electronics

A McGraw-Hill Weekly 75 Cents April 26, 1963

TOP-DRAWER COMMAND NET

Would survive nuclear attack, p 20

PRACTICAL RFI CONTROL

Case from proposal to prototype, p 56

MEET THE GTO SWITCH

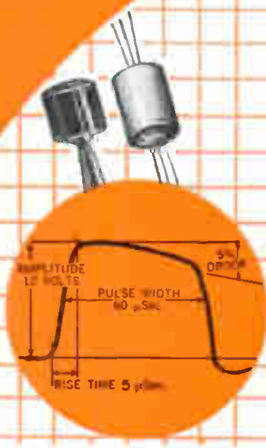
Latest silicon controlled rectifier, p 60

FAMILY TREE OF SEMICONDUCTORS *p 45*

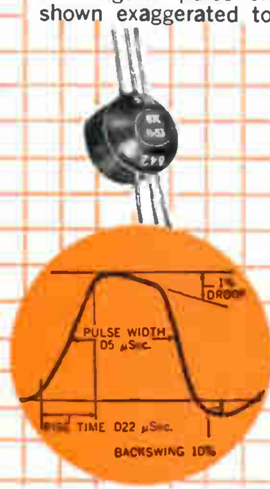
SPECIAL
PULSE TRANSFORMERS
TO YOUR REQUIREMENTS

The pulse units illustrated below show a few of the thousands of special types designed and produced by UTC, to customers' requirements. Range covered on special pulse units is from a few microwatts to 10 megawatts. Rectangular pulse shapes are deliberately shown exaggerated to clarify parameters.

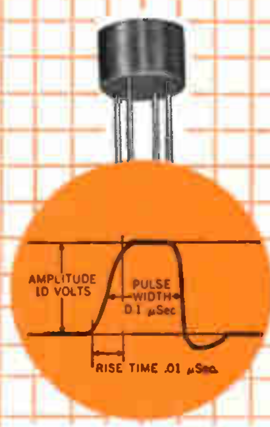
Almost thirty years of pioneering in the design and production of transformers plus exhaustive life testing programs and rigid quality control measures guarantee components of the highest reliability in the industry. . . . You can stake YOUR reputation on UTC products.



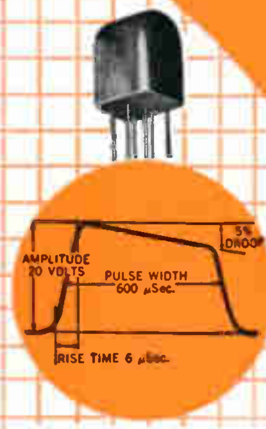
25 KC pulse transformer, DO-T or DI-T configuration. Pulse width 60 µSec. Rise time less than 0.5 µSec. Secondary C.T. balance each side to within 1% to ground. MIL-T-27A, GR 4. Size: DO-T, 5/16 dia. x 13/32", wt. 1/10 oz.; DI-T, 5/16 dia. x 1/4", wt. 1/20 oz.



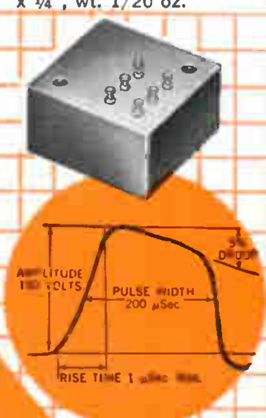
Special precision miniature pulse transformers. Designed in our standard stock mold to your specs. Checked and precisely adjusted in your tube or transistor blocking oscillator circuit. Sizes: 3/8 dia. x 3/8", 1 gram; 5/16 dia. x 5/16", 4 grams; 5/8 dia. x 5/8", 6 grams.



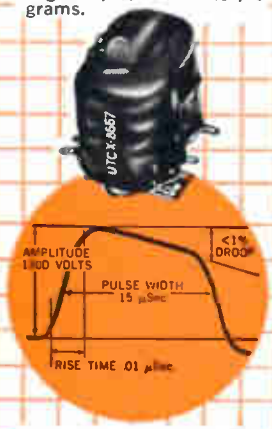
Ferrite core blocking oscillator transformer. 0.1 µSec. ±10% @ 200 KC PPS. 2 windings, rise time .01 µSec. Epoxy case. MIL-T-27A; 5/16 dia. x 1/4", .07 oz.



600 µSec. coupling transformer for printed circuit application. 3 windings, mu metal case for extreme shielding. Z=20 K Ω, 10 V. MIL-T-27A; standard UTC ML case; 7/16 x 31/64 x 5/16" h., .2 oz.

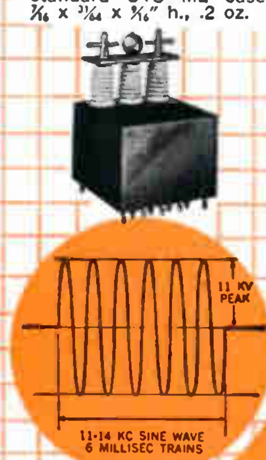


Toroidal pulse transformer, 150 V. 200 µSec. @ 400 PPS. Molded in epoxy. 3 windings, low leakage, less than 1 µSec. rise time, —40°C. to +85°C.; output voltage within 1%. MIL-T-27A; 1⅜ sq. x ¾"; 1.5 oz.



