Over-Horizon Radar's Role in Defense

page 28

electronics

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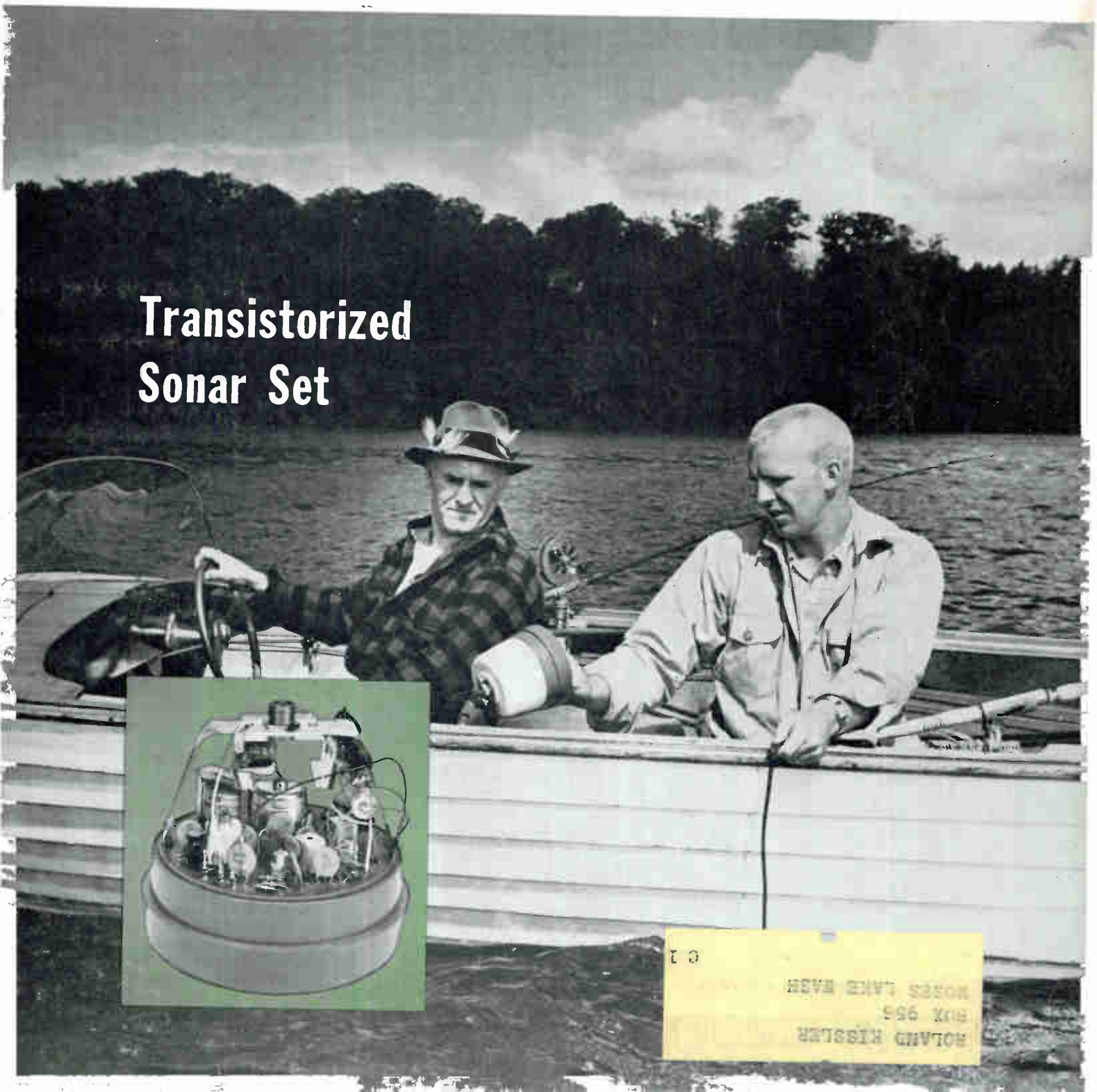
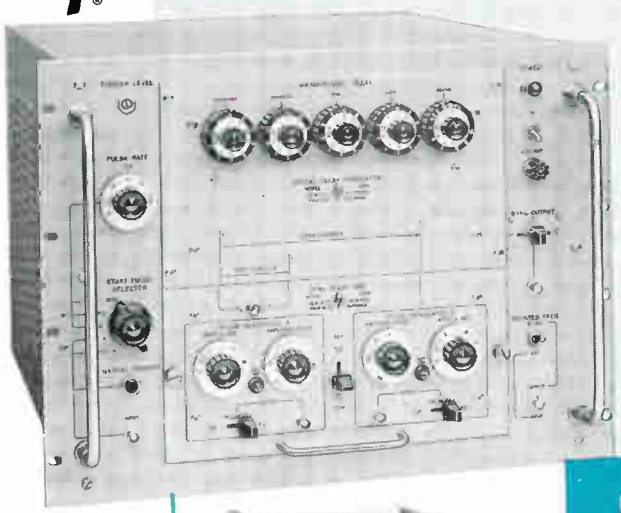
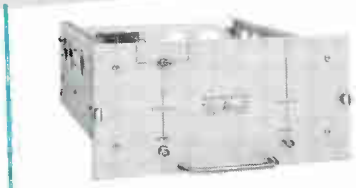


MEASURE TIME; 0.1 μsec ACCURACY!



218AR Digital Delay Generator produces crystal controlled pulses accurately spaced in time. It is a perfect slave to any pulse, even though random, and locks in constant phase during each counting period.



219A

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219C

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Built along strict military standards, 218AR uses a pulsed crystal oscillator synchronizable in *constant phase* with an initial trigger pulse (zero time) and two positionable terminating pulses. Time is counted with a 1 Megacycle preset counter, and two independent output pulses are available in any relationship.

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For utmost versatility, output pulses are generated in various arrangements by three plug-in pulse generators. These include 219A, supplying two positive pulses, 219B providing two pulses, each positive or negative and variable in amplitude, 219C, providing a high power pulse, positive or negative, digitally controlled as to delay and duration, variable in amplitude.

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(Basic 218AR Generator; plug-ins essential)

Time Interval Range:	1 to 10,000 μsec
Accuracy:	± 0.1 μsec ± 0.001%
Digital Adjustment:	1 μsec steps, full range
Interpolation:	Variable 0 to 1 μsec
Input Trigger:	Internal 10 cps to 10 KC; External 0 to 10 kc pulses, also sine wave
Jitter:	0.02 μsec or less
Recovery Time:	50 μsec or 10% of interval, whichever is greater
Sync Output:	50 v pos. pulse, 0.1 μsec rise time
1 MC Output:	1 v pulses, 500 ohm impedance
Price:	-hp- 218A, $2,000.00 -hp- 219A Dual Trigger Unit, $100.00 -hp- 219B Dual Pulse Unit, $450.00 -hp- 219C Digital Pulse Duration Unit, $350.00

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FEBRUARY 5, 1960

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Vol. 33 No. 6

Issue at a Glance

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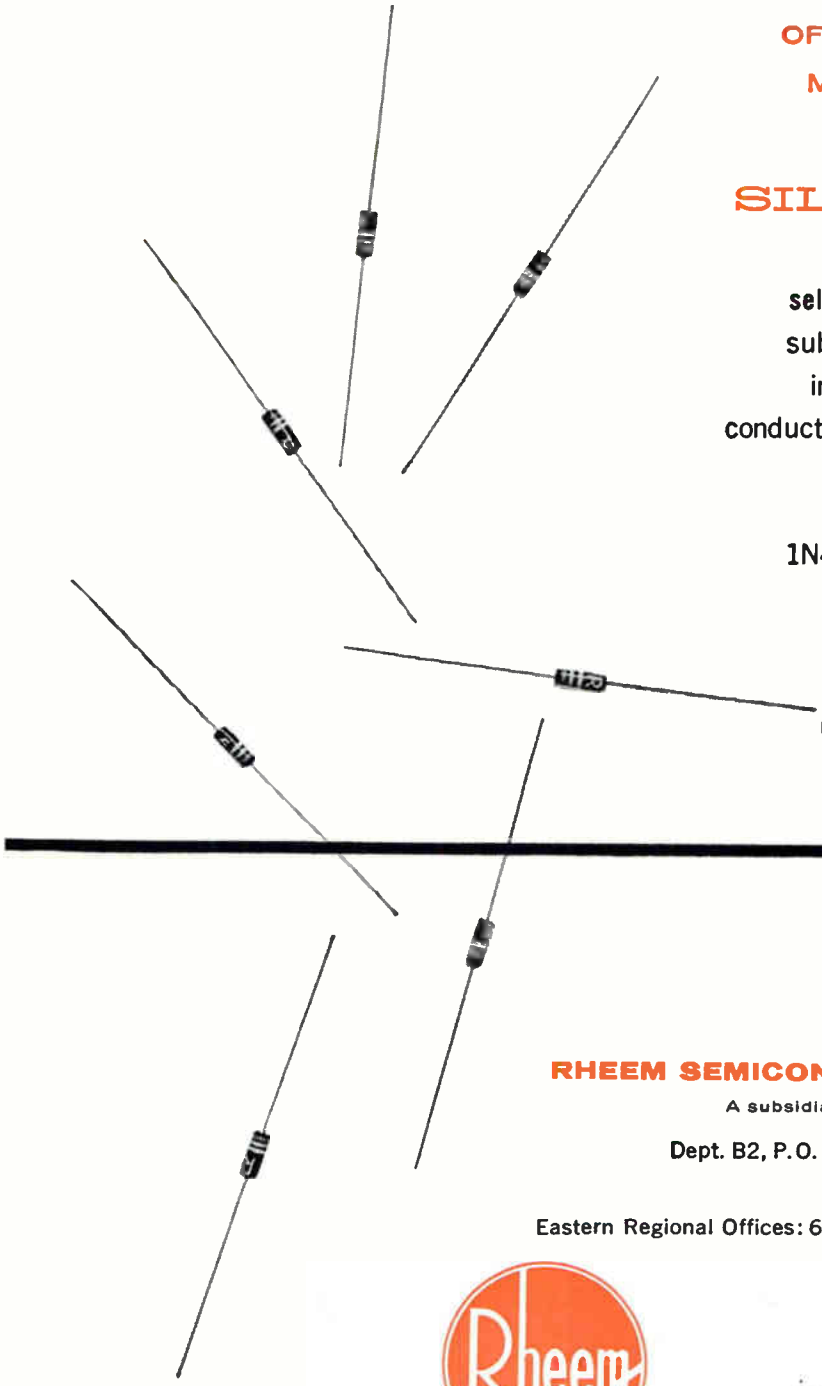

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SHOPTALK . . . editorial

RELIABILITY. We noted two things in particular while attending sessions of the 6th National Symposium on Reliability and Quality Control in Electronics. Both were minor personal annoyances, but both, in their way, reflect a healthy trend in our industry.

One was that, weeks in advance of the Symposium, there wasn't any hotel space available anywhere near Washington's Statler-Hilton, where the Symposium was held.

The other was that job hunting was going on much more feverishly than we had observed before at a reliability meeting. Resumes were changing hands at a great rate, and many engineering managers had peeled eyeballs for managers of reliability programs and engineers schooled in the principles and techniques of designing for reliability.

We tend to disapprove of using conventions as employment bureaus; and of course we were unhappy to be shunted out of our favorite hotel, which is hard by the Statler-Hilton. But we can't help thinking that the increased attention paid by this industry to reliability, to reliable design, to controlled quality of production, is a happy sign of a mature and intelligent approach to many of the challenges which face us.

Coming In Our February 12 Issue . . .

WORLD-WIDE R&D. Rapid growth of research and development is one of our industry's hallmarks. Moreover, this is not a phenomenon limited to the United States; next week's special report shows electronics forging ahead rapidly in many countries.

Compiled by Editor MacDonald, the report spotlights significant work being conducted around the world. Included is a discussion of British R&D by E. Eastwood of Marconi's Wireless Telegraph. Eastwood reveals the latest trends in semiconductor research and describes current radar, air-traffic control, point-to-point communications and c-w Doppler studies. You'll also learn about a new program for research into the magnetic properties of thin films.

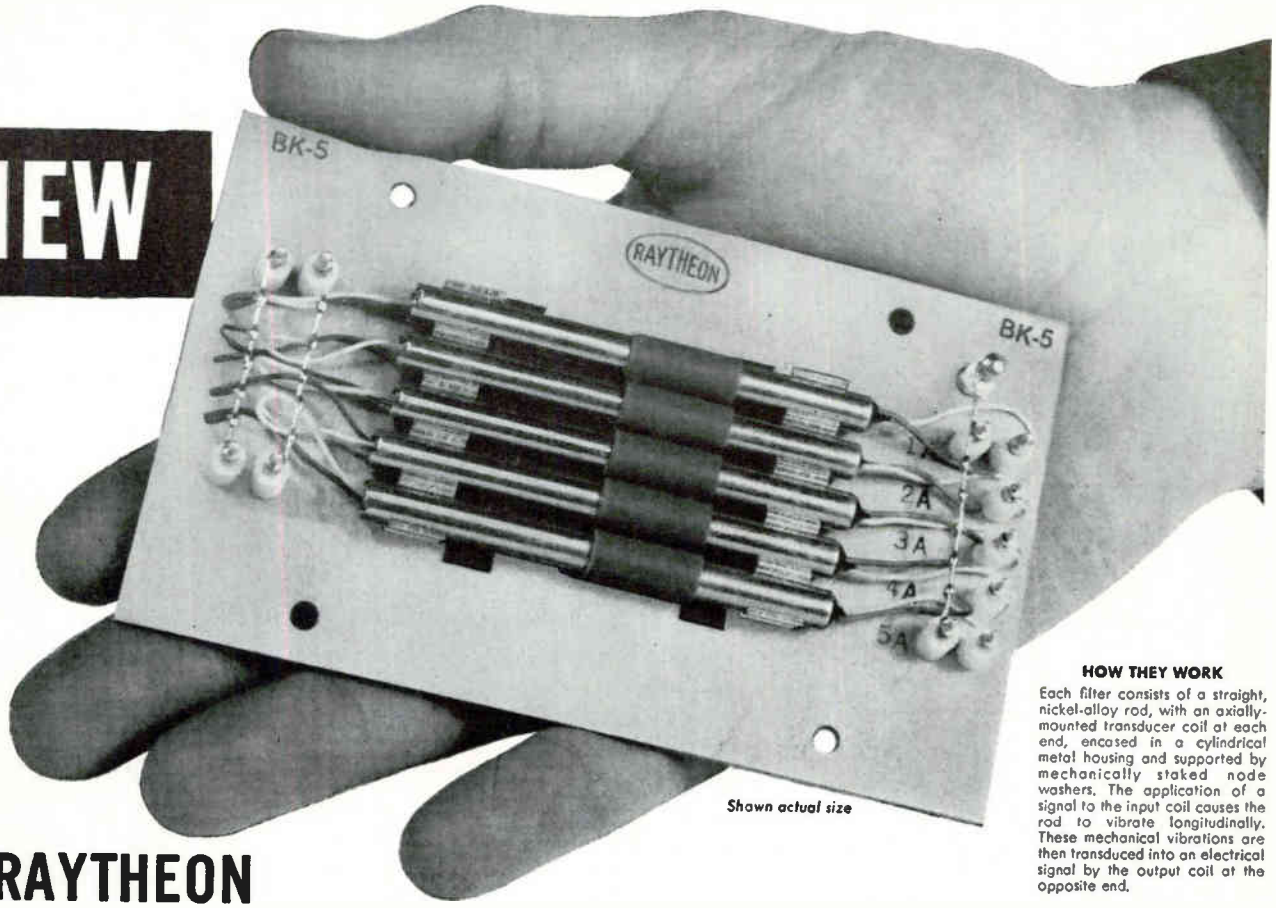
Sophisticated communications systems are receiving considerable attention from French researchers. G. Goudet of the Laboratoire Central de Telecommunications and P. Grivet of the University of Paris disclose the latest developments in wireless communications, including a transmission method combining tropospheric scattering and diversity by variation of frequency. They also report details of work in radar, navigation, reactor technology, computers, electron tubes and masers.

H. Wada of the Japanese Ministry of International Trade and Industry discloses progress in the further development of tunnel diodes, novel switching elements and transistors. Wada's remarks about the status of Japanese R&D also cover advanced work in computers and process control by digital techniques.

Included too in next week's special report is the latest news about automatic control research in Italy (P. Marsili, University of Genoa and G. Quazza, Instituto Ricostruzione Industriale), plasma research in Sweden (B. Agdur, Royal Institute of Technology), electronic switching studies in Switzerland (J. Bauer, Hasler), semiconductor research in Israel (R. Gamzon, Weizmann Institute of Science) and a giant radiotelescope in Australia (E. G. Bowen, Commonwealth Scientific and Industrial Research Organization).

We believe this fascinating survey and report successfully pictures the wide scope and dynamic nature of electronics research in the world today. You won't want to miss it.

NEW



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Higher Q and higher frequencies than toroidal coils — Q from 2000 to 15,000. Resonant frequencies from 45 to 300 kc.

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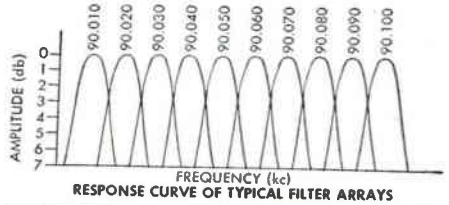
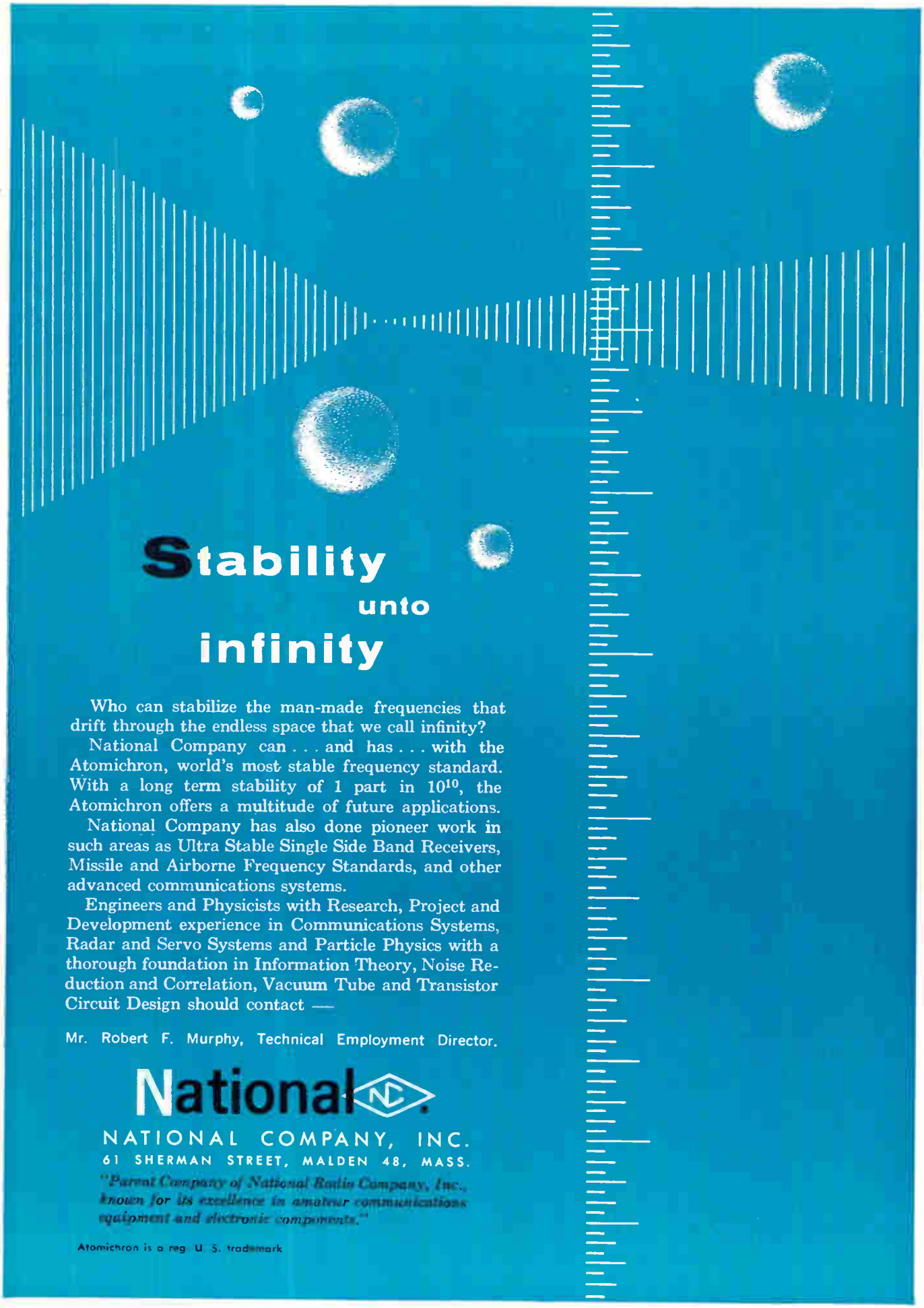
Ideal impedances for transistor circuits — Single filter input impedances from 15 to 90 ohms, output impedances from 600 to 2000 ohms (depending on resonant frequency).



RESPONSE CURVE OF TYPICAL FILTER ARRAYS



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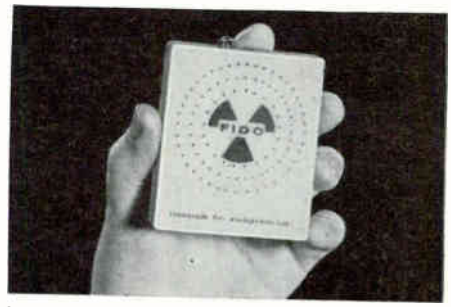

IDEAL FOR TRANSISTOR CIRCUITS
A pocket-size radiation detection alarm for personal and area protection, FIDO℗ produces a warning sound clearly heard many feet away. Controls for Radiation, Inc. chose Mallory mercury batteries as the power pack because they ideally fit transistor circuit requirements for compactness and steady voltage output.
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SMALL SIZE, STEADY VOLTAGE
This noise survey meter is used for measuring noise hazard in industrial hygiene studies, for noise reduction surveys and for architectural acoustic measurements. This small portable instrument is powered by a single Mallory mercury battery, chosen for its small size, steady voltage and long life.

FOR ACCURATE OUTPUT
This new small boat tachometer designed by McCulloch Corporation's Marine Products Division depends on Mallory mercury batteries as a voltage reference source. Open circuit output stays constant within 1% over periods up to 36 months.

NEW LOW-TEMPERATURE CELL
The RM-1450R mercury cell, using ribbon wound anode, gives considerably higher capacity at low temperatures. Ideal for emergency beacons, marker lights, rescue transceivers, it produces over 10 times as much output as earlier mercury cells at 32°F, and gives useful output even at —20°F. Capacity of packs is up to 45 watt-hours per pound. Write for new folder.

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BUSINESS THIS WEEK

Atmospheric "Pipeline" for Radio Waves Found to Exist Over the South Atlantic

Existence of a 500-ft-thick atmospheric duct, extending from West Africa to the coast of Brazil at a height of 5,000 ft, which can trap and propagate radio waves at low loss has been proved by Air Force and Navy researchers. **Airborne radio equipment operating at a frequency of 220 mc (slightly above the vhf television band) was used to measure signals.** With a transmitter power of 100 w, signals beamed from Brazil were detected some 1,430 mi away. This, says the Air Force Cambridge Research Center, represents a significant technological breakthrough in transoceanic communications possibilities." Similar ducts may be present in other tradewind zones, due to temperature inversion layer characteristic to tradewind regions.

Space Agency Lets $30-Million Contract For Mercury Tracking and Communications

Worldwide tracking and communications network for Project Mercury manned satellite will be built for National Aeronautics and Space Administration by Western Electric. The $30-million contract calls for 18 sites, including two ships, that encircle the globe.

Major subcontractors are: Bendix, for ground-to-capsule voice communications, radar for tracking, command links for ground control of certain capsule functions; also, telemetry receiving system, associated command-display consoles and data-processing. More than 90 channels will be provided for data transmission between the capsule and ground stations.

Bell Telephone Laboratories, for basic systems engineering for communications and visual presentation. Bell Labs will also study the compatibility of various pieces of equipment and develop operational plans to insure systems capabilities. Burns & Roe, for architectural and engineering work. Western Electric, for overall management; WE is responsible for design and implementation of ground communications and for training maintenance and operations personnel. Completion date is set for 1961.

Silicon Radiation Detector May Give New Speed and Accuracy to Particle Analysis

Solid-state radiation detector—essentially a slice of doped silicon—reportedly counts particles at a rate 1,000 times faster than other detectors and with such accuracy that it can analyze particle energy to less than one-half of one percent error. The device, dubbed a "solid-state ionization chamber," was announced last week by Hughes Aircraft Co.

The detector can be made small enough to fit into the tip of a surgical probe used in cancer treatment control. It operates at very low voltage, puts out a signal whose amplitude is a millivolt per million electron volts of particle energy. **Count rate of 10^9 counts per second is said to be beyond the pulse rise time of presently available transistors.**

Hughes proposes that thousands of the tiny detectors be used in a three-dimensional space package to provide precise measurements of cosmic rays and define the limits and nature of the Van Allen radiation belt. Military use in a small, rugged meter for radioactivity measurement is foreseen. Hughes also sees industry use for flow measurement, thickness gaging, liquid-level measurement and oil-well logging.

ELECTRONICS NEWSLETTER

Navy experimental moon-relay communications system connecting Washington and Hawaii by teletypewriter and facsimile was demonstrated last week. Voice experiments will follow. Signals in the 400-mc band, normally unaffected by ionospheric disturbances, were received in two and a half seconds. System beams uhf waves with a highly directional narrow-beam antenna 84 ft in diameter, produces effective radiated power of more than 400 megawatts, and uses a high-gain antenna to collect reflected signals. Moon must be visible to both terminals for operation of the system. Jamming requires very high power from another station in the line-of-sight of the moon. Problem of the moon's avaliability could be eased by hovering satellites.

Digital oscilloscope to be marketed next month by Allen B. DuMont Labs reduces operator time spent in interpolating waveforms, the company says. Scope gives direct readout of amplitudes and time intervals when two display dots are superimposed on the trace using six thumb wheels and a joy-stick positioner. New model 425 general-purpose instrument provides for the preservation of data on remote printers, punched cards or magnetic tape. DuMont says frequency range is d-c to 60 mc, accuracy 2 percent.

Stereophonic broadcasting made news last week when Kahn Research Laboratories, Freeport, N. Y., filed a broadcast application with the FCC. The Kahn system is an a-m/a-m method in which two receivers are used, one slightly below and one slightly above frequency. FCC comment will come after 30 days.

Tunnel diode pioneer Leo Esaki has been granted a leave of absence from the Sony Corp. in Tokyo and has joined IBM as a resident consultant. He will work at the company's semiconductor research department in Poughkeepsie, N. Y.

Data-processing system built around two RCA 501 computer systems, with peripheral equipment and check-processing gear manufactured by Burroughs, will be installed by Chase Manhattan Bank in New York. The bank handles 1.5 million checks a day worth about $1.25 billion. Meanwhile, the Federal Reserve plans five pilot installations of electronic check-handling equipment.

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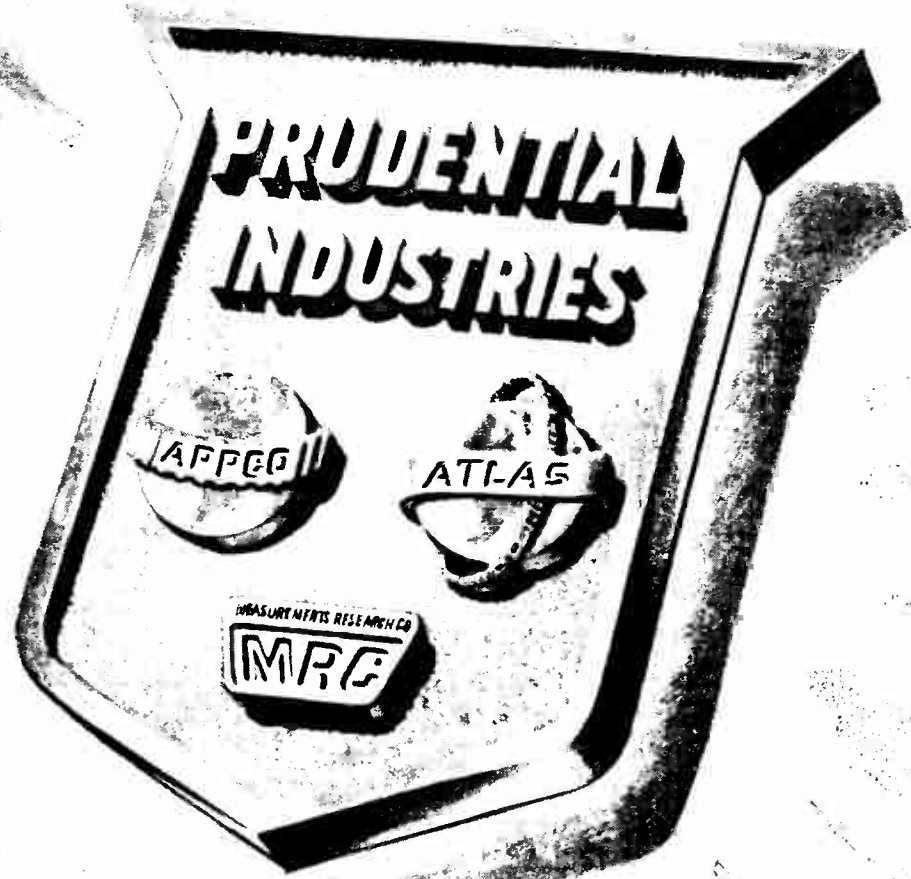

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1004-B VIDEO TRANSMISSION TEST SIGNAL RECEIVER

Very rapid and accurate measurement of differential phase and differential gain characteristics of video facilities. Responds to standard stairstep test signal modulated with 3.58 mc, or any differential phase or gain test signal.

1005-A VIDEO TRANSMISSION TEST SET

1005-A1 — Produces composite television waveforms suitable for measuring amplitude vs. frequency; differential gain vs. amplitude; dynamic linearity; differential phase vs. amplitude; high frequency transient response; low frequency transient response; low frequency phase of streaking, smears, mismatches; and other video characteristics.

1005-A2 — Supplies composite E1A Sync, blanking, horizontal and vertical drive signals and regulated B + power for itself and 1005-A1. Features magnetic core binary counters.

1008-A VERTICAL INTERVAL KEYER

Permits test and control signals to be transmitted simultaneously with program material, between frames of TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signal. Test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.

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Produces new waveform for testing TV or other pulse unit or system for amplitude and phase characteristics. Sin^2 — Square Wave pulse is equivalent to TV camera signal and is more sensitive than a Square Wave in indicating ringing. Video test signal adjustable for 1.0 volts or 1.4 volts peak to peak. Now in use by major TV networks and telephone companies.

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WASHINGTON OUTLOOK

WASHINGTON—THE DEFENSE DEBATE goes into high gear with the administration's new arguments minimizing the missile gap. Eisenhower strategists have now revised their intelligence estimates of Soviet missile strength. The latest estimate is based on what the administration considers Moscow's intentions on ICBM deployment rather than on considerations of Soviet capabilities to produce the missiles.

Up to now, the strategists have gone by production capability. The upshot has been a general consensus that the Soviet Union would have an arsenal of operational ICBM's at least three times the size of ours during 1961-64. The administration now concedes only a moderate numerical superiority, and Pentagon spokesmen even downgrade this advantage, arguing that a maximum nuclear blow could not destroy our ability to devastate any enemy in retaliation.

The administration is convinced that Soviet missile strength has been exaggerated. About two years ago, for instance, experts predicted that the USSR would have 300 operational ICBM's by 1960. There's no evidence now, however, that the Soviet Union has such missile power.

The administration's new stand has infuriated some members of Congress and Pentagon officials, who see it as dangerous complacency. These critics of defense policy will intensify their efforts to get ICBM production boosted beyond the increase provided for in the new budget.

Latest plans call for deployment of 13 Atlas squadrons and 14 Titan squadrons—a total of 270 missiles—over the next three years. This is a 30-percent larger force than was planned a year ago. The expanded ICBM program is, of course, equally important in any reappraisal of where the U. S. stands vis-a-vis the Soviets on ICBM's.

- **One figure buried deep** in the new defense budget gives the tipoff on how military spending for key projects is being levelled off. Direct obligations—that is, new contracts—for research, development, testing and evaluation of new weapons will total $3.9-billion in fiscal 1961 under present plans. That's $400 million under the current rate of contracting.

  Actual figures on funds earmarked for specific projects are still classified. But ELECTRONICS has learned percentage changes planned for some major R&D projects.

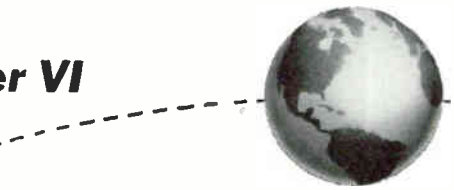
  Obligation of new funds for the Nike Zeus anti-ICBM system will be cut 31 percent. The actual outlay of money for the project, however—reflecting contractual commitments already made—will remain at the $300-million level.

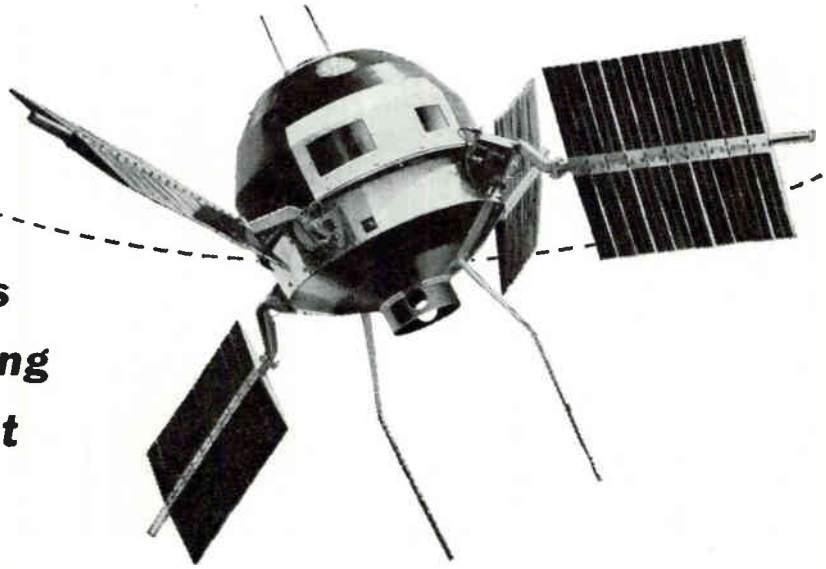
  The Air Force's B-70 project will be trimmed 50 percent in terms of new funds; the Navy's Transit navigation satellite, 58 percent, and the Navy's ASROC antisubmarine missile, 34 percent.

  Contracting for other R&D projects, now at a relatively low level, will be stepped up. The Air Force's Midas early-warning satellite is scheduled for a 70-percent boost in new obligations. Funds for the Air Force's Dynasoar experimental boost-glide orbital vehicle will be increased 66 percent; for Navy's Eagle air-to-air missile, 48 percent; for Army's Pershing tactical missile, 42 percent; for Air Force's Samos reconnaissance satellite, 33 percent; for Army's Sergeant tactical missile, 30 percent; for Air Force's Minuteman ICBM, 19 percent, and for Army's Notus communications satellite, 8 percent.

- **The Air Force** expects to recover $127.2 million from its contract with Sperry Gyroscope for the ALQ-27 electronic countermeasures system. The project was cancelled two months ago after expenditures totalling $182.6 million, including termination costs. Reason for the cancellation: downgrading of the "priority of this system in competition with other high-priority items."

Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power





The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29" payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.

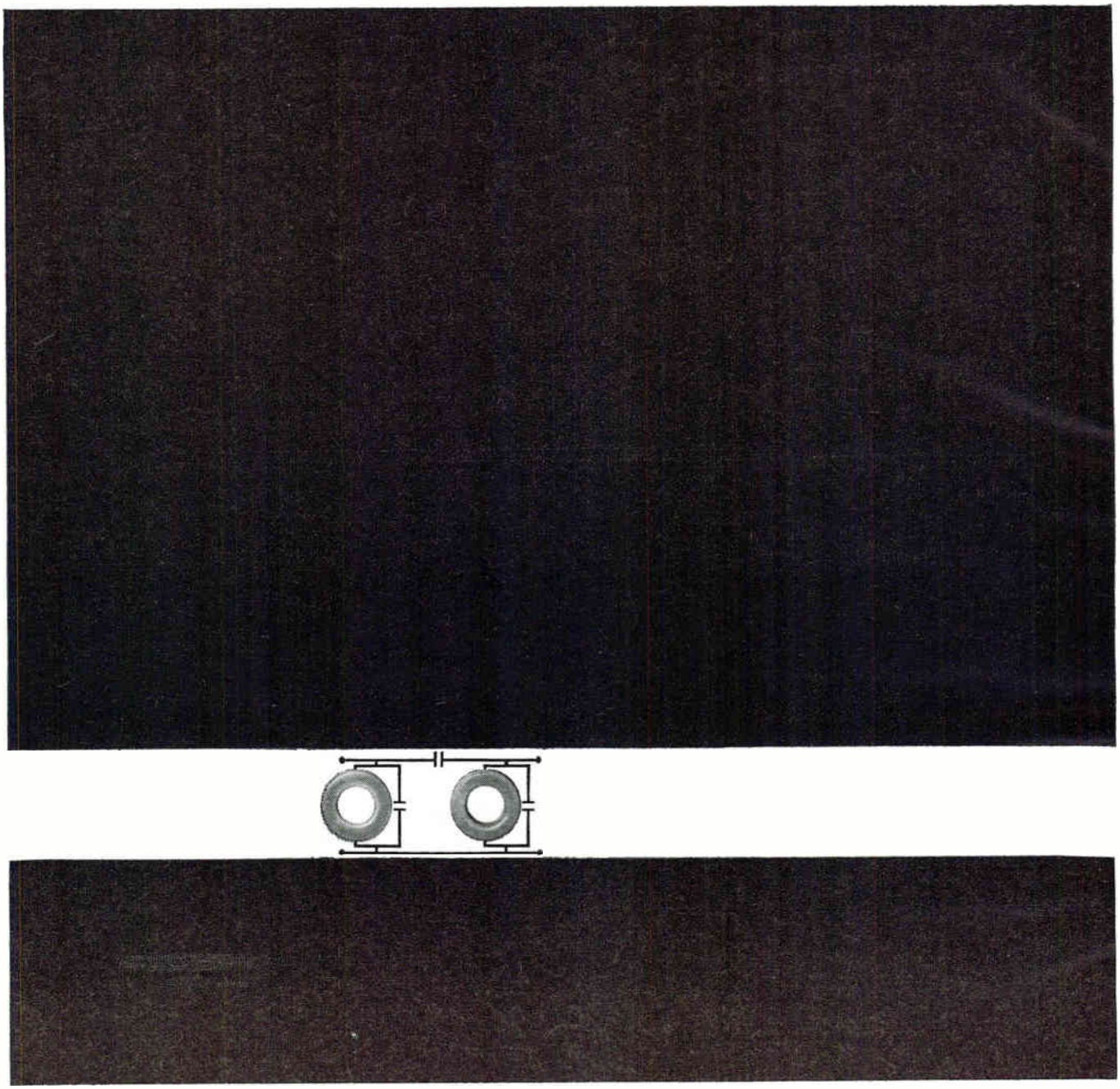
How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet in area ● Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.

Space Technology Laboratories, Inc.

Inquiries and resumes are invited.

P.O. Box 95004
Los Angeles 45, California



Smaller filters ease the squeeze!

