFERENTIAL high accuracy, low cost. Dynamic Gear Co., Inc., 175 Dixon Ave., Amityville, L. I., N. Y. (359)

TINY COAX CONNECTORS closed-contact. Du Tron Corp., 777 W. 17th St., Costa Mesa, Calif. (360)

GRID WINDING & BRAZING MACHINE for pencil tubes. Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. (361)

ELECTRON BEAM FURNACE for high temperature testing. Gilliland Instrument Co., Inc., 1448 Twenty-Ninth Ave., Oakland 1, Calif. (362)

COUNTER MODULES diode-type. Micro Measurements Corp., 2412 Norwood Ave., Melrose Park, Ill. (363)

H-V STATIC INVERTER for submarines. Microdot, Inc., 220 Pasadena Ave., South Pasadena, Calif. (364)

TEMPERATURE SWITCH stable under extreme vibration. Custom Component Switches, Inc., 3137 Kenwood St., Burbank, Calif. (365)

PRECISION POTENTIOMETERS three and five-turn. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif. (366)

TERMINAL BOARDS with captive clamp-type terminals. General Electric Co., Schenectady 5, N. Y. (367)

MICROWAVE MIXER less than 9.5 db noise figure. Douglas Research Corp., Mt. Vernon, N. Y. (368)

VLF RECEIVER for space probes. Aerospace Research, Inc., 153 California St., Newton 95, Mass. (369)

MINIATURE SILICON RECTIFIER 1 amp at 25 C. Diodes, Inc., 7303 Canoga Ave., Canoga Park, Calif. (370)

Literature of the Week

MAGNETIC TAPE Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif. A 22-page brochure describes the company and its capability for manufacturing magnetic tape. (371)

BALANCED MIXER Microwave Development Laboratories, Inc., 15 Strathmore Road, Natick Industrial Centre, Natick, Mass. Data sheet describes the WR28 sidewall hybrid balanced mixer. (372)

METALLIZED CAPACITORS Sprague Electric Co., North Adams, Mass. Current recommendations on the use of metallized capacitors are given in technical paper No. 62-5. It is available on letterhead request.

SIGNAL GENERATOR Boonshaft and Fuchs, Inc., Hatboro Industrial Park, Hatboro, Pa. Bulletin describes a variable phase l-f signal generator for use in frequency response analyses. (373)

MAGNETIC MEMORY DRUMS Digital Development Corp., 7541 Eads Ave., LaJolla, Calif., offers a design parameters chart for systems utilizing magnetic memory drums. (374)

PULSE TRANSFORMERS Technitrol Inc., 1952 E. Allegheny Ave., Philadelphia 34, Pa. Two-page technical bulletin covers a line of 25 miniature pulse transformers. (375)

SPECTRUM ANALYZER Quan-Tech Laboratories, Inc., Boonton, N. J. Brochure covers operating characteristics of a transistorized wave and noise spectrum analyzer. (376)

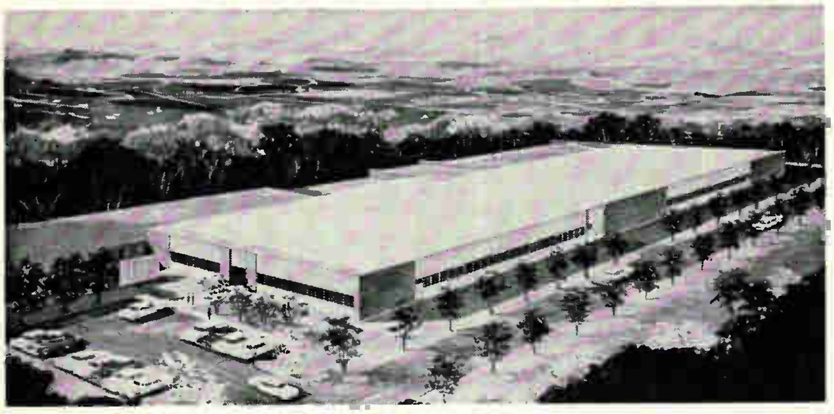
OVENS Hotpack Corp., Cottman Ave. at Melrose St., Philadelphia 35, Pa., has compiled a handbook entitled "A Basic Guide to the Selection of Laboratory Pilot Plant and Production Ovens." (377)

SYSTEM INPUT PROTECTORS Electro-Neutronics, Inc., 1401 Middle Harbor Road, Oakland 20, Calif. Four-page brochure describes fast acting models 500-510 protectors against voltage transients and other overvoltage conditions. (378)

MICROWAVE TUNNEL DIODES Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J. Data sheet L-1045 describes a line of microwave tunnel diodes designed for amplifier, converter and mixer applications. (379)

COIL WINDERS Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill., has issued a 2-page catalog on 24 in. and 72 in. precision coil winders. (380)

LINEAR ACCELEROMETER Dynamic Measurements Co., 104 Terwood Road, Willow Grove, Pa. Bulletin describes a high output linear accelerometer with automatic damping compensation. (381)



Burroughs Expanding Division Plant

CONSTRUCTION has begun on a 50,000-square-foot plant addition at Burroughs Corporation's Electronic Components division, Plainfield, N. J., more than doubling present engineering and manufacturing facilities.