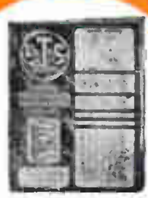
Output to 2J42 magnetron. Input 1300 V.-50 ohms. Output 6.5 KV to 1200 ohms and .6A. bifilar filament winding. .15 µSec., 1000 PPS. Trigger winding. MIL-T-27A GR 5; 1½ x 2½ x 2¾", 10 oz.

Output to Klystron, 5 µSec. pulses in groups of pulse trains at high rep rate. Droop 1% over pulse trains. 30 KV W.V., 43 KV hipot; —53°C. to +85°C.; MIL-T-27A; 4¼ x 5 x 6¾"; 11½ lbs.



Sonar sine wave pulse output transformer. PP 4-65A's, 11-14 KC flat. Pri. 11 KV; 28 KV hipot. Spark gap protected. Sec. 1500 V. @ 800Ω, 60 millisec on, 6% duty cycle. MIL-T-27A; —65°C. to +85°C.; 6 x 6 x 8½", 13 lbs.

Plus over 1,000 STOCK ITEMS with UTC High Reliability from your local distributor



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April 26, 1963

electronics

A McGraw-Hill Weekly *75 Cents*

W. W. MacDONALD, Editor

Contents Continued

electronics

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CONTENTS continued

DEPARTMENTS

CROSSTALK

IT'S WORSE IN JAPAN. We were quite shaken up last week by a message from Charles Cohen, a McGraw-Hill World News staffer in Tokyo.

We have used these columns twice in the past two months to point out what we consider to be deficiencies in the selection and presentation of papers at engineering conferences here in the U.S. (ELECTRONICS, p 3, April 5, and p 3, March 15). But compared to what goes on in Japan, American conferences are heaven.

Without even using an exclamation point, Charlie says that at this year's convention of Japan's four electrical societies, no less than 1,894 (one thousand, eight hundred, ninety-four) general papers and 9 symposiums were given.

"Since 23 different technical sessions and 2 symposiums were held simultaneously it was impossible to listen to a substantial portion of the papers," he wrote.

Moreover, Setsuo Fukuda, president of Japan's IEE, predicts that around 1970 the convention will be inundated with 4,000 papers.

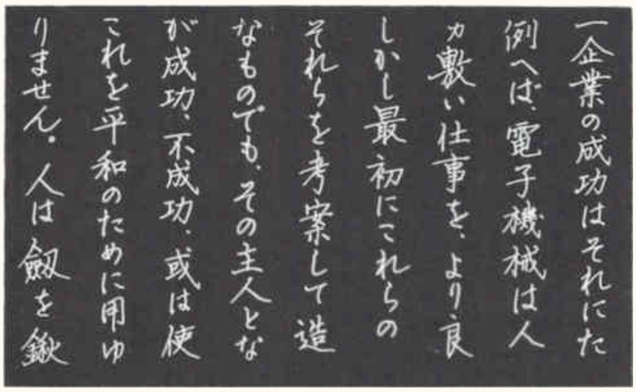
"Nobody," commented Cohen, "greeted this with pleasure."

Engineers he talked to about this are generally agreed that selection of papers or some other means is needed "to prevent the number of papers from getting out of hand." At present, all the selection committee does is rule out papers outside the bounds of interest of the societies.

Few of the 1,894 papers were on substantial advances, Cohen says. Most were on extremely specialized work. One Kyoto University professor said that attention to minute detail resembled the painstaking care with which the corners of Japanese lacquered wooden boxes are fitted together. He was not alone in complaining about the time wasted by hair-splitting details.

In other respects, however, Japanese conference problems are not too different from those in the U.S.

Cohen says that one reason for the lack of good papers is a growing reluctance by companies to make early disclosure of important developments. For example, of the 1,894 papers only 1 was on integrated circuits and that was by two government lab researchers. Many Japanese companies are active in this field.



Then, too researchers who can get permission to publish favor rapid publication in magazines like ELECTRONICS, rather than wait the long period between meetings.

A slowdown in the number of breakthroughs is another factor, says Cohen. Much of the work in Japan is now concerned with practical developments. "Some engineers who gave papers hadn't even done much practical development. The only motivation behind their papers was a chance to go to Kyoto."

The upshot: many Japanese engineers prefer to attend symposiums rather than the general sessions—just like Americans.

Coming In Our May 3 Issue

CONSUMER ELECTRONICS. Advances in entertainment electronics—a field that for years has meant bread and butter to a large portion of the electronics industry—will be surveyed in a three-part series beginning next week. The first installment, by Assistant Editor Gray, covers developments in transistor and color tv, organs, stereo recording and f-m multiplex receivers.

Other articles in next week's issue:

- New method, employing tunnel-diode switching circuits, for analog-to-digital conversion with nanosecond resolution
- Magnetic-amplifier frequency multiplier that lets 400-cps equipment be run from a 60-cps line
- Three new approaches to pulse modulation. One modulator uses four-layer diodes, another diodes and transistors, and the third tubes and semiconductors
- D-c level shifter that's high in precision and linearity, low in output impedance and drift.