Filter designers! First 160-mu moly-permalloy powder cores pack high performance into smaller space

Filter and inductor designers specify our 160-mu moly-permalloy powder cores for low frequency applications. Where space is precious, such as in carrier equipment and telemetering filters, the high permeability of these 160-mu cores eases the squeeze.

In many cases, 160-mu cores offer designers the choice of a smaller core. In others, because inductance is 28 percent higher than that of 125-mu cores, at least 10 percent fewer turns are needed to yield a given inductance.

If Q is the major factor, 160-mu cores permit the use of heavier wire with a resultant decrease in d-c resistance.

Like all of our moly-permalloy powder cores, the 160's come with a *guaranteed* inductance. We can ship eight sizes from stock, with a choice of three finishes—standard enamel, guaranteed 1,000-volt breakdown finish, or high temperature finish. Further information awaits your inquiry. *Magnetics Inc., Dept. E-78, Butler, Pa.*

MAGNETICS inc.

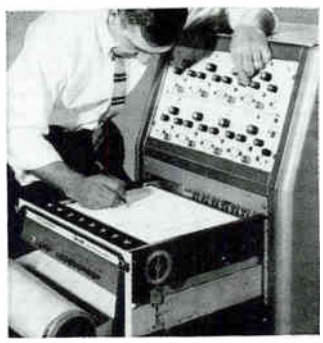
this is the Brush Mark II...

anyone can plug it in put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Immediate shipment from stock. Call, write or wire for complete details.

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

for direct writing recording systems no one is as qualified as Brush



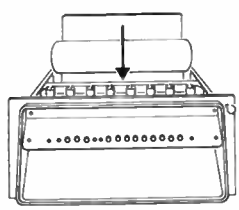
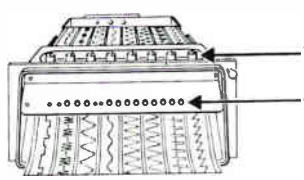
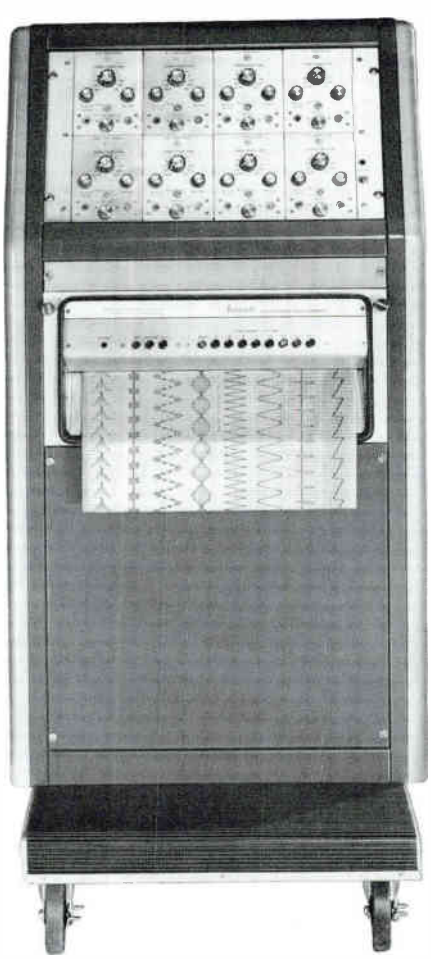


Chart paper loads from top



Trace contrast control

Simple pushbutton speed selection



Why? Simply because Brush recording systems such as this 6-8 channel unit incorporate all of the known refinements in the art of recording by direct writing. No comparable system in existence today is as compact . . . as simplified . . . as reliable . . . as versatile. Note slide-mounted oscillograph and interchangeable "plug-in" signal conditioners that provide four vital functions in addition to amplification: high input impedance, zero suppression, attenuation and calibration.

Instantaneous rectilinear presentation gives clear, uniform and reproducible traces for precise readout of telemetry, computer, ground control and other data gathering operations. Further, this functionally designed system has a "pull-out" horizontal writing table for convenient annotation and reading . . . without turning off the recorder! Check these and many other advanced features for yourself and you'll see why *no one* is as qualified as Brush. Call, write or wire for complete details.

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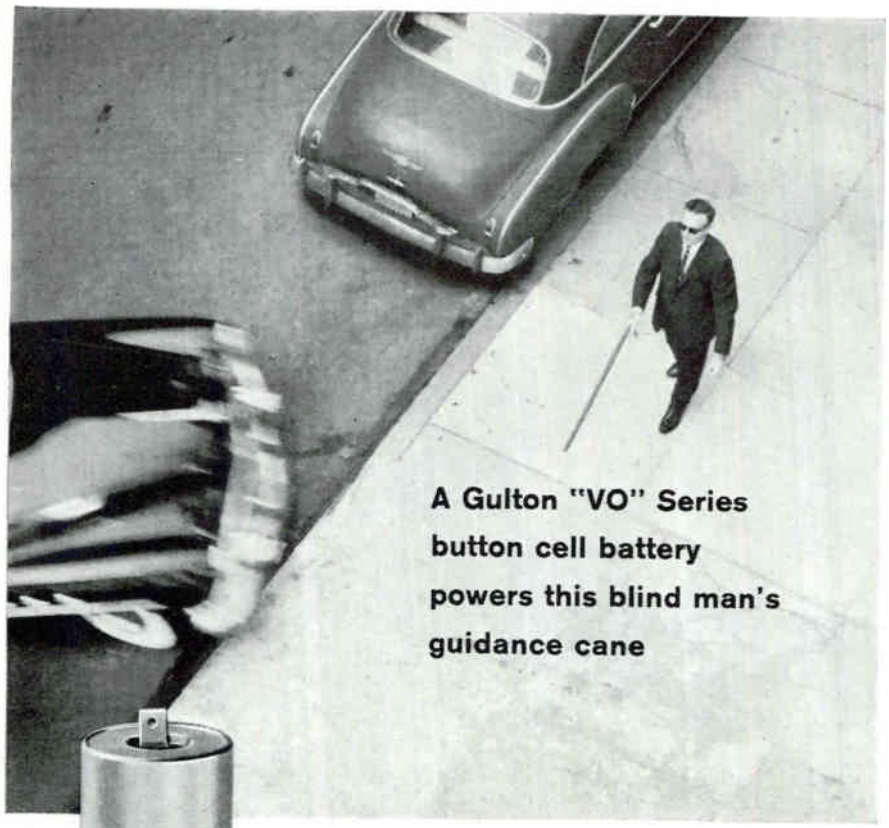
CLEVITE CORPORATION
37TH AND PERKINS CLEVELAND 14, OHIO



rugged . . . reliable . . . rechargeable!

The cane in the man's hand is a proximity guidance device designed by Franklin Institute for the blind.

Requirements called for the power supply to be small enough to fit in the handle of the cane, rugged enough to perform well under abuse, and . . . to be rechargeable.

After extensive testing, designers chose the Gulton "VO" sealed nickel cadmium button cell battery to do the job.

How Can You Use These Batteries?

Powering this and other prosthetic devices is only one of many imaginative uses for these rechargeable batteries. Engineers have already designed them into transistorized radios, photo-flash power packs, missiles—wherever *small size, strength, light weight, long life, complete reliability, no maintenance and easy recharging are desired.* Like more information? Write us for Bulletin No. VO-103.

		VO-.080	VO-.180	VO-.250	VO-.500
ELECTRICAL SPECS.	Capacity (1 Hour rate):	80 mah	180 mah	250 mah	500 mah
	Charging Current (1c):	2-10 ma	4-18 ma	5-25 ma	10-40 ma
	Charging Time (Constant Current):	150/Ic hrs.	270/Ic hrs.	375/Ic hrs.	750/Ic hrs.
	Trickle Charge Rate:	2-5 ma	2-5 ma	2-5 ma	5-10 ma
	Cell Voltage During Charge:	1.4 V	1.4 V	1.4 V	1.4 V
	Maximum Peak Discharge Current:	1.5 A	3 A	5 A	7.5 A
MECHANICAL SPECS.	Diameter:	.900	.975	1.375	1.375
	Thickness:	.200	.270	.1875	.3125
	Weight:	.25 ounce	.35 ounce	.5 ounce	.75 ounce

Available from stock— GLENNITE BATTERY DISTRIBUTORS
92-15 172nd Street, Jamaica, New York

Gulton Industries, Inc.
Alkaline Battery Division, Metuchen, New Jersey

"VO" SERIES BUTTON CELL BATTERIES

Available Immediately From These Distributors

ARROW ELECTRONICS
525 Jericho Turnpike
Mineola, L. I., N. Y.
Pioneer 6-8686

D. & H. DISTRIBUTING CO.
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Baltimore, Md.
SAratoga 7-5100

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1095 Commonwealth Avenue
Boston 15, Mass.
ALgonquin 4-9000

ELECTRA DISTRIBUTING CO.
1914 West End Avenue
Nashville 4, Tenn.
ALpine 4-8444

ELECTRONIC EQUIPMENT CO.
2701 N.W. 42nd Avenue
Miami 48, Florida
NEwton 5-0421

ELECTRONIC WHOLESALERS, INC.
2345 Sherman Avenue, N.W.
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4736 West Century Blvd.
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ORchard 4-8440

NEWARK ELECTRIC CO.
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STate 2-2944

OLIVE ELECTRONIC SUPPLY CO.
6662 Olive Blvd.
University City 5, Missouri
VOlunteer 3-4051

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LOcust 8-7444

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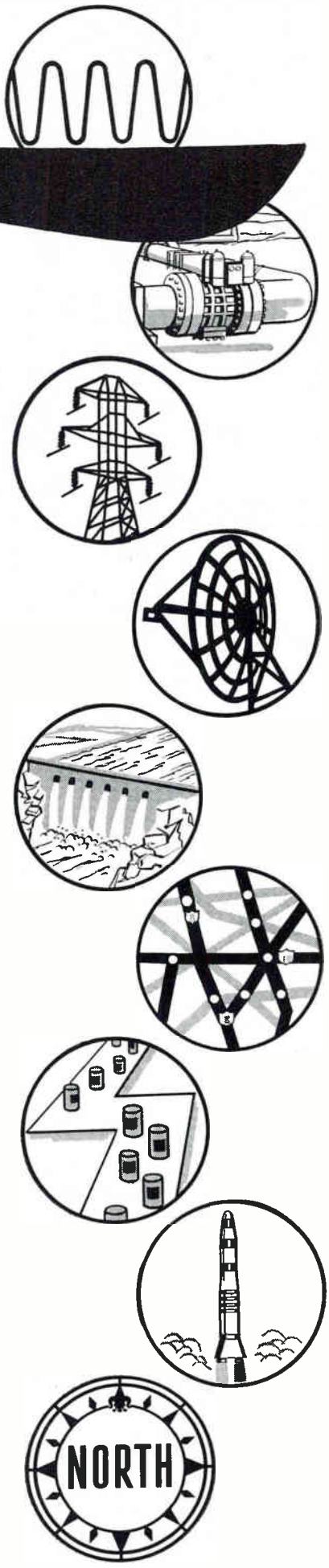
←CIRCLE 18 ON READER SERVICE CARD

CIRCLE 19 ON READER SERVICE CARD

our business is communications and control systems...



For over 75 years North Electric has been designing, engineering and manufacturing "systems" designed on the dual functions of communications and control.

Today, North Systems speed man's thoughts and words over vast distances, between continents and over oceans in seconds.

Today, North Systems control the flow of light, heat, power and water for homes and industry, petroleum products for the wheels of America and chemicals for industry.

Today, North Systems are at work on land, sea and in the air as integral cogs in our vast transportation network.

Today, North Systems make possible high speed data processing complexes functioning through highly efficient switching centrals.

Today, North Systems automate production tools and production lines, handle packaging and pricing chores, perform scientific testing, measuring, weighing and analysis, and hosts of similar functions.

Today, North Systems help BMEWS guard our frontiers, add to our missile capability in projects THOR and JUPITER and help keep our nation safe and strong in many other defense programs.

At North Electric, the engineering team represents a cadre of professional competence with the solid background that comes from long experience in the application of system concepts.

To learn what North can do for you, systemwise, today and tomorrow, write for your copy of "North System Concepts" booklet—now.

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

642 S. Market St. *Galion, Ohio*

NORTH

Earnings Reports Show Upturn

MINNESOTA MINING & MANUFACTURING reports 1959 consolidated sales of about $445 million. These figures are described as preliminary in advance of a final audited sales figure slated for public disclosure early next month. The $445 million figure represents an increase of about $69 million, or 18 percent, over 1958's sales of $376,293,016.

• **Television-Electronics Fund** shareholders approved a two-for-one stock split at the 12th annual meeting last week in Chicago. This is the second split in the fund's history, the last being made in 1954. A quarterly dividend of 8 cents a share was also voted.

• Stockholders of **Packard-Bell Electronics,** Los Angeles, were told to "expect a boom year" for 1960 by company president Robert S. Bell. The firm established a new sales record of $46,608,062 for fiscal 1959, some 24 percent higher than last year's figure of $37,371,081. After-tax profit was $1,375,346, up 37.2 percent from last year's $1,002,594. A two-percent stock dividend as well as the regular quarterly cash dividend of 12½ cents was also announced.

• **General Electronic Control, Inc.,** Minneapolis, reports entry into an agreement to purchase all assets of **Minnesota Engineering Co.,** in the same city. Purchase is contingent on approval of GEC stockholders. Minnesota Engineering, which employs about 200 engineers, scientists and technicians is engaged in the field of automation for industrial applications.

• **Crane Co.,** Chicago manufacturer of plumbing equipment reports purchase of the business and assets of the **Swarthout Co.,** Cleveland, Ohio, which will operate as a subsidiary of the Chicago plumbing firm. Reason for the acquisition is based on Crane's wish to enter the fields of automation and automatic valving. Swarthout is a manufacturer of fully electronic process control equipment for petroleum, chemical, metal and other industrial process industries.

• **International Business Machines** announces preliminary gross income figure of $1,309,788,307 for 1959 as compared with $1,171,788,199 in 1958. Net income for 1959 amounted to $145,633,212 after taxes, or $7.97 a share on 18,268,943 shares outstanding. Same figure for the year preceding was $126,191,858, equal to $6.93 a share on a similar number of shares outstanding. A percentage of 12.4 of net income was derived from direct sales of equipment to customers who had been leasing during the 1958 period. Net income from this source in 1959 was reported to be substantially lower.

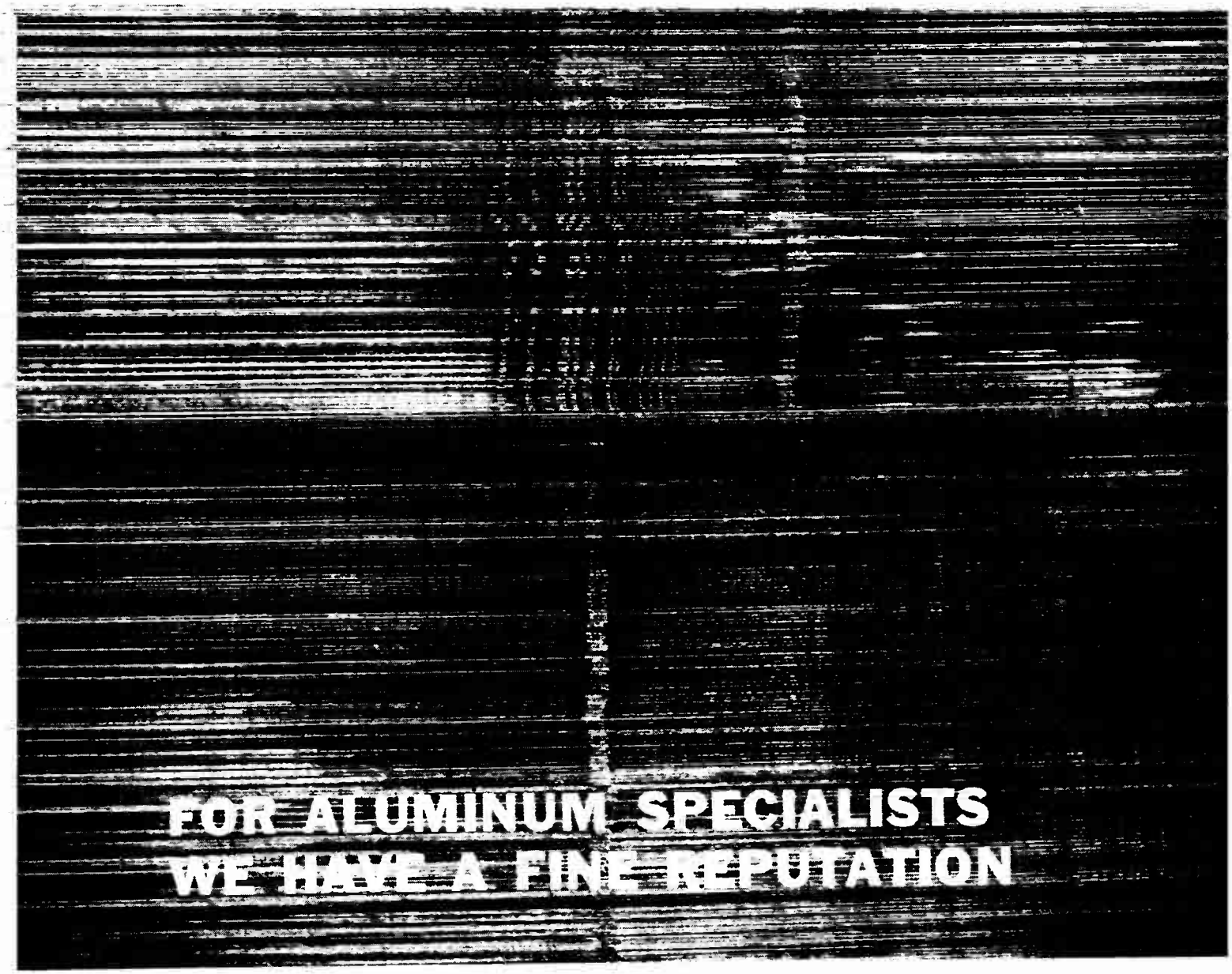
• **Gertsch Products,** Los Angeles manufacturer of precision electronic instruments reports sales of $1,355,742 for the six months ended Dec. 31, 1959, a 67 percent increase over the similar period of 1958's $810,950. Net earnings for the first half of fiscal 1960 were up 20 percent from 1958 to a total of $77,904, or 26 cents a share.

25 MOST ACTIVE STOCKS

WEEK ENDING JANUARY 22

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	848	24¼	23	23⅛
Gen Electric	777	93½	89¼	90⅜
Avco Corp	634	14⅜	13¾	13⅞
RCA	622	65¼	62	63¼
A. B. Du Mont	599	9⅞	8⅜	9⅞
Int'l Tel & Tel	538	37¾	35¼	37
Lear Inc	515	19	17⅛	18
Univ Control	487	17⅞	16⅝	17¼
Philco	467	32¼	30	31⅜
Raytheon	444	50⅝	48¼	48¼
Int'l Resistance	420	25⅛	22½	23½
Ampex	384	106	100	102½
Clarostat	318	14⅝	10½	11⅜
Gen Tel & Elec	312	82⅞	80⅛	80⅜
Gen Dynamics	305	51⅛	49¼	49⅞
Texas Inst	300	171	163¼	170¾
Varian	295	43⅝	40⅛	43½
Litton Ind	291	62⅝	60	62½
Beckman Inst	287	67¼	64	66¼
Reeves Sndcrft	285	10¾	9⅞	10½
Gen Transistor	283	25⅞	22½	24¼
Westinghouse	270	108	102⅝	103½
Burroughs	268	32⅛	30⅝	32⅛
Loral	261	44¾	40½	42¾
Collins Radio	259	63⅝	60¼	62¾

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



Progress in Systems packaging... for the Missile Age

There's a trend worth watching in America's missile program today.

It's aimed squarely at greater flexibility and reliability of ground support equipment . . . away from bulk, heaviness, immobility — more and more toward highly mobile support systems housed in lightweight, high-strength aluminum shelters and vans.

More mobility, more reliability, through smart ground support systems packaging — those are the targets.

That's why the top brass (both military and civilian) and Craig, are sitting together these days at the system planning stage.

For lightweight, high strength, all-weather shelters are precisely Craig's specialty. Not only does Craig develop and build shelters that are lighter, stronger, and pack more payload . . . but Craig engineers have the experience and capability to tie the entire package together . . . provide complete system integration.

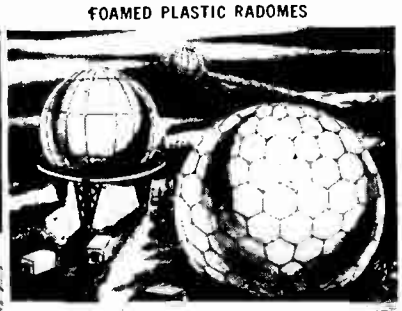
In short, Craig can wrap up the whole problem in one neat aluminum package.

CRAIG SERVES YOU IN ALL THESE WAYS:

- **Systems housing** — light weight, high-strength aluminum shelters, vans and trailers for mobile, transportable ground support and electronic systems.
- **Systems components** — including telescoping antenna masts, transit cases, spare parts boxes, equipment racks, and cabinets.
- **Systems installation service** — layout and installation of complete systems, through final checkout for maximum mobility and reliability. Includes all cabling, shock & vibration isolation,

ENGINEERING AND RESEARCH SERVICES

FOAMED PLASTIC RADOMES



AIR TRANSPORTABLE SHELTERS

MOBILE GROUND SUPPORT

. . . WITH BRASS

human engineering, environmental control, testing, and repackaging.

- **Systems packaging research** — engineering design and development for ground support and electronic equipment protection.
- **Complete production facilities** — all the manpower, all the tools, all the space required to handle the complete packaging assignment.
- **A unique "aluminum-chemical research" service** — a highly versatile "brainpower pool" for solving virtually any problem in aluminum and foamed plastic fabrication.

Craig's complete 16 page capabilities brochure will be sent on request. Write to Dept. E-1.

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360 MERRIMACK STREET, LAWRENCE, MASSACHUSETTS — Telephone Boston Capitol 7-7794

WASHINGTON, D. C., The LaSalle Suite 815 1028 Connecticut Ave., N. W. District 7-1575

DALLAS, TEXAS 6300 North Central Expressway EMerson 1-5522

LOS ANGELES 45, CALIFORNIA 6214 W. Manchester Ave. SPring 6-0025

Business systems and equipment are another Craig specialty through LeFebure Corporation, Cedar Rapids, Iowa — a Craig subsidiary

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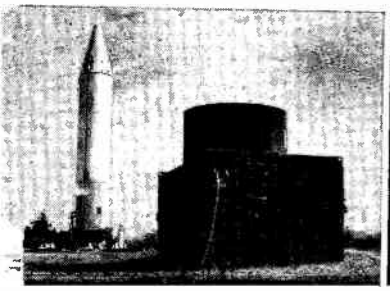
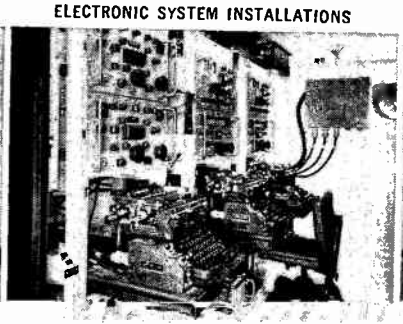
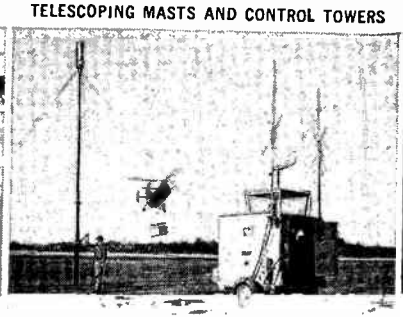
MISSILE SUPPORT



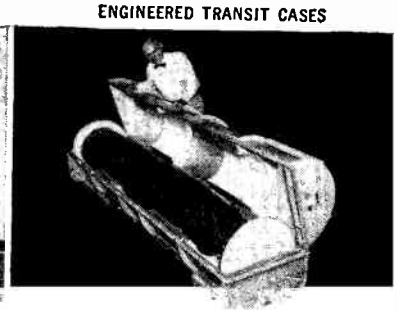
ELECTRONIC SYSTEM INSTALLATIONS



TELESCOPING MASTS AND CONTROL TOWERS

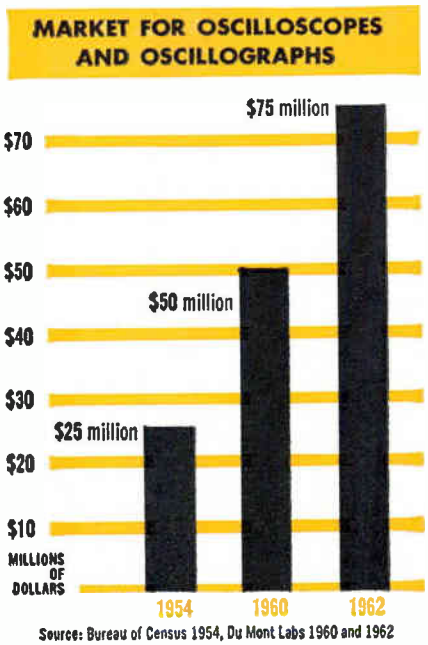


ENGINEERED TRANSIT CASES



MARKET RESEARCH

Scope and Graph Sales Rising



COMBINED oscilloscope and oscillograph market among both industrial and military customers will increase by 50 percent between 1960 and 1962, according to predictions from Allen B. Du Mont Labs.

The company estimates sales of the two instruments this year will total $50 million and predicts sales of about $75 million in 1962.

Last sales count of the two instruments by the government was in 1954 when Bureau of Census found sales totaling $25 million, including $7.1 million for **high** frequency scopes, designed **primarily** for radio testing, and $17.9 million for other types of oscilloscopes and oscillographs. Bureau will bring these figures closer to the present later this year when it releases results of the 1958 Census of Manufacturer.

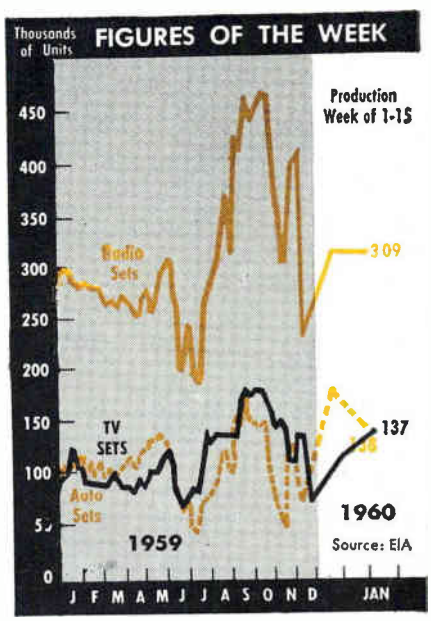
Du Mont's market estimates were made public along with the announcement of availability of its new high-speed, high-frequency oscilloscope, model 425. Basis of estimates was sounding of opinions of prospective oscilloscope customers made as part of the development program for the new product.

The $25 million gain of oscilloscope and oscillograph sales over 1960 which is foreseen by 1962 rests on normal sales growth expectations plus expectations of additional sales resulting from broadening of the scope market.

Key that will open the door to new markets is a direct-reading system (digital readout) incorporated in the new oscilloscope, claims Allen B. Du Mont, chairman of the electronics firm. It will enable untrained production line workers to accurately read the instrument, he says. Heretofore, oscilloscope use was limited to technicians and others with oscilloscope training.

Petrochemicals, textiles, machinery manufacture and metal working are among the new industries expected to find use for the scopes in manufacturing and quality control work. Data handling and statistical analysis are two other applications regarded with promise.

• Sales of color tv receivers are running much better than originally estimated reports James K. Toney, vice president RCA Victor Television Products.



LATEST MONTHLY SALES TOTALS

(Source: EIA)
(Add 000)

	Nov. 1959	Oct. 1959	Change From One Year Ago
Rec. Tubes, Value	$31,600	$35,527	+ 5.8%
Rec. Tubes, Units	37,211	42,680	+ 4.5%
Pic. Tubes, Value	$16,059	19,307	+ 7.0%
Pic. Tubes, Units	840	1,007	+ 6.4%
Transistors, Value	$22,743	$22,110	+82.8%
Transistors, Units	7,847	8,711	+44.2%

AUTOGRAF • AUTOGRAF • AUTOGRAF

Every feature you've ever wanted, now yours with this

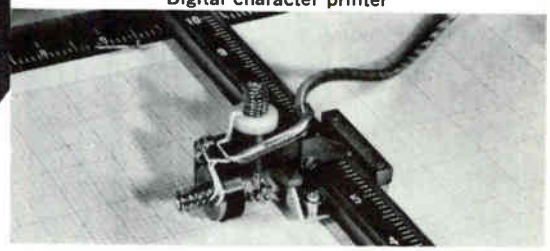
NEW MOSELEY X-Y RECORDER

- New, integral AC/DC input
- No extra AC converter to buy
- Built-in X-axis time base
- Operates direct from transducer
- Accuracy, resolution ± 0.25%
- Local or remote operation

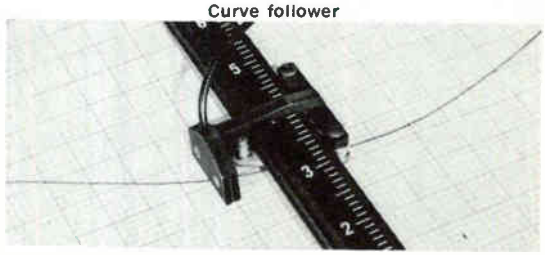
and look at the broader utility you get with these precision Moseley accessories

NEW MODEL 2D

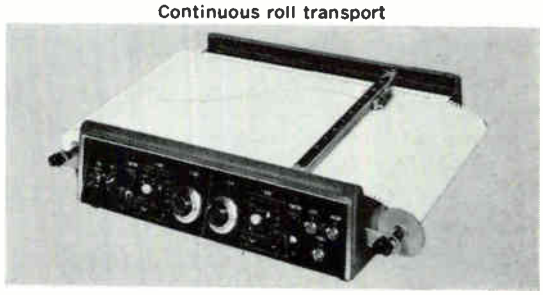
Digital character printer



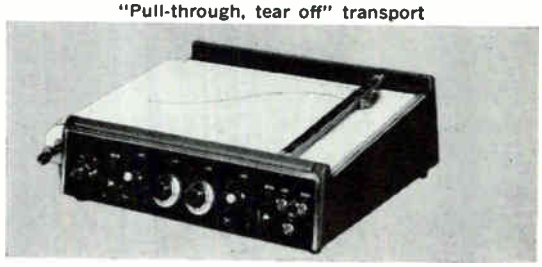
Curve follower



Continuous roll transport



"Pull-through, tear off" transport



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Over-Horizon Radar's Role in Defense

Navy's Project Madre will plug East and West Coast gaps in defense against submarine-launched missiles. Uses autocorrelation circuits

PULSED HIGH-FREQUENCY ENERGY is being suggested by the Naval Research Laboratory for an over-the-horizon radar system for early warning against missile launchings from submarines.

NRL's Madre—for "magnetic-drum receiving equipment"—employs some sophisticated techniques, including autocorrelating circuits which use a magnetic-drum record of the transmitted pulse to correlate successive echoes. This reduces the power requirements of the system, and at the same time makes it possible to use the echo return for doppler analysis to derive target velocity information.

System Details

Engineers associated with the Madre project refuse to discuss the system, which is still in the pre-prototype stage. NRL emphasizes that a $4-million engineering test model is only now under construction near Chesapeake Beach, Md., and that this system will have to undergo rigorous testing and evaluation before it will be perfected for use. The Chesapeake Beach research model is scheduled for completion this fall; when finished, it will be capable of covering the North Atlantic from the Azores to Nova Scotia.

Madre is a short-wave system operating in the h-f spectrum, from 3 to 30 megacycles (100 to 10 meters). It puts out 100 kw of average power, sending out 100-microsecond pulses spaced at 180 per second. Peak power is about 5,000 kw.

The antenna system consists of two big inverted-V current-fed radiators mounted on a 330-by-150-ft steel frame. The radiators are fed alternately to provide azimuth data.

The system will use single-skip propagation. At the peak powers to be employed, short-wave signals travelling over water reach 500 to 1,000 miles on the ground wave alone. One-skip bounce transmission will carry the signal to the 1,000-to-2,600-mile range reported for the system—if the right frequency is used and the atmosphere and ionosphere are in good shape.

For a given angle of incidence, skip distance is less for the lower frequencies than for the higher ones. Ideally, the system would beam its main lobe at the ionosphere at an angle that would bring the bounce back to the earth's surface just where the ground wave fades. In order to change the angle, either the frame would have to be tilted or the angle between the two quarter-wave legs of the antenna radiator would have to be variable.

Drum Correlator

Returned echo trains will be recorded on a sensitive magnetic drum for correlation. The Madre system is unusual in employing a drum as the storage device for coherent correlation; electroacoustic delay lines have been widely used heretofore.

Advanced concepts of the information theory find use in the system. The 100-microsecond pulse provides a hefty return and enough doppler-shift data to make accurate velocity determination possible.

The Madre autocorrelator compares quantized values randomly sampled from successive returned echo trains to find echoes buried in the noise. Sophisticated techniques from the pulse doppler technology are used to derive extremely accurate velocity data.

The fairly low frequency range in which the system is designed to operate reduces its range discrimination to about 10 miles and its angular discrimination to several degrees. But the pulse-doppler measurement techniques make the system sensitive even to varying speeds among aircraft flying in close formation.

General Electric's heavy military electronics department designed the drum correlator system, and developed the random-sampling process to work with the drum recording. Sampled echo trains representing the last 20 seconds of history are maintained on the drum for continuous correlation. The sampling system is compatible with coherent moving-target detection, and makes it possible to use digital techniques for computing velocity data.

Ten-Year Development

Madre has been under development for ten years or so. An ex-

perimental unit operating on the NRL grounds in the District of Columbia has picked up missiles lofting from Cape Canaveral, Fla., some 700 miles away.

The system will probably be most useful for plugging up the ocean-side gaps in our missile-defense curtain. The system's ability to cover the ocean from sea level up makes it useful in detecting low-flying aircraft coming in over the water. It is significant in this regard that the Air Force has reportedly funded part of Madre's development cost.

Over sea water—as experiments by NRL's Hoyt Taylor and others demonstrated as early as the mid-'20s—skip transmissions suffer less attenuation than they do over land. A thousand miles from the transmitter, signals are frequently as strong as at 75 miles.

Signals tend to be steadier over water, too, and to depart less frequently and less violently from normal values. This may be due to the homogeneity of the ionosphere over the smoother sea surface, or to the smooth surface itself, or to both.

The Madre system suffers from the familiar problems of short-wave skip transmission, including diurnal and seasonal dips in signal strength. On 4.5 mc, for instance, there is usually a bad blackout around noon anywhere in the mid-Atlantic during the fall.

Tepee

Another NRL project, related to Madre, is project Tepee. The Tepee project was aimed at the detection of both missile launchings and nuclear explosions. Like Madre, the equipment operates in the meter-length wave bands and relies on ionospheric bounce.

The two systems differ in that Tepee uses several bounces, and also in that its echo would be returned from the ionized missile trail, or from the ionized cloud which is a byproduct of a nuclear explosion.

Many government research men share doubts about the effectiveness of Tepee-type detection systems at ranges of 1,000 miles or more. So far, Madre has not evoked equivalent doubts.

Mushrooming class D users like this Connecticut oil tanker driver may be looked to in new industry self-policing effort

Industry to Police Class D

SELF-POLICING by industries, much in the news recently, has come with particular significance to the class D Citizens Radio service.

Manufacturers, under heavy fire from Washington and from other spectrum users, have begun on their own to investigate the problems and abuses that have come to plague the class D band. This is now being done on a voluntary basis by nearly a dozen companies with hopes that others will join in.

Originators of the idea were Kaar Engineering Co., San Diego, Calif., and Vocaline Co. of America, Old Saybrook, Conn. Meeting at the invitation of these two companies, nine other manufacturers assembled during the recently concluded Motor Boat Show in New York and participated in a series of discussions on the problems of class D. Also attending were representatives of the Federal Communications Commission, the Electronics Industries Association and marine hobby groups.

Emerging from the discussion is a plan to urge all class D radio manufacturers selling to marine users to provide equipment operating on one of two channels. Selected for this purpose were channels 9 (27.115 mc.) and 13 (27.065 mc). This choice was made in the belief that these two frequencies are best suited to operations in coastal and lake regions.

If this plan to stratify class D users works for the marine licensees, plans are to extend the program into other user groups such as truckers, public utilities and others. Ultimate aim of the group is to have each of the 22 slots set aside on a voluntary basis for a given category of user.

Speaking for the manufacturers, Edward Manville of Vocaline told ELECTRONICS that companies represented at the meeting have pledged their support for the marine phase of the program.

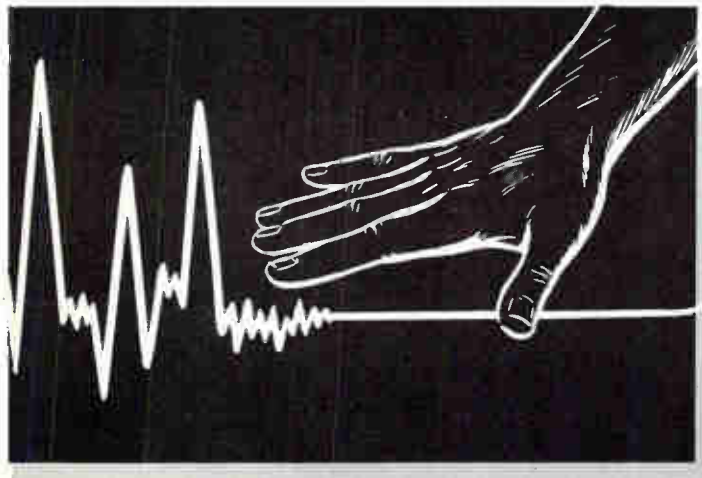
Companies now involved are: Acton Labs., Apelco, Globe, Ray Jefferson Inc., E. F. Johnson Co., Kaar, Multi-Products, RCA, Raytheon, Rowe Industries and Vocaline.

Policing Begins

Action this week centers around mailing and educational campaigns aimed at both manufacturers and users. Pleasurecraft owners will be urged to adopt the terminology "non-commercial" rather than "pleasure." This is being done in the hope that a serious attitude toward spectrum use will come about.

Another avenue being pursued is a cleanup on descriptive literature. The aim here will be to end what one manufacturer feels is a failure by some makers and distributors to explain clearly the differences between amateur and class D bands.

A study is now being planned by the FCC to spell out distance and time limitations for class D. The Commission is currently receiving 6,000 to 7,000 applications a month.