Commenting on the expansion, Ray Eppert, president, noted that Burroughs, a manufacturer of computers and office machines, has also engaged for over a decade in the research, manufacture and marketing of components. From this program have come some advanced devices. These include high-speed. magnetic thin-film memory planes and Bipco modules, a high-volume method of producing multiple semiconductor elements.

"These devices will permit advances in microminiaturization and high density packaging of computers and other electronic equipment at a cost which is consistent with commercial requirements. In line with Burroughs' policy of actively marketing our electronic component products, these devices will be utilized both in our own equipment and made available to the entire industry," Eppert said.

The new facilities will provide additional manufacturing space for these components as well as the company's line of high speed switching tubes and electronic display devices.

Occupancy is slated for October of this year.

HRB-Singer Names Musser President

GLENN L. MUSSER has been named president of HRB-Singer, Inc., State College, Pa., to succeed John L. McLucas who has accepted the position of Deputy Director of Defense Research and Engineering, Tactical Warfare Program, The Pentagon.

Musser has held the post of vice president for systems and operations at HRB-Singer since 1958.

McGarry Advances At General Mills

JAMES H. MCGARRY, who joined General Mills, Minneapolis, Minn., in 1960 as director of manufacturing for the Electronics division, has been appointed general manager of the firm's Daven division.

The Daven unit, with plants in Livingston, N. J., and Manchester, N. H., manufactures a line of electronic components including precision resistors, switches, attenuators, networks, filters, transistorized power supplies, and measuring instruments.

Granger Announces Senior Appointments

GRANGER ASSOCIATES, Palo Alto, Calif., has made two senior appointments to its Antenna department staff—Peter D. Kennedy, as project engineer on research activity, and Robert G. Conn, as senior mechanical engineer for antenna design.

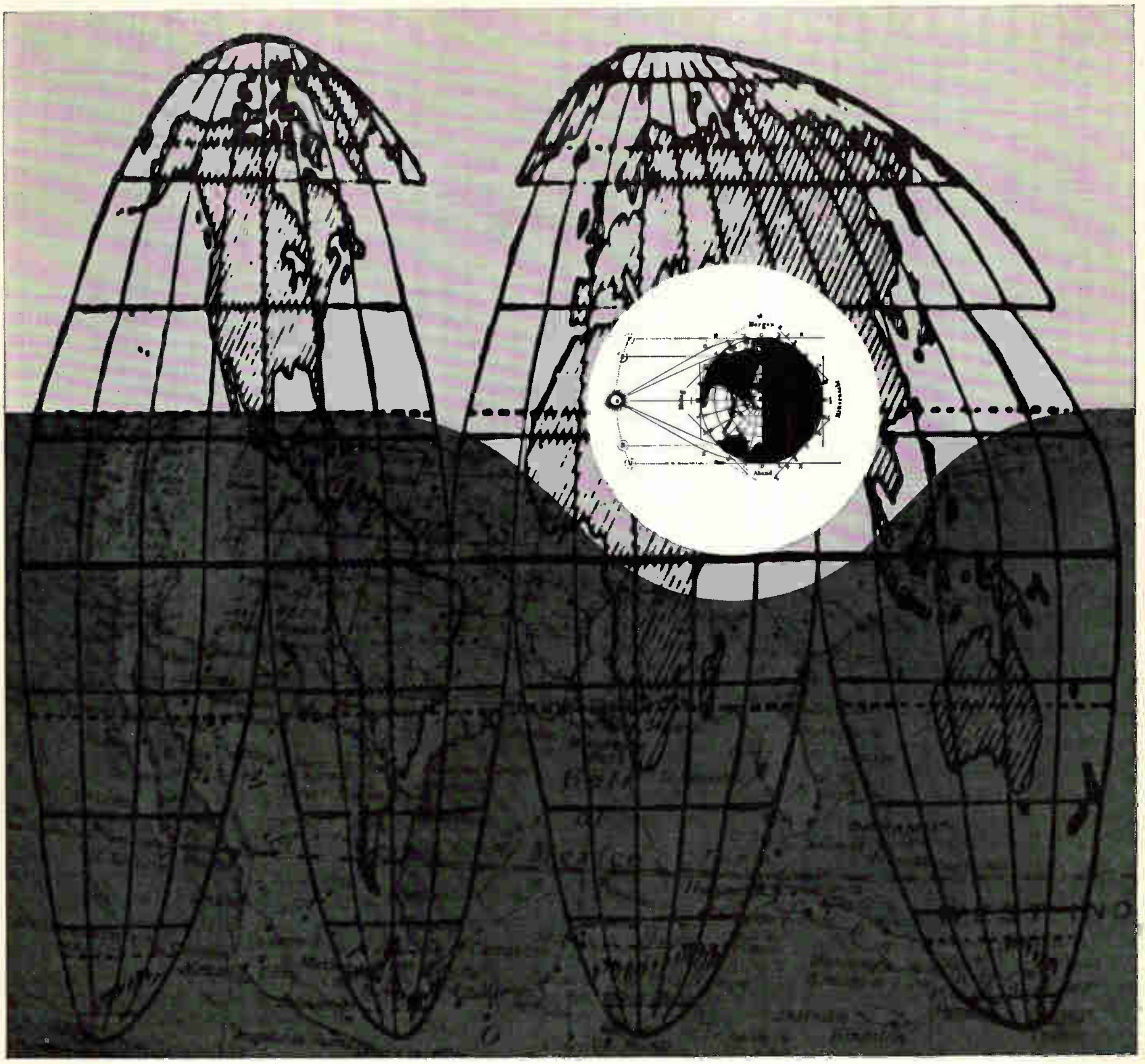
Kennedy came from Lockheed Missiles & Space Co., and Conn, from Lockheed Aircraft Corp.