COMMENT

ESP

I enjoyed your article on extrasensory perception (p 14, March 29), and I hope you will keep track of and report further work on connections between electronics and ESP. I am myself hoping to set up sensitive radio receivers in all wavebands to see if biological radio emissions exist.

CHRISTOPHER P. GADSEN
Associate Professor
Electrical Engineering Dept.
Tulane University
New Orleans, Louisiana

IBM Fellows

I was delighted to read under the *People and Plants* headline, IBM Corporation Appoints Fellows (p 102, Feb. 22), that a corporation famed for its progressive management policy had voted that the swing against status recognition had gone too far. Ignoring snide criticism, IBM have given a good push in the forward direction.

To make the move still more popular, I suggest that Fellows be encouraged, but not compelled, to wear academic cap and gown—special ones could be designed—while visiting their colleagues.

C. E. G. BAILEY
Ewhurst, Cranleigh, Surrey
England

Negative Resistance?

The article by Vasil Uzunoglu on Negative-Resistance Devices (p 35, March 8) is an example of the widespread use of the term "negative resistance." Occasionally some authors, such as Shockley and Mason (Journal of Applied Physics, May, 1954) acknowledge the inaccuracy of the term by putting it in quotation marks. I first heard about "negative resistance" in 1926.

As so widely used, the term refers to a situation where an increase in voltage results in a decrease in current, or a decrease in current results in an increase in voltage. Mathematically, the term is used when dI/dV or dV/dI is negative. This is undoubtedly where the word "negative" originally entered the picture. But the trouble is that resistance is not dV/dI. It is V/I.

When the potential is higher at the point where the current enters an object than it is at the point where the current departs from the object, the values assigned to the potential difference, V, and to the current, I, are both positive, and the resistance of the object, V/I, is also positive. A negative resistance thus implies a device where the current enters it at a potential that is lower than the potential at the point where the current exits. Such a device is a battery or dry cell, for example. Thus a negative resistance is really found only where there is an emf.

However, those who write about negative resistance are not writing about emf or about devices such as dry cells. They are writing about devices in which dV/dI is negative over a certain range of values for I or V. Such devices are fundamental in amplifiers and oscillators.

I propose that the term "negative resistance" be recognized as a misnomer and replaced by a term such as "metastable resistance," which much more accurately describes what we are talking about.

WAYNE T. SPROULL
Western Precipitation Division
Joy Manufacturing Company
Los Angeles, California