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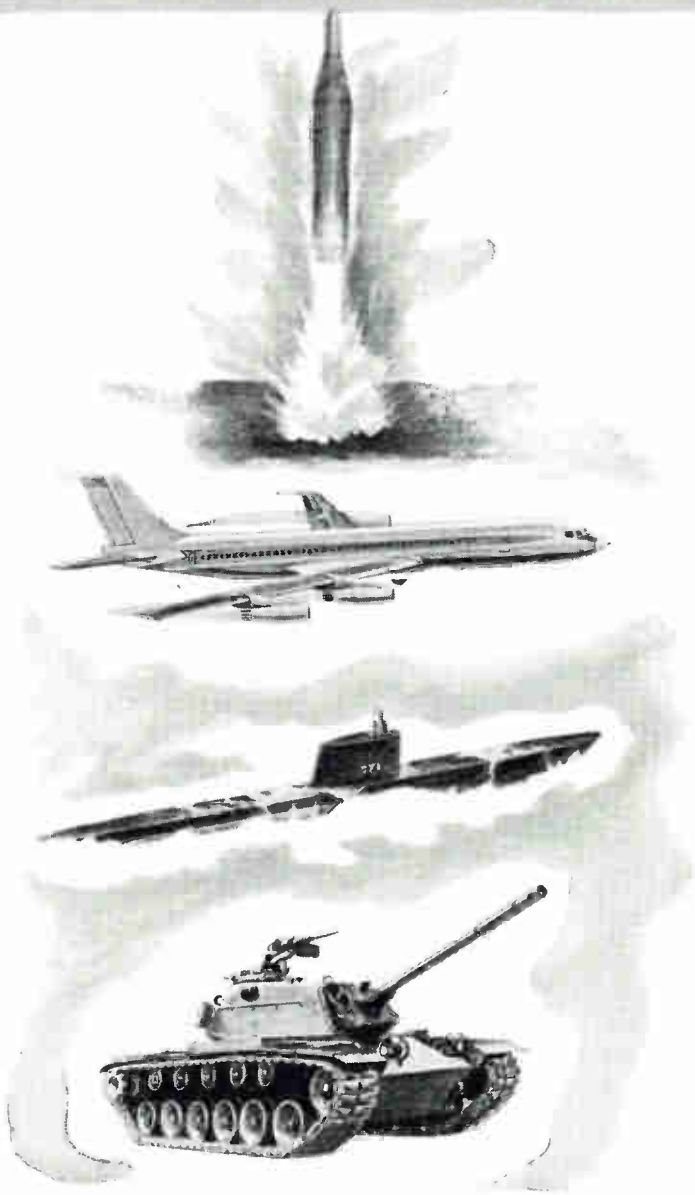

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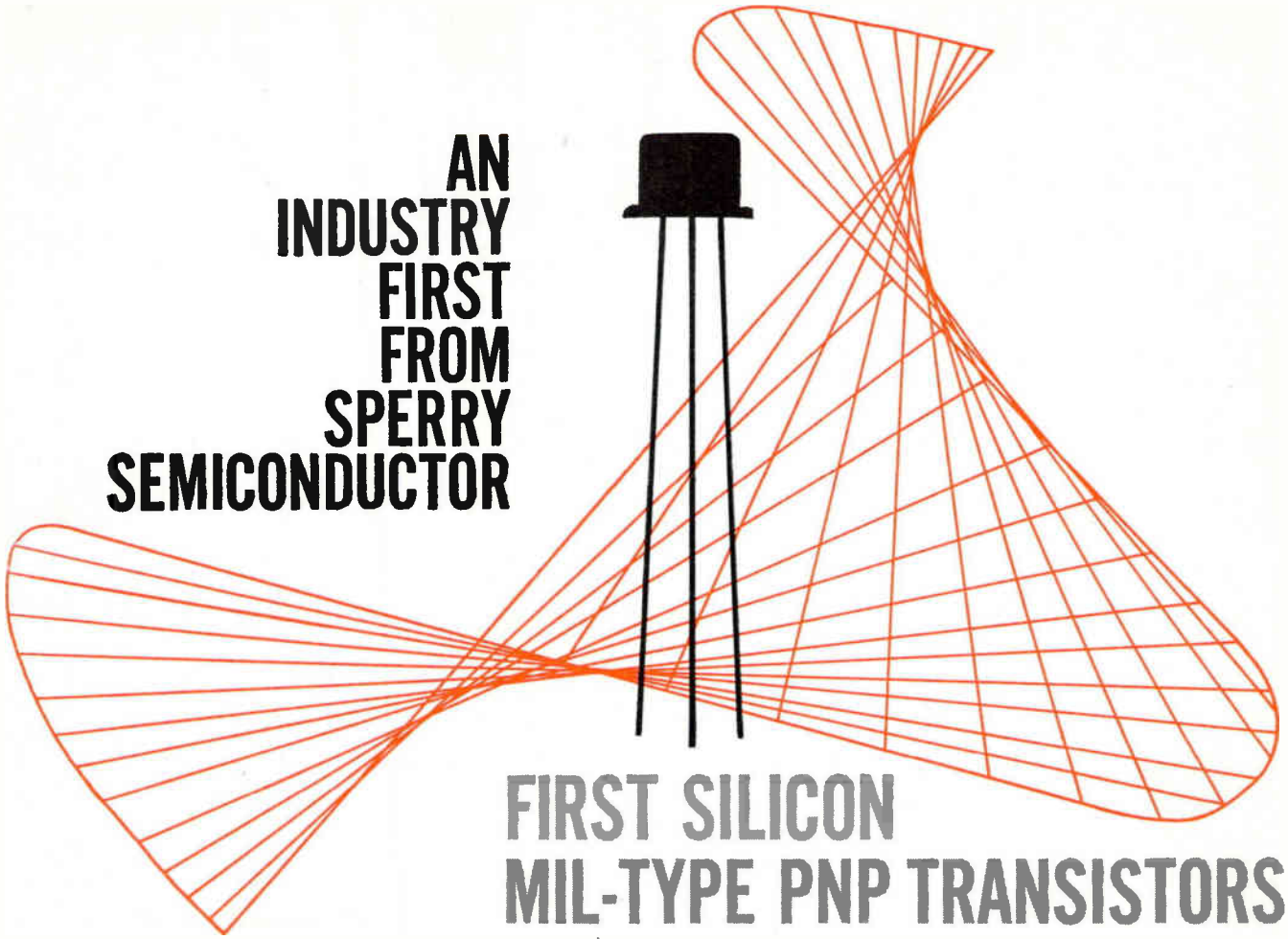

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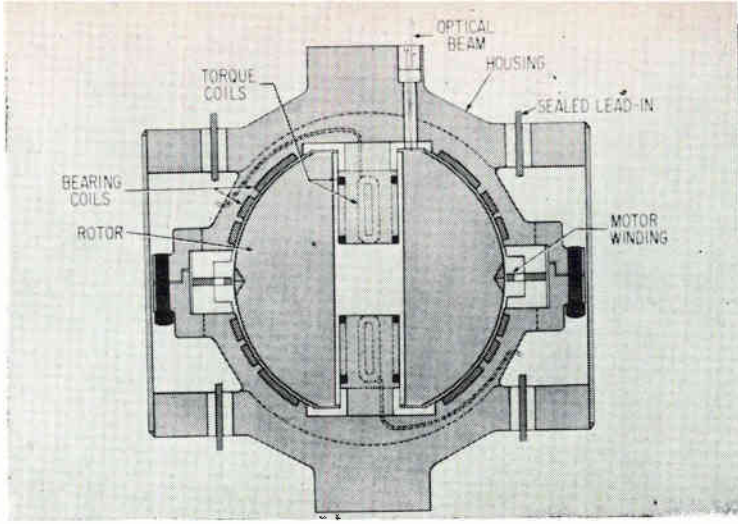
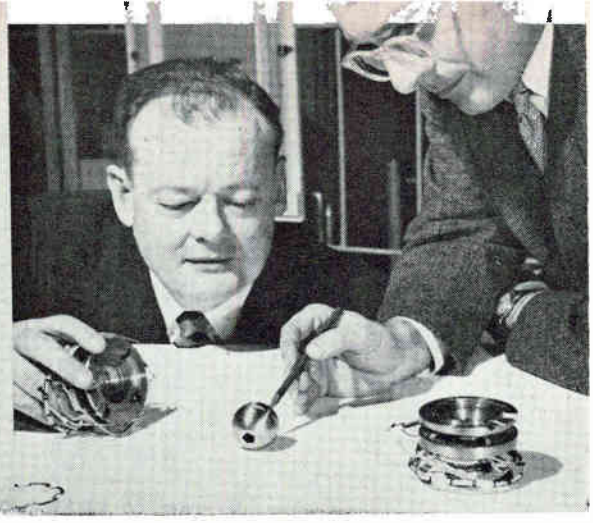


Cutaway of cryogenic gyroscope being developed at General Electric shows design features. Spherical rotor, which floats in magnetic field, is about 4 cm in diameter



GE engineers point out gyro rotor and housing. In operation, entire gyro structure will be at liquid helium temperature (4.2 degrees above absolute zero)

Cryogenic Devices on the Way

Sparked by the broad capabilities inherent in low-temperature devices, many laboratories are pushing cryogenic engineering

CRYOGENIC GYROSCOPE under development at General Electric's engineering laboratory (ELECTRONICS, p 11, Jan. 29) points up the rapid advances being made in applying low-temperature phenomena to the development of electronic devices.

The new GE gyro, which operates at the temperature of liquid helium, promises to be an order of magnitude more accurate and more reliable than conventional gyroscopes. GE scientists say a low drift rate is obtainable with a cryogenic gyro because it is relatively free of friction effects, is dimensionally stable, and has practically no losses.

The scientists add that, because of the low drift rate, the gyroscope would need only one correction for drift on a trip to Venus, where a conventional gyro would require at least three.

Floating Rotor

Phenomenon responsible for the operation of the cryogenic gyro is that superconductors repel magnetic fields up to certain critical field strengths. A magnetic field is set up in the bearing coils embedded in the gyro housing (see cut); the field will maintain itself indefinitely as long as the housing is kept at about 4.2 K, the temperature of liquid helium. The superconductive rotor floats free of the housing, supported solely by the magnetic field. The only friction force present is caused by the imperfectness of the vacuum.

According to details released by GE, work on the superconductive gyro began in the summer of 1958 under a $214,000 first-phase contract from the Army. GE proved the gyro's feasibility by developing a motor with a thin-shell cylindrical rotor supported in a vacuum solely by a magnetic field. This rotor was spun up to 20,000 rpm; coastdown time was reportedly 16 hours. Ultimate coastdown time has not yet been determined, but it is estimated that a rotor might be made to spin freely for months, possibly for years.

Final configuration of the gyro is not yet fixed, and there are still severe problems in materials and design to be solved. The gyroscope will require an extremely high vacuum, on the order of 10^{-6} or 10^{-7} millimeters of mercury. Isolation methods must be found to maintain the extremely low temperature with minimum cooling system. A way of making the rotor accurately spherical must be devised.

Despite these problems, GE expects to have a prototype in operation by the end of the year. Final development, scientists feel, is still a few years away.

Superconductivity

The remarkable material changes associated with extremely low temperatures have been known for a long time. Superconductivity, the abrupt disappearance of electrical resistance in some metals and alloys, was first observed in 1911 by H. K. Onnes; the expulsion of magnetic fields by superconductors was discovered in 1933 by Meissner and Ochsenfeld. But exploitation of these phenomena has been hampered by the difficulty—and costliness—of producing and maintaining temperatures near absolute zero, the point at which all molecular activity theoretically ceases.

As late as 1940, for example, there were only about a dozen installations in the world for liquefying helium. The boiling point of helium, 4.2 K, is the lowest of any gas and makes helium the most useful gas for cryogenic work.

Recent interest in the cryogenic phenomena has resulted in a pronounced increase in the number of low-temperature laboratories, and

has stimulated the development of new insulating materials and less costly cryostats—the devices used to achieve low temperatures.

New Developments

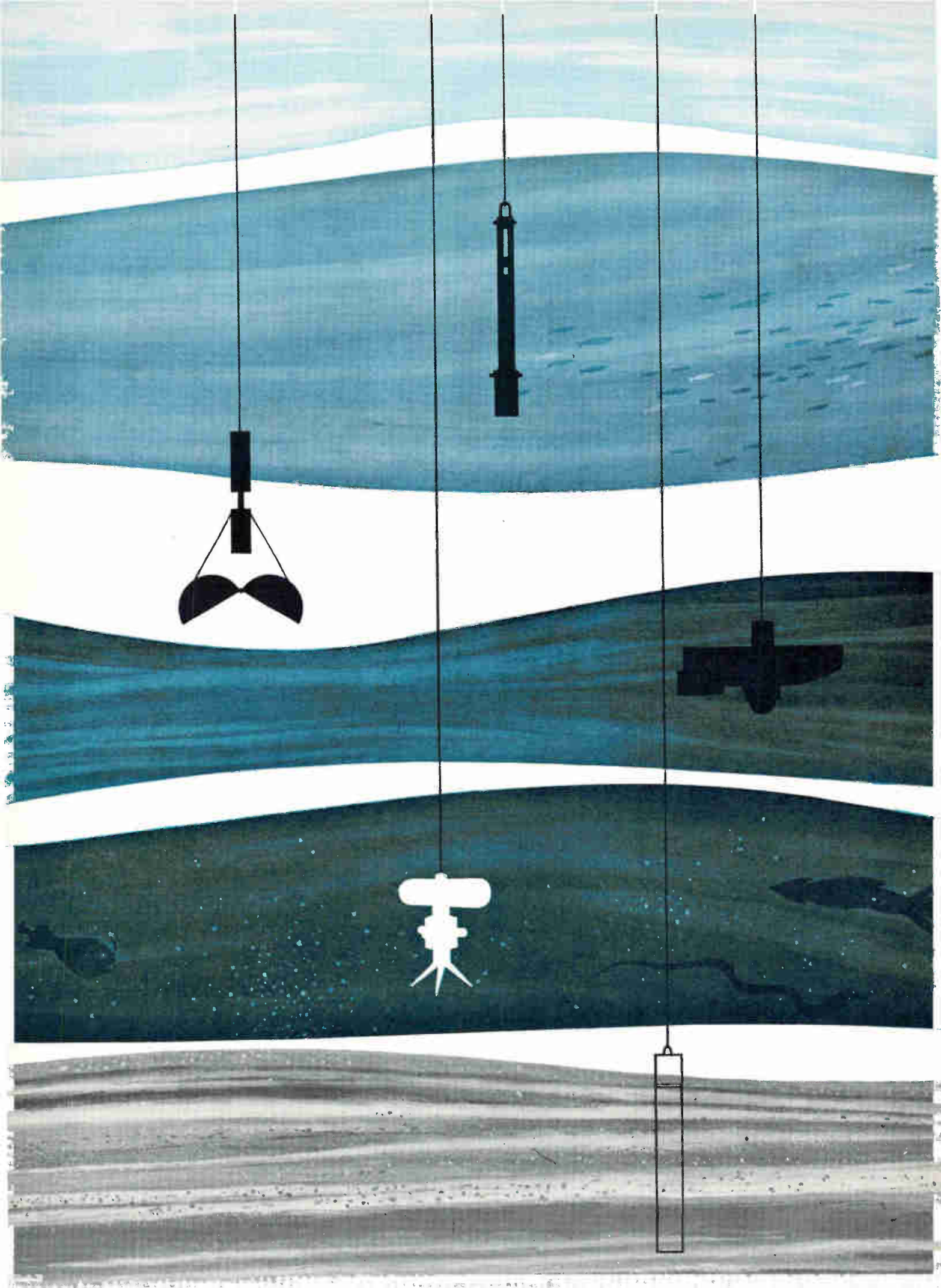
Many manufacturers and development laboratories now have cryogenic facilities and are conducting research into new applications of superconductivity. Cal Tech's Jet Propulsion lab is also working on a superconductive gyro. A. D. Little is active in basic cryogenic research and has contributed substantially to the development of inexpensive cryostats.

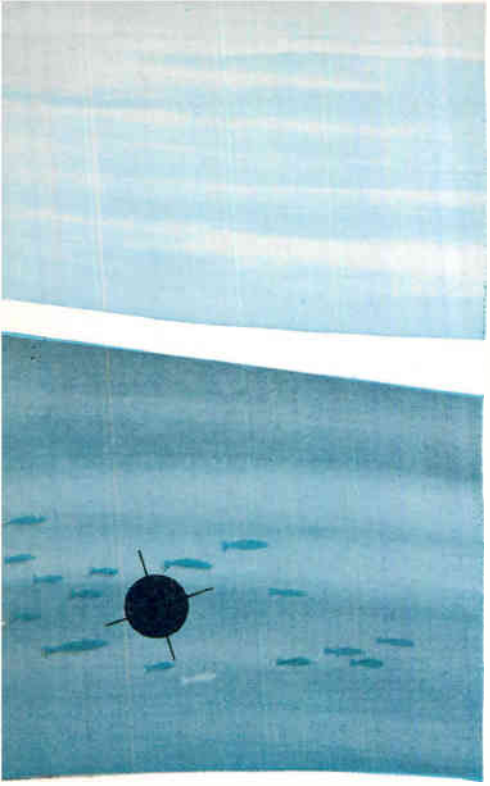
Applications for superconductors loom especially large in the computer field. The abruptness with which superconductors shift from resistive to nonresistive states, and the ability of these materials to circulate currents indefinitely, makes them doubly useful as components for high-speed switchgear and memory systems. Such systems could be small in size and require relatively little power. MIT's Lincoln Laboratory has devised cryogenic circuits for computers, as has IBM. (See "Components of a 100-mc Computer," Components & Materials, p 66, ELECTRONICS July 10 '59, and "Computers Head for 1,000-mc Operation," p 55, ELECTRONICS, Jan. 29.)

Also under development are d-c to a-c amplifiers with no zero drift and no noise, and highly sensitive missile-tracking equipment.

An exciting possibility for use of cryogenics, still in the distant future, is an electron microscope that might give man his first view of an atom. Since superconductors repel magnetic fields, an arrangement of superconductors could be devised to shape a series of magnetic lenses. Such lenses would have less lens error and greater resolving power than present electron microscopes.

Even with recent advances, however, cryogenic devices retain one basic disadvantage: any cryogenic device requires a sizable cooling system. For laboratories, land vehicles such as tanks, and submarines, this is not necessarily a major disadvantage; but for rockets and missiles in which launch weight is a critical factor, the additional burden of the cooling system might be phohibitive.

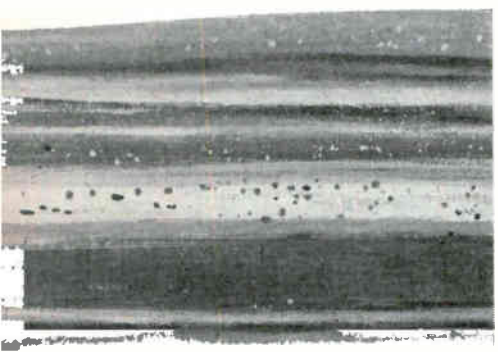




Lockheed's interest in the virtually unknown 360,000,000 cubic miles of this planet's oceans, stems naturally out of its underwater environmental development work with the Navy's POLARIS Fleet Ballistic Missile.

Proposed studies in the increasingly important field of oceanography include: oceanographic research vessels; measuring instruments; data collection systems; underwater communication and navigation; and basic research regarding natural phenomena and military aspects of the deep sea.

EXPLORING THE WORLD OF WATER



Division Diversification— Oceanography is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetodynamics; man in space; materials and processes; applied mathematics; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space communications; space medicine; space navigation; and space physics.

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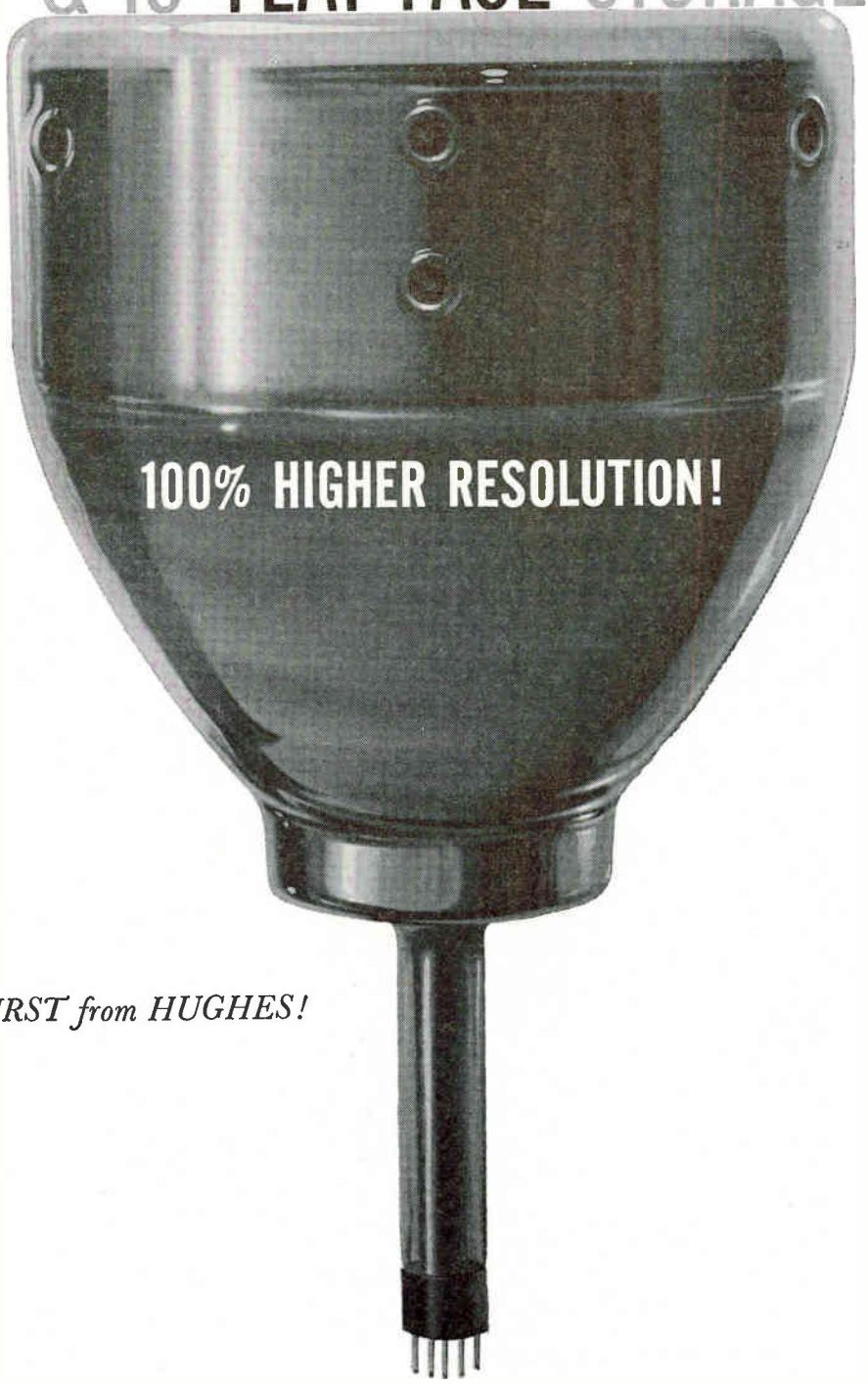

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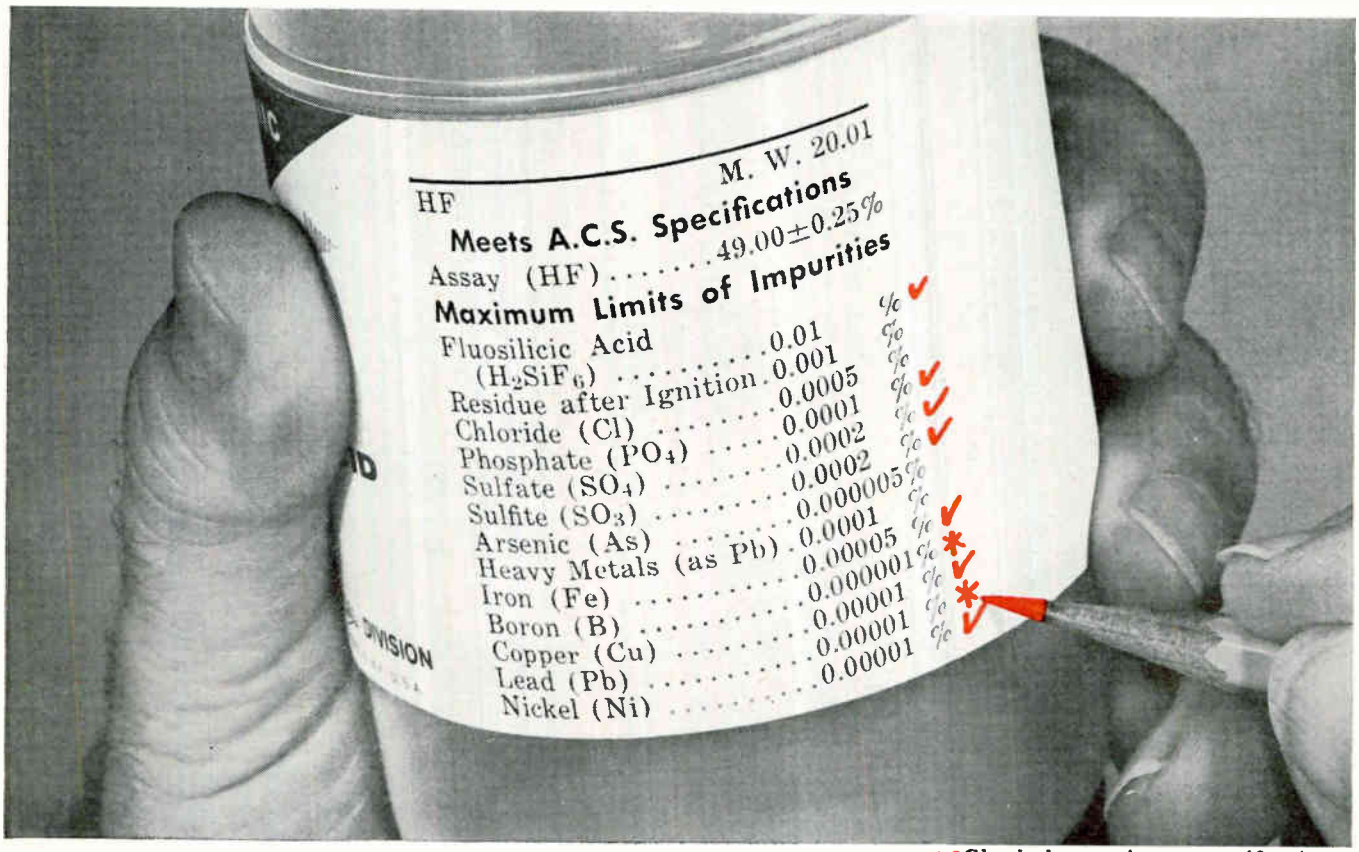

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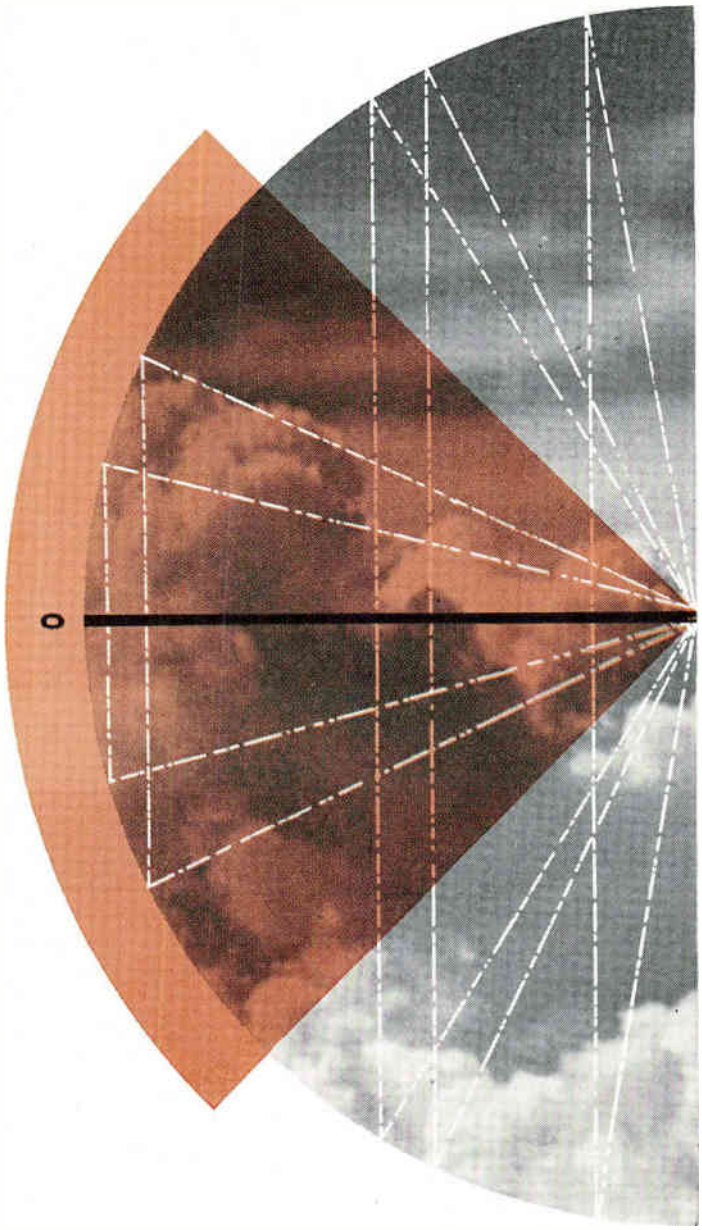

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Entertainment Market Growing

Manufacturers expect continued increase in sales of tv and audio equipment. Remote tuners and stereo speakers are seen as sales spur

SALES in the entertainment electronics field promise to be brisk this year with all indications that competition will be keener than ever.

Estimated 1959 sales by manufacturers of 6.3 million tv sets, 4.3 million phonographs and 15.4 million radios, all far exceed 1959 performance. Forecast is for further increases in 1960.

A check of sales officials shows that little is being done to promote color television receivers. As in past years, the main effort will be made by RCA. Programming in color will continue at about the same level as during 1959.

In contrast, however, to the lack of emphasis on color sets, tv manufacturers appear to be solidly behind sales campaigns for 23-in. and 19-in. black-and-white receivers. They are banking heavily on a new design featuring a square display face which eliminates the rounded corners now obscuring a part of the picture. This development centers around new design possibilities relying on recent developments in glass bonding.

Enthusiasm for remote control devices for tv receivers as sales boosters is running high. In many lines, the remote control features were introduced about a year ago. Sales people say that enough time has elapsed to guarantee a fairly high level of consumer demand for the remote control devices.

Also providing a spur to sales is consumer interest in lightweight sets which can be carried from room to room. H. R. Seelen, Manager of RCA's Kinescope Operations, calls this a key factor in the upward trend in picture tube sales —from 12 million in 1958 to more than 13 million last year. The same trend is expected for 1960.

Stereo: A Battleground

"Confusion confounded is the essence of the stereo business today," according to a spokesman for one major manufacturer. Lack of industry acceptance of universal standards in production and technology is a major complaint. Although standards have been formulated, the large number of firms marketing and manufacturing audio equipment makes policing very difficult. One frequently expressed sentiment is that more effort should be made by manufacturers to educate consumers.

In the sales picture, fierce competition appears to be centering about remote speakers. Biggest sales push appears to be on shelf-sized units designed for location about six to eight feet from the main amplifier unit.

Package stereo manufacturers are offering a wide variety of styling and size in separated tweeters. Attention to audio equipment as furniture appears to be even more intense than in previous years. Highly polished hardwood cabinets are in evidence in all lines.

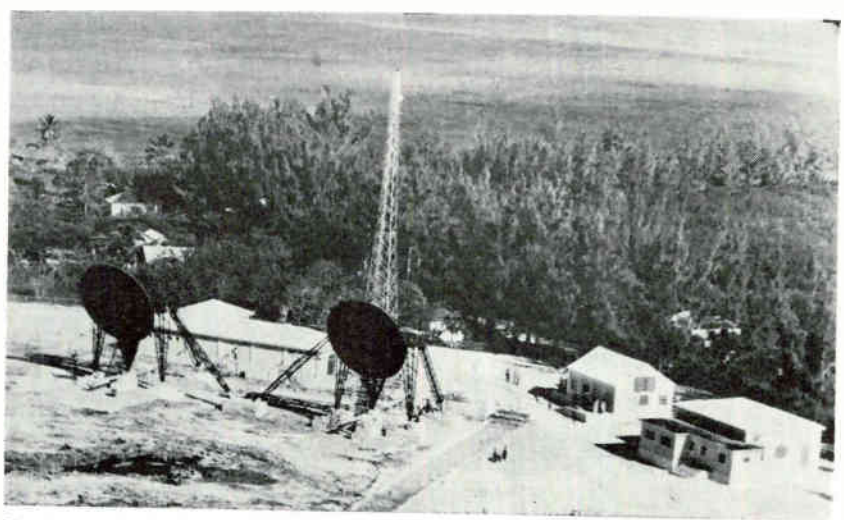
What's Ahead

Some indication of the shape of things to come was evident at last month's Home Furnishings Show held in Chicago's Merchandise Mart.

Still in the experimental stage, but of great interest to showgoers was Westinghouse's demonstation of a three-dimensional television picture with stereophonic sound. A combination of optics and electronics was used to give a picture of the type obtained with stereoscopic photographs while the sound was produced stereophonically to "follow" the picture.

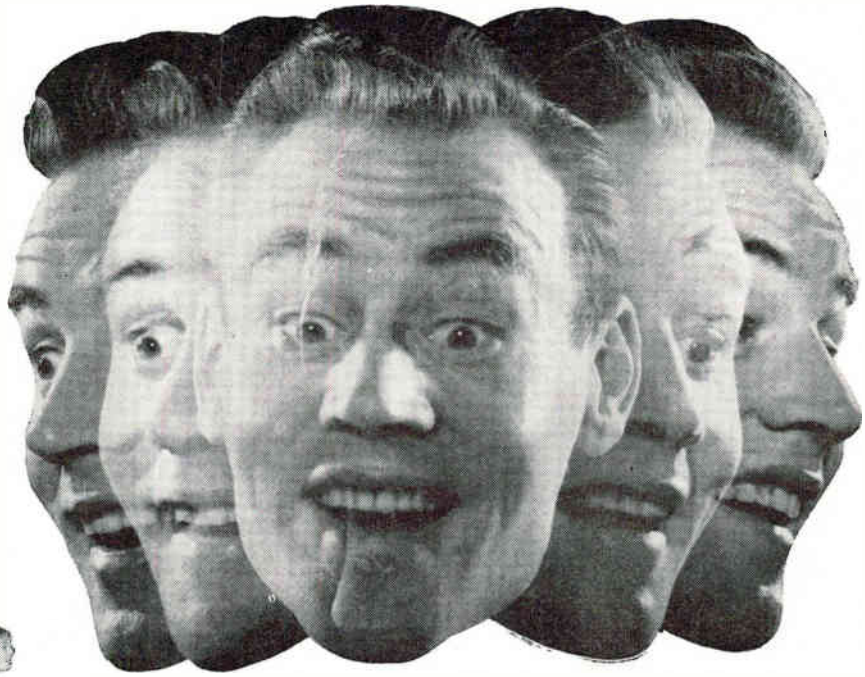
Another item displayed in Chicago was a two-band (short-wave and portable a-m) radio. The nine-transistor model, ordinarily powered by six flashlight batteries is operated by a rechargeable nickel-cadmium nine-volt cell. A cadmium-sulfide radiation detector is built into the unit to produce a raucous sound through the radio amplifier when exposed to radiation exceeding half a roentgen per hour. The two-band radio is equipped with a hand-powered generator for operation in case of battery failure. Operating life of the nickel-cadmium battery is eight hours.

New Tropo Link to the Bahamas



Nassau terminus of 186-mile over-the-horizon system, a joint project of AT&T and the Telecommunications Dept. of the Bahamas government. Linked with Florida City, Fla., the new system can carry 24 simultaneous telephone conversations. Total cost was $1½ million

The new concept of electronic equipment manufacture



A new philosophy:

Made for everyday use

Wide range available

Modern techniques

Flow production

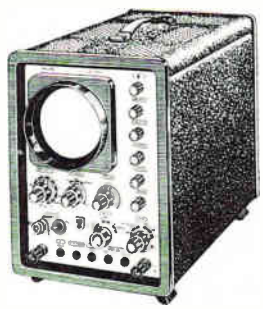
Automatic inspection *

Easy servicing

* An outstanding virtue of the new Philips electronic measuring tools for industry is that they give uniformily reliable and accurate results. Flow production, automatic inspection, eliminating operator error, ensure that this is so. To uniform reliability, add robustness in hard daily use under normal workshop or laboratory conditions and simplicity of operation. The sum of all these virtues is an entirely new conception of. industrial electronic tools - by Philips, of course.

GM 5601
High Frequency Oscilloscope

Cathode Ray Tube: DH 10-78
Flat faced 10 cm tube, EHT - 1.7 kV
Vertical Amplifier: 0 - 5 Mc/s (- 3 ± 1/2 dB)
Sensitivity 100 mV/cm,
Calibration accuracy 3%
Time Base: 0.5 μsec/cm - 200 msec/cm
Calibration accuracy 5%
Horizontal magnification up to x 5
Internal trigger facilities up to 5 Mc/s



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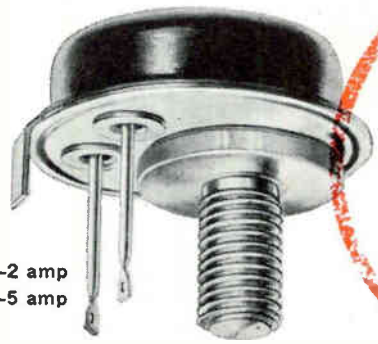
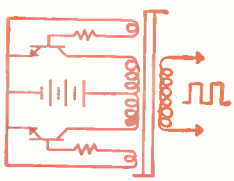


2N1015—2 amp
2N1016—5 amp

PROVED PERFORMANCE IN
- Inverters
- Series Regulators
- A.C. Amplifiers

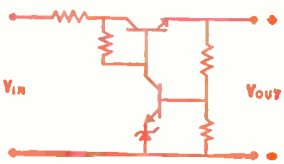
Westinghouse 2N1015 and 2N1016 Silicon Power Transistors offer positive, *proved* benefits to designers of inverters, series regulators, and A.C. Amplifiers.

INVERTERS...



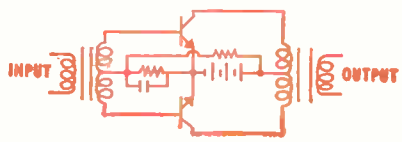
Extremely low saturation resistance (typical .3 ohms) minimizes power losses in the transistor. High temperature (150°C T_j max.) operation permits compact inverter designs for missiles, aircraft, and other military equipment.

SERIES REGULATORS



High voltage ratings and high temperature operation, plus internal power dissipation of 150 watts made possible by low thermal resistance of .7°C/watt make the 2N1015 and 2N1016 an ideal choice for constant voltage and constant current regulators.

A.C. AMPLIFIERS...

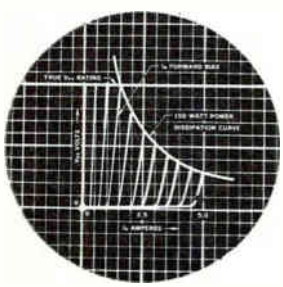


Perfect choice for high power audio and A.C. Amplifier applications, thanks to their high power dissipation capabilities and common emitter frequency response to 20KC.

PLUS TRUE VOLTAGE RATINGS...

guaranteed by 100% power testing. Means you can operate these transistors continuously at the V_{CE} listed for each rating without the risk of transistor failure.

Production quantities of Westinghouse Silicon Power Transistors are available in 2 and 5 ampere collector ratings. Both are available in 30, 60, 100, 150, and 200 volt ratings for immediate applications. Contact your local Westinghouse Apparatus Sales Office, or write directly to Westinghouse Electric Corp., Semiconductor Department, Youngwood, Penna.



*Designed to meet or exceed military specifications and currently being used in many military, industrial, and commercial applications.

Type	V_{CE}*	B (min)	R_S (max)	I_C A (max)	Tj max. operating	Thermal drop to case (max)
2N1015 2N1015A 2N1015B 2N1015C 2N1015D	30 60 100 150 200	10 @ I_C=2 amp	.75 ohms @ I_C=2 amp I_B=300 ma	7.5	150°C	.7°C/W
2N1016 2N1016A 2N1016B 2N1016C 2N1016D	30 60 100 150 200	10 @ I_C=5 amp	.50 ohms @ I_C=5 amp I_B=750 ma	7.5	150°C	.7°C/W

*TRUE voltage rating (The transistors can be operated continuously at the V_{CE} listed for each rating.)