Cerro Corp. Board Elects Mitchell

ELECTION of Don G. Mitchell to the board of directors of Cerro Corp., New York, N. Y., is announced. Mitchell is a director and former president of General Telephone & Electronics Corp.

General Instrument Promotes Solomon

EUGENE A. SOLOMON has been appointed to the newly-created post



purposeful imagination....in form

The men of Aerospace exercise high technical competence and constructive imagination in the creation and assessment of form and configuration for advanced ballistic missile and space systems. □ As a partner of the Air Force-science-industry team, Aerospace Corporation is chartered exclusively to serve the United States Government in this mission. The men of Aerospace provide advanced systems analysis and planning; theoretical and experimental research; general systems engineering and corresponding technical direction of programs. □ Through concept, research, development and completed mission the men of Aerospace improve the form of components, equipments, and systems. Trade-offs and interface considerations are objectively appraised on the basis of performance, reliability, and cost. □ Men with the depth and breadth of experience required to solve these interdisciplinary problems are needed by Aerospace Corporation, an equal opportunity employer. Highly skilled engineers and scientists with advanced degrees are invited to contact Mr. Charles Lodwick, Room 110, Aerospace Corporation, P. O. Box 95081, Los Angeles 45, California. □ Organized in the public interest and dedicated to providing objective leadership in the advancement and application of science and technology for the United States Government.

AEROSPACE CORPORATION

of works manager-Tazewell operations of the General Instrument Corp. Capacitor division in Tazewell, Va.

Production manager at the Tazewell facility since 1959, Solomon will be responsible in his new executive post for all manufacturing, shipment and administration at the plant.

Adler Electronics Appoints Adams

DONALD K. ADAMS has joined Adler Electronics, Inc., New Rochelle, N. Y., as manager of the Government Relations department. He was formerly marketing manager for the ACF Electronics division of ACF Industries, Paramus, N. J.

Announce Formation Of New Company

FORMATION of Codamite Corp., Anaheim, Calif., was recently announced by R. W. Johnson (picture) newly appointed president of the firm. The organization has been underwritten by private subscription through a group of Southern California electronic engineers and will specialize in the field of subminiature digital communications equipment.

Johnson is a former management and technical consultant, recently a participant in the Navy Polaris missile program.

Vice president of engineering for Codamite is George Takenaka. His prior positions were with Ling-Temco-Vought and Interstate Electronics Corp.

Tracerlab Names V-P, Operations

E. DOUGLAS GRAHAM has been named vice president, operations, for Tracerlab, Waltham, Mass., division of Laboratory For Electronics, Inc.

Before joining Tracerlab, Graham was vice president, manufacturing, for the Raytheon Co.

Stachelhaus Takes New Sylvania Post

APPOINTMENT of Gustav A. Stachelhaus as manufacturing superintendent of the Electronic Defense Laboratories of Sylvania Electric Products Inc., Mountain View, Calif., is announced.

He formerly served with the company's Microwave Device division.

General Precision Elects Herbert

FRED D. HERBERT, JR., has been elected to the executive committee of the board of directors of General Precision Equipment Corp., Tarrytown, N. Y.

Herbert, a vice president, and a member of the board of directors of the corporation since 1952, recently was designated president of the company's new Aerospace group in Little Falls, N. J., set up to design and produce complete guidance and control systems for the nation's missile and space programs.

Molecular Science Names Nall President

JAMES R. NALL has been named president of the recently-formed Molecular Science Corp., Menlo Park, Calif. The newest subsidiary of Universal Microtron Corp. will develop and manufacture microelectronic subsystems as part of the parent company's program of expansion and diversification in the electronics packaging field.

Nall was formerly head of microelectronics research at Fairchild Semiconductor.

TRG Appoints Ross Manufacturing Mgr.

TRG, INC., East Boston, Mass., has named James Ross as manager of manufacturing.

Ross was in manufacturing for ten years with Western Electric in

Kearney, N. J., and for twelve years with FXR, Inc., Woodside, N. Y., where he rose to the position of vice president and manager of manufacturing.

Packard Bell Hires Bixler

OTTO C. BIXLER has been appointed assistant general manager of the Technical Productions division of Packard Bell Electronics Corp., Los Angeles, Calif.

Before joining Packard Bell, Bixler was with the Aeronutronics division of Ford Motor Co.