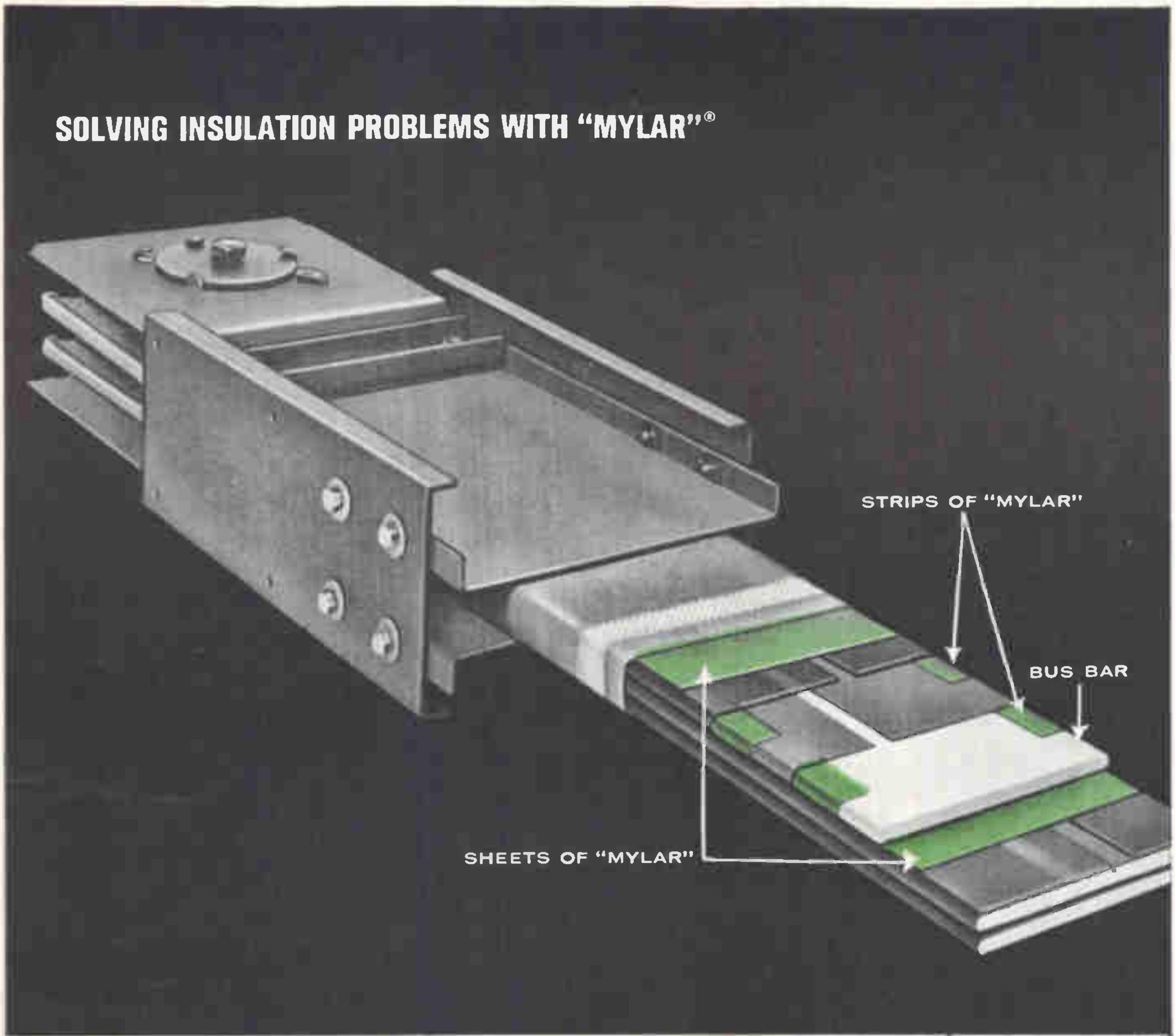
Femto-

Re your issue of April 5 and the article, Tunnel Diode Detects Currents Down to 100 Femtoamperes (p 33):

Contents (p 1) cites ". . . down to 100 femtoamperes (10^{-15})," which implies 1 fa = 10^{-18}. *Crosstalk* (p 3) defines 1 fa = 10^{-15}. The article (p 33) defines 1 fa = 10^{-18}.

S. BERINKSY
Lockheed Electronics Company
Plainfield, New Jersey

The Crosstalk definition is correct: a femtoampere is 10 to the minus 15 ampere. The error on p 33 was corrected while the magazine was on the press, but not before some copies had already been printed.



THE INSULATION OF "MYLAR" IS SHOWN IN GREEN

High dielectric and thermal properties of "Mylar" make busway smaller...at lower cost

The outstanding performance of "Mylar" polyester film in thin gauges allowed the Square D Company to design a more compact busway at lower cost. "Mylar" provided an insulation material that was both strong and durable, with higher dielectric and thermal properties that eliminated the air space needed for cooling between the bars. Unlike many conventional insulating materials, heat can be dissipated directly through the "Mylar" without causing any breakdown of the insulating value.

While the Square D busway operates within Class A temperature limits, the unit was subjected to a Class B test (130°C.). "Mylar" withstood this test, giving a 25° safety factor—and an expected insulation life of four times Class A insulation.

The combination of properties of "Mylar" offers you added benefits that can lead to product improvement. "Mylar" is resistant to solvents, easy to work with as compared with other insulation materials. "Mylar" has excellent volume resistivity even at elevated temperatures. It has low moisture permeability.

You may be able to reduce your costs through design modifications and manufacturing economies, using "Mylar" to replace your present insulating material. Why not investigate its unique combination of properties in your applications? Save time and money now by writing to Du Pont Company, Film Dept., Wilmington 98, Delaware.

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Out of the run of signals on a line, Sierra's Model 126A Frequency Selective Voltmeter rounds up only the ones you want to measure. It repulses noise and spurious harmonics at the bandpass — a narrow 250 cps wide.

126A rides herd over a roomy 5 to 1620 kc range, keeping a tight rein on accuracy all the way (typical limit of error, ± 0.8 db). It can be a tunable or flat voltmeter depending how you set the selector knob. And it lets you play the range by ear with a switch that broadens the bandwidth to 2500 cps.

$1,195 corrals everything a 126A has to offer. Except for a 50-megohm probe, which costs $195, and input transformers for 600, 135, and 75Ω lines priced at $75 each. Our new literature surveys Sierra's select herd of prime voltmeters and wave analyzers. Write for it, or have your Sierra sales representative saddle up for a faster-than-by-mail response to your needs.

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Dipole Belt Dispute Flares Up Again

WASHINGTON—The on-again, off-again controversy on the effects of Project West Ford on world-wide radio and optical astronomy (p 9, Oct. 27, 1961; p 9 Jan. 26, 1962; March 16, 1962, and p 7 Feb. 1, 1963) was kicked into life again last week. Fred Singer, University of Maryland physicist who heads the Weather Bureau's satellite program, says the orbital life of West Ford's radio-reflecting dipoles is likely to be 10 times the 7-year estimate that placated worldwide scientific criticism of the project.

Singer says the Air Force fails to take into account the effect of the electrical charge the orbiting copper dipoles will pick up. He says electrostatic drag in the earth's magnetosphere on this half-volt charge will extend the life of the West Ford belt to "up to 100 years."

The first effort to launch West Ford failed. Early this year, after Lincoln Laboratory scientists developed the electric charge theory, the Air Force launched a few 13-inch "nails" into orbit and determined to its own satisfaction that electrostatic drag had no effect on orbit decay. West Ford II, a copy of the first attempt with the bugs out, is now ready for launching.

Singer stated his position in a paper delivered at the American Geophysical Union meeting. He said such experiments ought to be submitted to the world scientific community for discussion to prevent inadvertent and irreversible effects on the environment. But he insists, however, that the U. S., regardless of international opinion, must remain free to conduct experiments it feels are important to national security.