YOU CAN BE SURE...IF IT'S Westinghouse

Missile Warning Gets

First submarine cable north of the Arctic Circle ties Greenland BMEWS site to mainland network

REARWARD COMMUNICATIONS for the Ballistic Missile Early Warning System (BMEWS) moved closer to readiness this week with the successful testing of a 700-mile undersea dual cable from the site in Thule, Greenland, to Cape Dyer on Canada's Baffin Island. This is the first undersea telephone cable above the Arctic Circle.

Carried out under the direction of the Western Electric Co.—responsible to the Air Force for the design, installation and testing of all rearward communications routes for the BMEWS project—the cable placing was handled by American Telephone and Telegraph. The first cable was laid in the summer of 1958 and its companion during August and September of 1959. Total cost was $9 million.

Similar in construction to existing transoceanic cables, amplifying repeaters using vacuum tubes with an estimated 20-year reliability are spaced at 40-mi intervals. The cable provides 36 channels.

Two BMEWS sites now under construction are located in Thule, Greenland and in Clear, Alaska. Construction on a third in the U. K. will begin soon. Rearward communication from all three to the North American Air Defense Command headquarters in Colorado Springs, Colo., will employ a number of independent techniques following various geographic routes. Complete fulltime reliability is necessary for BMEWS to fulfill its function: providing the continent with 15 or more minutes warning of a ballistic missile attack.

Other communications techniques used include low frequency radio, medium frequency, high frequency, microwave, ionospheric scatter,

Power plant (2,800 volts) supplies the repeaters in the undersea cable. Instrumentation displays voltage and current fluctuations, amount of voltage each plant is supplying

New Link

All messages pass through the distributing frame in the cable terminal building in Thule, Greenland, where they are terminated and rechanneled to other communications facilities

troposcatter, and leased commercial long lines.

Raw data from the more-than-2,000-mi-range radars at each site will feed into IBM 7090 computers. The missile's trajectory will be determined and the data transmitted via all existing communications systems to Colorado Springs. Another computer in headquarters converts the information to a visual type display.

Communications from Thule to Cape Dyer, Canada, over the cable is retransmitted to Colorado Springs by microwave, leased commercial long lines, and portions of the troposcatter link called Polevault, the first communications network built for DewLine.

The site in Clear, Alaska uses a civilian-owned undersea cable that runs out of Anchorage down the West Coast. Portions of the White Alice troposcatter system are used as well as microwave and leased commercial long lines.

Communications from the projected site in the U. K. to NORAD headquarters will use existing transatlantic cables as well as radio.

Land line links will terminate each of the three networks in Colorado Springs.

MEETINGS AHEAD

Feb. 3-5: Military Electronics, Winter Convention, Biltmore Hotel, Los Angeles.

Feb. 8: Stress Analysis, Soc. for Experimental Stress Analysis, Hotel New Yorker, N. Y. C.

Feb. 10-12: Solid-State Circuits Conf., AIEE, IRE, Univ. of Penn., Hotel Sheraton, Philadelphia.

Feb. 10-12: Cleveland Electronics Conf., ISA, IRE, AIEE, CPS, CIT and WRU, Cleveland Eng. & Scientific Center, Cleveland, O.

Feb. 11-13: Electronic Representatives Assoc., Annual Convention, Drake Hotel, Chicago.

Feb. 16-18: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Institute, Hilton Hotel, San Antonio, Tex.

Feb. 19-23: Component Parts and Electronic Tubes, International Exhibition, Porte de Versailles, Place Balard, Paris.

Feb. 25-26: Scintillation Counter Symposium, AIEE, AEC, IRE, NBS, Hotel Shoreham, Wash., D. C.

Mar. 17-18: Synchro Design and Testing Symposium, Bureau of Naval Weapons, Dept. of Navy, Dept. of Commerce Auditorium, Wash., D. C.

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

Mar. 24-25: Human Factors in Electronics, PGHF of IRE, contact J. E. Karlin, c/o Bell Telephone Laboratories, Murray Hill, N. J.

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

Apr. 11-13: Protective Relay Engineers, Annual, A. & M. College of Texas, College Station, Tex.

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

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

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 78.

TELECOMMUNICATIONS

Signal fires flaming across a network of some nine stations over a distance of sixty miles flashed the news of the fall of Troy to Agamemnon's palace at Mycenae. *Tele* in Greek means distance, and this—in 1194 B.C.—was *telecommunications.*

The newest and most advanced technique in telecommunications is the tropospheric scatter method using ultra high frequency signals which travel beyond the horizon, leap-frogging mountains, oceans, and other geographical barriers.

The development of tropo scatter equipment technique has been pioneered by Radio Engineering Laboratories, Inc. We at REL are responsible for the design and construction of the radio equipments for eight out of nine major tropo networks.

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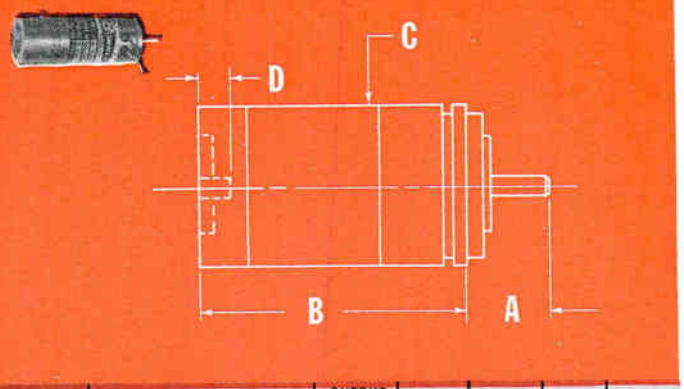
- **GEARHEADS**
- **SPEED REDUCERS**

Bowmar single-unit 2-speed gearchangers can reduce the weight and size of any control package or system which requires or which could be improved by multi-speed operation. Such systems typically include those which may benefit from fast slewing and slow zeroing. These Bowmar gearchangers permit extremely fast system dynamic response, plus slow fine-tune modes of operation which reduce inertial hunting effects.

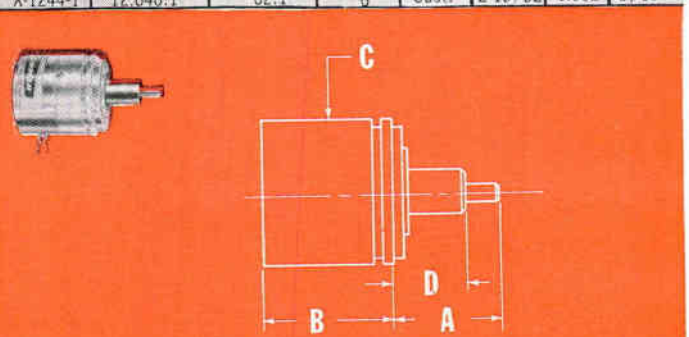
Scarely larger than a gearhead or speed reducer alone, Bowmar's new gearchangers are electrically operated and are completely self contained. They eliminate the need for outboard mechanisms, extra mounting plates and "accident prone" shifting complexes.

Bowmar produces these precision gear changers in sizes from 11 to 23, in all ratios and ratio differentials. Units shown are representative of a few Bowmar types.

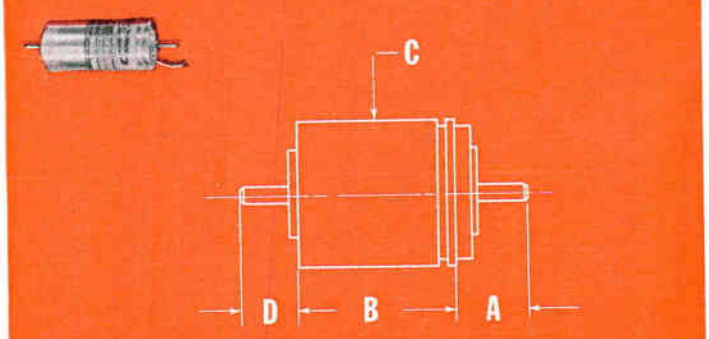
Send for Data Package 1159



PART NO.	RATIO ENERGIZED	RATIO DE-ENERGIZED	OUTPUT TORQUE (IN.-OZ.)	A	B	C	D
X- 801-1	36,600:1	20:1	6	3/8	3-11/32	1.437	9/16
X- 863-1	8:1	*1:1	3	7/16	2.000	1.062	7/16
X- 924-1	470,000:1	320:1	24	11/16	3-11/32	1.437	7/16
X- 989-3	42,978:1	26:1	5	5/8	2.450	1.062	7/16
X- 709-1	24,000:1	2,400:1	6	5/8	2.450	1.062	7/16
X- 740-1	10,000:1	100:1	6	11/16	2.376	1.437	7/16
X-1244-1	12,648:1	62:1	6	Cust.	2-19/32	1.062	9/16



PART NO.	RATIO ENERGIZED	RATIO DE-ENERGIZED	OUTPUT TORQUE (IN.-OZ.)	A	B	C	D
X- 637-1	6:1	*1:1	16	.860	*1.062	1.500	.563
X- 691-3	50:1	*1:1	10	1	2.058	1.750	5/8
X- 853-1	135:1	*1:1	5	1-3/32	1.994	1.437	23/32
X- 853-2	10:1	*1:1	5	1-3/32	1.994	1.437	23/32
X-1240-1	18,500:1	50:1	4	1.132	2.750	1.437	.632
X-1240-2	5,000:1	50:1	4	1.132	2.750	1.437	.632
X-1343-3	300:1	*1:1	4	1	1.750	1.437	9/16



PART NO.	RATIO ENERGIZED	RATIO DE-ENERGIZED	OUTPUT TORQUE (IN.-OZ.)	A	B	C	D
X- 748-1	36,600:1	20:1	4	1/2	2.215	1.062	15/32
X-1008-1	36:1	*1:1	8	11/16	1-17/32	1.437	9/16
X-1008-2	1,463:1	*1:1	8	11/16	1-17/32	1.437	9/16

**Running torque dependent upon input torque at least of equal value.*

BOWMAR INSTRUMENT CORPORATION

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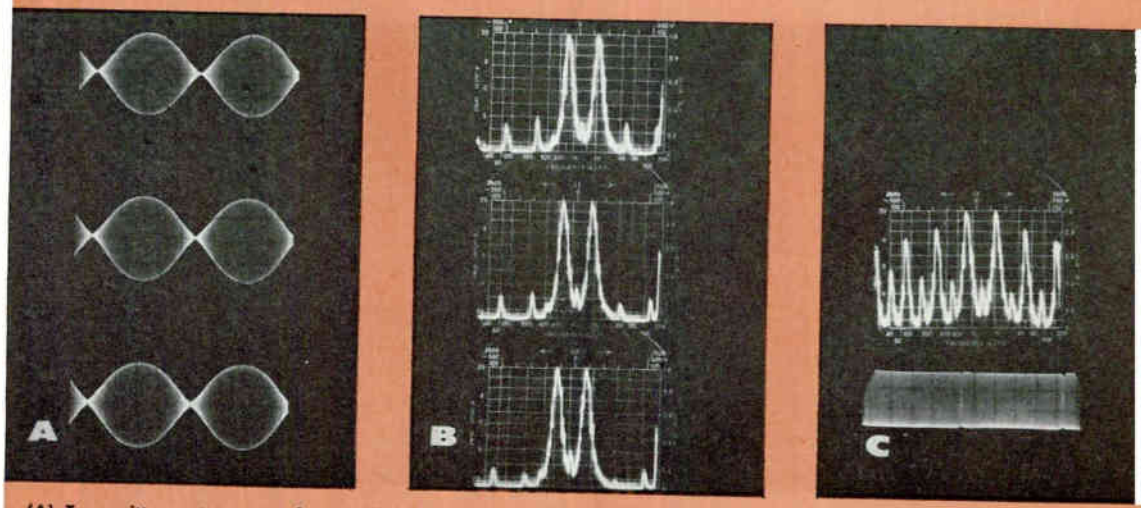
Precision Electromechanical Controls and Instrumentation, Servomechanisms
Precision Miniature Gearheads, Navigational Counters, Indicating Devices

electronics
FEBRUARY 5, 1960



(A) Transmitter output waveforms; (B) transmitter output spectra, 500-cps modulation, screen bias —35, —30, and —25 v; (C) phase-shift keyed spectrum and waveform, 500 cps modulation

New Suppressed-Carrier Modulation Technique

Provides saving of power required for carrier generation and permits exalted-carrier detection for communications circuit noise advantage

By JOHN DYSINGER, WILLIAM WHYLAND and ROBERT WOOD,
General Electric Co., Advanced Electronics Center, Cornell University, Ithaca, N. Y.

POWER ADVANTAGES of a suppressed-carrier communication system arise primarily from two factors: an increase in transmitter efficiency resulting from carrier suppression; and a more efficient demodulation process than conventional envelope detection can be used. The first advantage is that the wasteful power consumed in transmitting a carrier is not needed while the second results from a coherent demodulation in which the noise advantages of exalted-carrier detection are realized. (Exalted-carrier operation is an a-m receiver technique that keeps carrier level high to reduce distortion introduced by selective fading. In one exalted-carrier technique, a local oscillator is synchronized with the incoming carrier to get a constant-amplitude, carrier-frequency voltage with which to drive the a-m detector.)

In many cases it would be advantageous to suppress the carrier of a double-sideband signal even though a single-sideband receiver must be used to demodulate at the opposite end of the communication link. If a high degree of peak-to-average speech clipping is employed at the transmitter, the over-all system gain over conventional a-m can be considerably better than that achieved by a single-sideband system, although 3 db poorer than that of a pure dsb (double sideband) synchronous system.

SIGNAL GENERATION—A new method of double-sideband suppressed carrier (dsbsc) generation has been developed for application to transmitter configurations using single-ended class-C output amplifiers. With this system balanced modulating is done

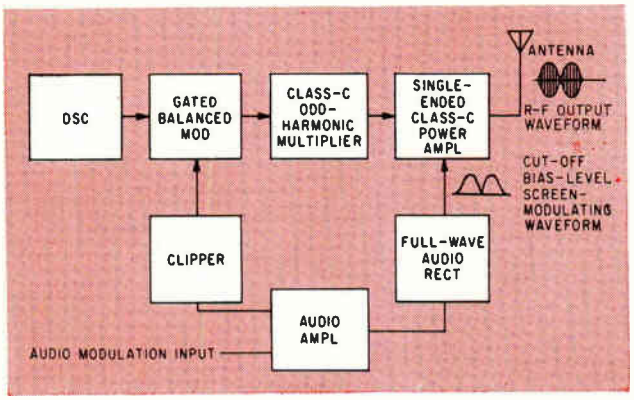


FIG. 1—Simplified block diagram of a dsbsc transmitter

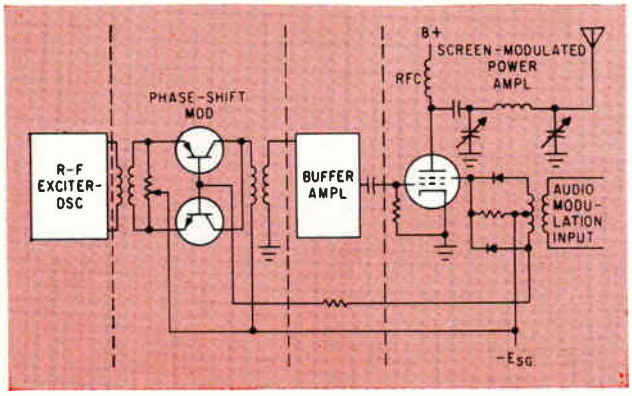


FIG. 2—Audio madulator configuration for dsbsc transmitter

at low level to achieve phase reversal, and can be followed by odd-value frequency multiplication, frequency translation or class-C nonlinear amplification. Envelope modulation is achieved in the grid-modulated final-amplifier stage.

Figure 1 illustrates the essential stages of such a transmitter. The audio input is effectively 100 percent clipped to produce a gating wave for the low-level balanced modulator. From that point on, the transmitter is phase-shift keyed in accordance with the zero crossings of the modulating a-c waveform. The audio input is also full-wave-rectified to produce a positive waveform to envelope-modulate a grid of the final-amplifier stage.

These two operations must take place synchronously. Advantages of this arrangement are: suppressed-carrier transmitter design without a high-power-level balanced modulator or linear amplifiers; suppressed-carrier transmitter design with a low-frequency phase-reversal circuit and a single-ended high-frequency amplitude modulator; and modification of existing a-m transmitters without changeover of high-level r-f circuits (that is only the bias and modulator circuits of the high-level modulator need be modified).

RATINGS—In grid-modulated service, either dsbsc or conventional a-m, amplifier plate voltage may be increased to the ratings for r-f power amplifier and oscillator service in class-C telegraphy and class-C f-m telephony.

Power tubes of the beam-tetrode class are fre-

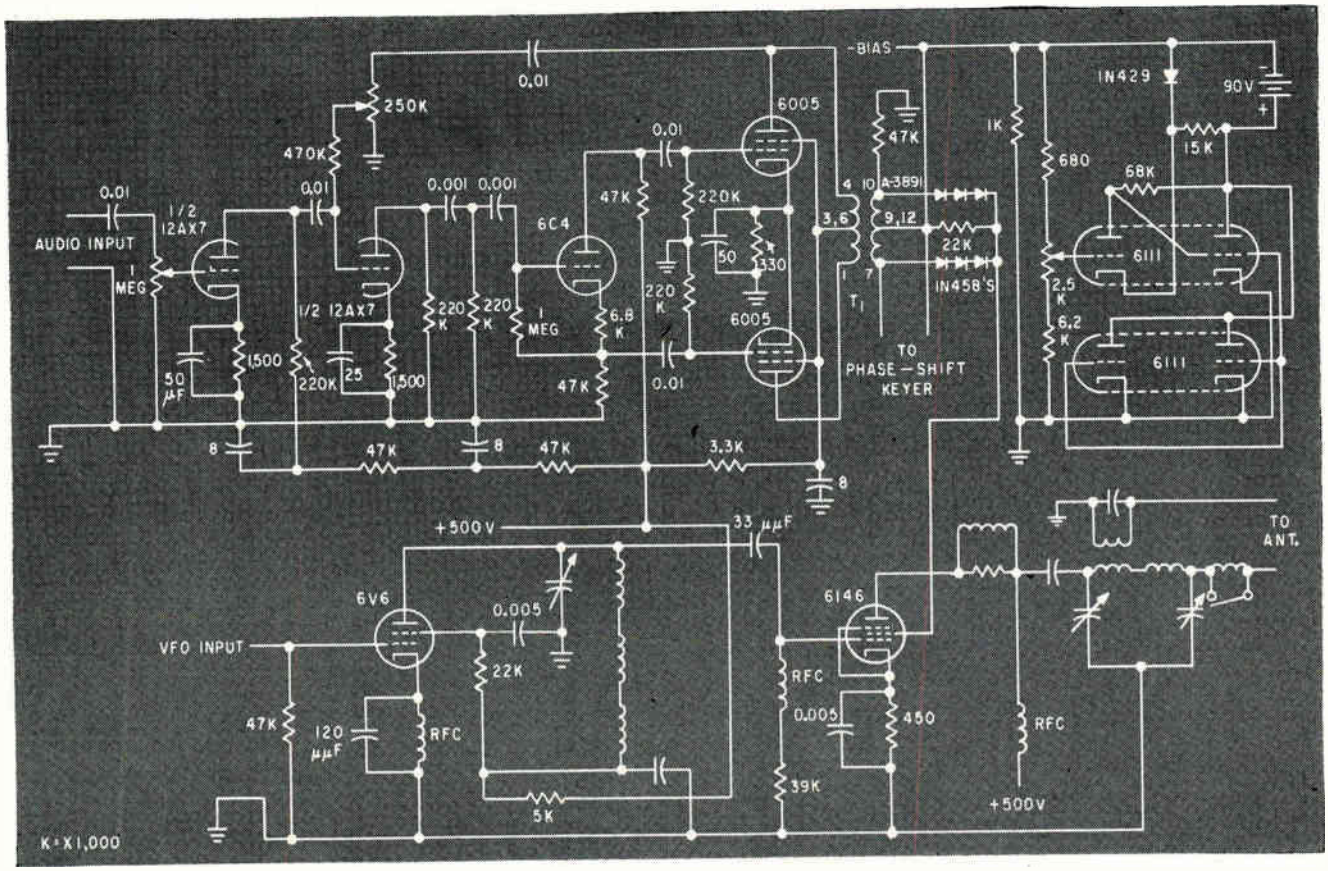


FIG. 3—Modified schematic diagram of a medium-powered transmitter showing application of new suppressed-carrier modulation

Modified medium-power transmitter and phase-shift keyer

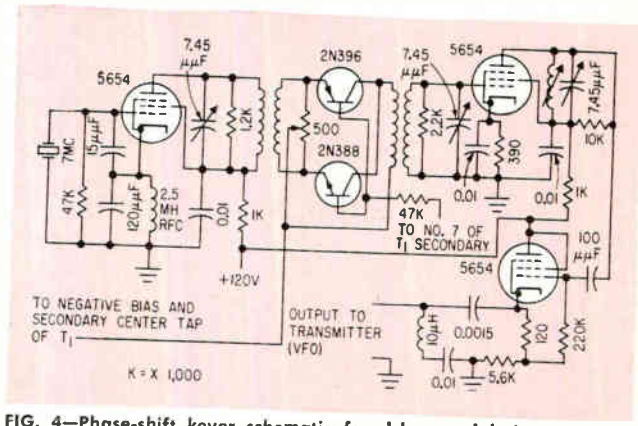


FIG. 4—Phase-shift keyer schematic for dsbsc modulation system

quently used in a-m screen-modulated service when a low-power modulator is desired. This method of modulation is particularly appropriate for dsbsc generation because the final amplifier so modulated is not highly sensitive to excitation voltage. For this type of dsbsc service, a regulated screen-bias supply is necessary and should be adjusted to barely cut off plate current. The full-wave rectified audio modulation is used to raise the screen voltage from the bias point to generate the r-f envelope characteristic of dsbsc signals; i.e., the peak screen voltage at modulation peaks should reach the screen voltage normally used for class-C telegraphy and class-C f-m telephony.

OPERATION—When there is no modulation applied to the screen the audio rectifiers are in a nonconducting state and it is necessary to apply the negative bias voltage to the screen through a resistor. This resistor should be as small as possible, since it is also the screen-capacitance discharge path. If this *RC* time constant is significant, relative to the half-cycle period of the maximum modulating frequency, distortion will be apparent on the trailing edge of the modulating signal. The regulated screen-bias supply must be capable of supplying screen current at audio peaks, current through the bias resistor at audio peaks, and current necessary to switch the low-level balanced modulator used in reversing the excitation phase.

Figure 2 shows a simple power amplifier and phase-shift modulator configuration. The low-level phase-shift modulator is automatically kept in synchronism with the screen envelope modulating waveform by taking the gating signal directly from the modulation transformer secondary and referring both modulators to a common d-c level.

APPLICATION—A modified medium-power transmitter is illustrated in Fig. 3, 4 and the photograph. Modification consisted of the following changes:

The 6U8 preamplifier and 6L6 modulator were replaced by a 12AX7 twin-triode amplifier circuit and a push-pull modulator circuit consisting of a 6C4 tube used as a phase splitter and two 6005 tubes as a push-pull audio power amplifier. A negative-feedback network was connected from the output of the push-pull amplifier to the input of the second half of the 12AX7 preamplifier. The secondary of the modulation transformer was connected to the full-wave audio rectifier circuit and the negative-bias regulator as shown in Fig. 3.

The bias resistor of the 6146 class-C final amplifier was changed from 22,000 ohms to 39,000 ohms. The screen-bias circuit was removed and replaced by a full-wave audio rectifier connected directly to the screen grid.

KEYER—The phase-shift keyer is shown in Fig. 4. The oscillator is a crystal-controlled Colpitts with electron coupling to the plate circuit. The plate transformer drives the transistor gate, which is transformer coupled into a conventional tuned pentode r-f amplifier. This is followed by a tuned cathode follower which feeds a coaxial cable and the exciter.

TEST RESULTS—Output signal of the modified transmitter, measured across a 50-ohm termination at a 7-mc center frequency, with 500-cps modulation, is shown in (A) and (B) of the waveform photographs. The waveforms shown in (A) are for three screen-bias potentials, −35 v, −30 v and −25 v. Corresponding spectra are shown in (B). The spectra are presented on a logarithmic scale, with +20 db at the top of the scale, −20 db at the bottom. Note that with a −30-volt bias, correspondeng to the center display in both pictures, the carrier is suppressed 30 db with respect to the fundamental sidebands. All other spectral components are greater than 30 db down from the fundamental sidebands. It is also apparent that the screen-bias voltage is not critical, since a ±17 percent variation in bias produces little change in spectrum.

A partial presentation of the phase-shift keyer output spectrum, together with the corresponding waveform, is shown in Fig. 6C. The familiar 6 db/octave square-wave spectrum is shown with carrier suppression of approximately 30 db.

Radio-frequency power output of the modified transmitter was 35 w on the peak of the audio cycle, with screen potential of 250 v on audio peaks.

CONCLUSIONS—Results indicate that the method offers a practical approach to production of dsbsc in new equipment design or in simple modification.

Portable Depth Finder For Small Boats

Instrument locates fish and measures depth to 120 feet. Here is the circuit and explanation of a portable device in which a mechanical arrangement removes the need for a cathode-ray tube

By **HERBERT C. SINGLE**, Design Engineer, Commercial Apparatus and Systems Div., Raytheon Co., Waltham, Mass.

DEPTH INDICATORS ARE BASICALLY time-measuring devices. They measure the time taken for a transmitted sonic pulse to travel down through the water, reflect from the bottom and return to the instrument. The instrument then converts the elapsed time into feet of water below the transducer. If there are any objects, such as a school of fish, between the transducer and the bottom, a lower-intensity echo will arrive at the transducer before the stronger bottom echo.

The transistorized depth indicator to be described is a portable unit using either an external 12-v battery or an internal 7.5-v battery and has an indicating range of 120 feet.

The depth indicator is a neon lamp rotated at the end of an arm driven by a constant-speed motor. A magnet is also located on the revolving arm and is used to trigger the transmitter when the neon lamp is approaching the zero feet indication. When the transmitter operates, the generated sonic pulse is passed simultaneously to the transducer and the receiver causing the neon lamp to glow brightly as it passes the zero feet indication of the depth scale. The neon lamp glows again when the echo pulse is received and the angular position at the second glow can be read in terms of water depth on the calibrated scale.

The transducer is a single disk of barium titanate operating in the thickness mode. It has a beamwidth of 6 degrees and is potted in a salt-water resistant plastic.

Circuit

Figure 1 shows the circuit of the five-transistor instrument. Transmitter transistor Q_1 is connected in a normally-quiescent Hartley-type oscillator circuit with its base circuit loaded by R_1. When the magnet, rotated by the constant-speed motor, passes close to inductor L_1, a negative pulse is generated and passed to the transistor through C_4 and the pulse-shaping network R_2, C_2 and R_1.

Transmitter Q_1 is driven into oscillation for a period of 300 to 500 μsec. Tank circuit L_2 and C_3 determines the transmitted frequency.

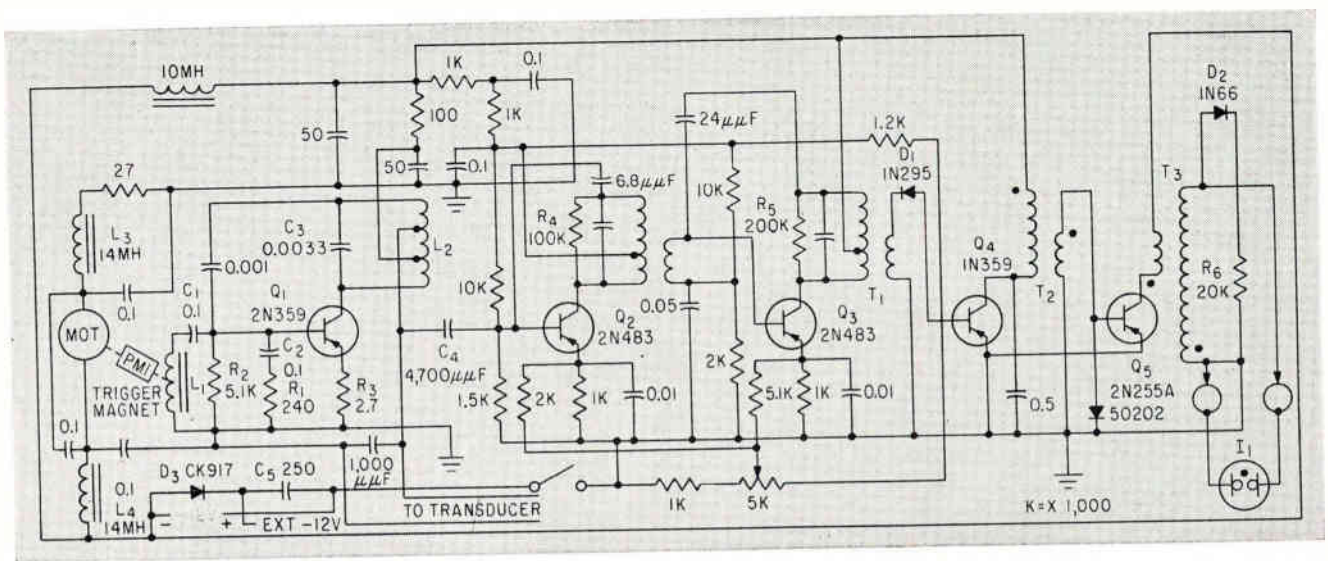
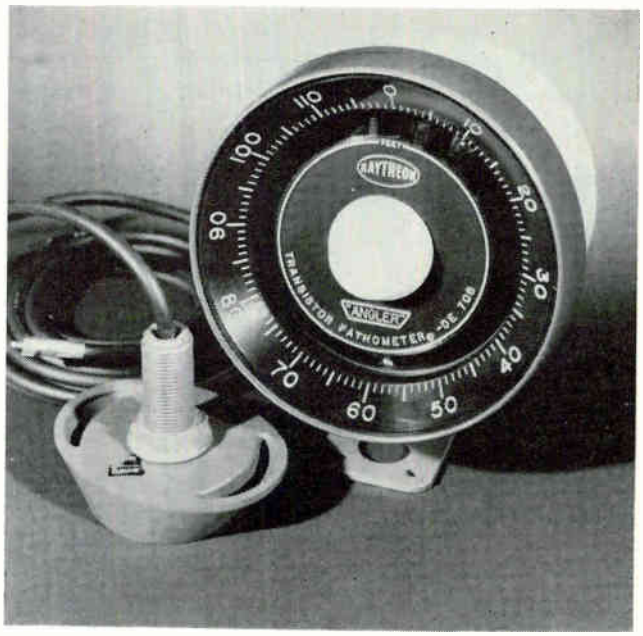


FIG. 1—Constant-speed motor simultaneously drives triggering magnet past L_1 and rotates neon lamp I_1 around transparent depth scale

THE FRONT COVER—Likely fishing spots for sportsmen are indicated by presence of low-intensity echoes



Transducer (left) is connected to the fathometer depth sounder with a twelve-foot cable

The transmitter operates 1,200 times per minute at a frequency of approximately 200 kc. Using L_2 as an autotransformer holds the coupling losses to a minimum while matching the transmitter to the transducer.

The returning echo is coupled through C_4 to the first r-f amplifier Q_2. The conventional r-f amplifiers Q_2 and Q_3 have their bandwidths increased by damping resistors R_4 and R_5. The amplifiers are also slightly stagger tuned to further broaden their bandwidth to be compatible with the slight differences between transducers.

Gain Control

Since the received pulses can vary in amplitude between 75 μv and 2 v and overloading the r-f amplifiers can cause incorrect operation of the following stages, a large dynamic range of control is necessary.

Amplifier gain is determined by varying the base voltage applied to Q_2 and Q_3. With this method of varying gain, the impedance of the transistors and their operating point is changed and slight detuning and bandshifting occur.

The peak of the bandpass will shift about 1.5 kc between maximum and minimum gain. By correctly neutralizing the r-f amplifiers at full gain, maximum stability at lower gain is assured.

Output of amplifier output transformer T_1 is detected by diode D_1 which is directly connected to the base of amplifier Q_4. High-power transistor Q_4 is a grounded-emitter unbiased amplifier which will conduct only when a negative-going pulse is applied to its base.

Lamp Operation

The detected negative-going pulse drives Q_4 into saturation and the resulting pulse in the collector circuit is transformer-coupled to output amplifier Q_5. Amplifier Q_5 is also a grounded-emitter unbiased power amplifier. The pulse from transformer T_2 drives Q_5 into saturation. When Q_5 conducts, approximately 1.5 amperes peak current flows through the primary of transformer T_3.

The voltage pulse developed across the secondary of T_3 is sufficient to ignite (through slip rings) neon lamp I_1. When the voltage pulse is over, the neon lamp will extinguish. When the flux in transformer T_3 collapses, a reverse-polarity voltage is generated that will re-ignite I_1. To prevent this, diode D_2 in series with R_6 conducts to remove the voltage.

Power is supplied by internal mercury cells or external batteries. Diode D_3 is used to protect the circuit from accidental reverse polarity battery installation. Capacitor C_5 is used to provide a low-impedance power source.

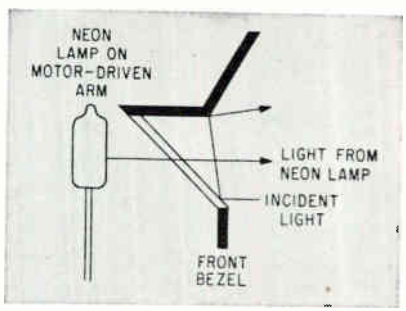


FIG. 2—Design of depth scale bezel permits viewing at high light levels

Reflections Reduced

To reduce reflections on the indicating face of the depth scale, the portion directly over the indicating scale is sloped backwards as shown in Fig. 2. Incident light is reflected to a black, light-absorbent ring and the high-intensity red light from the neon lamp can shine directly through the transparent part.

In common with many other types of electronic equipment, the depth sounder and associated cables should be kept as far away from motor ignition leads as practicable.

Ignition interference shows up as stray flashes of light from the depth indicating lamp. Shielding or bypassing of offending leads may reduce the trouble.

Indicator Triode For Direct Data Readout

Indicator triode has a fluorescent anode whose illumination is controlled by grid potential. This article describes flip-flop and shift-register circuits which use the triode as an active element

By **H. RODRIQUES de MIRANDA*** and **I. RUDICH,** Amperex Electronic Company, Hicksville, N. Y.

OUTPUT LEVEL of fast switching transistor flip-flops is normally so low as to require a stage of amplification before a neon indicator can be used. The new Amperex 6977 triode combines the functions of both amplifier and indicator in a single envelope. Furthering the elimination of components, this triode actually replaces one of the transistors in a binary pair.

Described here, is the bistable circuit that results from the replacement of one transistor by the 6977 triode. Its advantages are low-impedance output, high input-impedance, low power consumption, and that it can be flipped over by a low level (30 μw) signal. Additionally, a shift register formed by cascading the triode-transistor flip-flops is described.

Bistable Circuit Operation

The circuit of Fig. 1B is unusual, since both the tube and transistor conduct are cut off together, rather than alternately as are the active circuit-elements in most flip-flops. A negative pulse applied to the grid of the triode turns them off; they are held off by a negative bias from the battery. When turned on by a positive pulse, the bias is overcome and a second stable, conducting, state exists.

Considering the circuit in the OFF condition, a positive pulse at the triode grid will cause it to conduct, and its anode current will flow into the transistor base-circuit. Thus the transistor will be turned on too. Transistor collector current flows through R_3 bringing the potential of point A nearer to the 50-volt supply potential. The rise in potential at A is transferred to the triode grid by the divider network R_1-R_2, and causes the triode to conduct more heavily. Transistor current is further increased and the ensuing cumulative action turns both transistor and triode on hard. Resistor R_3 is chosen so that the transistor is saturated, and resistors R_1 and R_2 are chosen to give zero potential at the triode grid when the circuit is in the ON state.

A negative pulse at the triode grid will reduce the anode current and consequently the transistor collector-emitter current. A reverse cumulative action is thereby precipitated and the negative bias from the battery once more holds the circuit in the OFF condition. In this OFF state, the full battery voltage is applied across the transistor collector-emitter circuit.

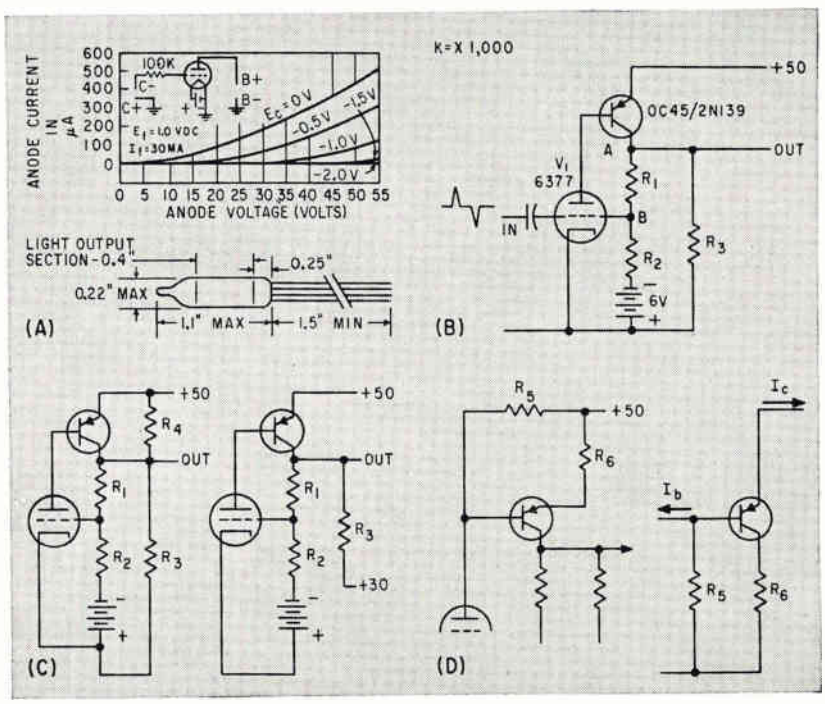


FIG. 1—Tube characteristics and dimensions (A); basic flip-flop shows operating principles (B); two methods of reducing collector-emitter voltage (C); stabilization against variations in β value (D)

*Now with Philips Gloelampenfabriken, Semiconductor Division, Nijmegen, Holland.

Most fast switching transistors cannot withstand the 50 volt collector-emitter voltage that is needed to operate the 6997. Since this voltage appears across the transistor in the OFF condition, the circuit must be adjusted to prevent transistor damage. One way of doing this is shown in Fig. 1c, where the voltage across the transistor in the OFF condition is reduced from the full supply voltage to some safe value by the resistor R_4. With R_4 equal to R_3 the voltage across the transistor is reduced to half the supply voltage.

In the ON condition, R_4 has no influence on the circuit operation because the transistor represents a small impedance and the supply voltage appears across load resistor R_3. This form of protection requires higher battery power consumption and reduces the output voltage. The right-hand circuit of Fig. 1C shows an alternative method of protection that uses an additional positive supply voltage to reduce the collector potential when the transistor is cut off.

Variation Of β

The factor β relating the base current to the collector current is liable to vary from transistor to transistor. It would be possible to design the circuit so that even with the lowest value of β the transistor still saturated in the ON state. However, this would lead to excessive dissipation and reduced switching speed where higher values of β were encountered.

The method used to obviate harm caused by β variation is shown in Fig. 1D. Resistor R_5 is chosen so that its value is several times smaller than the product $\beta \times R_6$, and R_6 in turn is much larger than the transistor emitter resistance. Thus the effective value of β becomes R_5/R_6. Reasonable values are $R_5 = 600$ and $R_6 = 40$ ohms.