PEOPLE IN BRIEF

Herbert Herz resigns as president of Magnetic Amplifiers div. of The Siegler Corp. to start an industrial consulting firm. **Max Krawitz** advances at Sylvania to mgr. of color tube mfg. for the Electronic Tube div. **Theodore E. Andrews,** formerly with GE, appointed mgr. of engineering for Cryo-Therm, Inc. Fansteel Metallurgical Corp. ups **George T. Brennan** to v-p operations. **Ray N. DuShane, Jr.,** previously with Arcadia Sliding Door Co., joins Jonathan Mfg. Co. as chief engineer. **Jerome D. Kennedy** moves up to president of Applied Dynamics, Inc. Motorola promotes **Arnold R. Sabel** to engineering planning mgr. for integrated electronics applications at the Military Electronics div. **Robert A. Arrison, Jr.,** leaves Laboratory for Electronics to join Vacuum-Electronics Corp. as director of engineering. **Francis M. Hope,** ex-GE, now mgr. of the ground support engineering dept of Dalmo Victor Co. **Homer A. Ray,** formerly with Rixon Electronics, named antenna systems program mgr. at Emertron, Inc. **John B. Lawson,** a Ford Motor Co. mfg. exec, appointed g-m of the Aeronutronic div. The division has also transferred **Donal B. Duncan** to the post of asst. g-m/operations. Endevco Corp. adds **Robert H. Russell,** from Fairchild Controls Corp., to its engineering staff. **William R. Ryan,** exec v-p of Edo Corp., elected president. **Noel B. McLean,** Edo's president since 1950, named chairman of the board.

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ATOMIC PERSONNEL INC. Philadelphia, Pennsylvania	77*	1
COLLINS RADIO COMPANY Dallas, Texas	14*	2
DOUGLAS AIRCRAFT CO. Missile and Space Systems Division Santa Monica, California	17*	3
ESQUIRE PERSONNEL Chicago, Illinois	77*	4
INTERNATIONAL BUSINESS MACHINES CORP. Space Guidance Center Owego, New York	77*	5
McDONNELL St. Louis, Missouri	147	6
MICROWAVE SERVICES INTERNATIONAL, INC. Denville, New Jersey	145	7
NATIONAL AERONAUTICS & SPACE ADMINISTRATION Washington, D. C.	146	8
NORTHROP CORP. Norair Division Hawthorne, California	135	9
NORTHROP CORP. Space Laboratories Hawthorne, California	137	10
REPUBLIC AVIATION CORPORATION Missile Systems Division Mineola, L.I., New York	145	11
SCOPE PROFESSIONAL PLACEMENT CENTER Waltham, Massachusetts	145	12
SPACE TECHNOLOGY LABORATORIES, INC. Sub.of Thompson Ramo Wooldridge Inc. Redondo Beach, California	26	13

(Continued on opposite page)

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY ......................ZONE......STATE.............

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 62962

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for Additional Employment Opportunities advertising.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

———RATES———

DISPLAYED

The advertising rate is $40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to CLASSIFIED ADV. DIV. of ELECTRONICS, P.O. Box 12, N. Y. 36, N. Y.

"Put Yourself in the Other Fellow's Place"

TO EMPLOYERS

TO EMPLOYEES

Letters written offering Employment or applying for same are written with the hope of satisfying a current need. An answer, regardless of whether it is favorable or not, is usually expected.

MR. EMPLOYER won't you remove the mystery about the status of an employee's application by acknowledging all applicants and not just the promising candidates.

Mr. **EMPLOYEE** you, too, can help by acknowledging applications and job offers. This would encourage more companies to answer position wanted ads in this section. We make this suggestion in a spirit of helpful cooperation between employers and employees.

This section will be more useful to all as a result of this consideration.

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.

330 West 42nd St., New York 36, N. Y.

electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from opposite page)

SPERRY GYROSCOPE COMPANY Division of Sperry Rand Corp. Great Neck, NY	147	14
SYLVANIA ELECTRONIC SYSTEMS • WEST Mountain View, California	76*	15
UNION CARBIDE NUCLEAR COMPANY Oak Ridge, Tennessee	145	16
P 8932	77*	17

*These advertisements appeared in the 6/22/62 issue.

Electronic Instrument Technicians
The Oak Ridge National Laboratory
Operated by
UNION CARBIDE NUCLEAR COMPANY
at
Oak Ridge, Tennessee
Has openings for

Highly skilled electronic instrument technicians to work with electronic engineers in the development, installation and maintenance of electronic systems. Digital data handling, transistorized pulse height analyzers, analog and digital computer systems are only a few examples.

Minimum high school education, with additional training in electronics and at least three years' experience in installation and maintenance of complex electronic systems. Entrance rate $3.10 per hour; $3.16 per hour after six months. Reasonable interview and relocation expenses paid by Company.

Excellent Working Conditions
and
Employee Benefit Plans
An Equal Opportunity Employer

Send detailed resume to:

Central Employment Office
UNION CARBIDE NUCLEAR COMPANY
Post Office Box M   Oak Ridge, Tennessee

SCIENTISTS/ENGINEERS

Career opportunities in:

- DESIGN
- RESEARCH
- DEVELOPMENT
- SALES
- MARKETING
- APPLICATION

Submit resume in confidence to:

- Alan Glou ......Technical/Scientific
- Sid Hopner .....Sales/Marketing

Specialists in the personalized placement of Electronic Engineers and Scientists, on a national basis, who have a BS or advanced degree. Client companies assume fee and relocation costs.