Fast Diode Employs Metal-Silicon Junction

HP ASSOCIATES, of Palo Alto, said last week that it is making a new class of diodes employing metal-silicon junctions. This structure provides majority carrier conduction and results in virtual elimination of charge storage. The company says turn-on and turn-off times are in the picosecond range, too fast to measure with available test equipment. Effective minority carrier lifetime is less than 100 picoseconds, capacitance is less than 1 pf, and breakdown voltage is greater than 15 v, for a reverse current of 10 μa.

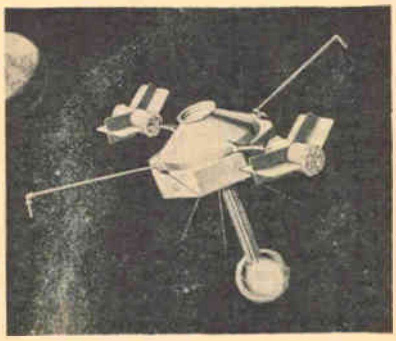
NATO Defense System Rouses Europe's Ire

BONN—Questions about the NATO Air Defense Ground Environment (Nadge) system and the F104 Starfighter production program are being raised in the Western European press. The planes are identified with Nadge since they are the most imminent European defensive weapon, but Nadge in the long run will be used for the ground-to-air rocket system still to be installed.

One major question is payment for Nadge. The U. S. has refused to pay more than 30 percent of the cost, originally estimated at $300 million. High sources now estimate $1 billion.

The other major question is whether the F104 can perform its defensive missions without Nadge. The U. S. refusal led the Belgian Air Force to claim it could have

A-Power for the Imp



ATOMIC GENERATORS *will supply power for radio transmitters aboard the Imp, Interplanetary Monitoring Probe, shown here (p 8, Feb. 15). Martin received a $174,000 contract from the AEC last week to start development on the atomic units and a $74,000 contract to study strontium-90 fuel requirements for the system*

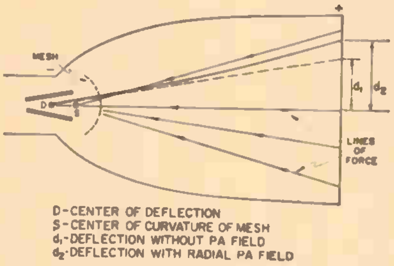
Headaches on the Road to Nuclear Stalemate

TWO DISCONCERTING points brought out in the February Senate Armed Services Committee hearings have been released this month. Although the Defense Department is relying on the Polaris missile and the Minuteman ICBM as the bulk of our contribution to achieving a "mutual deterrence" with the Soviet Union, both systems leave cause for concern.

To allay the fears of the committee members, Defense Secretary McNamara said: "At the present time we see no reason to believe that the Polaris will lose its invulnerability in the near future." Then, shattering this cheerful news, he added: "When I say 'near future' let's say five years." After five years, McNamara went on, he wouldn't "even hazard a guess." The vulnerability will result from expected improvements in Soviet ASW detection techniques.

Due to problems with Minuteman guidance, test results have been worse than poor: eight tests were scheduled at Vandenberg between June 11, 1962 and Feb. 15, 1963. Four were actually launched, and all were unsuccessful. Minuteman is considered operational

Crt Brightness Raised



DEFLECTION *demagnification from a slightly negative spherical mesh makes a new closed-structure crt useful at high frequencies, S. Slade of Hewlett-Packard reported last week at the Cleveland Electronics Conference. Conventional post-accelerator tubes, using bands or helices, trade scan to intensify brightness because of the converging action of the lenses formed. The mesh, followed by a radial field, overcomes this limit at a sacrifice of screen current and some enlargement of spot size*

bought a cheaper plane than the $1.5-billion-plus F104 for offensive-reconnaissance missions. Germany, however, is said to have overcome the defensive-mission limitation and Bonn sources point out that Germany adopted the F104 in 1959, before Nadge was considered.

Cold Solder Joints Delay Mercury Launch

CAPE CANAVERAL—Informed sources here have indicated a possible delay of a week or more in the scheduled May 7 launching of Astronaut Gordon Cooper into a 22-orbit flight around the globe. The problem is believed to be one of cold solder joints inside the gyro cans of the Atlas guidance system. These joints are created when a number of wires are soldered together and inserted in a plug. The heat travels back to the original point where the wires are soldered and loosens them.

Technicians, upon discovering this problem in one of the nine gyros, sent all of them back to the factory for checking and necessary overhaul. There are three sets of gyros in the Mercury Atlas. One set of three determines the pitch, roll and yaw of the Atlas in flight. The second set of three determines the rate of pitch, roll and yaw. The third set is a back-up set for the rate gyros.

Continuous Beam Accelerators Possible

WASHINGTON—Perry B. Wilson, of Stanford University, suggests that 30-Mev continuous-beam linear electron accelerators may be possible through cryogenic techniques. Stanford scientists are now preparing a 1-ft experimental accelerator. High-power accelerators are now pulsed to avoid burning out klystron driver tubes. A superconducting accelerator structure, he says, could eliminate most of the electrical resistance that causes the heating.

In another report, at the American Physical Society meeting this week, Ethan Hoag, of Avco-Everett Research Lab, reported a new method of energizing superconducting magnets. He said magnetic flux is fed from series of five normal magnets placed across a strip of niobium zirconium in a liquid helium bath. As the magnetic flux is moved across the strip, the field becomes trapped and a persistent current is set up.