Circuit Constants

The supply voltage should be fairly near 50 volts to satisfy the tube operating requirements. Components and voltage values derived from the following calculations are shown in Fig. 3A. In the ON state, most of the 50 volts is developed across R_3, since the transistor is then saturated. Thus $R_3 = 50/\beta I_a$. This gives $R_3 = 5{,}600$ ohms for $I_a = 0.6$ ma and $\beta = 15$. A linear relationship ($I_a = SV_g$) between the anode current and grid potential is assumed. The value of S is approximately 0.15 ma/V.

A plot of voltage V_g at point B in Fig. 1B, against current I_r in resistor R_1, is shown in Fig. 2. The curve equation is $I_r = (1 - SR_3)V_g/R_1 - SR_3V_a/R_1$, hereby indicating a negative resistance region if $SR_3 > 1$. Since $SR_3 = 12.6$ the curve does have a negative slope, as Fig. 2 shows. Positive resistance regions occur for grid voltage more negative than −4 volts (triode cutoff) and more positive than zero volts (transistor saturation).

A load line drawn on the V_g versus I_r characteristic intersects it in three places, implying two stable states. The condition for stability is $R_2 > R_1/(SR_3 - 1)$, or in this case, $R_2 > R_1/11.6$. A compromise between triggering sensitivity and stability is obtained by choosing $R_2 = 6R_1/50$ and choosing bias 6v. Absolute values of R_1 and R_2 should be chosen to give high input impedance. With $R_2 = 30{,}000$ ohms, R_1 becomes 250,000 ohms. The ON stable state shown in Fig 2 implies a positive 1.5 grid voltage.

Engineer checks output of laboratory data-processing unit

Final Circuit

The final circuit incorporating collector protection and stabilization against β variation is given in Fig. 3B. In addition to the refinements discussed, capacitor C_1 has been connected in parallel with R_1 to provide more positive feedback at the beginning of the switching process. Circuit sensitivity is thereby increased and switchover-time reduced.

Shift Register

A shift register formed by joining the bistable circuits just discussed is shown in Fig. 4. Also shown in this circuit is a phase splitter which converts single polarity shift pulses to positive- and negative-going pulses for application to all stages.

Usually, shift pulses of a single polarity are fed to each stage of a

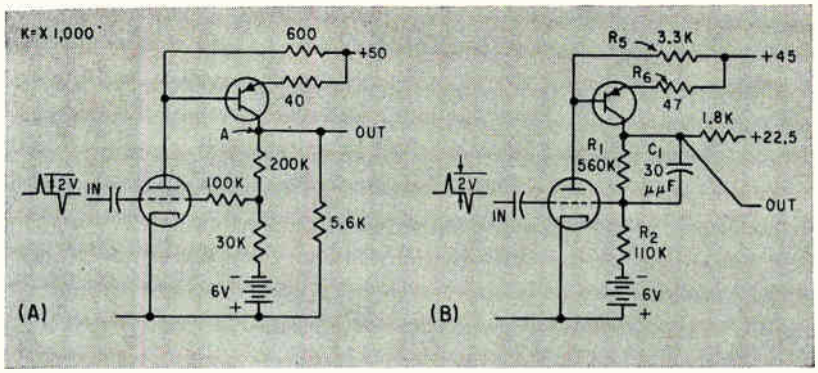


FIG. 3—Comparison of basic and final flip-flop circuits

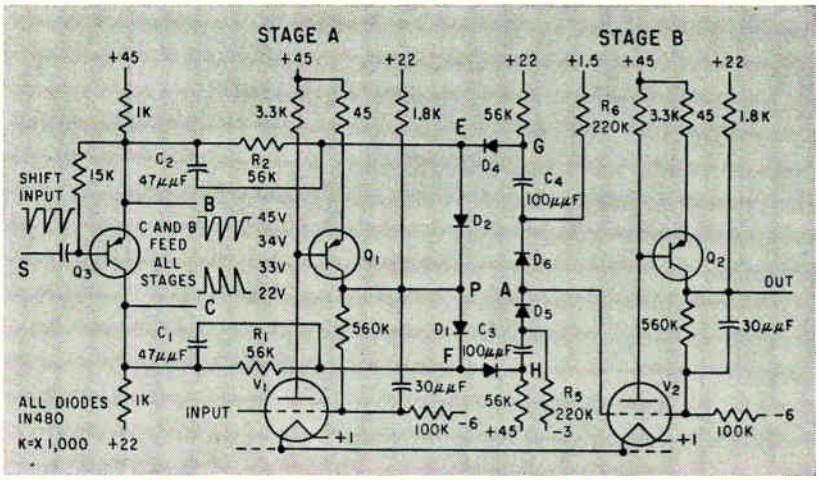


FIG. 4—Triode-transistor flip-flops are coupled to form a shift register

conventional shift register, where they are gated by the content of the previous stage to turn on the correct circuit element. In this register, shift pulses are applied only to the 6977 grid; consequently, both positive and negative pulses are required. Shift-pulse polarity is determined by the state of stage A.

From the description of the transistor-triode flip-flop, it will be remembered that a positive pulse causes the circuit to conduct (ON state) and a negative pulse turns it off (OFF state).

Shift Register Operation

Figure 4 circuit shows two representative stages of an N-stage shift register. The content of stage A is required to be reproduced in (or transferred to) stage B on receipt of a shift-pulse at the grid of V_2. Transistor Q_3 produces positive and negative shift pulses at B and C.

Positive shift-pulses reach the grid of V_2 through the coupling circuit path CFHA, negative ones by path BEGA. Memory capacitor C_1 must be charged for positive pulses to pass to V_2 grid; memory capacitor C_2 for negative pulses. The output from stage A is impressed on Point P; it has potential of 22 volts if stage A is OFF, and 45 volts if ON.

ON State Transfer

Assume stage A is ON and potential at P is 45 volts. Capacitor C_2 is not charged because the potential at point P is the same as at B. However, since C is at 22 volts and P at 45 volts, capacitor C_1 is charged through diode D_1 to about $(45 - 22) = 23$ volts.

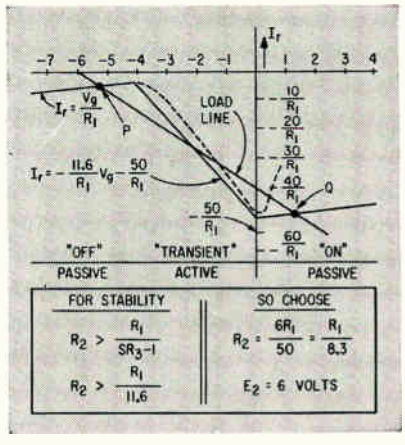


FIG. 2—Stable states at P and Q

The negative-going shift pulse drops the potential of both B and E to 34 volts. For the negative pulse to pass through diode D_4 the potential at E would have to be reduced to a value lower than the 22 volts at G. In this instance then, the negative shift pulse does not pass beyond E.

The positive shift pulse, raises the potential of C to 33 volts. Since memory capacitor C_1 has previously been charged to 22 volts, the potential of F is above the potential at C by the charge on the capacitor C_1. Potential of F therefore becomes $(33 + 22) = 55$ volts. Diode D_3 conducts and passes the positive pulse to H and to the grid of V_2 through C_3 and D_5. The ON state results.

Off State Transfer

A negative pulse must be passed through the coupling circuit when stage A is in the OFF condition. Potential at P will be 22 volts and memory capacitor C_2 will be charged to $(22 - 45) = -23$ volts. Memory capacitor C_1 will be uncharged. When the shift pulses arrive the 11 volt negative shift pulse reduces the potential at B to 34 volts, and the potential at E to 34 less the charge on C_2, that is, 11 volts. Diode D_4 conducts, and the negative shift pulse is impressed on the grid of V_2. The positive pulse at C, in absence of charge on capacitor C_1, does not cause D_3 to conduct, so a positive pulse is not transmitted.

Diodes D_5 and D_6, in combination with resistors R_5 and R_6, enable the grid voltage of triode V_2 to change between the limits of -3 volts and -1.5 volts without loading the preceding circuit. Capacitors C_3 and C_4 separate the various d-c levels which occur between points G and H.

Since the memory capacitors are charged before the arrival of shift pulses, the polarity of the pulse applied to the grid of V_2 is independent of any change in state of stage A. The gating is controlled by the state of stage A between shift pulses.

Automatic Display of Noise Suppression Factor

This noise suppression factor display unit, part of a noise display machine under development, computes and automatically displays on an oscilloscope the ratio of two time-varying quantities

By **JUN TAMIYA,** Research Fellow, Department of Electrical Engineering, University of Minnesota, Minneapolis, Minn.

AN IMPORTANT OPERATION in various forms of data processing is the computation of the ratio of two time-varying quantities. Both analog computers with servo control and digital computers have been used for this purpose.[1, 2] However, for special applications it is often more desirable to design a purely electronic analog circuit. Such circuits are faster than the servo type and are simpler than the digital type.

An electronic analog-type ratio computer is described in this article. This instrument automatically computes and displays on a cathode ray oscilloscope the noise suppression factor of tube shot noise. Noise suppression factor, Γ^2, is a ratio of true shot noise ($2eI_{eq}\,df$) to pure shot noise ($2eI_p\,df$), or $\Gamma^2 = I_{eq}/I_p$, where I_p and I_{eq} are, respectively, the plate d-c of the tube under test and the equivalent noise diode current. This ratio computer (or division computer) is designed as a unit of a noise display machine.[3, 4]

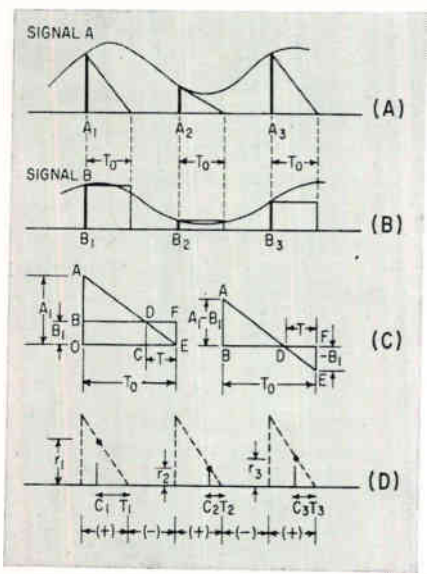


FIG. 1—Principle of calculating the ratio of signal *A* to signal *B*

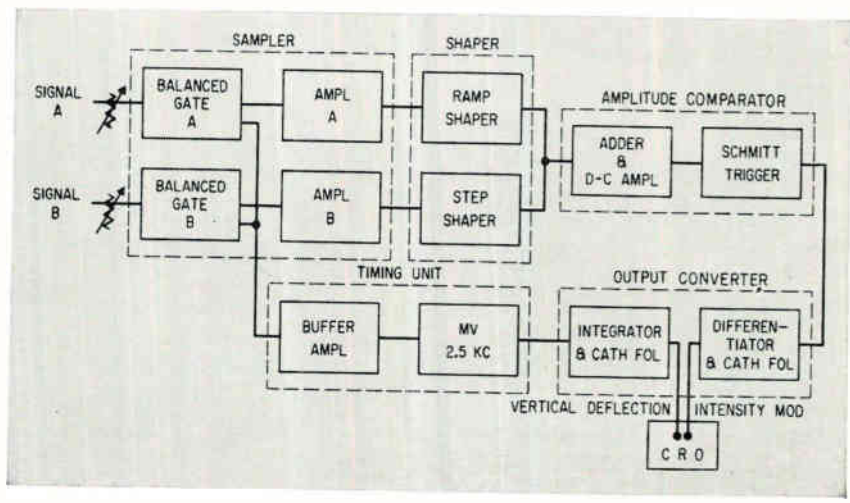


FIG. 2—Diagram of unit which displays noise suppression factor on a cathode-ray tube

In order to display on an oscilloscope various noises as functions of tube current, the noise display machine is provided with means for sweeping the tube current at a low frequency. Thus, both I_p and I_{eq} are time functions with the period of the sweep signal, and Γ^2 is simply a ratio of these non-negative time functions. In the practical circuit these two functions consist of an amplified signal of I_p and the rectified output of a shot noise amplifier, which is proportional to I_{eq} if the detection is quadratic.

Computation of the ratio of two continuous time functions is in this electrical analog method a sequence of computations for pairs of samples of the original signals.

Basis of Method

Figure 1 shows the method graphically. Pulse signals A_1 and B_1 are sampled simultaneously from input signals A and B respectively. Signal A_1 is first transformed into a ramp voltage, starting at the instant of sampling and decaying with a slope proportional to the amplitude of A_1. In other words, its initial height is same as the magnitude of the signal A_1; it decreases linearly to zero within a predetermined time interval T_0, as shown in Fig. 1A. Signal B_1, on the other hand, is transformed into a

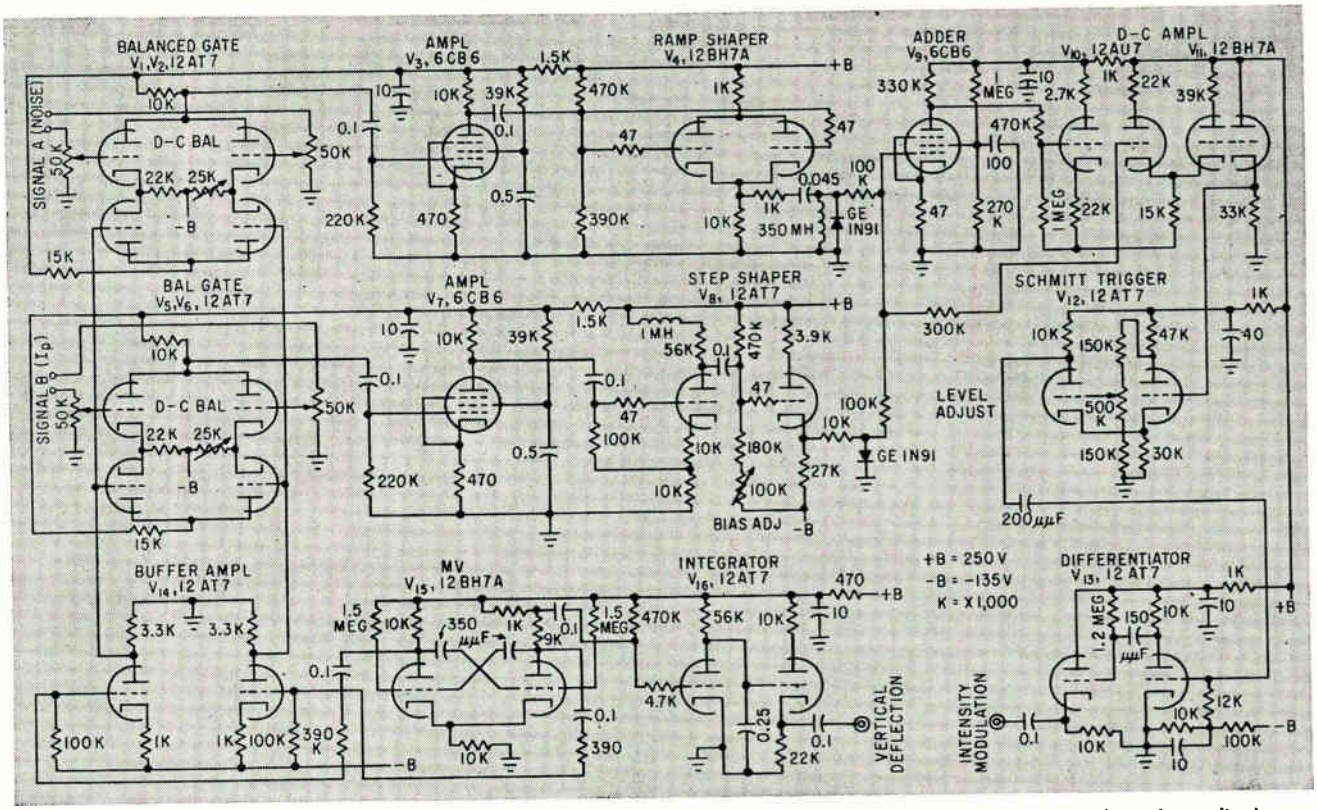


FIG. 3—Noise suppression factor display unit consists of five main parts—sampler, shaper of ramp or step in each channel, amplitude comparator, converter for final indicator and timing unit which provides sampling signal

step voltage, holding a height of the signal B_1 over the same interval T_o, as shown in Fig. 1B.

Assuming that A_1 is larger than B_1, the ratio of these two quantities is equal to that of two time intervals, T and T_o (Fig. 1C), where T is the time between the end of the interval and the crossover point of the ramp and the step. That is, from the proportionality law in plane geometry, $r = B_1/A_1 = OB/OA = DF/BF = T/T_o$. Since T_o is a constant, the interval T is proportional to the desired ratio. It is not difficult to find the instant of the crossover point of these electrical waveforms with an amplitude comparator. Moreover, various methods are available to convert such a variation in time interval into an electrical signal, which can be fed to a final indicator.

The assumption $A_1 > B_1$ need not impose a restriction on the input signals since A and B can be adjusted with an attenuator before comparison.

Circuit Description

The noise suppression factor display unit (Fig. 2 and 3) consists of five main parts—a sampler, a shaper of the ramp or the step in each channel, an amplitude comparator, a converter for a final indicator, and a timing unit providing the sampling signal.

For driving the shapers, a sampled signal with a long flat top is required in each channel. Such a waveform could be generated with a circuit combining a true sampler and a holding circuit. In this unit, however, each input signal is converted into an amplitude-modulated wave with a square-wave carrier at the sampling frequency. A balanced gate circuit, driven by a square-wave generator in the timing unit, is employed for this purpose. Such an a-m signal can be considered as a sampled signal with an extended flat top over a half period of the sampling square-wave when sampling frequency is much higher than signal frequency. An a-m signal of this kind is simple to generate and amplify since the waveform has no d-c components.

The most important part in this unit, the ramp shaper in channel A, consists of an L-C series tuned circuit, properly damped with a series resistor, with a damper diode connected in parallel. A cathode follower drives these circuits, as shown in Fig. 4A. Output is taken from the terminals across the inductor. This circuit is suitable as a ramp shaper because its response to a step function is a nearly straight line of decay, within a quarter period of the resonant frequency.

When there is no parallel diode, the output voltage shows a ringing given by the equation:

$$e = E\left\{[4(L/C) - Rr]/[4(L/C) - (R+r)^2]\right\}^{1/2} \epsilon^{-(R+r)t/2L} \sin\left\{\tan^{-1}\left\{[4(L/C) - (R+r)^2]^{1/2}/(R-r)\right\} - [1/LC - (R+r)^2 t/4L^2]^{1/2}\right\}$$

where E is the step voltage, r the internal resistance of the inductor, and R an additional damping resistor. Plotting this equation, one can easily find the best condition for obtaining a nearly straight ramp in the first quarter period as follows:

$$R + r = 0.32\sqrt{L/C} \qquad (1)$$

The first zero-crossing under this condition occurs at a time given by

$$T_o = 1.05\sqrt{LC}\tan^{-1}(0.95/\sqrt{0.1 - rC}) \qquad (2)$$

By putting T_o equal to the half cycle of the sampling period, an optimum design of the tuned circuit is obtained by Eq. (1) and (2). The resistance of the inductor has little effect on the output waveform, as long as r/L is smaller than R/L.

A diode connected in parallel to the output, known as an absorbing diode, absorbs the energy in the oscillatory circuit by its low resistance when the ringing swings to the forward polarity of the diode. Thus the ringing dies out and the output is kept to ground potential (or a reference potential). The diode also serves to eliminate the entire response for the trailing edge of the input step, because this response has a forward polarity to the diode from the beginning of its ringing. Therefore, a ramp proportional to the input voltage appears only at leading edges of the square wave and dies out linearly in a fixed time given by Eq. (2).

The step shaper in channel B is nothing but a half-wave rectifier, as shown in Fig. 4B. This circuit cuts off an undesired half part of the a-m signal so as to give a unipolar square wave with the ground potential as a reference level.

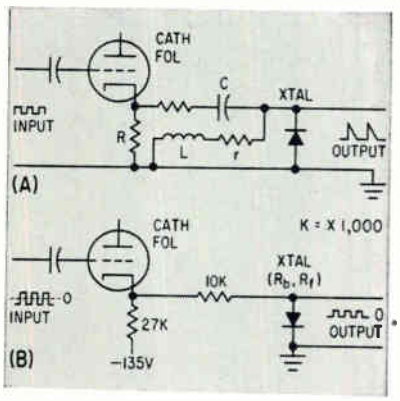


FIG. 4—Important elements in display unit are the ramp shaper (A) and step shaper (B)

In order to find the crossover point of the ramp and the step generated thus far, an amplitude comparator is used, consisting of an adder, a d-c amplifier and a Schmitt trigger circuit. The crossover point is first converted into a zero-crossing point by means of the adder, in which the ramp and the step are added in opposite polarity. Then the zero-crossing point is determined by the Schmitt circuit in such a manner that a steady state is flipped to another state at the instant of zero crossing. To mark this point, a sharp pulse is generated from the output of the Schmitt trigger through a differentiator.

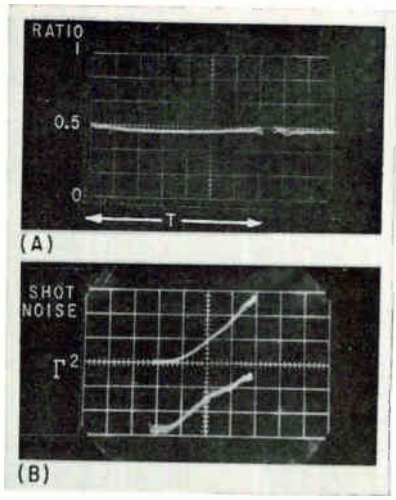


FIG. 5—Cathode-ray tube displays ratio of two sinusoidal waves (A); shot noise vs plate current, and I^2 vs plate current (B)

Ratio Indication

For a final indication of the ratio given by a time interval, various methods are available depending on the desired purpose. However, the following method is adopted here, since the final objective of this unit is to display the ratio on a scope. When we apply a sawtooth wave to the vertical deflection plates of a scope, in general, an instantaneous position of the spot or its height from a reference level is proportional to the lapse of time from the instant of fly back. A conversion from the time interval into a vertical deflection on a scope is possible as follows.

A sawtooth wave with a constant amplitude, generated from the gating square wave, is applied to the vertical terminal on the scope. The marker pulse specifying the crossover point is simultaneously applied to the intensity modulation terminal of the same scope, so as to give a bright spot only at the instant of this pulse. Since the sawtooth wave has been synchronized with the ramp signal, the height of each visible spot is proportional to the time interval T or to the desired ratio, as shown in Fig. 1D. The highest spot corresponds to the maximum ratio of unity, and the lowest one to the minimum ratio of zero in this case.

The ratio of continuous time functions is thus displayed by a sequence of spots at each instant of the sampling. If the rate of sampling is considerably higher than the signal frequency (as in this display unit, where sampling frequency is 2,500 cps for input signals with recurrence rate of 10 cps) the trace looks continuous.

Results

Figure 5A gives a display of the ratio as a function of time when a 10 cps sinusoidal wave is applied to both channels. Attenuators in both channels have been set with difference of 6 db so as to give the constant ratio of 0.5, regardless of variations in instantaneous amplitude. The flat portion in Fig. 5A, extending over 95 percent of the period, shows the range of proper operation where the ratio display gives the expected value of 0.5. The gap corresponds to the region where the instantaneous amplitudes in both channels are so small that operation becomes ambiguous. Such an ambiguous region is unavoidable in any analog computation of this type; improper functioning over 5 percent of period is satisfactory.

Figure 5B shows an ultimate display of the noise suppression factor as well as of the shot noise as a function of current of a tube under test. From these displays one can estimate the cathode quality as suggested by Dahlke[5] and developed by others.[3, 6]

The author wishes to express his appreciation to Professor A. van der Ziel, University of Minnesota, for his valuable advice, and to the support given by U. S. Signal Corps which made this work possible.

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Transistorized Inverters For Fluorescent Lights

Inverter working at 1,250 cps permits 40-watt fluorescent light to operate from 24-volt d-c battery. Transistorized equipment has been installed in British railway coaches

By **L. J. GARDNER,** Lighting Equipment Engineer, A.E.I. Lamp and Lighting Co., Ltd., Leicester, England

CURRENT SOURCE for lighting British railway coaches is a 24-volt d-c battery. To provide fluorescent lighting from this supply, the current must be converted to a-c so that a step-up transformer can be used.

A small transistorized inverter, working at a frequency of 1,250 cps, has been devised for this purpose, and the first railcars embodying the new equipment have recently been completed. Either one four-foot 40-watt lamp or two two-foot 20-watt lamps can be run off each inverter.

Circuit Operation

Basic circuit for the inverter (shown in Fig. 1A) contains two *pnp* transistors (Q_1 and Q_2) and a transformer with three windings—primary W_1, feedback W_2 and secondary W_3. Capacitor C is included to allow self-starting and resistor R controls the value of feedback current. The circuit operates as follows. When the supply switch, S, is closed, the capacitor charges by way of the emitter and base of Q_1. This current, flowing through the base and emitter, reduces the emitter-collector impedance (which is normally very high) and current begins to flow into the lower half of the primary winding, W_1. Thus, in effect, the charging current into the capacitor switches on transistor Q_1.

While the current flowing in W_1 produces magnetic flux in the transformer core and voltages are induced in all the windings, the polarity of feedback winding W_2 is such that current passes through the emitter and base of Q_1, and Q_2 remains cut off since the voltage across its base and emitter is in the reverse direction. In these circumstances, the collector-emitter impedance is very low and the lower half of the primary winding is virtually connected directly across the supply voltage. The rise in current in this part of the winding is, therefore, rapid and is limited only by the inductance of the transformer. While the current is increasing, magnetic flux in the core is also increasing and the change of flux maintains the voltages on all windings.

Once the current exceeds the critical value, the collector-emitter impedance begins to rise rapidly and, consequently, the rate of increase of both the current and the flux is reduced, as are the voltage induced in the feedback winding and the current fed into the base of Q_1. With the decrease in the collector current brought about by the reduction in the current to the base of Q_1, the magnetic flux in the core begins to decline and the voltages across all the windings are reversed. This reversal of feedback voltage switches off Q_1 and switches

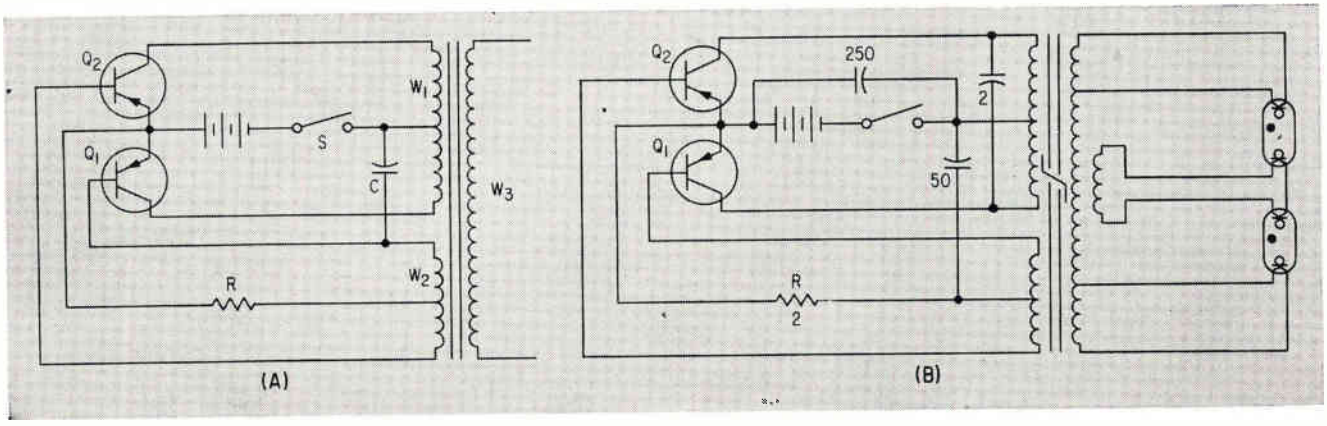


FIG. 1—Basic inverter circuit (A) is modified to operate with two 20-watt fluorescent lamps (B)

New British railway coach uses fluorescent lighting

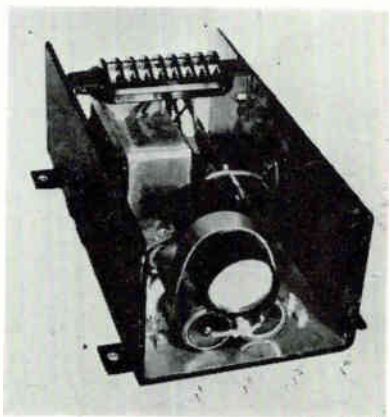
One inverter for each lamp is installed in ceiling

on Q_2, and the cycle begins again, but with current flowing into the upper half of W_1.

Actual Circuit

For the operation of a fluorescent lamp, some form of series impedance is required, owing to the negative volt-ampere characteristic of the discharge. If a separate inductance is used in series with the lamp, it will cause additional losses. Therefore, the transformer is designed as a high-reactance unit, with the secondary winding loosely coupled to the primary. The circuit for operating two 20-watt lamps is shown in Fig. 1B. It is similar, as far as the primary side is concerned, to that of Fig. 1A except that the starting capacitor is connected to the midpoint of the feedback winding instead of to the base of Q_1. The capacitor then charges up by way of the feedback winding, the base and emitter of Q_1 and Q_2 and the feedback resistor. There is sufficient asymmetry in the circuit to insure that either transistor is switched on by the current pulse. One other difference from the primary circuit of Fig. 1A is the addition of a smoothing capacitor across the supply and a surge-limiting capacitor across the full primary winding of the transformer.

Without the smoothing capacitor, the current taken from the supply is severely chopped. If several inverters are operated from a common supply line, the potential drop in the conductors will impose an a-c ripple on the d-c supply and, in some circumstances, may give rise to appreciable fluctuations in the light output.



Inverter has one transistor on outside of housing at left, the other on opposite side of housing

The surge-limiting capacitor reduces the magnitude of the surge voltages across the transistors. Each transistor operates as a switch, and as the circuit is inductive when the switch is opened (as at cutoff), a voltage surge is produced by the magnetic energy stored in the core of the transformer.

Except that the waveform of the output voltage and current is sinusoidal rather than square, the operation of the inverter with a lamp is similar to the process already described. The transformer is designed with leakage reactance between primary and secondary windings, so that the secondary voltage decreases rapidly as the current increases. In this way, stable operation of the lamp is automatically obtained.

One of the advantages of the quantity production of small transistors is that it allows the use of an inverter for each lamp, which means that the conventional low-voltage cable can be employed, and that consequently, tungsten lamps can easily be substituted for fluorescent, if required.

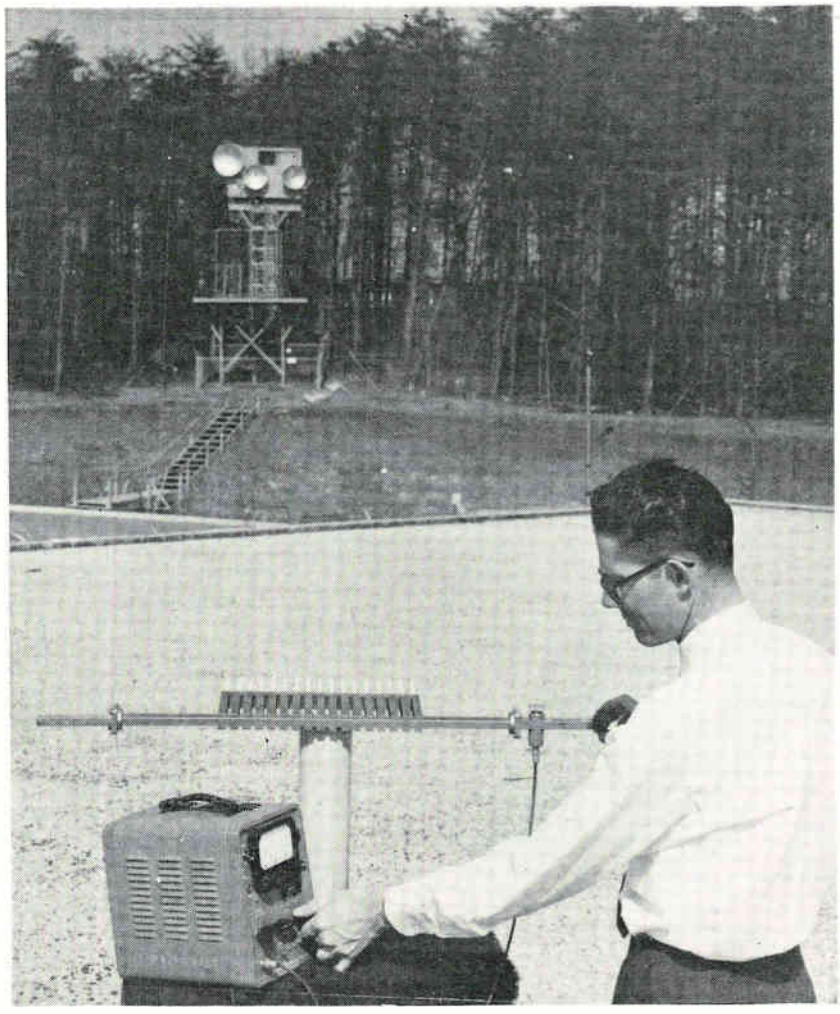
High-Dielectric Rod Antenna Arrays For UHF

End-fire arrays of ceramic rods provide a low silhouette and high vertical resolution. Weight problems are reduced with high-dielectric materials

By CARROLL W. MORROW and JERRY L. MOORE,
Melpar, Inc., a subsidiary of Westinghouse Air Brake Co., Falls Church, Virginia

CERAMIC RODS used as antenna elements have a high power handling ability that is limited only by the temperature effects of the low-loss material. With high-dielectric material, the volume of the individual elements is reduced and the weight is therefore kept sufficiently low that it is not a limiting factor in typical applications. Such characteristics make the rods suitable for antenna arrays in the uhf region.

The ceramic rods have several other advantages. They are durable, easily machined and can be assembled without special tooling. The performance of a dielectric end-fire array compares favorably with the more complicated Yagi array, and, furthermore, the dielectric rod system does not show the extreme mutual coupling effects of a Yagi system.



Seventeen-element Alite rod array is being tested for radiation pattern

End-Fire Radiator

The dielectric rod radiator serves as an efficient transmission line by almost complete transfer of microwave energy to free space over the rod length. To allow end fire radiation, the hybrid TE_{11} mode of propagation was used. The field lines, feed technique and the geometric parameters are shown in Fig. 1A and B.

The radiation pattern is defined by the velocity of propagation within the dielectric rod and the power distribution along its length. Velocity of propagation is derived by considering Maxwell's basic formula and the boundaries of the rod. This expression may be conveniently written as[1]

$$\left[\frac{1}{y}\left(\frac{J_1'(y)}{J_1(y)}\right)-\frac{1}{x}\left(\frac{Y_1'(x)}{Y_1(x)}\right)\right]\left[\frac{\epsilon}{y}\left(\frac{J_1'(y)}{J_1(y)}\right)-\frac{1}{x}\left(\frac{Y_1'(x)}{Y_1(x)}\right)\right]=\frac{(y^2-x^2)(y^2-\epsilon x^2)}{y^4x^4} \quad (1)$$

where

$$y^2+(x/j)^2=(\epsilon-1)(\pi d/\lambda)^2 \quad (2)$$

$$\frac{\beta}{k}=\left[\epsilon-x^2\left(\frac{\lambda}{\pi d}\right)^2\right]^{1/2}=\left[\epsilon-y^2\left(\frac{\lambda}{\pi d}\right)^2\right]^{1/2}=\frac{\lambda}{\lambda_\epsilon} \quad (3)$$

and

λ = free space wavelength, λ_ϵ = wavelength of dielectric rod, $k = 2\pi/\lambda$, $\beta = 2\pi/\lambda_\epsilon$, ϵ = relative dielectric constant, J_1, Y_1 = Bessel and Hankel functions of the first kind, J_1', Y_1' = first derivatives of the Bessel and Hankel functions of the first kind, d = dielectric rod diameter.

The graphical solution of Eq. 1, Fig. 1C, shows that β/k increases with d/λ_o and approaches $\epsilon^{1/2}$ as a limit; further, the rate of change increases with higher values of the dielectric constant. Standing wave measurements on an aluminum oxide ceramic, indicated in Fig. 1C, were in excellent agreement with the calculations.

Rod Dimensions

Accurate analysis of the field distributions of dielectric rods for the complex TE_{11} hybrid mode has not been made. However, the effect of the rod diameter or velocity of propagation on the power distribution along the rod length is indicated in Fig. 2.[2,3] It is apparent from this graph that, for a given velocity of propagation, the portion of microwave energy bound to the rod surface increases with dielectric constant. Also, the ratio of the power propagated in the rod to the power bound to the rod surface tends to zero as the diameter decreases or the velocity of propagation approaches that of air. Radiation losses increase in the same fashion.

The absolute gain of a dielectric rod of a given power distribution along its length is optimized by observing the Hansen-Woodyard criteria for end fire radiators,[4] $(\beta - k)L = \pi$.

To obtain desirable sidelobe and gain levels, the limit of the bracketed parameters for $L = 1$, is $0.9\pi < (\beta - k)1 < \pi$.

For any given dielectric constant, β is selected from Fig. 1C. Within these limits the dielectric rod may be tapered for a more nearly sinusoidal power distribution and, consequently, an improved radiation pattern.

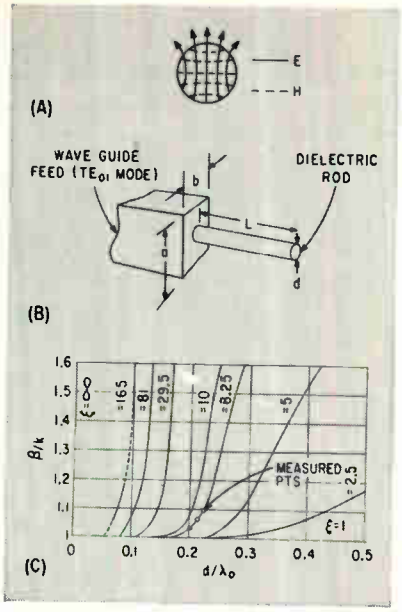


FIG. 1—For end-fire radiation, the TE_{11} mode is used (A); feed technique and geometry are shown in (B). Graphical solutions of Eq. 1 for various dielectric constants are shown in (C)

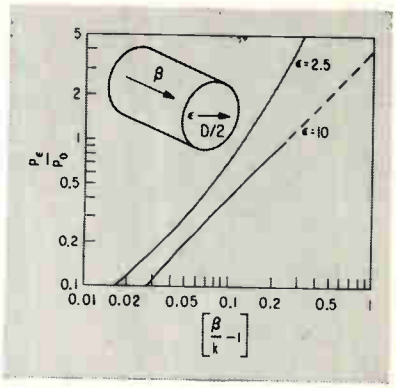


FIG. 2—Ratio of power propogated in the rod, $P\xi$, to power outside, P_o, is plotted as a function of rod wavelength for the TE_{11} mode

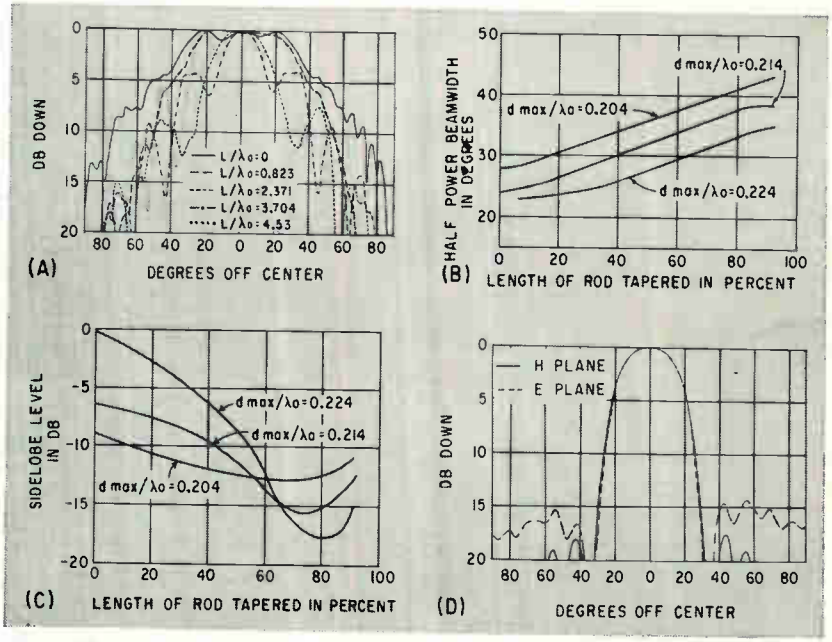


FIG. 3—Characteristics of Alite AE-212 rod with a diameter of 0.270 inch and length of 6 inches. Radiation pattern for various lengths of protruding rod are shown in (A). Half-power beamwidth for tapered rod, with minimum diameter of 0.170 inch, is shown in (B). Sidelobe levels for tapered rod (C) and radiation pattern for 6-inch rod with optimum 4-inch taper (D) are indicated

Radiator Characteristics

The decrease in diameter with increasing dielectric constant is significant in design. With one type of material, for example, a 3.5 wavelength rod at 450 mc will have a length of 7.65 feet, a diameter of 1.685 inches, and weigh 22.6 pounds. At 1 kmc, a similar antenna of the same base would weigh 4.56 pounds, be 41.3 inches long and have a diameter of 0.76 inch. The half power beamwidths for both is approximately 23 degrees. Thus weight is not an obstacle to the use of dielectric rod radiators in the uhf range. Mallach[5] noted the weight advantage resulting from increasing the dielectric constant of the rods.