SCOPE

PROFESSIONAL PLACEMENT CENTER
1277 MAIN ST. WALTHAM, MASS.

COMMUNICATIONS APPLICATION ENGINEER

Analysis of advanced electronic communication systems including radio, carrier, telephone, microwave:

Must have design and marketing experience with commercial and military users.

EE degree, 5 yrs. exp. min.

Send Resume to:

Microwave Services International Inc.
Consulting Engineers
Route 46   Denville, N. J.

POSITION VACANT

Communications Engineer — To supervise technical assistance to schools participating in the Midwest Program on Airborne Television Instruction. Desire graduate Electronic or Electrical Engineer with experience in UHF TV reception or UHF air-ground communications. Send resume and salary requirements to DeW. Schatzel, Director of Engineering, MPATI, Memorial Center, Purdue University, Lafayette, Indiana.

ELECTRONICS ENGINEERS & SCIENTISTS

Explore Today's Most Advanced Projects in Near and Deep

SPACE COMMUNICATIONS

(Vehicle-to-Ground Vehicle-to-Vehicle)

A diversity of advanced communications problems offer you stimulating assignments at Republic's Missile Systems Division. These include communications systems for a number of next-generation satellites and hypersonic vehicles. Emphasis is on applications of new digital techniques in wideband information transmission; multiplexing, security coding and noise reduction. Re-entry blackout communications problems are under study; new concepts in IR cameras are under development.

Openings at all levels on Systems and Component Design & Development, Systems Analysis, & Test Programs for

MICROWAVE ENGINEERS
RADAR ENGINEERS
COMMUNICATIONS ENGINEERS
IR & OPTICS SPECIALISTS
DIGITAL COMPUTER SPECIALISTS

Also, unusually varied assignments for CIRCUIT DESIGN ENGINEERS with experience in transistorized UHF & microwave systems, including: High Frequency Pulse Circuits, Digital Computer Building Blocks, RF Circuits, Communication Coding Circuits, Feedback Control Circuits.

Write Mr. Paul Hartman,
Technical Employment Supervisor

MISSILE SYSTEMS DIVISION

REPUBLIC
AVIATION CORPORATION

223 Jericho Turnpike
Mineola, Long Island, New York
•
An Equal Opportunity Employer

NASA Office of Manned Space Flight

CAREER APPOINTMENTS IN

Project Management

Vehicles & Propulsion Directorate

The Vehicles & Propulsion Directorate seeks to appoint engineers and scientists to positions of unusual responsibility. The duties inherent in these positions will have a direct and material bearing on the nation's manned space flight programs.

More specifically, the selected applicants will participate in the top level planning and implementation of NASA activities relative to large hydrogen-oxygen booster and spacecraft engines and large launch vehicle stages. You will direct, control and evaluate the programs assigned to NASA field centers, university laboratories, and private corporate contractors as well as prepare long range plans in the launch vehicle and propulsion areas.

Respondents must have at least a BS in ME, EE, aeronautical or chemical engineering and several years' experience in rocket propulsion and/or launch vehicles. Experience in project management or supervision is also required.

SEND RESUME IN CONFIDENCE TO:

DIRECTOR OF MANNED SPACE FLIGHT, DEPT. 133

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR, OR NATIONAL ORIGIN.

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GIBBS & HILL, Inc.
Consulting Engineers
Systems Engineering
Operations Research • Development
Field Studies • Design • Procurement
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Water Supply • Waste Treatment
393 Seventh Avenue New York 1, N. Y.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 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

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.
PROPOSALS, $2.70 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).

FOR RESEARCH — DEVELOPMENT & EXPERIMENTAL WORK

Over 10,000 different electronic parts: waveguide, radar components and parts, test sets, pulsers, antennas, pulse xmfrs, magnetrons, IF and pulse amplifiers, dynamotors, 400 cycle xmfrs, 584 ant. pedestals, etc.
PRICES AT A FRACTION OF ORIGINAL COST!
COMMUNICATIONS EQUIP CO.
343 CANAL ST., N. Y. 13, WO 6-4045
CHAS. ROSEN (Fomerly at 131 Liberty St.)

CIRCLE 950 ON READER SERVICE CARD

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about Classified Advertising