British Testing Color-Tv Systems

LONDON—First field trials by the British Broadcasting Corporation of the three competing color-tv systems started last week.

First contender on trial is the French SECAM system. Tests of the NTSC and the German PAL systems will follow in a few months. A decision on which of these will be adopted as the British and also the European standard is expected by the end of the year.

Latest contender in the contest is Telefunken's PAL (Phase Alternation Line) system. This system aims to reduce color inaccuracies during transmission by reversing one of the two color signals between alternate lines, thus averaging out color errors. PAL is an improved NTSC system and not an entirely new idea.

In Brief . . .

WESTINGHOUSE has designed a centralized control system for ship engine rooms.

AEC AWARDED General Dynamics and General Instrument Corp. contracts totaling $500,000 to develop a generator to convert the heat energy of radioisotopes directly into electrical power. Device would weigh less than 1 pound and produce 1 mw of power.

BENDIX WILL STUDY techniques for random on-site inspection of missile-producing facilities under a $158,500 contract from the U. S. Arms Control and Disarmament Agency.

DYNASOAR will use a Verdan computer built by North American in its primary guidance system.

NIKE-ZEUS was fired successfully at White Sands Missile Range last week. It met all test objectives and executed commands from the ground properly, Army says.

SMITH-CORONA is offering a portable electric typewriter with rechargeable nickel cadmium cells.

TELSTAR II launch is set for May 7.

WESTINGHOUSE bought the controls division and the Hagan name from Hagan Chemicals & Controls, Inc. Hagan's new name is Calgon Corp.

NASA has narrowed to Hughes and Space Technology Laboratories the field of bidders for the Pioneer spacecraft contract.

NORTH AMERICAN received a $3.1-million contract for the attitude control system of the Titan III.

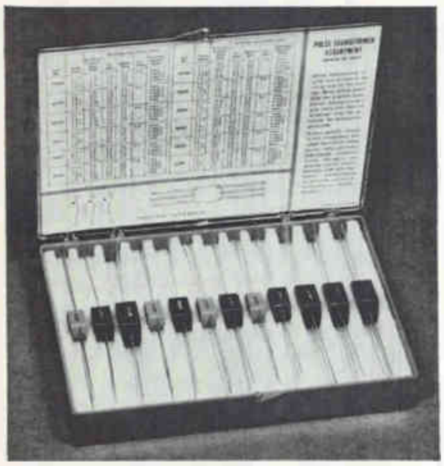
JAPAN'S new tv allocation plan calls for 18 uhf channels in the 662 to 770 Mc frequency band. Purpose is to bring tv to more small communities.

NAVY AWARDED Sylvania a $390,000 contract for operational microminature magnetic tape handling unit of new design (p 66, Feb. 22).

DISK FILE by Burroughs has an access time of 20 msec.

ADVERTISEMENT

New Pulse Transformer Assortment Facilitates "Bread-Board" Designs



The 100Z41 Pulse Transformer Assortment offers the circuit designer a versatile selection of miniature pre-molded pulse transformers. Developed by the Sprague Electric Company, this experimental assortment is suitable for a wide range of requirements and designs in either electron-tube or transistorized circuitry.

Provides 58 Combinations

This assortment contains 12 specially-selected type 32Z miniature pulse transformers which permit 58 turns-ratio and primary inductance combinations. With proper choice of terminal windings and connections, these transformers provide primary inductances ranging from 160 microhenries to 43 millihenries, and turns-ratios from 1:5 step-up to 6:1 step-down.

Permits Frequent Re-Use

The potted, pre-molded case construction of these pulse transformers facilitates bread-board wiring and permits frequent re-use.

The assortment is packaged in a clear, hinged-lid plastic case, complete with simple instructions. A printed table inside the lid indicates all turns-ratios, inductances, windings, and connections.

Specific Designs Available

When the required transformer characteristics are determined, production quantities to exact requirements can be easily obtained from Sprague's broad line of hermetically sealed or encapsulated pulse transformers.

For fast delivery or additional information on the 100Z41 Pulse Transformer Assortment, contact the nearest Sprague Products Co. Industrial Distributor, or write Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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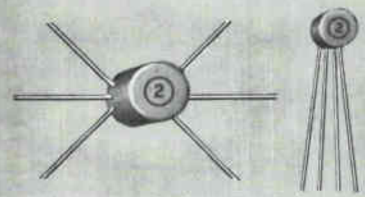
MAGNETIC LOGIC DEVICES

Core-diode and core transistor magnetic shift registers and magnetic counters for switching and storage applications in computer and logic circuitry.

CIRCLE 277 ON READER SERVICE CARD

MOLDED PULSE TRANSFORMERS



Miniature Pulse Transformers with tough molded cases for increased protection against physical damage and severe atmospheric conditions.

CIRCLE 278 ON READER SERVICE CARD

NANOSECOND PULSE TRANSFORMERS IN TO-5 TRANSISTOR CASES

Special design offers distinct advantages: (1) Minified size. (2) Welded hermetic seal. (3) Increased reliability. (4) Compatibility with transistor mounting techniques.