Aperture blocking is reduced in dielectric rod arrays by virtue of smaller rod diameters and the beam structure of a single unit in an array is improved. Furthermore, experiments show a decrease in mutual coupling between elements with higher dielectric bases.

Rods excited in the TE_{11} hybrid mode have little dielectric loss as the majority of power is transmitted outside the rod. Also, the higher the dielectric constant of the rod the higher the portion of microwave energy traveling on the outer surface; consequently dielectric losses are smaller.

Power handling capabilities of the high dielectric constant ceramic rods are high and are limited only by the temperature rise caused by losses. But the large surface area of the rods offsets the temperature increase, and the power rating should not be a limitation.

Experimental Data

Experiments were made on three materials with particular regard to

half-power beamwidth, sidelobe level and vswr. The dielectrics were: Alite,[6] an aluminum oxide ceramic with a dielectric constant of 8.25 and a loss tangent of 0.0067; Ceramic NPOT 96, with a dielectric constant of 29.5 and a loss tangent of 0.0002; and Tanco Ticon C, a calcium titanate ceramic with a dielectric constant of 165 and a loss tangent of 0.001.

The half power beamwidths of untapered Alite rods decrease with an increase in L/λ or d/λ, where L and d are length and diameter as in Fig. 1B. Radiation patterns of untapered rod elements with d/λ equal to 0.224 are shown in Fig. 3A. Sidelobes are large above four wavelengths.

The high sidelobes of the untapered antenna are decreased by tapering the rod. A ratio of minimum to maximum diameter of 0.63, as proposed in separate work by Kieley[1] and Mallach[5], is consistent with tests. Figure 3B is a graph for increasing linear taper of a rod 4.5-wavelengths long. Figure 3C is a plot of sidelobe level for the same variable. The level minima of Fig. 3C appeared to be characteristic of the tapered Alite rod for all values of d/λ and for both E and H planes. Figure 3D is a typical radiation pattern of a tapered Alite rod. The radiation pattern, taken at a wavelength of 3.2 cm, indicates the coincidence of the E and H plane main lobe, a result of the similar distributions of the electric and magnetic fields of the hybrid mode.

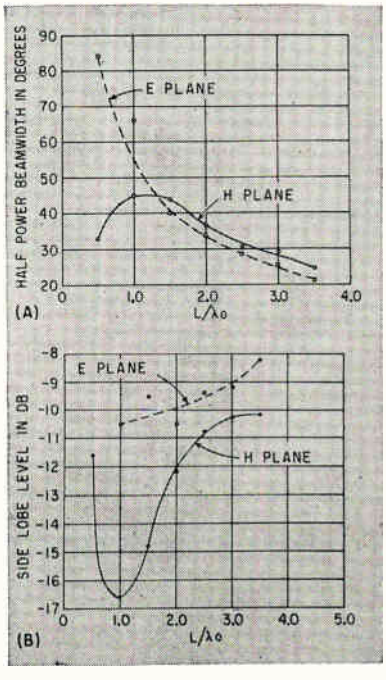


FIG. 4—Characteristics of ceramic NPOT-96 rod with diameter of 0.300 inches. For d/λ_o of 0.163, beamwidth is shown in (A); sidelobe level (B)

The vswr of the Alite rod was below 1.1 over a narrow band with a plate thickness of 0.187 inch and depth of rod penetration into the guide of 0.270 inch. The match was improved by chamfering the feed end of the rod. A vswr of less than 1.5 is easily achieved over ±5 percent of the band.

The half power beamwidth for ceramic NPOT 96 for d/λ_o equal to 0.163 is illustrated in Fig. 4A. Interaction between the rod and the comparatively large ground plane formed by the a dimension of the waveguide accounts for the small H plane beamwidths for rod lengths less than λ. The narrow b dimension has little effect on the E plane pattern for lengths greater than 0.5λ. Figure 4B illustrates the sidelobe levels for the same element. In general, the sidelobe levels of the ceramic NPOT 96 are lower than for the lower dielectric constant Alite material.

Calcium titanate rods are expected to be similar to ceramic NPOT 96 rods.

Rod Array

Dielectric rods are excellent array elements because of small cross section and weight for a given radiation beamwidth. With only the middle element of a three rod array excited, radiation patterns similar to single elements are obtained, thus showing the permanence of the beam in the presence of other elements. These radiation patterns, similar to those of Fig. 3D, are shown in Fig. 5A. The H plane patterns are unchanged except for minor changes in the sidelobe structure; the E plane beamwidth has decreased at the expense of a higher sidelobe level. The vswr of a single unit in free-space and in an array are alike.

A 17-element Alite rod array was designed for X-band operation, with inter-element spacing of 0.800 inch. The antenna has a beamwidth of 8.5 degrees in the array plane; the aperture distribution is the one described by Taylor[7] for an optimum beamwidth vs sidelobe relationship. Figure 5B shows the radiation patterns of the antenna at 9,050 mc for both E and H planes. The vswr at 9,050 mc was 1.02 and increases with frequency to a maximum of 1.8 at 9,850 mc where the slot spacing becomes resonant at half guide wavelength. A more efficient method of coupling to dielectric rods in a large array is directly from the narrow guide face of a rectangular waveguide.

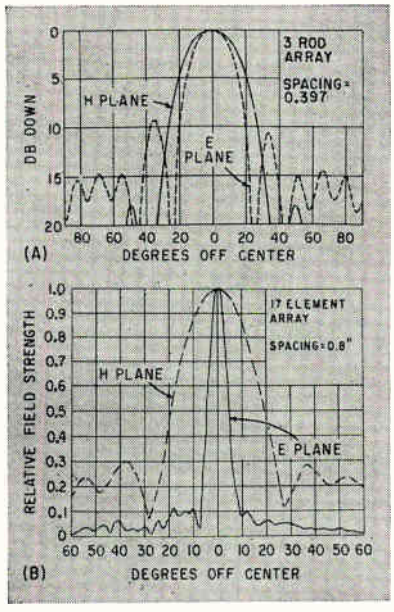


FIG. 5—Radiation pattern for 3-element array (A), 17-element array (B). Rods are Alite AE-212, 6 in. long, 4 in. taper, D_{max} 0.270, D_{min} 0.170

Ceramic end-fire arrays are well adapted for use where a low silhouette with a high degree of vertical resolution is required.

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*Failure of 10% of the total contacts involved eliminated any group from the test. Additional data available on request.

Line Voltage Control Uses Zener Diodes

Compact five-transistor circuit uses breakdown diodes to regulate voltage inputs between 140 v and 113 v to within 0.5 volt of 110 v. Waveform distortion is no problem

By **R. A. GREINER,** Assistant Professor, College of Engineering, University of Wisconsin, Madison, Wis.

A SMALL, inexpensive, and light weight line voltage controller is described here. This controller is designed for use where the line voltage is always somewhat higher than the desired value. It provides regulation with some loss in voltage. In cases where the line voltage must be boosted, it is possible to use an autotransformer ahead of the regulator to increase the normal line voltage above the required regulation point at its lowest expected normal fluctuation.

Regulation

The regulator, shown in Fig. 1, was designed to deliver two amperes to the load. This capacity can be easily increased by the use of higher power transistors or by paralleling the output transistors.

The regulation for an input voltage range of from 140 v to 113 v is ± 0.5 volt at 110 volts. As can be seen from the circuit, the operation is relatively straight-forward. The output voltage is detected by the filament transformer and half wave rectifier combination. This signal is filtered and sent to a comparison amplifier where it is compared to a reference voltage established by the breakdown or Zener diode.

The signal from the comparison amplifier is then amplified by the 2N250 and sent to the control transistors. The impedance of the transistors is controlled by the current in the emitter-base loop which contains the 2N250 and the power supply.

Diode Protection

The diodes protect the transistors from large reverse bias on the emitters and forward bias on the collectors. A half-wave capacitor-filtered supply supplies the control currents. Again, breakdown diodes are used to regulate the supply voltage. Despite the simplicity of this regulator, it gives good results.

Waveform distortion was expected to be a problem with this type of regulator. It was found, however, that no distortion was observed on the oscilloscope. Since any small residual distortion was of no concern in the proposed application, this matter was not pursued further.

Filtering

It may be noted that in order to make a comparison between the alternating output voltage and a more convenient d-c reference voltage, it is necessary to rectify and filter the output signal. There are two limits to the amount of filtering which must be observed. In one case, that of inadequate filtering, ripple at the difference amplifier will overdrive the amplifier, reduce the effective gain, and give distortion in the regulated signal. In the second case, if filtering is too great, the response to sudden line voltage changes will be poor.

The 8-ohm shunt resistor may be adjusted to increase or decrease the range of regulation and the current capacity of the regulator over a considerable range. The resistor should be physically isolated from power transistors when line voltage is high.

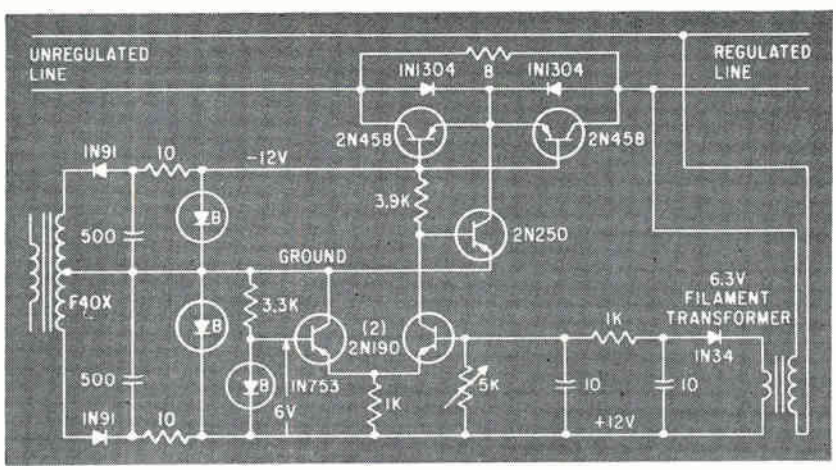

FIG. 1—Transistorized line voltage regulator can be modified for increased capacity

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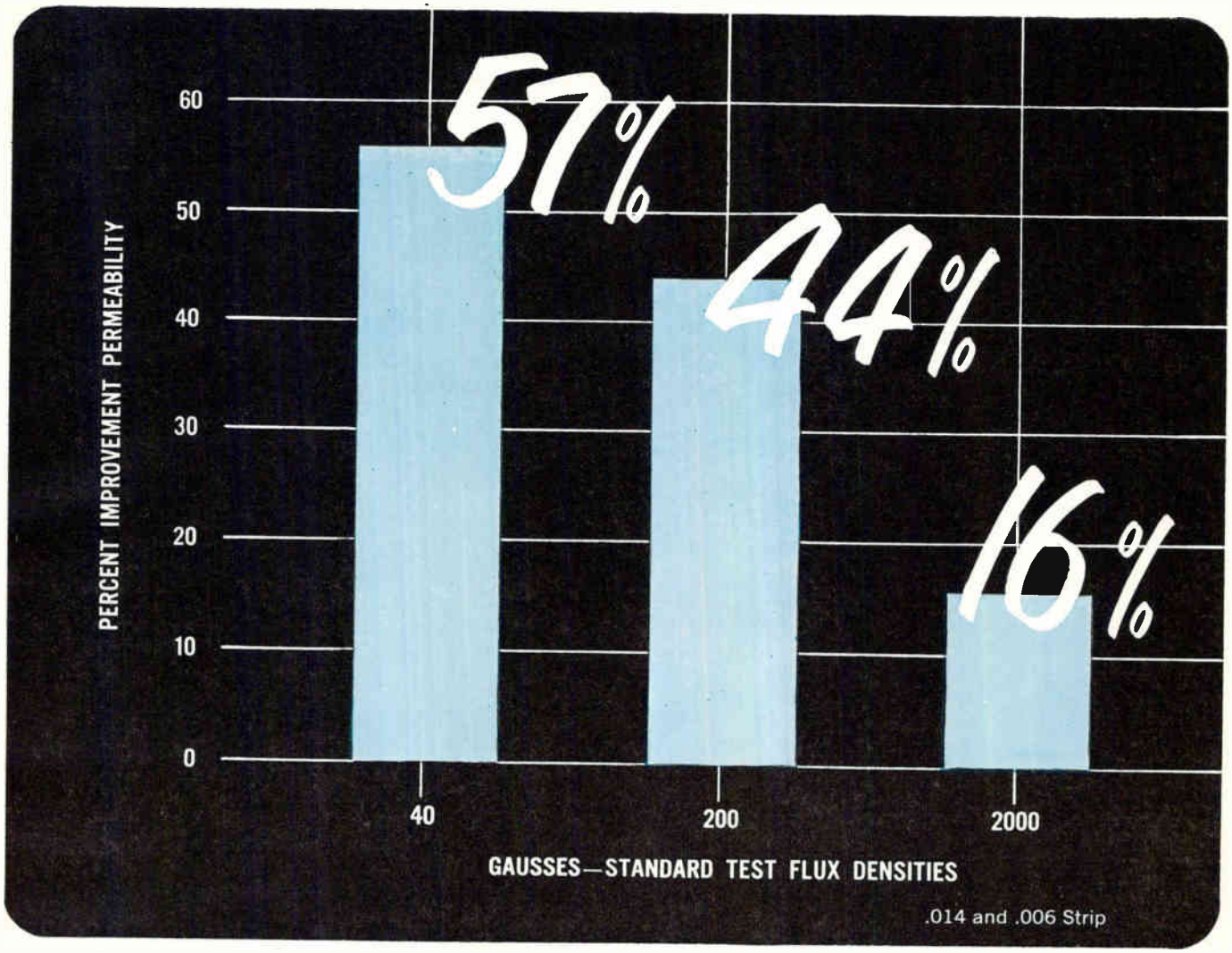

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AF Plans Re-Entry Plasma Tests

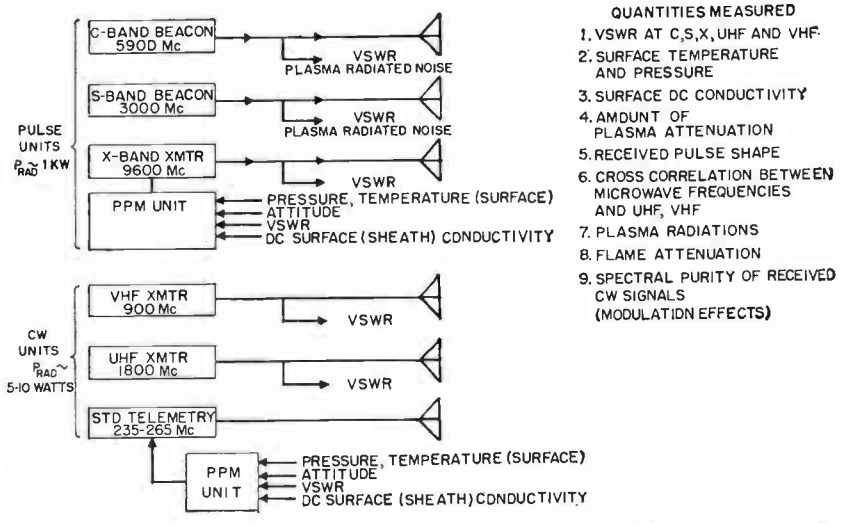


FIG. 1—Re-entry experiment will attempt to determine quantities listed at right with equipment shown at left

NONABLATIVE nose cone in a re-entry trajectory will be used to investigate effects of the plasma sheath on radio signals. The Air Force is preparing to fly an instrumented nose cone next fall from Cape Canaveral for the research.

The Scout, 4-stage, solid-propellant space research vehicle will be used. The test will be part of a series of 10 flights with ballistic missiles or space probes. Aeronutronic will supply the nose cone, a heat-sink type using copper and stainless steel. It is expected to burn up at 100,000 ft, but to survive during the specific region of interest—400,000 to 100,000 ft altitude.

Equipment

Equipment will also be supplied by Avion, Melpar and RCA. Results will be compared with calculated values and with test data from the University of California's hypersonic wind tunnel.

The flight profile will be such that an altitude of about 100 miles and a maximum velocity of 16,500 ft/sec will be reached in a shallow (8 to 12 deg) re-entry path.

Instrumentation will consist of 5 microwave transmitters in the L, S, C and X bands and receivers in the S and C bands (see Fig. 1). Units operating in the S and C bands will also serve as radar beacons, while telemetered data is transmitted at the X-band frequencies. The instrument package will be an 18-inch cylinder 3 feet long.

Standard S and C-band receivers at Canaveral will be used, and RCA will implement the range to receive X-band frequencies. Receiving equipment will be located at Grand Bahama Island and San Salvador, in addition to Canaveral.

Objective of the experiment is to investigate the properties of the plasma medium and also the interaction of this medium with electromagnetic energy. Researchers headed by Walter Rotman and Lt. Gerald Meltz of Air Force Cambridge Research Center will try to determine the average electron density in the flow field and at what altitude the electron density builds up appreciably.

The test is also expected to help determine attenuation versus operating frequency in the plasma medium. Scientists will monitor the noise radiated from the plasma, and also separate attenuation produced by voltage breakdown from that produced by absorption. They hope to determine effects of plasma turbulence on a c-w signal and to look for possible cross modulation (Luxembourg effect).

Reflective energies of the plasma will be measured at all frequencies; and in the ascending portion of the flight, flame attenuation will be measured.

Noise Source Has Constance Impedance

By A. C. MACPHERSON, U. S. Naval Research Laboratory, Washington 25, D. C.

STANDARD method for measurement of noise figure of microwave amplifiers involves alternately connecting a cold load and then a hot load (usually a gas tube) to the test amplifier input. Gas tubes with about the same impedance in the unfired and fired conditions have been successfully used for both loads.

Some newer microwave amplifiers, such as cavity masers and parametric amplifiers, are very sensitive to source impedance. The small impedance change of the gas tube from the unfired to the fired condition is not acceptable. The amplifier may even go into oscillation when the gas tube is fired.

One method of dealing with this problem is to pad the gas tube with an attenuator[1]. However, an attenuator reduces equivalent source noise temperature, and it introduces errors because of attenuator calibration and because the attenuator is not properly terminated.

Figure 1 shows a quick method of producing hot and cold loads with almost identical impedances. The transformer is adjusted so that impedance looking in at flange AA' is independent of switch position. This adjustment can be easily and

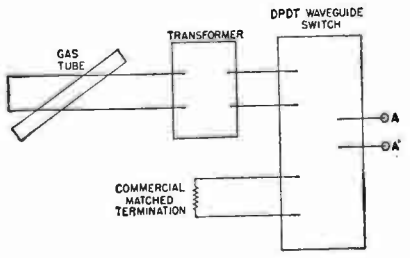
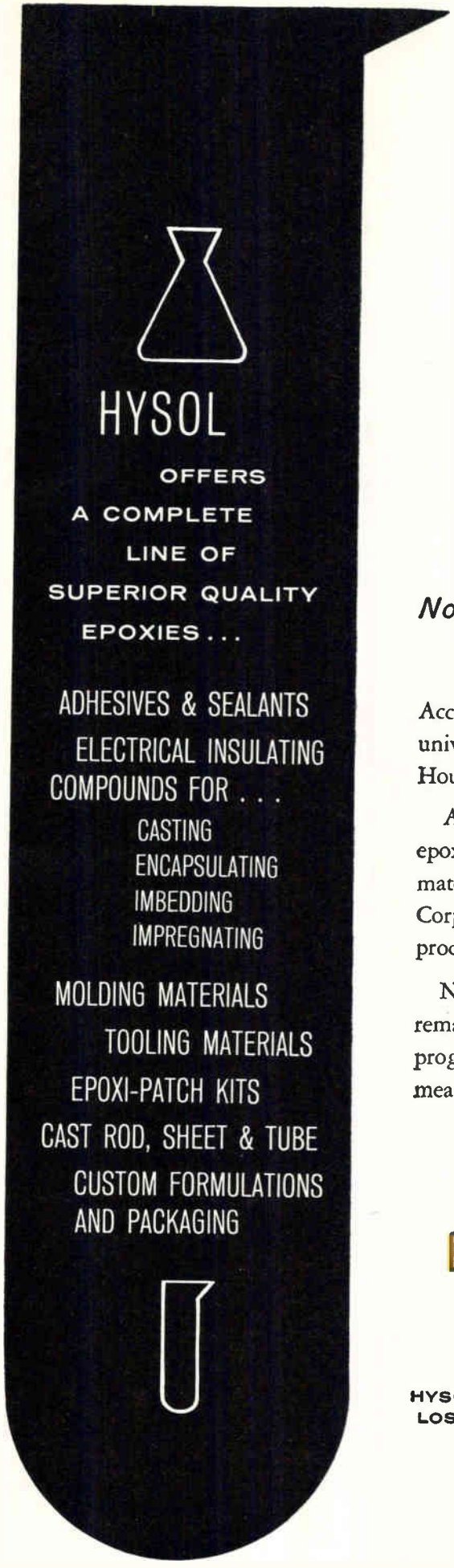


FIG. 1—Hot and cold loads for measuring noise figure of microwave amplifiers have almost identical impedances



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CIRCLE 67 ON READER SERVICE CARD

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Microwave Mixer for Airborne Radar

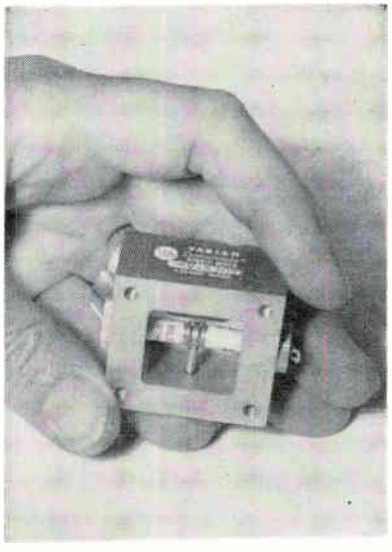
By PAUL I. CORBELL, Radiation Division, Varian Associates, Palo Alto, Calif.

MOST MICROWAVE receivers ordinarily utilize a balanced mixer for the suppression of local oscillator noise and consequent improvement of receiver sensitivity. The balanced mixer utilizes two separate mixers driven in shunt by the signal and in push-pull by the local oscillator or vice versa.

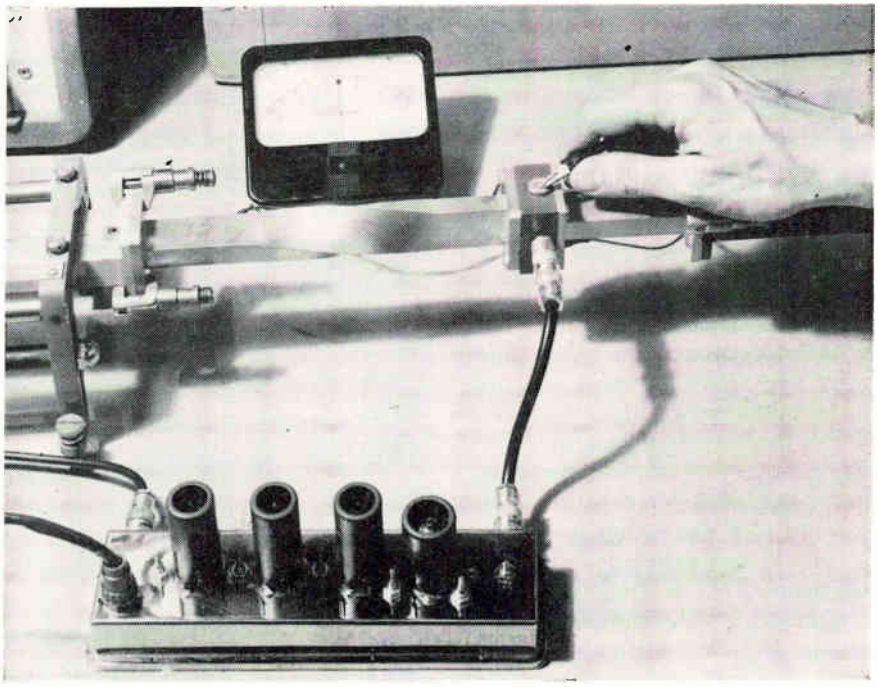
A new type of hybrid mixer, the ORTHOMODE* hybrid mixer, more compact than existing balanced mixers, is now available from Varian Associates. The hybrid retains all the desirable characteristics and low noise performance of magic-T and short-slot hybrid types but is much smaller and lighter. The design is of particular interest for airborne radar and missile receiver applications where space and weight are important considerations.

This mixer is suitable for frequency ranges from S-band through Ku-band and models are commercially available at C-band and X-band at the present time. One of these models, the V-8302, is rated for low noise operation in the range 8.5 to 9.6 kmc without adjustment. Typical noise figure data for the V-8302 is shown in Fig. 1. The data shown includes noise contribution of a 3 db i-f strip and includes 3 db allowance for image noise.

*Patent Pending, Trademark



Microwave mixer saves weight and space and provides sensitivity identical with that of conventional balanced mixers



Compact mixer duplexer arrangement. The mixer is connected between two waveguides. Waveguide on the left supplies local-oscillator power and the right waveguide supplies microwave power from a noise source for noise figure measurements. Slots at the l.o. face of the mixer permit adjustment of a built-in attenuator card to set the appropriate level of l.o. injection. A crystal protector is bolted on to the crystal side of the mixer

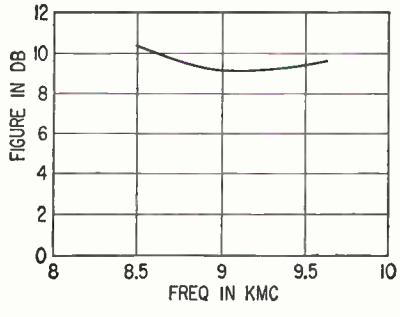


FIG. 1—Typical data for hybrid mixer rated for low-noise operation

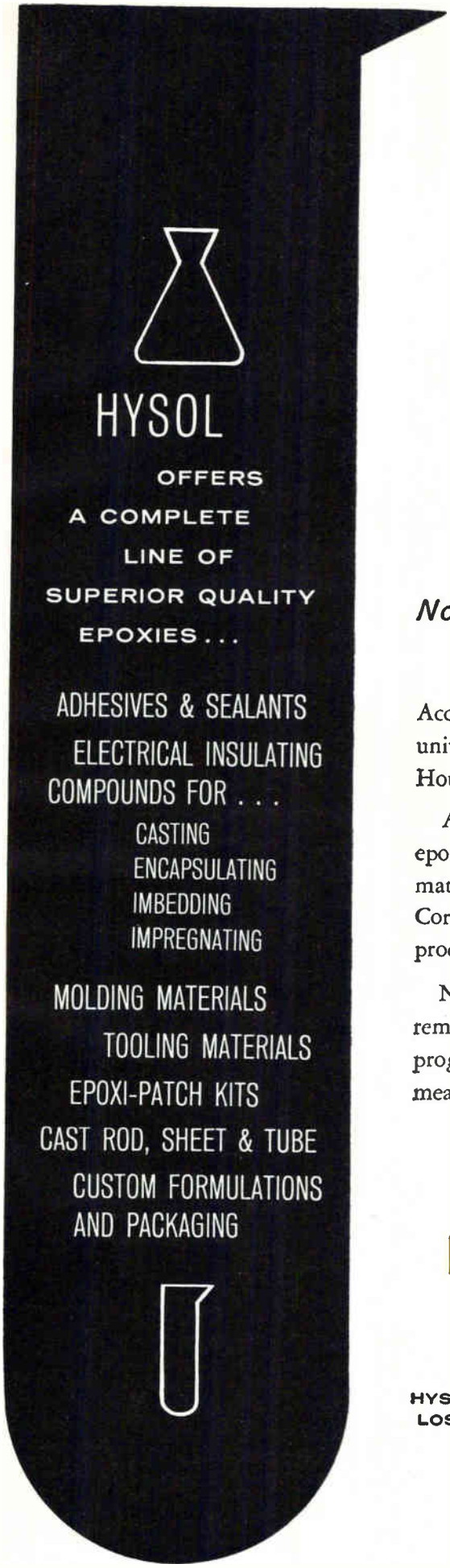
Signal Field

The mixer body is a section of square waveguide which will support waveguide modes at right angles or orthogonal to each other. Two crystals are connected in series across the square waveguide with a connection to the i-f output at the junction of the two crystals. One of the crystals is of reversed polarity such that although the signal field is in the same direction, the i-f output of the crystals add at the common junction.

The signal field is applied in the direction of the crystals as shown in Fig. 2A and the signal voltages across the crystals are *in phase*.

The local oscillator field is applied at right angles to the crystals and this direction of field would normally apply no voltage to the crystals. However, the local oscillator field is deliberately distorted by the conductor which passes from the center or crystal junction to the i-f output. This distorted field has components of *opposite phase* across the crystals. (See Fig. 2B). The signals and l. o. fields on one crystal add while on the other crystal the fields substract. The local oscillator noise is cancelled in this balanced mixer arrangement.

Figure 3 shows the complete cir-



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accurately made using a magic Tee technique[2]. The resultant swr at AA′ is approximately one.

If a measurement of noise figure versus impedance is desired, a transformer can be connected at AA′ and any desired impedance can be realized that will be identical for hot and cold loads. For fast operation, it is only necessary to switch from the cold to the hot load, leaving the gas tube in the fired condition. Since matching procedure includes the switch, mismatch in the switch is not objectionable as long as the switch is accurately repeatable. The switch must not be lossy, however. Nearly perfect waveguide switches (low loss and mismatch) are commercially available.

REFERENCES

(1) J. C. Green and P. P. Lombardo, Low Noise 400-Mc Reactance Amplifiers, *Microwave J.*, p 28, May 1959.
(2) A. C. Macpherson, Magic Tee Techniques Refine Load Matching, ELECTRONICS, p 230, Nov. 1957.

Cooler Modules for Components

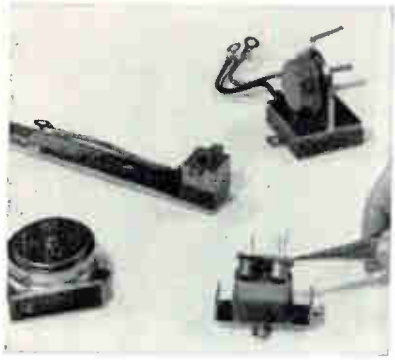
EXTENSIVE research and development program at Westinghouse has resulted in thermoelectric cooling devices for industrial and military applications. They are designed for use as electronic component coolers where compactness, silent operation with no moving parts and a controlled cooling rate are desired.

The modules are designed in a variety of shapes and sizes for simple mounting in any position when used with transistors, diodes and other components. The basic units can be physically parallel to cool a large flat area, or stacked in series for increased cooling.

Need for Coolers

Electronic advances have created the need for an efficient electronic component cooler. Space, weight and operating temperatures have become more critical in control and guidance systems of new aircraft and proposed unmanned vehicles. Components have been miniaturized along with their associated circuits. But these compact designs create difficult heat dissipation problems.

Present cooling techniques are complicated by the nonuniform dis-



Modules, adapted with different mounting fixtures, can cool various sizes and types of transistors

tribution of heat generated by certain components. Such hot spots effectively derate the total equipment and limit its maximum operating temperature. Heat dissipation using ambient air can only limit the temperature rise of components above ambient temperature. They cannot cool the component below ambient temperatures. However, thermoelectric cooling provides a lower local temperature, reducing the probability of early component failure. Equipment can be operated in higher ambient temperatures with greater reliability.

Because the thermoelectric cooling modules have no moving parts, they can be mounted in any position. For example, by proper orientation, a number of modules could be constructed to form the walls of a box. Special mounting fixtures can accommodate one or more components like transistors or diodes.

Cooling Capacity

Heat pumping capacity depends on the temperature difference between hot and cold surfaces of the cooler and on the power input to the unit. A typical module can maintain a temperature differential of 25 C with a heat load of more than 17 Btu/hr. To supplement the heat rejection capacity of the module, air or liquid cooling can be applied to the hot side of the thermoelectric cooler. The exact amount and type of this cooling will affect the heat pumping capacity and ultimate temperature of the cold surface of the module. In general, the modules require high d-c at low voltage.

In many cases equipment need not be redesigned to accommodate the thermoelectric devices.

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By PAUL I. CORBELL, Radiation Division, Varian Associates, Palo Alto, Calif.

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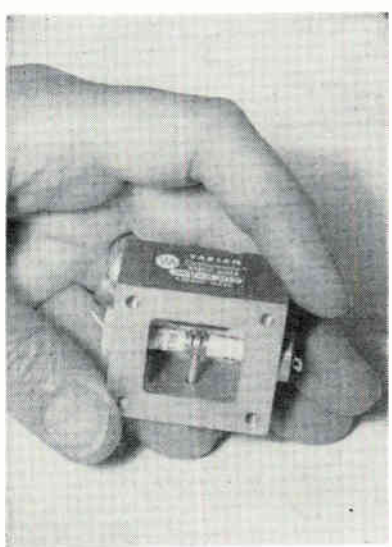
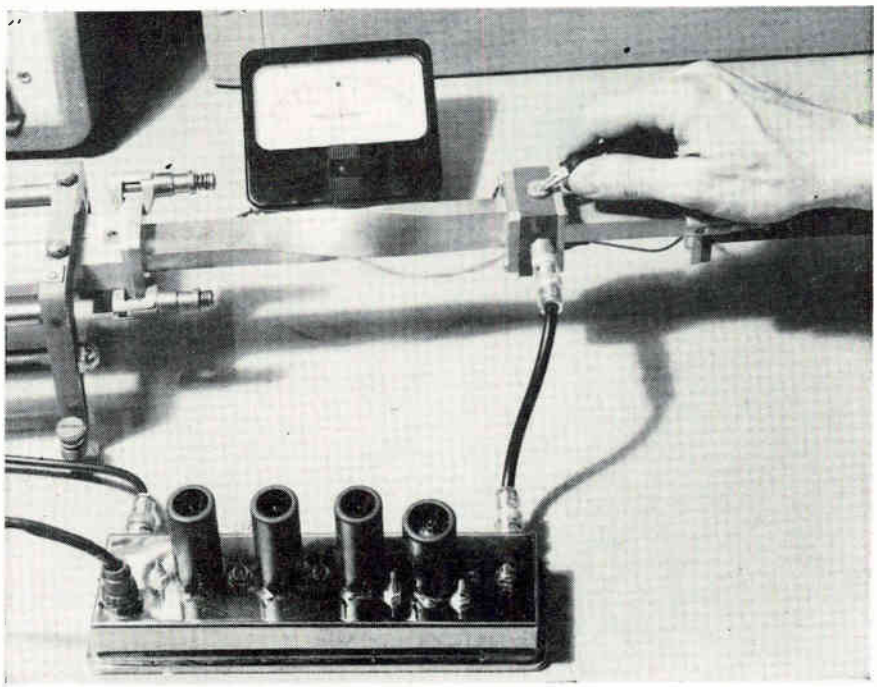


Microwave mixer saves weight and space and provides sensitivity identical with that of conventional balanced mixers



Compact mixer duplexer arrangement. The mixer is connected between two waveguides. Waveguide on the left sepplies local-oscillator power and the right waveguide supplies microwave power from a noise source for noise figure measurements. Slots at the l.o. face of the mixer permit adjustment of a built-in attenuator card to set the appropriate level of l.o. injection. A crystal protector is bolted on to the crystal side of the mixer

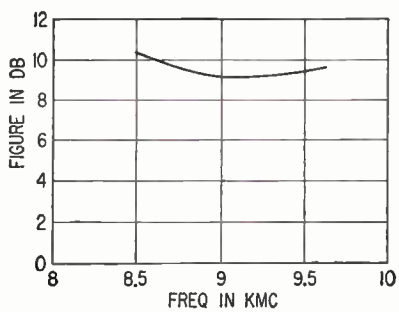


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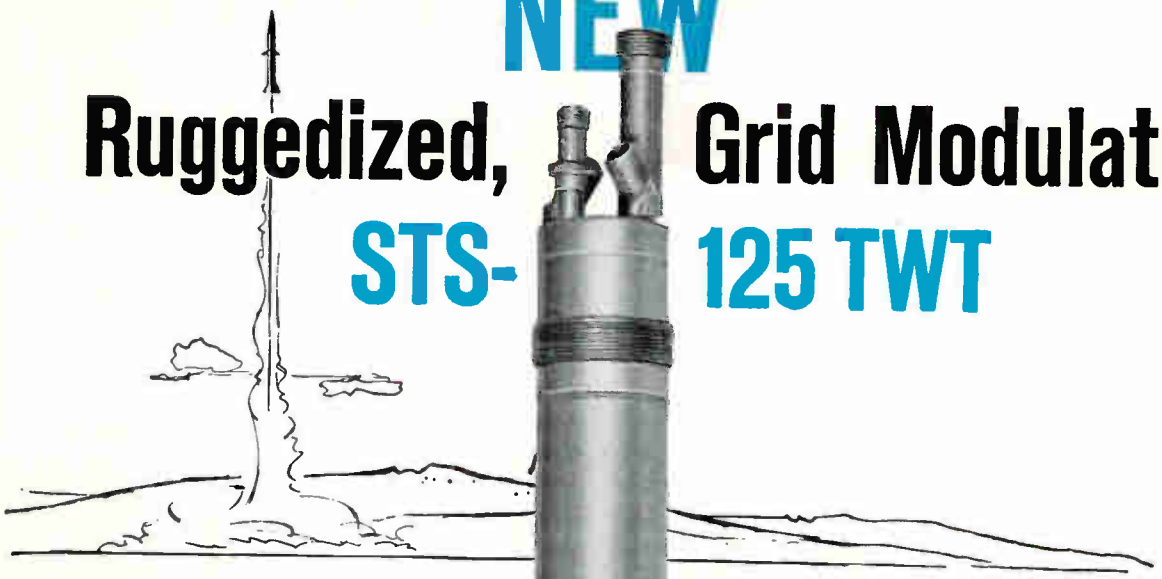
Figure 3 shows the complete cir-

NEW

Ruggedized, Grid Modulated STS-125 TWT



provides 2% duty cycle operation

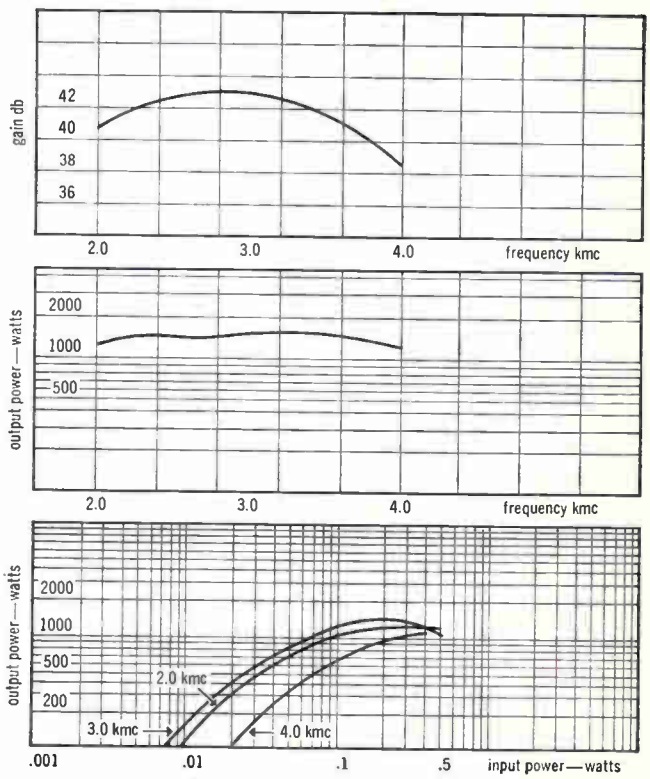
This new pulsed traveling wave tube amplifier—the Sperry STS-125—offers *2% duty cycle operation* for greater reliability in a broad variety of applications. An ideal driver for high duty cycle radars and for missile guidance radar, it has been subjected to severe environmental tests — including 4 G's of vibration and 15 G's of shock—with negligible performance variation. Its wide range of operating temperatures (—55°C to 90°C) suits it to storage and service in any climate.