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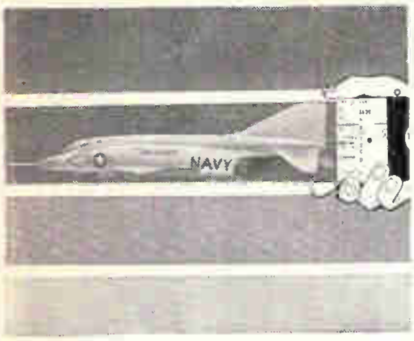
BOSTON, 16 M. Shouvlin
Copley Square COngress 2-1100
CHICAGO, 11 W. J. Higgens—D. Beran
645 No. Michigan Avenue MOhawk 4-5800
CLEVELAND, 13 I. C. Hill
1164 Illuminating Bldg. SUperior 1-7000
DALLAS, 2 F. LeBeau
1712 Commerce St., Vaughn Bldg. RIverside 7-9721
DENVER, 2 J. Patten
1700 Broadway—Tower Bldg. ALpine 5-2981
DETROIT, 26 Wm. H. Ginder, Jr.
856 Penobscot Bldg. WOodward 2-1793
HOUSTON, 25 J. Page
Prudential Bldg., Room W-724
Holcombe Blvd. RIverside 8-1280
LOS ANGELES, 17 Wm. C. Gries
1125 W. 6th Street HUntley 2-5450
NEW YORK, 36 H. T. Buchanan—T. W. Bender
500 Fifth Avenue LOngacre 4-3000
PHILADELPHIA, 3 W. B. Sullivan
Six Penn Center Plaza LOcust 8-4330
PITTSBURGH, 22 D. Beran
4 Gateway Center EXpress 1-1314
ST. LOUIS, 3
7751 Carondelet Avenue PArkview 5-7285
SAN FRANCISCO, 11 J. A. Hartley
255 California Street DOuglas 2-4600



ENGINEERS

Why you should know more about

MCDONNELL

In the 22 years since its founding, the McDonnell name has become associated with an increasing number of outstanding engineering achievements in aeronautics and astronautics.

Among these are America's Manned Spacecraft built for NASA . . . the record-setting F4H Phantom II, all weather fighter and attack airplane; the world's fastest jet.

Programs initiated include:

FOR NASA: GEMINI . . . an extended mission, two-man spacecraft capable of orbital rendezvous.

FOR THE AIR FORCE: F-110A and RF-110 Tactical Fighter and Photo-Reconnaissance Aircraft.

FOR THE NAVY & MARINE CORPS: Continuing F4H Phantom II and Fighter Attack Aircraft.

Other projects now under way include Typhon and Talos Airframes, Asset and Aeroballistic Space Research Vehicles.

The extensive McDonnell facilities—encompassing modern aerospace engineering research laboratories and production facilities are located in suburban St. Louis, Missouri. Diversified industry and commerce, well-established cultural and entertainment centers and a progressive minded population exceeding two million make this important metropolitan city an excellent one in which to work and reside.

Present and planned phases of our activities have created these career opportunities:

ELECTRONIC ENGINEERS

Responsible for concept, design, analysis and development of electronic equipment in the areas of: R.F. SYSTEMS, OPTICAL SYSTEMS, SPECIAL DEVICES, MICROWAVE AND ANTENNAS, THIN FILM TECHNIQUES, ADVANCED WELDED PACKAGING TECHNIQUES AND NUCLEAR STUDY PROGRAMS.

Please submit resume in confidence to:

MR. D. F. Waters,
Supervisor of Engineering Employment,
Dept. E

MCDONNELL

P. O. Box 516, St. Louis 66, Missouri

An equal Opportunity Employer

ENGINEERS

WORK IN AN ENGINEERS' ENVIRONMENT AT SPERRY GYROSCOPE COMPANY

For more than fifty years engineers have acknowledged that Sperry is a good place to work. The reason? Simply stated it's because Sperry possesses a true **engineers' environment.** Here you will find the broad range of programs that insures stability and because of their advanced nature you can forget "off-the-shelf" concepts and start using your creative imagination. At Sperry you will be working with the top men in your specialty and from these men you will gain increased professional competence. Finally Sperry's management is technical management that knows an engineer's problems and recognizes his contributions.

Gain the many advantages of an engineers' environment by joining the Technical Staff at Sperry. Openings are currently available for engineers experienced in one or more of these areas.

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Inquiries may be sent in complete confidence to:
Mr. J. W. Dwyer, Employment Manager

SPERRY *GYROSCOPE COMPANY*
Division of Sperry Rand Corp.
Great Neck, Long Island, N.Y.
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INDEX TO ADVERTISERS

Audited Paid Circulation

• See advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

PROFESSIONAL SERVICES
CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

■

INDEX TO CLASSIFIED ADVERTISERS

■

• See advertisement in the July 20, 1961 issue of Electronics Buyers' Guide for complete line of products or services.