CIRCLE 279 ON READER SERVICE CARD

SOMETHING NEW IN COUNTING TECHNIQUES

Simple yet versatile, low-cost yet reliable counters available for predetermined (2 to 11) or selectable (5 through 10) counting cycles.

CIRCLE 280 ON READER SERVICE CARD

DYNACOR® BOBBIN CORES

Series "300" Cores with logical flux values in popular physical sizes are stocked in production quantities for fast delivery. They're value engineered for quality with economy!

CIRCLE 282 ON READER SERVICE CARD

HERMETICALLY-SEALED TO-5 ENCASED SWITCH CORES

Designed especially for high-speed, low-power switching up to 100 kc, adaptability with conventional transistor packaging techniques, and performance under MIL-S-21038 environmental conditions.

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For application engineering assistance (without obligation, of course) on any of the above products, write or call the Special Products Division, Sprague Electric Company, 35 Union Street, North Adams, Massachusetts.

455P-111-63

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WASHINGTON THIS WEEK

RENTAL FEE DISPUTE STYMIES ASW TEST RANGE

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The satellite findings so far are not spectacular. Besides refining known information on the upper atmosphere, Explorer XVII confirmed, for the first time from space, Soviet ground-based discovery last year of a helium blanket some 600 miles above earth.

SEISMIC CENTER OPENS

NEW SEISMOLOGICAL data and analysis center has been set up in Washington, D. C., by the Coast and Geodetic Survey to receive and store information from 125 seismic recording stations in some 60 countries. It is designed to pick up seismic disturbances from earthquakes —or other sources—that the U.S. wants to monitor. Cost of instrumenting the new center was about $500,000. Cost of operating the center and the stations is estimated at $2 million a year. The center and stations were jointly developed by C&GS and ARPA.

ADVERTISEMENT

New Pulse Transformer Assortment Facilitates "Bread-Board" Designs

The 100Z41 Pulse Transformer Assortment offers the circuit designer a versatile selection of miniature pre-molded pulse transformers. Developed by the Sprague Electric Company, this experimental assortment is suitable for a wide range of requirements and designs in either electron-tube or transistorized circuitry.

Provides 58 Combinations

This assortment contains 12 specially-selected type 32Z miniature pulse transformers which permit 58 turns-ratio and primary inductance combinations. With proper choice of terminal windings and connections, these transformers provide primary inductances ranging from 160 microhenries to 43 millihenries, and turns-ratios from 1:5 step-up to 6:1 step-down.

Permits Frequent Re-Use

The potted, pre-molded case construction of these pulse transformers facilitates bread-board wiring and permits frequent re-use.

The assortment is packaged in a clear, hinged-lid plastic case, complete with simple instructions. A printed table inside the lid indicates all turns-ratios, inductances, windings, and connections.

Specific Designs Available

When the required transformer characteristics are determined, production quantities to exact requirements can be easily obtained from Sprague's broad line of hermetically sealed or encapsulated pulse transformers.

For fast delivery or additional information on the 100Z41 Pulse Transformer Assortment, contact the nearest Sprague Products Co. Industrial Distributor, or write Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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Did you know Sprague makes...?

MAGNETIC LOGIC DEVICES

Core-diode and core transistor magnetic shift registers and magnetic counters for switching and storage applications in computer and logic circuitry.

CIRCLE 277 ON READER SERVICE CARD

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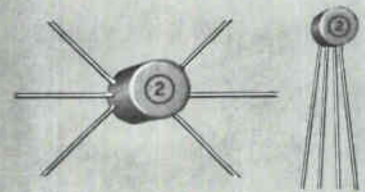


Miniature Pulse Transformers with tough molded cases for increased protection against physical damage and severe atmospheric conditions.

CIRCLE 278 ON READER SERVICE CARD

NANOSECOND PULSE TRANSFORMERS IN TO-5 TRANSISTOR CASES

Special design offers distinct advantages: (1) Minified size. (2) Welded hermetic seal. (3) Increased reliability. (4) Compatibility with transistor mounting techniques.

CIRCLE 279 ON READER SERVICE CARD

SOMETHING NEW IN COUNTING TECHNIQUES

Simple yet versatile, low-cost yet reliable counters available for predetermined (2 to 11) or selectable (5 through 10) counting cycles.

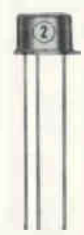
CIRCLE 280 ON READER SERVICE CARD

DYNACOR® BOBBIN CORES

Series "300" Cores with logical flux values in popular physical sizes are stocked in production quantities for fast delivery. They're value engineered for quality with economy!

CIRCLE 282 ON READER SERVICE CARD

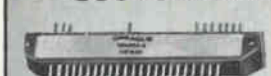
HERMETICALLY-SEALED TO-5 ENCASED SWITCH CORES



Designed especially for high-speed, low-power switching up to 100 kc, adaptability with conventional transistor packaging techniques, and performance under MIL-S-21038 environmental conditions.