The STS-125 also features grid modulation (2½% of beam voltage), dielectric liquid cooling, and unusually rugged metal ceramic construction. Operation is over a broad band (2:1 frequency bandwidth) at a minimum rated output power of 1 kilowatt.

Write for complete information and specific application data.

SPECIFICATIONS

Frequency Range	2.0-4.0 kmc
Rated Output Power	1 kw min
Input Power at Rated Output Power	½ w max
Small-Signal Gain	40 db nom
Gain at Rated Output Power	33 db min
Beam Power:	
Peak	25 kw
Average	500 w
Grid Voltage	300 with respect to cathode
Heater Current	3.2 a
Heater Voltage	6.3 vac
Pulse Length	10 u sec
Duty Cycle	.02
Cold Insertion Loss	60 db min



SPERRY

ELECTRONIC TUBE DIVISION, *SPERRY GYROSCOPE COMPANY, GREAT NECK, NEW YORK, DIVISION OF SPERRY RAND CORPORATION*
Address inquiries to Great Neck or Sperry offices in Brooklyn, Boston, Chicago, Philadelphia, Los Angeles and Montreal. Export Dept., Great Neck, N.Y.

cuit diagram of the mixer. The r-f choke in the i-f output presents a very low shunt impedance to the signal and local oscillator frequencies and transmits the i-f easily. This choke prevents the r-f from entering the i-f amplifier.

The crystals are insulated from the body of the mixer to permit

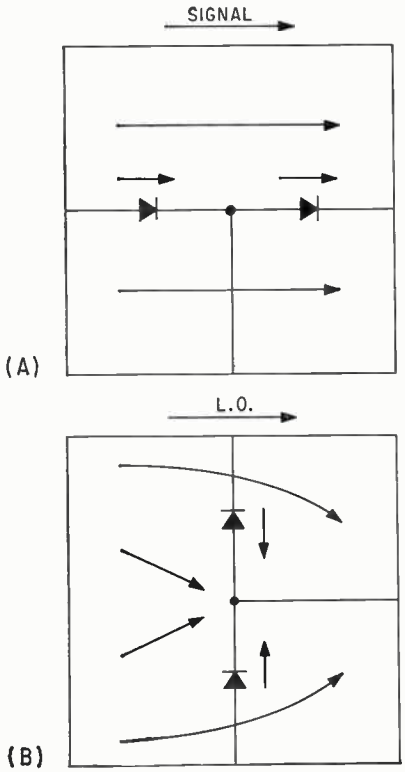


FIG. 2—Signal field arrangement showing signal voltages across crystals (A) and distorted field of local oscillator (B) applied at right angles to crystals

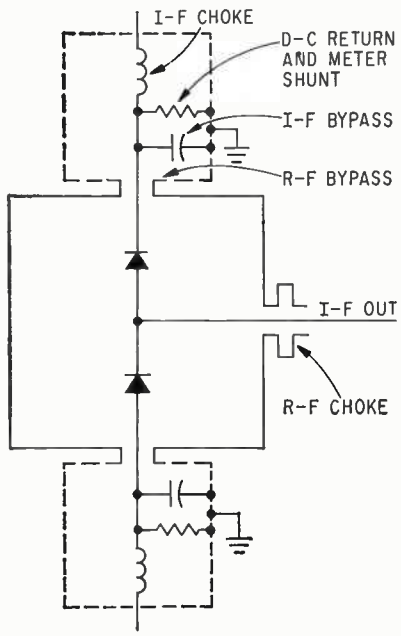


FIG. 3—Circuit diagram of mixer

measurement of d-c crystal current. An r-f bypass capacitor between the crystal and mixer body provides a low impedance path for the signal, l. o. and i-f frequencies.

Each crystal cap also contains a filter network to reject the i-f frequencies and provide a d-c return path for the crystal current. A 22-ohm resistor is connected between the crystal and ground. This resistor provides a path for the d-c crystal current and the voltage across the resistor is a measure of the crystal current. The total shunt resistance across a milliammeter connected between the cap terminals is thus 44 ohms. The hybrid mixer is expected to be important to designers faced with difficult packaging problems in missile and aircraft environments without any compromise in electrical performance and reliability.

Experimental Work On New Transducers

DESCRIPTION of a passive, reversible, distributed-coupling transducer was presented in a paper delivered by W. James Trott at the Third International Congress on Acoustics, Stuttgart, Germany last fall.

Reversible

Electrical energy is fed into a low-pass artificial line in which the capacitors are piezoelectric cylinders. The cylinders, coaxially mounted, convert the electrical energy through the distributed coupling into a progressively increasing acoustic wave in the water within the cylindrical tube so formed. There exists an optimum length of these coupled electrical and acoustical transmission lines of equal phase velocity for which, at one frequency, no electrical energy remains. A low Q, good efficiency, and essentially constant impedance are achieved by this design. The transducer is reversible. Theory, design and measurement data was obtained from an experimental transducer. Other designs will also be tried at the U. S. Navy Underwater Sound Reference Laboratory, Orlando, Florida.

Tube Tester Prepares Computer Data

ELECTRON TUBE TESTER which automatically prepares test data in digital form on punched tape for computer analysis was described at the Radio Fall Meeting by Roy A. McNaughton, of Receiving Tube Operations, Sylvania Electric Products, Inc., New York.

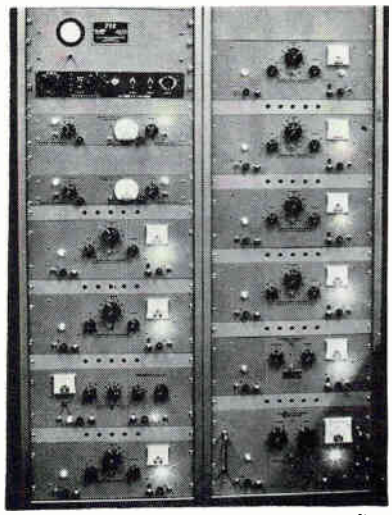
Designed to curtail increases in cost and time spent in quality control operations, the set performs 20 tests normally made on vacuum tube bridge consoles. Its speed is 5 times that of manually-operated test sets. It will handle a wide variety of tube types with a changeover time of about 3 minutes.

The set is housed in 3 cabinets (Fig. 1). The programmable, regulated d-c power supplies are preset by punched cards. Test conditions, connections and instruments are programmed through prewired program boards which can be changed as required. The readout section tapes test data and prints a copy which the operator can scan for obvious set malfunction. Codes, computer instruction and data acquired from other sources can be manually inserted in the tape with the keyboard.

The operator installs and loads the proper tube preheat socket panels and inserts a punched card. If necessary, he changes the test socket adapter and program board. Initial codes are typed on the keyboard. The operator then loads the 2 test sockets alternately, as test cycles are completed.

Test voltages required for each tube type are picked up from the power supplies by a switching system. Pressing the start button activates a scanning switch, which in turn activates the tape punch and advances the test selection switch bank through the test positions.

The digital voltmeter is arranged to read out at balance and feed each test result into the memory matrix.



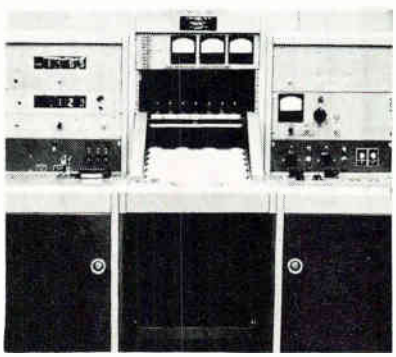
Number of regulated power supplies allows d-c voltages to be preset

The reading is held in memory until read out by the memory scanning switch, which feeds the value through the diode coding matrix into the tape punch. After a value is scanned, a control signal unlocks the memory matrix and the voltmeter.

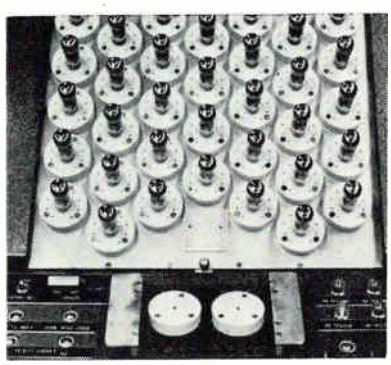
After all tests are completed, a stop symbol is taped, the serial number for the next tube is punched and testing switches to the second test socket. If the operator fails to reload the first socket before testing is completed on the second socket, the set shuts down until restarted. Provision is also made for manual test cycling, deletion of tests, addition of tests and repetition of tests under changed conditions without reloading small lots.

If a test value is so variable that the digital voltmeter fails to balance within a preset time, the circuit of Fig. 2 forces a readout. The value is not recorded and the computer is instructed to delete all measurements for that tube. If set malfunction is suspected, the tube can be retested.

In Fig. 2, S_1 is open during the test and closed between tests and at the end of the test cycle. A goes to the read circuit of the a-c voltmeter, B to the read circuit of the d-c voltmeter and C to the forced readout printout control. Time de-



Main console of test set



Preheat panel and test sockets

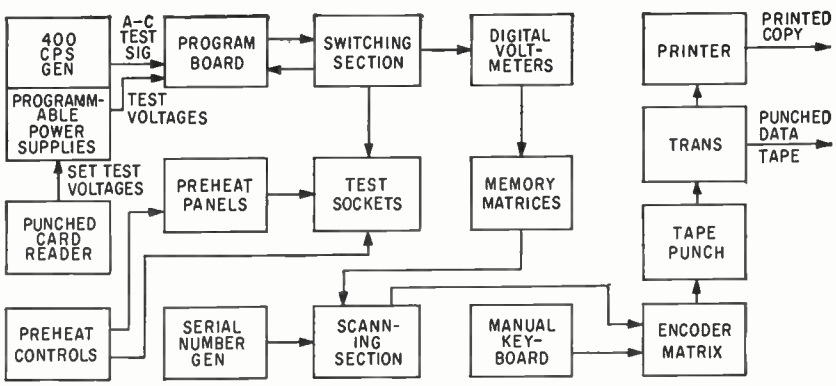
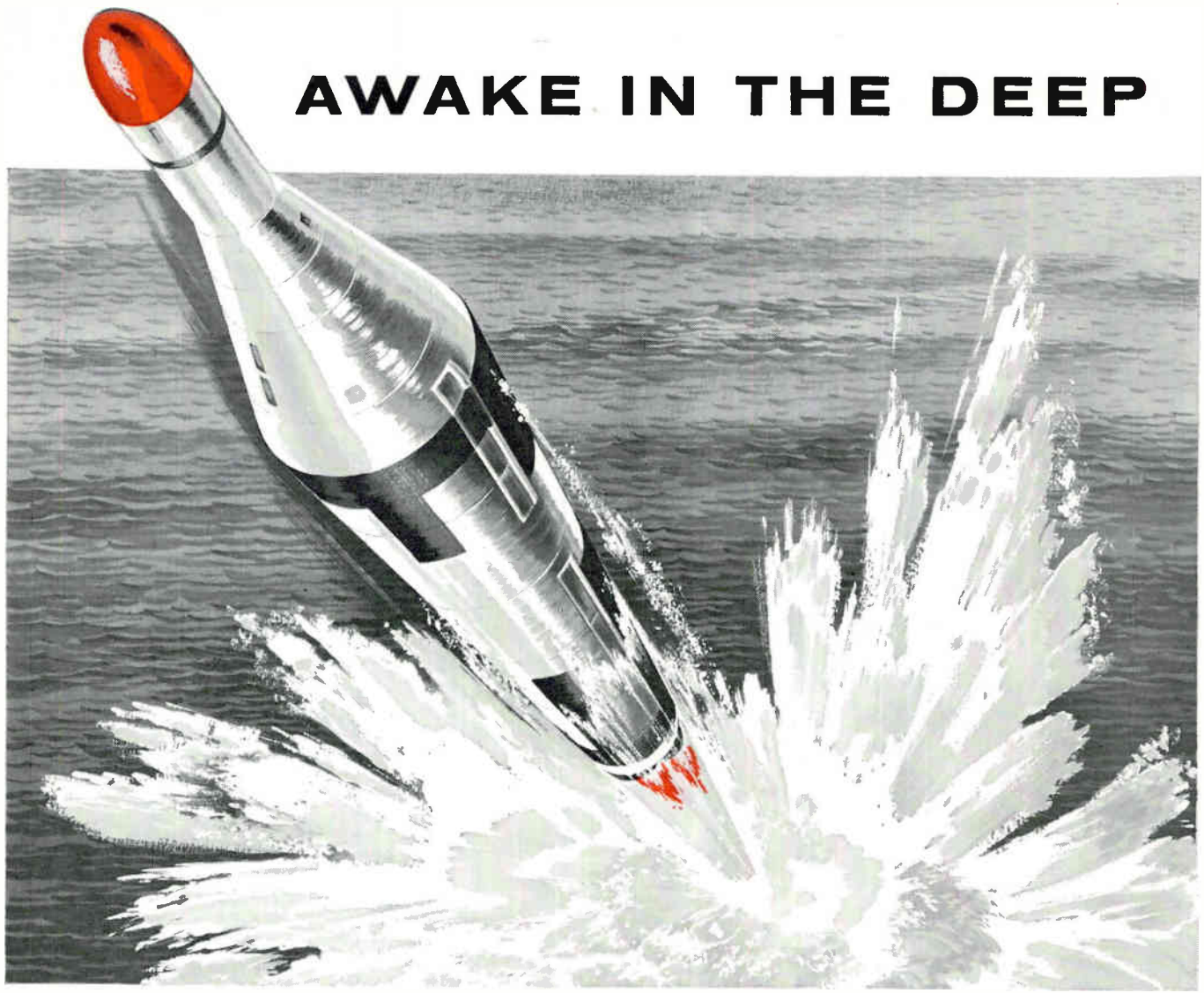


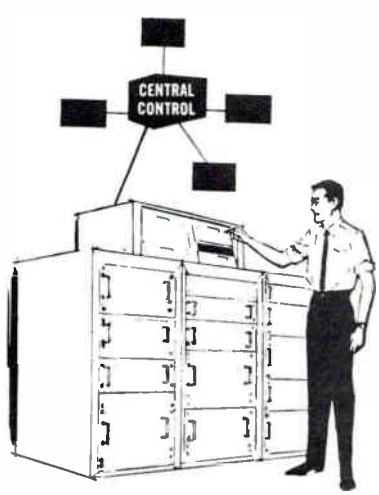
FIG. 1—Cabinets containing power supplies, main console with switching and scanning sections, and keyboard and readout are connected by cables to allow freedom of location in test area

AWAKE IN THE DEEP



and ready...checked out by PBE system

Soon American seamen aboard swift, nuclear-powered submarines will patrol "Awake In The Deep"...armed with the U.S. Navy's devastating POLARIS fleet ballistic missile. Besides alertness there will be readiness, guaranteed by automatic production checkout units designed and built by Packard Bell Electronics for the Missiles and Space Division of Lockheed Aircraft Corporation. The factory checkout system for POLARIS consists of a central control station and remote test consoles for *Receiving Inspection, Package, Flight Control and Systems* checkout. All units are self-powered, self-checked, modular designed, fully automatic and solid-state. All can be adapted for use with any missile, aircraft or other weapon system.



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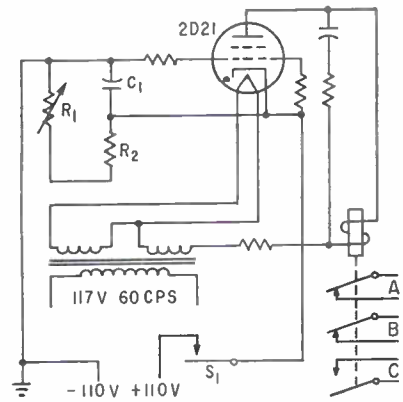


FIG. 2—Forced readout control circuit deletes spurious test results

lay before forced readout is controlled by the time constant $(R_1 + R_2)C_1$.

Lazy Susan Pace Timed by Relays

LAZY SUSANS which pace the work of electronic assemblers are being used at the Martin Company's Baltimore division. The company reports that the rotary assembly wheels have the capabilities of a conveyor line, but take no more space than an assembly bench.

Each wheel is 6 feet high, 6 feet in diameter at the base, has 24 assembly positions and is manned by 3 persons. Operation is controlled by a Ledex stepping relay, which permits circuits for stepping, counting and selecting. The wheel is moved by air pressure, at 30 psi, via an air solenoid. Three seconds before the stepping relay is energized, the timer actuates a warning buzzer.

Engineering and supervisory time normally required to establish procedures is reduced by the wheel,

Demodulators are assembled by 3 operators working together on motorized rotary wheel

Martin says. New work is set up by supervisors, who make a temporary analysis of the pace required. Time can be adjusted from 2 to 180 minutes per step.

Plasma Gun Sprays Refractory Coatings

MATERIALS with high melting points can be sprayed onto materials with relatively low melting points with a gas plasma spray gun developed by Metallizing Engineering Co., Inc., Westbury, N. Y. The gun will develop electrically dissociated gas streams as hot as 30,000 F, but is normally used at temperatures of 10,000 F to 15,000 F.

Among the materials spray-coated with the gun are alumina and other ceramics, nickel, molybdenum, tungsten and mixtures of ceramics and metal. High-temperature materials can be sprayed on glass-based plastic materials. Relatively low-melting materials can be sprayed on plastic. The gun has also been used to coat electronic tube parts.

The carrier gas is ionized by heating it with a d-c arc in a confined space. Nitrogen gas is used because it is inert, a good carrier of heat and inexpensive. The gun's heat output is about the same as acetylene metallizing equipment and it is water-cooled. Commercial availability of the gun was recently announced after some 18 months of field testing.

Ions Detect Pinholes In Wire Insulations

PINHOLES in wire and cable insulation may be detected by running the insulated wire between bare wires spaced a few inches apart. The bare wires are at high potential to create a cloud of ionization. In the absence of a pinhole, the current flowing to the wire under test is small. The current increase resulting from a pinhole is easily detected and can be made to operate an alarm or counter. The method was developed by the Division of Electrotechnology, Commonwealth Scientific and Industrial Research Organization, Sydney, Australia.

On The Market

Electronic Timers
two types

GEMCO ELECTRIC CO., 25685 W. Eight Mile Road, Detroit 40, Mich. Type D timer performs a time delay after deenergization and type E on energization. They are designed for applications in machine tool and automation circuits where a time delay is required in circuit function. Type D are available in time ranges from 0.06 sec minimum to 2.3 minutes maximum; type E, from 0.05 sec to 2.3 minutes. Dpdt, two normally open and two normally closed contacts are provided as standard with ratings of 5 ampere, 115 v, a-c, 5 ampere, 28 v, d-c.

CIRCLE 301 ON READER SERVICE CARD

LVDT Transducer
six models

PACIFIC ELECTROKINETICS, 329 S. Vermont Ave., Glendora, Calif. Type G linear variable differential transformer transducer has 0.3 percent to 0.4 percent nonlinearity over three-quarters of its full range. Series includes six models with a

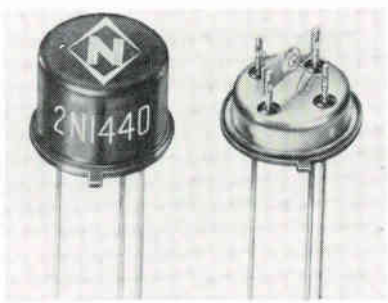
diameter of $\frac{1}{2}$ in. and lengths of $1\frac{1}{2}$ in. to 17 in. Input voltage is 6.3 v to 24 v, depending upon model. An environmental resisting instrument, it operates over a temperature range of − 100 F to + 350 F. Unit operates at a frequency of 400 cps. Phase shift is virtually constant over the stroke. Resolution is continuous, and repeatability is 0.01 percent. Sensitivity is specified as a millivolt output per 0.001 in. displacement.

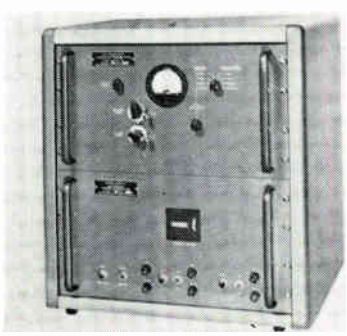
CIRCLE 302 ON READER SERVICE CARD

Silicon Transistors
for small signal use

NATIONAL SEMICONDUCTOR CORP., Danbury, Conn. Types 2N1440,-1, and -2 silicon alloy transistors are designed for small signal applications such as audio, servo and d-c amplifiers. Features include: very high device dissipation at elevated temperatures (170 mw at 125 C in free air); very high junction and operating temperatures; and guaranteed maximum current gain and maximum collector cutoff current at 150 C. For increased mechanical strength, wafer mounting tabs are welded on both ends to supports. Units exceed MIL-T-19500A specs.

CIRCLE 303 ON READER SERVICE CARD

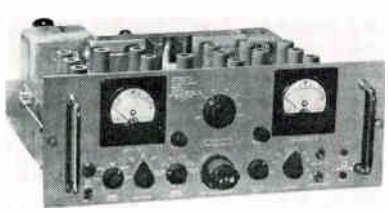




VHF Transmitter
frequency converter

CONTROL ELECTRONICS CO., INC., 10 Stepar Place, Huntington Station, L. I., N. Y. This vhf frequency converter transmitter covers the VOR band from 108 to 118 mc. It will be used with the new FAA doppler VOR navigational system. Unit provides the 9.960 kc subcarrier frequency required for furnishing the reference data to the navigational system. The transmitter, when furnished with an input signal of 1 w in the 108 to 118 mc range, delivers an output signal of 50 w c-w at a frequency 9.960 kc higher than the original input frequency. Stability of the 9.960 kc difference frequency is maintained at ±10 cycles.

CIRCLE 304 ON READER SERVICE CARD



Signal Simulator
self-contained

INSTRUMENT CORP. OF FLORIDA, Melbourne-Eau Gallie Airport, Melbourne, Fla. Model 52 signal generator generates pulse trains identical to the video data output of a standard telemetry receiver. It provides a wide range of pulse formats both stepped and continuous. Output signals exceed the accuracy requirements of the "Telemetry

Solving switch problems fast . . .

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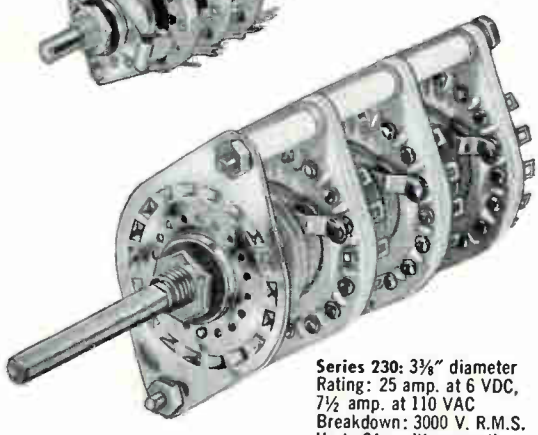
Series 100: 1 5/16" diameter
Rating: 0.5 amp. at 6 VDC, 100 ma at 110 VAC
Breakdown: 750 V. R.M.S.
Up to 12 positions/section

Series 20: 1 1/16" diameter
Rating: 2 amp. at 15 VDC, 150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 12 positions/section

Series 275: 1 7/8" diameter
Rating: 2 amp. at 15 VDC, 150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 23 positions/section



Series 230: 3 3/8" diameter
Rating: 25 amp. at 6 VDC, 7½ amp. at 110 VAC
Breakdown: 3000 V. R.M.S.
Up to 24 positions/section

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

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CENTRALAB'S unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

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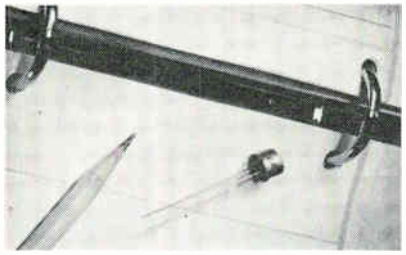
Standards for Guided Missiles," IRIG Document No. 103-56. Unit is ideal for setting up telemetry stations and conducting check-out before a missile firing.

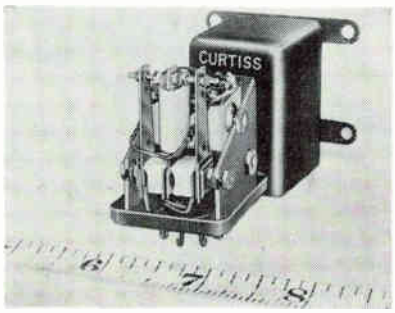
CIRCLE 305 ON READER SERVICE CARD



Silicon Transistors 15-megacycle

GENERAL ELECTRIC Co., Syracuse, N. Y. The 2N1276, -7, -8, and -9 *npn* silicon transistors, designed for general purpose amplifier and switching use, have a minimum alpha cutoff frequency rating of 15 mc. Fixed-bed mounting technique is used in their construction to assure extremely high mechanical reliability. A-C beta for the 2N1276 ranges from 9 to 22; for the 2N1277, from 13 to 44; the 2N1278, from 37 to 90; and the 2N1279 from 76 to 333 with a design center at 101. Devices have typical 1,000-cycle power gain ratings of 37, 39, 44 and 45 db respectively. Collector to base voltage ratings on the new line is 40 v. Temperature range is from −65 C to + 200 C.

CIRCLE 306 ON READER SERVICE CARD



Time Delay Relay instant recycling

CURTISS-WRIGHT CORP., 620 Passaic Ave., West Caldwell, N. J. The STR series relay for airborne and missile applications features isolated switching contacts. Voltage compensation is provided for operation on 22 to 32 v d-c. Temperature compensation is over the range of −65 C to +125 C. The instant resetting unit may be operated under high shock and vibration. Power drain is less than 3 w after the timing period, 10 w during timing. Contact rating is 2 amperes at 28 v d-c resistive load. Approximate dimensions are $1\frac{5}{8}$ by $1\frac{3}{16}$ by $1\frac{1}{2}$ in. with bracket or stud mounting.

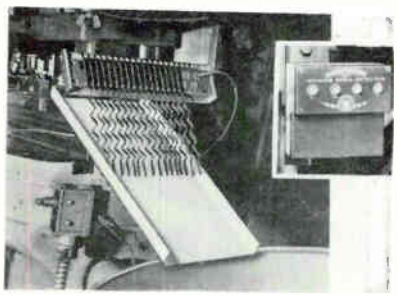
CIRCLE 307 ON READER SERVICE CARD

Variable Crossover and level control

OLSON RADIO CORP., 260 S. Forge St., Akron, Ohio. Model VC-213 is a variable high pass filter designed to allow accurate balance of volume

between the woofer and tweeter with only one control. It is a combination crossover and level control. It works with any impedance from 4 to 16 ohms. Size is 4 in. by 2⅝ in. by 1⅝ in.

CIRCLE 308 ON READER SERVICE CARD



Detector Assembly multiple feeler

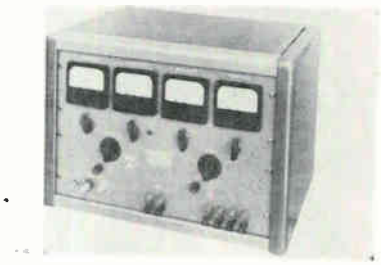
WINTRISS, INC., 20 Vandam St., New York 13, N. Y. Properly ejected small parts striking against the multiple feelers of the type 700-U assembly break a magnetic contact and send the required impulse to the Circuit-Master missing parts detector control unit. If the impulse is not received by the control unit, electronic circuits automatically signal the emergency stop circuit, preventing the machine from striking again. The unejected part cannot cause a die-damaging overload. Gravity plus magnetic pull return the feelers to normal position after each stroke.

CIRCLE 309 ON READER SERVICE CARD

Attenuators precision units

HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. Model 372 broadband attenuators remain accurately calibrated regardless of humidity, temperature or aging. They are offered in six waveguide sizes from 2.6 to 18 kmc, with nominal attenuations of 10 or 20 db. Attenuation accuracy averages better than ±0.4 db from nominal. Variation across the band is less than ±0.5 db from mean. Since there are no protrusions into the waveguide, swr's are permanent and extremely low—1.05 to 1. Price is from $115 to $375 depending on the waveguide band.

CIRCLE 310 ON READER SERVICE CARD



Dynamic Test Set self-contained

WALLSON ASSOCIATES, INC., 912 Westfield Ave., Elizabeth, N. J., announces a dynamic rectifier analyzer for incoming inspection, on-line testing and laboratory use. Forward current and reverse voltage controls are independently adjustable. Forward current range of

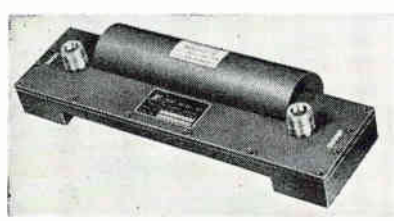
model 138A is 0-1 and 0-5 amperes d-c average, with a reverse voltage peak of 0-1,000. It measures a forward drop range of 0-1/5 v and a reverse current range of 0, 0.05, 0.5, 5, 50 ma average. Permanent provisions are included for monitoring all four parameters with an external oscilloscope.

CIRCLE 311 ON READER SERVICE CARD

Microwave Absorber flexible foam

EMERSON & CUMING, INC., Canton, Mass. Eccosorb AN-W is a weatherproof, fuelproof, flexible foam microwave absorber for use outdoors or in situations where the absorber will be in contact with fuel, lubricants or hydraulic fluids. It is particularly useful in airborne applications such as a radar nacelle. The material is extremely light in weight. It can be subjected to low pressure such as occurs at high altitude or in outer space. Several absorbers are available in the range from L band through K band with maximum power reflections of 1 percent or 20 db down.

CIRCLE 312 ON READER SERVICE CARD



Ferrite Isolator S-band

KEARFOTT CO. INC., 14844 Oxnard St., Van Nuys, Calif. Model WD-2106 octave S-band isolator permits the use of only one isolator for a

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NEW Simpson LABORATORY LINE

PULSE GENERATOR . . . model 2620

No Other Unit Offers Such Accuracy, Versatility, and Set-Up Speed Within This Price Range

Twin meters read pulse repetition frequency and pulse duration simultaneously. Rise time is 0.02 microseconds; decay time, 0.03 microseconds. Pulse duration, continuously variable from 0.1 to 1000 microseconds. Jitter, less than 0.005 microseconds. Pulse repetition rate, continuously variable from 10 to 100,000 pps in four ranges. Price **$625**

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WIDE-BAND OSCILLOSCOPE . . . model 2610

For the 1001 Jobs Where You Don't Need an Expensive Specialized Scope

Here's a high-gain scope that makes your test equipment appropriation go farther. Vertical sensitivity, 6 mv RMS. Vertical calibration accuracy, ± 3%. Response (linear position): DC to 5.0 mc/sec, ± 0.5 db; DC to 8.0 mc/sec, ± 1.5 db. Response (transient position): DC to 3.5 mc/sec.–3 db, and –6 db at 5.0 mc/sec. Triggered and recurrent sweeps. Precalibrated sweep positions of 5, 50, 500, 5000 microseconds. Price **$575**

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A Self-Powered Calibrator for Electrical Instrument Maintenance and High Accuracy Testing

Two terminal connections cover all 49 ranges for unusually fast operation. DC accuracy is ± 0.5% F.S.; AC, ± 0.75% F.S. (at 77°F, 25°C). Separate meters (*self shielded* movements) for DC and AC readings. Price. **$1620**

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full octave frequency range instead of covering the band in increments using a number of isolators. It is ideal for use in telemetry, radar systems and transponders. Frequency range is 2.1 to 4.3 kmc/sec; isolation, 20 db minimum; insertion loss indicated at 2 db maximum; input vswr, 1.5 maximum with type N connector; with peak power at 1,000 w maximum and average power at 5.0 w maximum.

CIRCLE 313 ON READER SERVICE CARD

Magnetic Modulator
miniaturized

GENERAL MAGNETICS, INC., 135 Bloomfield Ave., Bloomfield, N. J. Model MCM515-1 magnetic multiplier is a miniature magnetic modulator designed to deliver an analog output voltage which is the continuous product of two variable input voltages. One of these is an excitation voltage which varies over a predetermined range; in this case, 0 to 1 v rms 400 cps. The other signal is a d-c current which varies between 0 and ± 400 μa. Output voltage is 400 cycles a-c, and is always in phase or 180 deg out of phase with the variable excitation or fixed reference.

CIRCLE 314 ON READER SERVICE CARD

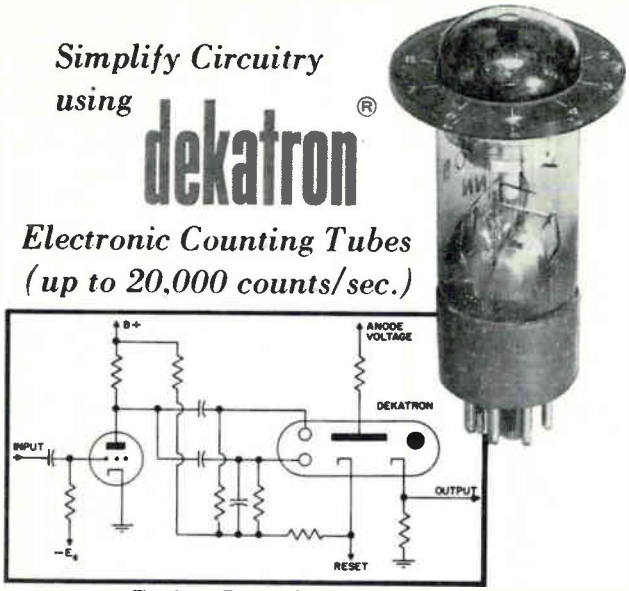
Noise Source
versatile unit

GENERAL RADIO CO., West Concord, Mass. Type 1390-B random-noise generator has many applications

Simplify Circuitry using

dekatron®

Electronic Counting Tubes (up to 20,000 counts/sec.)



Typical Drive Circuit

As a user of DEKATRON cold cathode glow-transfer counting tubes, you are welcome to use this and many other drive circuits designed by us. Circuits are patented (or applied for) but are available to DEKATRON customers.

Write to us for complete information.

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Now . . . a combination of features to bring you a most versatile lab utility . . . dries faster . . . maintains samples at desired temperatures . . . evaporates solvent traces rapidly . . . does double-duty as a vacuum oven . . . plus many more uses.

Combines . . . thermostatically controlled heater . . . aluminum interior . . . enameled steel exterior . . . Offers temperatures up to 125°C . . . lets you pull up to 28" of vacuum with complete safety . . . Includes hose connection, bleed valve, ground flanges and dial thermometer . . . won't chip or break like glass desiccators . . . eliminates makeshift heating devices.

Write for Bulletin 608 and the name of your nearest stocking distributor.

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professional opportunities at Honeywell Aero

FLIGHT CONTROL SYSTEMS: Analytical, systems, and component engineers to work in areas such as advanced flight reference and guidance systems. Positions range from analyzing stability and control problems, systems engineering through design, testing and proof of electrical and mechanical equipment—including flight test and production test.

GROUND SUPPORT: Electrical Engineers to design equipment for testing complex electronic systems, preferably with experience in digital techniques, solid state circuitry, and logic circuit design as applied to automatic checkout systems.

EVALUATION: Graduate engineers with electronic background desiring opportunity in development, qualification and reliability testing. Must have ability to design and develop specialized equipment which can duplicate environmental conditions encountered by advanced projects. Assignment in this work leads directly to a career in design, research or advanced system development.

ADVANCED GYRO DESIGN: Engineers with two and up to twenty years' experience in precision gyro and accelerometer development, servo techniques, digital techniques, solid state electronic development, advanced instrumentation and magnetic component design.

PRODUCTION: Electrical engineers to assume responsibility for placing complex devices such as platforms, floated gyros, accelerometers, vertical and rate gyros, calibrators and computers into production. Work with design engineers to introduce production know-how and techniques into original design. Responsible for estimating, processing, and tooling during the pre-production phase; directing assembly, calibration, and inspection efforts during initial production phases.

INSTRUMENTATION: Development and design in the critical areas of test instrumentation for Aero products. Two years' experience in test instrumentation desired.

To investigate any of the above professional opportunities at the Aeronautical Division, please write in confidence to Bruce Wood, Dept. 365A.

Honeywell

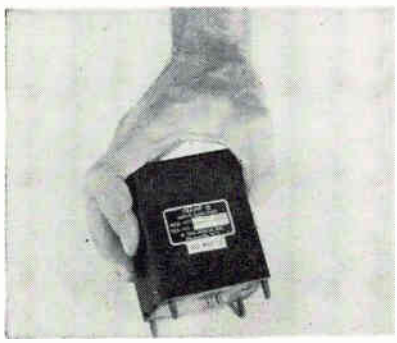
AERONAUTICAL DIVISION

1433 Stinson Blvd. N.E., Minneapolis 13, Minnesota

To explore professional opportunities in other Honeywell operations coast to coast, send your application in confidence to H. K. Eckstrom, Honeywell, Minneapolis 8, Minnesota.

for electrical and acoustical laboratories. As a noise source it is useful for: measurement of loudspeakers; intermodulation and crosstalk tests on multichannel-communication systems; simulating pulse noise in telephone line tests; tests on servo amplifiers; radar tests; radar target simulation; filter tests; dynamic range determination; and meter response tests. With suitable amplification, the instrument can drive shake tables for vibration testing and loudspeakers to produce high-intensity sound field tests.

CIRCLE 315 ON READER SERVICE CARD



Servo Amplifier
120 w unit

M. TEN BOSCH INC., Pleasantville, N. Y. This TRAMP model 1800-4500 is primarily intended to operate a two phase low inertia 60 cycle servo motor, and will deliver a maximum of 120 v to a properly matched load. Required driving power is 2 w maximum. It is recommended that a companion unit, TRAMP model 1800-0700-2, be used as a driver amplifier for higher overall power gain. Overall power gain for the 1800-0700-2 and 1800-4500 combination is approximately 100 db.