This Index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

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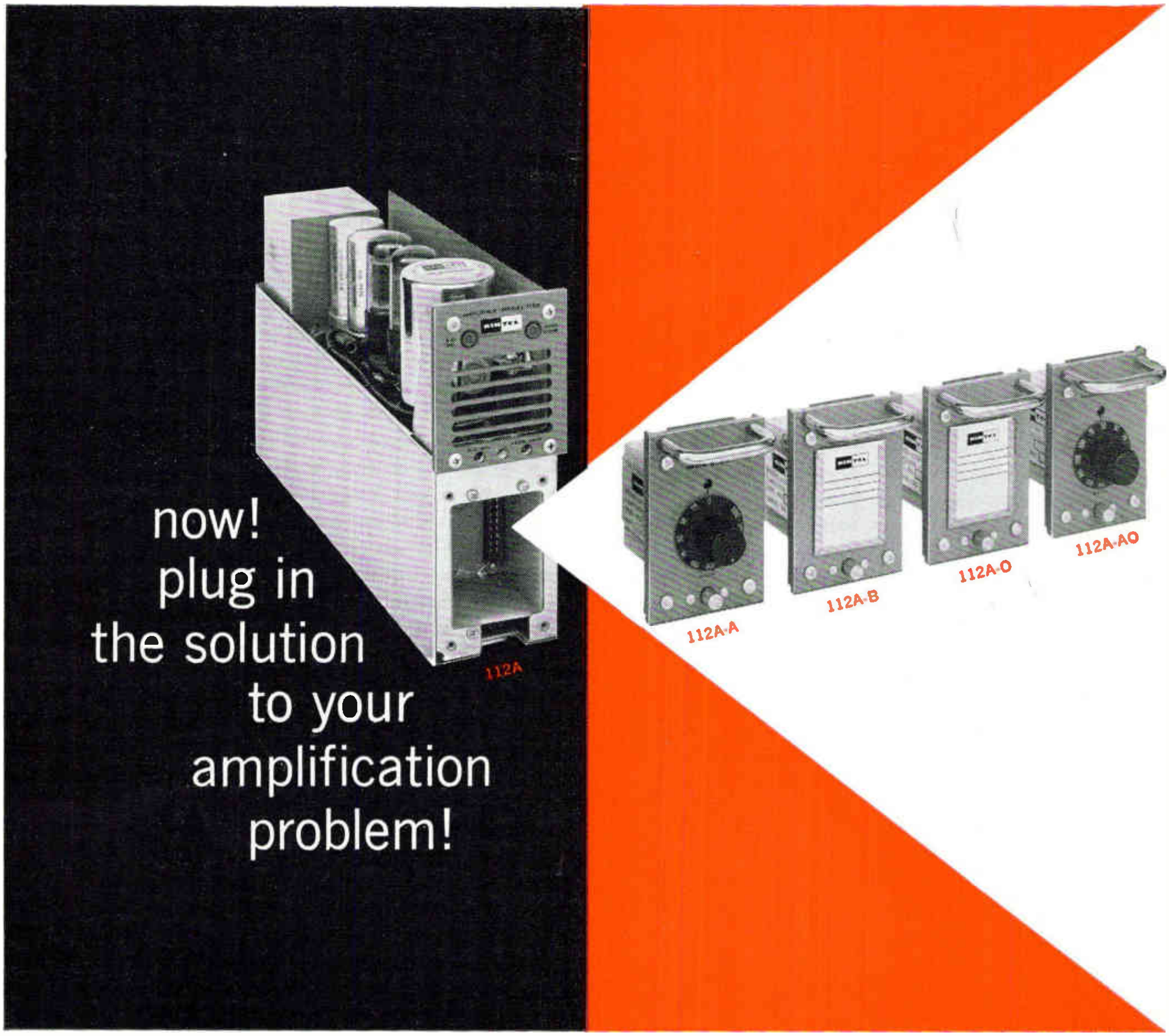

Special Plug-In Units Make KIN TEL's Wideband DC Amplifier the Basic Component in a Variety of Data Acquisition Systems. Why Not in Yours?

With a 112A-A Plug-in, the amplifier provides accurate drift-free signals at any of ten fixed gains from −20 to −1000 with a stability of ±0.1% and an accuracy within ±0.5%. A Micro-Gain control sets individual fixed gains within ±0.01%, and a 2:1 vernier control adjusts gains between fixed steps. Outputs are available up to ±45 volts or ±40 ma at an impedance less than 1 ohm, linear within 0.01% at DC and within 0.1% to 2 kc. Drift is less than 2μv for 400 hours, and noise is less than 5 μv from DC to 750 cps, less than 12 μv to 50 kc. Frequency response is within ±0.5% to 2 kc, ±3% to 10 kc, ±3 db to beyond 40 kc.

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With any plug-in, the 112A may be used in a single-amplifier cabinet on a bench or in either a one- or six-amplifier module to fit a standard 19-inch rack. Write today for detailed technical literature or demonstration. Representatives in all major cities.

PRICES: (50 cps operation at additional cost)