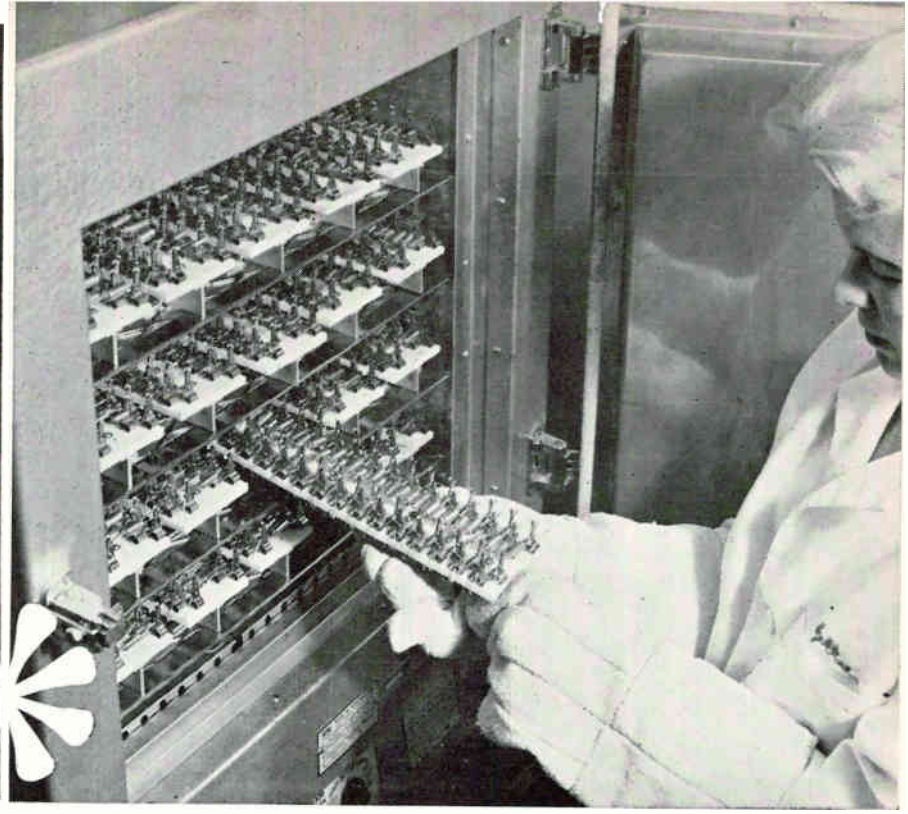
CIRCLE 316 ON READER SERVICE CARD

Silicon Transistors
symmetrical type

CRYSTALONICS, INC., 249 Fifth St., Cambridge, Mass. These symmetrical *pnp* silicon transistors can switch current in both directions. Saturation resistances are typically under 5 ohms at 10 ma. Leakage currents are held typically below 0.005 μa and low level switching

tan-TI-*cap*†

CAPACITOR STABILITY ASSURED BY 250-HOUR PERFORMANCE LOAD TEST



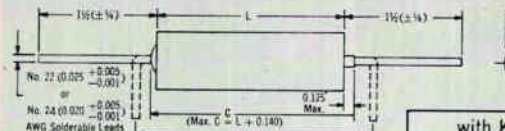
...expanded TI line of type SCM solid tantalum capacitors meets MIL specs

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

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

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

† trademark of Texas Instruments Incorporated



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

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

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

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

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

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
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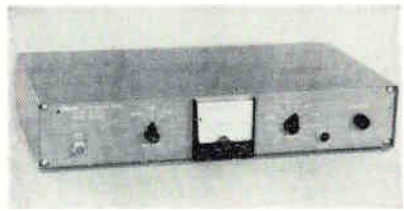
types are available with a maximum I_{co} of 0.0005 μa at 25 C. Units are finding extensive use in choppers, demodulators, bilateral applications and conventional switching circuits requiring exceptionally low saturation resistances.

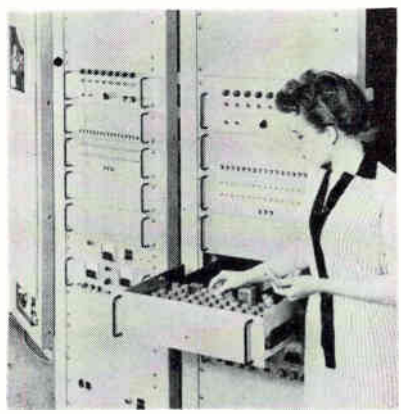
CIRCLE 317 ON READER SERVICE CARD



Count Rate Meter eight scale ranges

INTERSTATE ELECTRONICS CORP., Anaheim, Calif. Model 502 count rate meter has eight scale ranges, extending to 600,000 cpm, displayed on a 3-in., easy-to-read meter scale. Three time constants (1 sec, 5 sec and 10 sec) are available from a front panel mounted switch, as is a calibration control. The input is sensitive to a 250 mv negative pulse. Provisions are available on the rear of the instrument to drive either a 0-1 ma or 0-10 mv recorder. Price is $295.

CIRCLE 318 ON READER SERVICE CARD

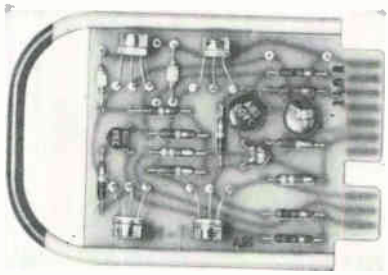


Tape Search and control system

ELECTRONIC ENGINEERING CO. OF CALIFORNIA, 1601 E. Chestnut Ave., Santa Ana, Calif. Tape search and control system will automatically play back a selected portion of tape on an Ampex FR-100 unit at a search speed of 120 ips. System automatically searches either backward or forward to find a pre-

selected time. At a speed of 120 ips, the searching process required for 2,500 ft of tape takes only 4 minutes. During the search a continuous visual display of the tape time is produced by a 17-digit code register. All-transistor construction is used throughout employing plug-in circuitry wherever possible.

CIRCLE 319 ON READER SERVICE CARD



Digital Module transistorized

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass., announces availability of its Schmitt Trigger (model ST-102), a transistorized module for driving its line of M-PAC circuits. It contains 2 independent circuits each of which can drive any of the other M-PAC circuits. The output signal switches between +0.7 and +20 v as the input signal crosses the triggering level. The triggering level is tailored to individual requirements between 1 and 8 v with an accuracy of ±0.5 v. Power requirements: +20 v at 7 ma, and −90 v at 0.1 ma.

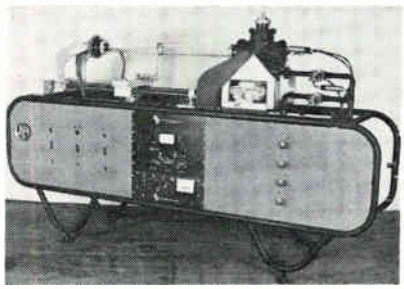
CIRCLE 320 ON READER SERVICE CARD

Voltage Regulators 1 mv residual noise

VALOR INSTRUMENTS, INC., 13214 Crenshaw, Gardena, Calif. Output voltages ranging from 6 to 35 v d-c are available from inputs ranging from 24 to 45 v d-c using this voltage regulator. Outputs for each model can be varied over a 15 v

range by means of a screw driver adjust. Ripple reduction 500:1 typical; line regulation ±0.1 percent or 10 mv whichever is greater; load regulation 50 mv for 0-0.5 ampere load change; residual noise 1 mv typical; output impedance 0.10 ohm maximum, d-c to 5 kc; size 3 by 3 by 5 in.; weight 16 oz.

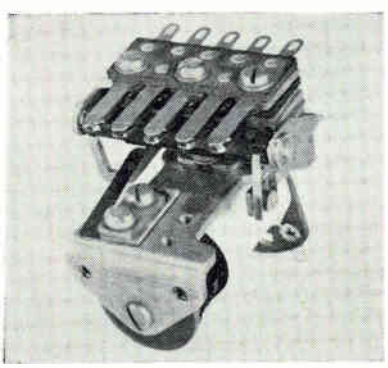
CIRCLE 321 ON READER SERVICE CARD



Zone Refiner
new program drive

MATERIALS RESEARCH CORP., 47 Buena Vista Ave., Yonkers, N. Y. The 1960 model zone melting apparatus is controlled by a new automatic program drive. It makes it possible to perform zone refining, zone leveling or crystal pulling without constant attendance at the machine. The program drive will turn off automatically after a preset number of passes; can be set for speeds from 0.10 to 18 in. per hr; has a quick return of 2 ips.

CIRCLE 322 ON READER SERVICE CARD

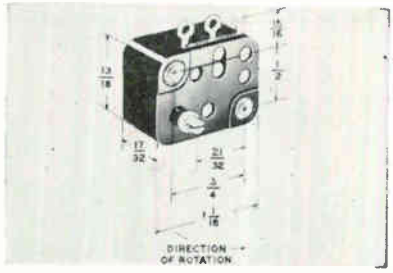


Program Relay
compact unit

STANDARD ELECTROMAGNETICS, INC., Walkersville, Md. Series 1450 program relay provides a wide variety of cam operated switching combinations. Cams and ratchet wheel are molded from a special material

which provides unlimited life and quiet operation. Cams of any configuration can be supplied. D-C or a-c coils can be provided for any voltage to 200. Contacts for dry circuit or 7½ amperes are available. Standard arrangement is 12 position, 5 pole but other arrangements are available. Size is 1 $\frac{9}{16}$ by 1 $\frac{3}{4}$ by 2 in. long; weight, 4½ oz.

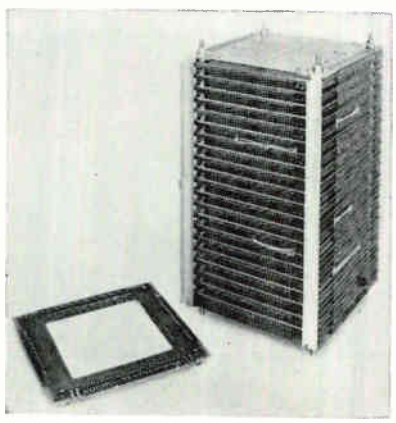
CIRCLE 323 ON READER SERVICE CARD



Rotary Switch low force

ROBERTSHAW - FULTON CONTROLS Co., P. O. Box 449, Columbus 16, Ohio. Model J rotary switch is suitable for installations requiring precise, sensitive snap action operation. It is listed by Underwriters' Laboratories for 5 amperes, 120-240 v a-c. The brass actuating shaft is drilled and slotted to accept the actuator wire.

CIRCLE 324 ON READER SERVICE CARD

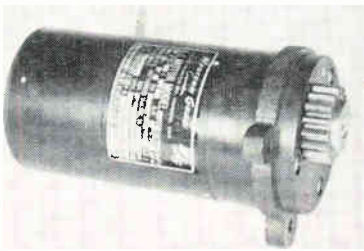


Military Memory wide applications

TELEMETER MAGNETICS, INC., 2245 Pontius Ave., Los Angeles 64, Calif., has developed Mil-Stak, a magnetic core memory stack. Made up of an assembly of core arrays, the new memory module is designed

to withstand the rigors of military applications where vibration and shock would destroy standard units. Units are unaffected by acceleration to 10 g with vibration to 2,000 cps. To achieve this rugged construction, a molded plastic frame was designed on which the cores are wired to form an array. The wired arrays are interconnected by a locked link method and then the entire stack is encapsulated in polyurethane.

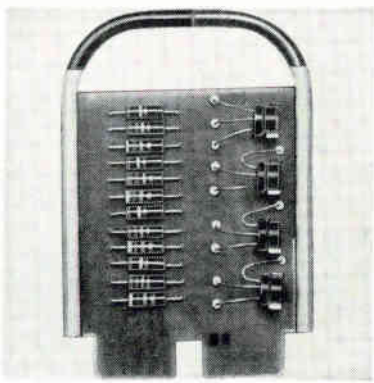
CIRCLE 325 ON READER SERVICE CARD



Geared Motor
azimuth drive

WESTERN GEAR CORP., 132 W. Colorado Blvd., Pasadena, Calif. Azimuth drive geared motor is 3-phase, 400-cycle, 200-v a-c operated and is $\frac{1}{10}$ h-p. Motor speed of 11,000 rpm is geared down to 290 rpm continuous duty operation in accordance with the requirements of MIL-M-7969A. Model 31R48R73 is 2 in. in diameter by 4 in. long.

CIRCLE 326 ON READER SERVICE CARD

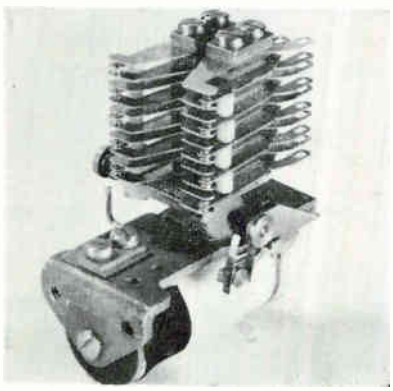


Digital Module
transistorized

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass. Model LA-101 indicator amplifier module contains 4 individual driver circuits. Each circuit can drive one

standard neon indicator assembly that includes a bulb and 100 K series resistor. The circuits can be driven either by a flip-flop or gate output. The driver turns the indicator ON when the input voltage is less than 2 v, and OFF when the input voltage is greater than 8 v. Power requirements: — 90 v at 1.5 ma for each circuit.

CIRCLE 327 ON READER SERVICE CARD



Bistable Relay
multipole

STANDARD ELECTROMAGNETICS, INC., Walkersville, Md. Series 1451 relay provides bistable operation for all contact arrangements obtainable with telephone type relays. Nonmetallic cams, ratchet wheel and stop give a quiet and long life. Positive stop is provided. Units can be supplied open, with dust cover or sealed. Coils: a-c or d-c to 200 v. Contacts: single or bifurcated; dry circuit to 7½ amperes. Size: 4 pdt 1¾ by 2⅛ by 2 in. long; weight, 4½ oz. Illustration: 10 pdt.

CIRCLE 328 ON READER SERVICE CARD

Phase Detector
precision unit

AD-YU ELECTRONICS LAB., INC., 249-259 Terhune Ave., Passaic, N. J. Type 205B2 consists of a coaxial continuously variable delay line and a sensitive phase detector.

(Continued on p 94)

Instrument is very convenient for measuring frequency characteristics of radar amplifiers, r-f cables, transmission networks and performance of location finding systems. Accuracy is ± 0.05 deg or ± 1 percent from 200 mc to over 1,000 mc. Resolution is less than 0.01 μμsec; the smallest phase angle which can be read on the dial is less than $10^{-11} \times 360 \times$ frequency in cps. Time delay of the continuously variable delay line is adjustable from 0 to 1.4 milliμsec. Two step variable delay lines have total delay of 37.5 milliμsec in E_1 channel and 7.5 milliμsec in E_2 channel, (in steps of 1 milliμsec). Characteristic impedance is 50 ohms nominal for input and output.

CIRCLE 329 ON READER SERVICE CARD

Silicon Rectifier
small size

SYNTRON Co., 241 Lexington Ave., Homer City, Pa. Style 33 silicon power rectifier is rated at 37.5 amperes average at 25 C ambient on a 5 in. by 5 in. by ⅛ in. copper heat sink. Piv's range from 50 to 400 v in 50 v steps. Temperature range is from −75 to +175 C. Unit is mounted on a ⅛ in. hexagon stud base. Maximum height is 1⅝ in. A typical forward dynamic resistance of 0.0035 ohm is achieved by diffused junction techniques.

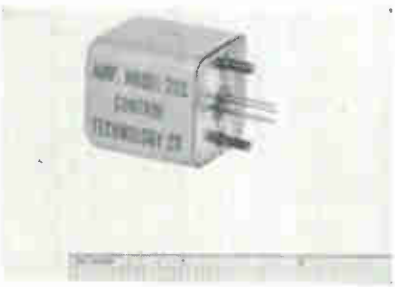
CIRCLE 330 ON READER SERVICE CARD

Power Supply
modular unit

INVAR ELECTRONICS CORP., 323 W. Washington Blvd., Pasadena, Calif.,

has developed a compact power supply module capable of delivering 6 amperes over the range of 26-30 v d-c. Regulation is better than 0.2 percent and ripple is less than 10 mv. Construction is according to MIL-E-4158B and unit is completely transistorized. Dimensions are 6½ by 6⅛ by 19¼ in.

CIRCLE 331 ON READER SERVICE CARD



Servo Amplifier
1 by 1 by 1⅛ in.

CONTROL TECHNOLOGY CO., 1186 Broadway, New York 1, N. Y. Model 200 transistorized servo amplifier will drive 2 w or 3.5 w servo motors from low level 400 cps signals at an ambient temperature of −55 C to 125 C. Maximum gain is 2,500 and may be adjusted by an external resistor. Gain stability is 2 db over temperature range. Internal limiting prevents overdrive or phase shift for high input signals. Operates on 28 v d-c. Completely potted, it will operate under MIL-E-5272A environmentals. Output impedance is 50 ohms, which gives good servo response and high servo system gains without oscillations.

CIRCLE 332 ON READER SERVICE CARD

Indicator Light
three lens types

ELDEMA CORP., 1805 Belcroft Ave., El Monte, Calif. A low priced miniature indicator light supplied with NE-2E neon lamp, or 2.5 v to 60 v incandescent lamps with round, short flat or long flat lens. Neon light may have encapsulated resistors and can be supplied with or without insulated leads. Mount in 0.316 in. diameter hole in panels up to ⅛ in. maximum with ½ in. round push-on retainer.

CIRCLE 333 ON READER SERVICE CARD

Literature of

PEAK SYMMETRIZER. Kahn Research Laboratories, 81 South Bergen Place, Freeport, L. I., N. Y. A 4-page brochure describes Symmetra-Peak, a passive network used by a-m, f-m and tv broadcasters to increase effective power and coverage range of voice transmissions and to improve limiter and agc amplifier performance.

CIRCLE 380 ON READER SERVICE CARD

SINGLE METAL CRYSTALS. Flow Corp., 85 Mystic St., Arlington 74, Mass. An 11-page bulletin 102, entitled "Large Single Metal Crystals," describes standard specimens as well as unusual shapes and special crystal orientations.

CIRCLE 381 ON READER SERVICE CARD

SOLDERING IRONS. General Electric Co., Schenectady 5, N. Y. Publication GED-3553, 8 pages, covers a line of soldering irons which feature light weight, calorized and ironclad tips and tubular heater.

CIRCLE 382 ON READER SERVICE CARD

POWER TRANSISTORS. Bendix Aviation Corp., Red Bank Division, Long Branch, N. J., has available data sheets on an improved series of eight 25-ampere peak current transistors capable of switching up to 1,000 w.

CIRCLE 383 ON READER SERVICE CARD

MICROWAVE TEST EQUIPMENT. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y. Foldout, 2-color bulletin 300 describes a variety of microwave test equipment with illustrations and descriptions of the Pacemaker line.

CIRCLE 384 ON READER SERVICE CARD

TIME DELAY-RELAYS. Ortron Electronics Corp., 29 Lincoln Ave., Orange, N. J. Catalog No. 100 contains a complete line of economical as well as quality commercial and military thermal time delay relays.

CIRCLE 385 ON READER SERVICE CARD

MILITARY QUARTZ CRYSTALS. Scientific Radio Products, Inc.,

the Week

2303 W. 8th St., Loveland, Colo. A 4-page catalog lists more than 50 military and scientific quartz crystals in all desired frequency ranges.

CIRCLE 386 ON READER SERVICE CARD

SERVO COMPONENTS. MOOG Servocontrols, Inc., East Aurora, N. Y. A 24-page three-color facilities book shows, by extensive use of photographs, the engineering and production facilities of the company's four plants and research laboratory.

CIRCLE 387 ON READER SERVICE CARD

PRINTED CIRCUITS. Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N. Y. Technical bulletin P-5a contains complete information on how the elimination of "lands" or pads around plated-through holes permits substantial size reduction of p-c boards and greater component densities.

CIRCLE 388 ON READER SERVICE CARD

ENCLOSURES. Automatic Electric Co., Northlake, Ill. A 32-page catalog shows hermetically-sealed and protective enclosures for relays, switches, and control packages.

CIRCLE 389 ON READER SERVICE CARD

DIALOG PROGRAM. Link Aviation, Inc., Binghamton, N. Y., has available literature describing its Dialog program, a complete line of basic building blocks and computing systems for universal application.

CIRCLE 390 ON READER SERVICE CARD

F-M/F-M TELEMETRY. Tele-Dynamics Inc., 5000 Parkside Ave., Philadelphia 31, Pa., has released a 24-page two-color brochure, No. 936, which describes a new line of ruggedized airborne f-m/f-m telemetry components.

CIRCLE 391 ON READER SERVICE CARD

BASIC NOISE SOURCE. Kay Electric Co., Maple Ave., Pine Brook, N. J., has published a mailing piece illustrating and describing the Therma-Node, a highly accurate instrument for noise-figure measurements.

CIRCLE 392 ON READER SERVICE CARD

McGregor: Wears Five Hats

CHAIRMAN AND PRESIDENT of Narda Ultrasonic Corp., John C. McGregor, has taken on the added responsibility of marketing the company's wares.

A physicist and Doctor of Jurisprudence, this affable Westbury, N. Y., businessman has helped husband not only Narda's growth but also that of other firms in allied and diversified fields. When Narda's directors recently abolished the position of vice president for marketing, McGregor was given full responsibility for this function with no diminution of his existing responsibilities for research, development, finance and manufacture.

Narda was organized only two years ago to enter the burgeoning ultrasonics industry, chose to concentrate on cleaners. The firm standardized a full line of models to clean various sized items and adopted mass production methods. Its sales exceeded $1,000,000 in the fiscal year ended last June 30, and are expected to double in the current year.

McGregor has long recognized a need for a small, low cost cleaner; his firm has just introduced a fully transistorized unit to market for less than $100. It fills the need of physicians and dentists, jewelers, opticians and other small businesses. But Narda figures it will be equally at home in the larger laboratories and on production lines where items to be cleaned are small in size.

Introduced recently were units designed to clean the ultrafine filters used in the power plants of today's supersonic aircraft, and dishwashers to handle the large volume of dishes and silverware of restaurants, hotel and institutional dining rooms.

McGregor is board chairman of the related Narda Microwave Corp. He is also board chairman of Technical Information Corp., and of Harper & Saladino, industrial art specialists.

With his wife Janet, McGregor now makes his home in Hicksville, N. Y., not far from Narda Uutrasonics' growing plant in Westbury. Only recently, 10,000 additional square feet were added to the facilities. To this new space was moved the research and development division whose old quarters were immediately taken over by the expanding production line.

Knapic Doubles Floor Space

NEW PLANT facilities doubling available floor space have been completed by Knapic Electro-Physics, Inc., Palo Alto, Calif. The added space will be used to greatly expand the company's R&D program in the field of new semiconductor materials. Plant capacity is also being increased to accommodate the rapid industry-wide expansion in semiconductor material requirements. Company sales forecasts, according to Dean D. Knapic indicate the plant output will at least double during 1960.

Knapic Electro-Physics, Inc., is a major supplier of grown silicon monocrystals for semiconductor use throughout the electronics industry. Company also produces germanium monocrystals for semiconductor use as well as large diameter silicon and germanium ingots for infrared lenses used in surveillance and missile guidance systems.

EFCON Appoints Project Engineer

APPOINTMENT of Adolph Herbst as project engineer of the Tantalum Capacitor division, EFCON, Inc., New York, N. Y., is announced.

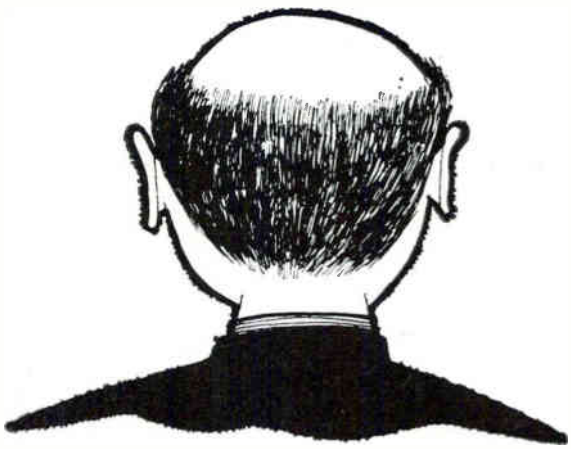
Before joining the EFCON staff, Herbst was associated with Pyramid Electric Co. as chief field engineer. He was responsible for the development of tantalum capacitors at that company.

Lambda Names Sales Manager

LAMBDA ELECTRONICS CORP., College Point, N. Y., manufacturer of power supplies, announces the appointment of Merrill Simon as sales manager.

Simon moves to Lambda from RCA where he served as a semicon-

IT'S WHAT'S IN HERE THAT COUNTS



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ductor application engineer for their new product investigation in Somerville, N. J., and Lancaster, Pa., semiconductor plants. Prior to that he was associated with Chatham Electronics, a division of Tung-Sol Electric, Inc., as a semiconductor development engineer.

Mycalex Elects Backus V-P

ELECTION of Alfred S. Backus as vice president, operations, of the Mycalex Corp. of America, Clifton, N. J., and its affiliated companies—Mycalex Electronics Corp., Mycalex Tube Socket Corp., and the Synthetic Mica Co.—was recently announced by Jerome Taishoff, Mycalex president.

Backus has been serving as acting general manager of the Mycalex Corp. of America and its affiliated companies for the past year and has been works manager since 1952. Backus joined Mycalex in 1944. He served originally as plant superintendent, later becoming plant manager and then works manager. Prior to joining the corporation, he had been employed by GE in its Pittsfield and Taunton, Mass., plants.

Announce New Company

THE Keinath Instrument Co. was recently formed in Columbus, Ohio, to manufacture industrial recording instruments based on inventions of George Keinath, Larchmont, N. Y., authority on instrumenta-

tion. Keinath will be consulting technical director; W. E. Van Horne of Columbus, until recently sales manager and assistant to the president of Industrial Nucleonics Corp., president.

The firm will operate only a design office and modest assembly-sales facility at the start, using Columbus area subcontractors to produce the electronic equipment.

More than 100 Keinath patents will be used to produce what Van Horne describes as new and unique types of recorders for use with complex industrial processes like oil refineries, power generating stations and chemical plants.

News of Reps

Delta Coils, Inc., Paterson, N. J., has appointed the following companies to extend its sales and service organization:

Moore Sales, for Michigan, Indiana and Kentucky; **Cox Sales Co.,** for Wyoming, Utah, Colorado, Arizona and New Mexico; **Fred Gross & Co.,** for Texas; **Kay Sales,** for Nebraska, Iowa, Kansas, Missouri, Oklahoma and Arkansas; **Kadell Sales,** for Illinois and southern Wisconsin; and **Frank C. Nickerson Co.,** for Georgia, South Carolina, North Carolina, Florida, eastern Tennessee and Alabama.

Valley Forge Associates, Devon, Pa., is named technical sales rep for National Beryllia Corp., North Bergen, N. J., in Pennsylvania, Delaware, Maryland and southern New Jersey.

Robert L. Lang and Associates has been appointed manufacturer's rep for Systron Corp., Concord, Calif., to cover the areas of Indiana, Illinois, Wisconsin and eastern Iowa.

C. H. Mitchell Co., rep for electronic components, has changed its address from Beverly Hills to larger facilities in Sherman Oaks, Calif.

Millard Leff Sales of Levittown, N. J., has been appointed industrial rep for the Middle Atlantic States by Premier Metal Products Co., manufacturer of metal housings for the electronic industry.

COMMENT

Citizens Radio

I am writing in connection with an article in the Jan. 8 issue of ELECTRONICS (p. 28), "Citizens Radio Crackdown Looms."

This was an excellent article, and certainly in keeping with the high standards I have always associated with your magazine.

There are, however, two points on which I would like to inquire. Mention is made of a distance limit of ten miles for class D radio, and the establishment date given for the service is September 1958. I am unable to find any documentation to substantiate these points, and would like to know more about both.

R. I. NEILSON

PROVIDENCE, R. I.

Reader Neilson is not the only one who wants to know more about distance; other readers have asked, and only last week we learned that a study will soon be undertaken to crystallize both time and distance aspects of class D use.

Our stated distance limitation of ten miles was in error. Interviews with Federal Communications Commission men evoked the comment that a class D operator shouldn't expect first-rate performance from his equipment beyond ten miles, unless he had altered it in some way outside the rules, and that when a station starts "reaching for the moon" the FCC becomes unhappy. Actually, good sense rather than a specific mileage limit should govern the class D operator.

Regarding the date, 1946 was the year Citizens Radio was authorized. September 1958 was the date when a new block of frequencies, higher up in the spectrum, was made available.

Kudos

. . . I have or have had subscriptions to at least ten different electronics publications, and without a doubt yours is the finest. It is not only informative, but the articles are extremely well written.

I am attending a microwave school, and many of the articles have been more explanatory than the textbooks we use with the

course, especially on waveguides, directional couplers, etc.

S/SGT DONALD H. JULIAN, USAF
APO 243
NEW YORK CITY

Medical Electronics

Your recent editorial on the subject of medical electronics (Shoptalk, p 4, Dec. 11 '59) was of deep interest to me, as I am the parent of a nine-year-old daughter who was rendered completely paralyzed from the neck down by an undiagnosed illness three and a half years ago. My experience in trying to get the best medical care for my daughter, and also in trying to make her life as happy as possible since the original onslaught, has convinced me that we are woefully far behind in our scientific and engineering achievements in the field of assistance to disabled persons.

I am not discounting a number of remarkable achievements and important contributions made in this field, but I have been struck by the fact that simple engineering know-how and techniques applied to individual problems in the rehabilitation field could do much to make life more meaningful for these helpless persons. I hope that the engineering profession, and particularly electronics engineers, will take a little time to make a little effort toward devoting some of their dynamic spirit and knowhow to human causes of this type. Certainly contributions of this nature are the real measure of this country's right to call itself the world leader.

ROBERT D. ECKHOUSE
NEW YORK CITY

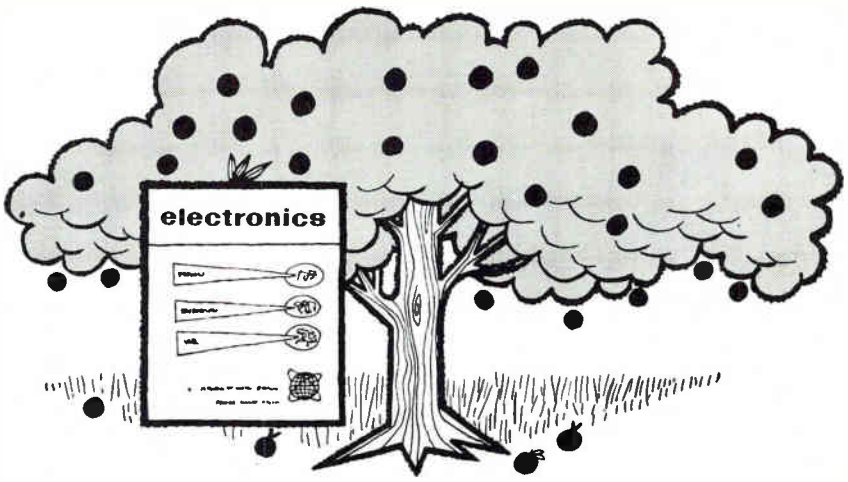
We agree.

Slip of the Hand

Ref.: the article "Current Pulse Generator Tests Magnetic Cores," by Hugh M. Goss (p 80, Jan. 1). Tube V_3 is said to be ½ 5687; however the 5687 is a dual triode . . .

DONALD E. KITTS
REMINGTON RAND
UTICA, N. Y.

The 5687 is indeed a dual triode, and V_3, shown correctly as a pentode, is actually a 6AS6. It was a slip of a draftsman's hand; half the other tubes in the circuit are 5687s.



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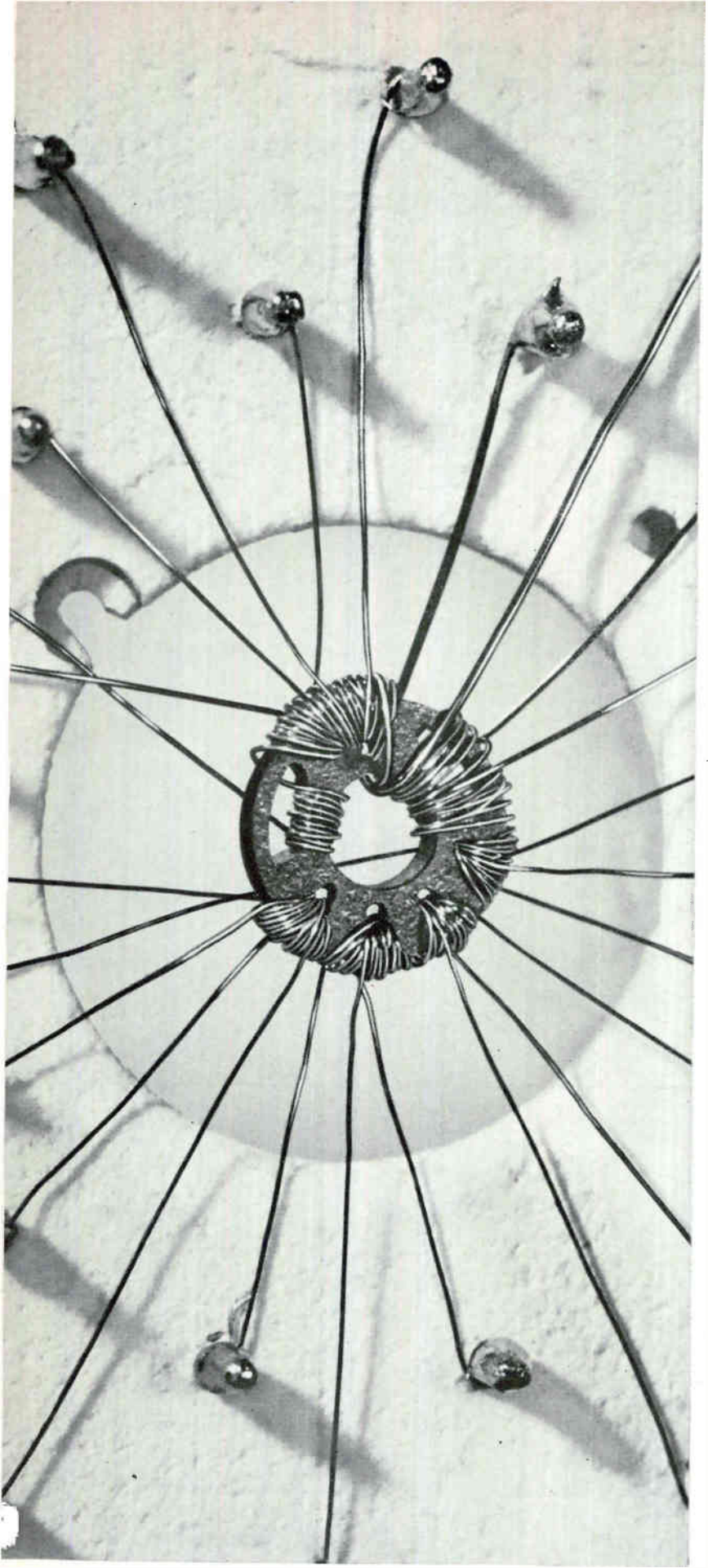

opportunities in
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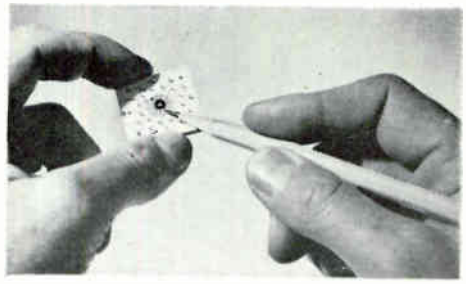

Capturing Logic in a Magnetic Web

This web was "spun" by IBM scientists and engineers.

It's a ferromagnetic, multiapertured core. It permits more versatile circuits, new techniques, new data storage concepts—all never before possible with basic toroidal cores.

For, instead of just two flux patterns provided by toroidal cores—now multiple patterns are possible. And instead of basic read-out being destructive, thus limiting logic facility, with the new multiaperatured core, read-out is nondestructive; binary information read from one output does not affect the information state of other outputs.

Perfection of this small, lightweight, magnetic device was not an easy job. It took the skills and cooperation of top-flight physicists, electrical and mechanical engineers, and mathematicians. It also took the progressive spirit of an organization wishing to maintain leadership in its field.

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ADVERTISERS INDEX

● See advertisement in the June, 1959 Mid-Month 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.

For high-accuracy data logging...to checkout missiles or meters, to test transducers or transistors...checkout a KinTel digital system

This system, one example of KIN TEL'S digital system experience, takes eight measurements at each of 7200 different data points. Outputs include visual readout, digital printer, X-Y recorder, and tape punch. Tape is perforated for direct entry into a digital computer. To provide 0.01% accuracy for low-level inputs, alternate channels scan calibration signals. These, with the unknown input signal, are fed to the computer and correction is made for any inaccuracy in the system itself. Cost: about $20,000.

This data system consists of a KIN TEL 453M scanner and 501 DC digital voltmeter, plus a parallel entry printer. Briefly, the system will accept 400 one-wire, 200 two-wire, or 100 four-wire inputs, and will provide both visual and printed indication of the channel being scanned and DC input signals from ±100 microvolts to ± 1000 volts. Accuracy is 0.01% ±1 digit, and ranging and polarity indication are automatic. The complete system costs approximately $6850. At the present time, delivery is off the shelf.

KIN TEL DIGITAL SYSTEM CAPABILITIES

You can have any number of channels: A single 453M scanner ($2500) accepts 400 one-wire, 200 two-wire, or 100 four-wire inputs. Additional scanners can be added if more inputs are required.

You can measure DC from ±1 μv to ±1000 volts: The KIN TEL 501 DC digital voltmeter ($2995) measures from ±100 μv to ±1000 volts. Addition of a KIN TEL digital preamplifier increases sensitivity to 1μv DC.

You can measure AC from 10 μv to 1000 volts: Addition of a 452 AC converter ($850) to the 501 DC digital voltmeter permits measurement of RMS AC voltages from 1 mv to 1000 volts in the frequency range of 30 cps to 10 kc. A KIN TEL preamplifier can be added to increase AC measurement sensitivity to 10 μv from 30 cps to 2 kc.

You can measure DC/DC and AC/DC voltage ratios: The 507B digital voltmeter/ratiometer ($3835) measures DC voltages from ±100 μv to ±1000 volts and DC/DC ratios from .0001:1 to 999.9:1. Accuracy is 0.01% ±1 digit. Addition of an AC converter permits AC/DC ratio measurements.

You can get 0.01% DC and 0.2% AC accuracy: The KIN TEL 502 AC/DC digital voltmeter ($3845) measures DC from ±100 μv to ±1000 volts with 0.01% ±1 digit of reading accuracy; and AC from 1 mv to 1000 volts, 30 cps to 10 kc, with 0.2% of full scale accuracy.

You can have 10,000 megohm input impedance: The KIN TEL 458A digital voltmeter preamplifier ($1225) has gain positions of 100 (for DC and 30 cps to 2 kc AC measurement) and +1 HI Z (for DC only). On the +1 gain position input impedance is >10,000 megohms and gain accuracy is 0.001%. Input range for +1 operation is 0 to 40 volts.

You can have visual, printed, or any other form of output: KIN TEL digital voltmeters provide visual indication of the measured quantity on a single-plane in-line readout. They are capable of directly driving commercially available 10-line parallel input digital printers. Converters are available for driving other types of printers, paper tape punches, typewriters, and IBM card punches.

To find out how a KIN TEL digital system can solve your particular data acquisition problem, send us an outline of your requirements, or contact your nearest KIN TEL engineering representative.

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RCA TRAVELING-WAVE TUBES FOR X-BAND OPERATION

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		Power Output	Low-level Gain (db)			Weight (lb.)	Length (in.)
A-1140	8000-12000	10 mw	40	CW	PPM	5½	14
A-1133	8000-12000	1 w	35	CW	PPM	6	15
A-1181	7500-11200	50 peak watts	35	0.05	PPM	6	14

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