112A amplifier alone	$530.00
112A-A Ten-gain Plug-in	95.00
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195 single-amplifier cabinet	125.00
191A Single-amplifier rack module	150.00
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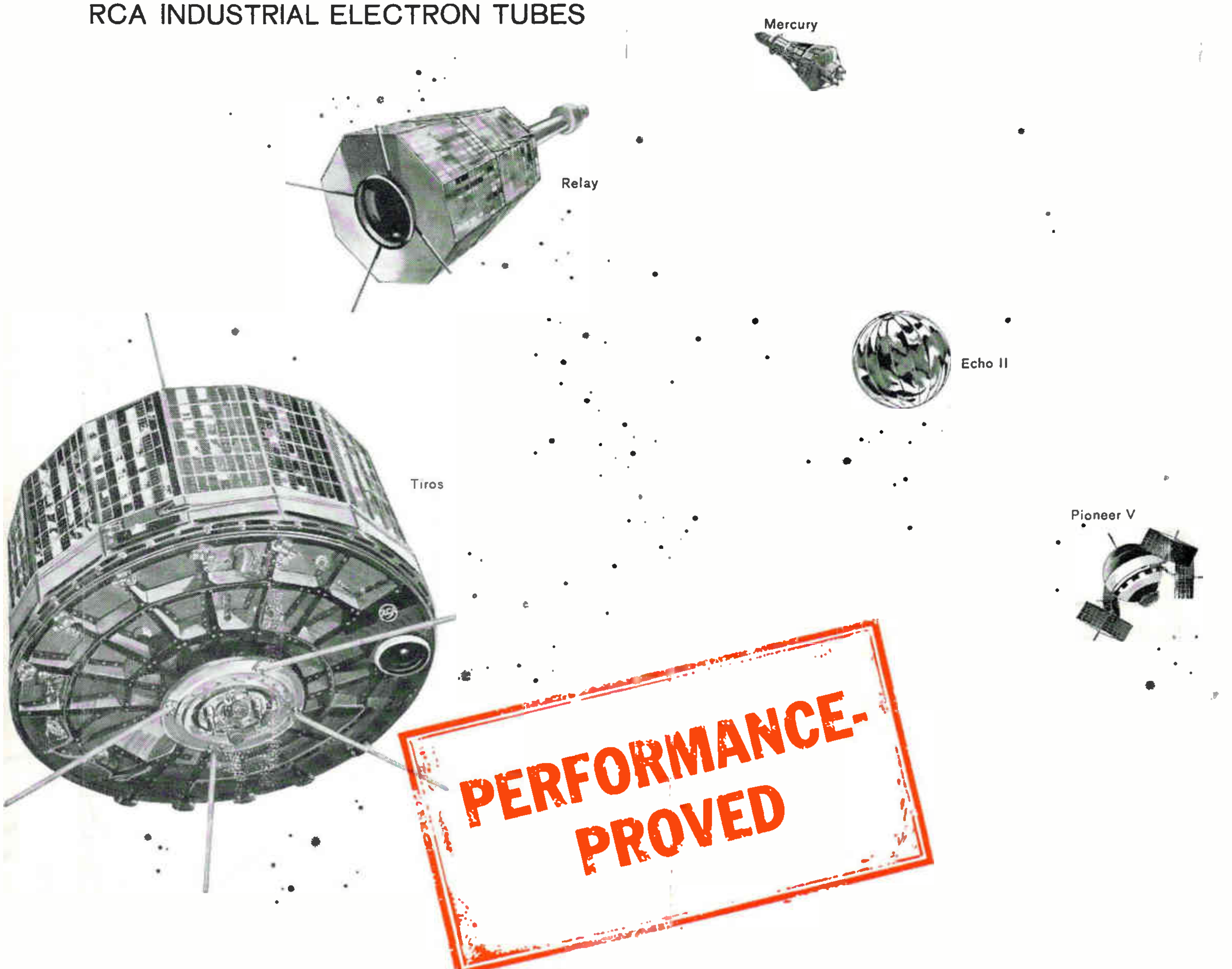

IN SPACE EXPLORATION

With the reliability that has made them world famous, RCA Industrial Electron Tubes have effectively met the challenge of space exploration.

Each family of special purpose tubes, products of RCA's Electron Tube Division, Industrial Tube Products facility at Lancaster, Pennsylvania, has served in space.

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In the *TIROS* weather satellites, RCA-4429 Vidicons have taken pictures to help meteorologists predict, perhaps someday control, weather phenomena.

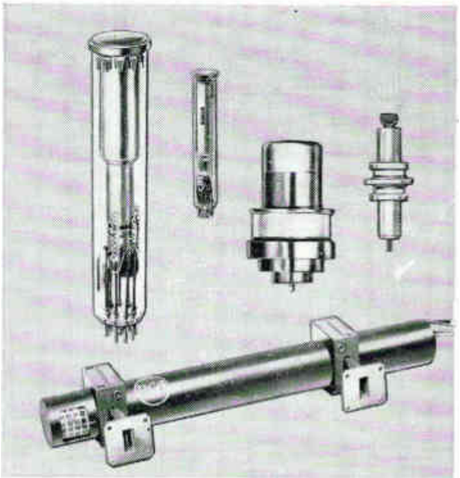
Greater power in a compact package made RCA-7842, a Cermolox Tube, the ideal choice of a beam power tube for *Pioneer V*, the reconnaissance satellite.

As the world listened in, RCA-5876 Pencil Tubes in a transmitter aboard each *Mercury Capsule* enabled the Astronaut to talk with his tracking stations.

Another RCA Vidicon, the 8134 was aboard the rocket which launched *Echo II*. Its performance brought back to earth the first live TV action in space: the explosion of Echo II.

The RCA-A1245 Traveling-Wave Tube was designed as an integral part of *Project Relay*, an experimental space vehicle for trans-oceanic communication and radiation study.

Whatever your space project, RCA Industrial Tube technology can be your foremost asset. RCA Industrial Tubes are available from your local RCA Industrial Tube Distributor. For information on specific RCA tube types write: Section f-19-Q-4, Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.



RCA Tubes in Space: Tiros, RCA-4429; Pioneer V, RCA-7842; Mercury, RCA-5876; Echo II, RCA-813 and Relay, RCA-A1245.

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