CIRCLE 281 ON READER SERVICE CARD

ELECTRONIC MODULES TO CUSTOMER REQUIREMENTS



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WE USE BOTH ENDS OF THE PENCIL...
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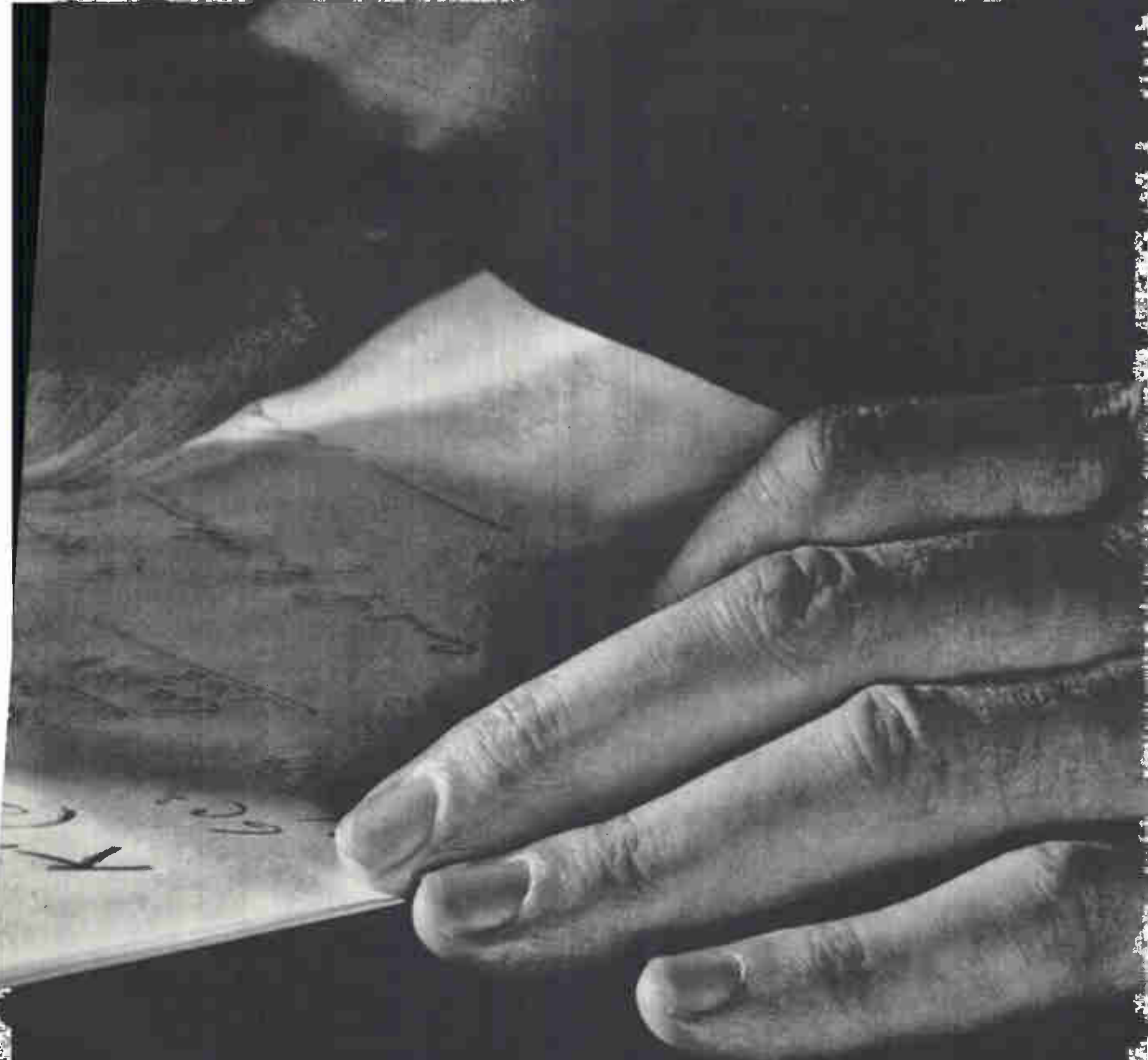

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rugged CK8167/4CX300A ceramic power tetrode now available from Raytheon!

Maximum Ratings		Class AB_1 AF Power Amp. or Mod.	Class AB_1 RF Linear Pwr. Amp., SSB	Class C RF Pwr. Amp. & Osc.	Class C Plate Mod. RF Pwr. Amp.
Eb	(volts)	2500	2500	2500	1500
Ib	(amps)	0.250	0.250	0.250	0.200
Pp	(watts)	300	300	300	200
P_{g2}	(watts)	12	12	12	12
P_{g1}	(watts)	2	2	2	2
Typical Operation					
Eb	(volts)	2500	2500**	2500**	1500
E_{c2}	(volts)	350	350	250	250
Ib	(amps)	0.500*	0.250	0.250	0.200
Drive	(watts)	0	0	2.8	1.7
P.O.	(watts)	800*	400	500	235

*two tubes—push-pull **below 250 mc only

The CK8167/4CX300A is now available from Raytheon. This compact, all ceramic-metal external anode tetrode is designed and manufactured to deliver outstanding, reliable performance under conditions of high temperature and severe shock and vibration. With a full maximum plate dissipation rating of 300 watts and a capability to perform at 500 mc, the Raytheon CK8167/4CX300A is ideal as an RF power amplifier, oscillator, linear amplifier, AF amplifier or modulator.

For complete technical data and sales information please write: Raytheon Company, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts. For small order or prototype requirements, see your local Raytheon franchised distributor.

RAYTHEON

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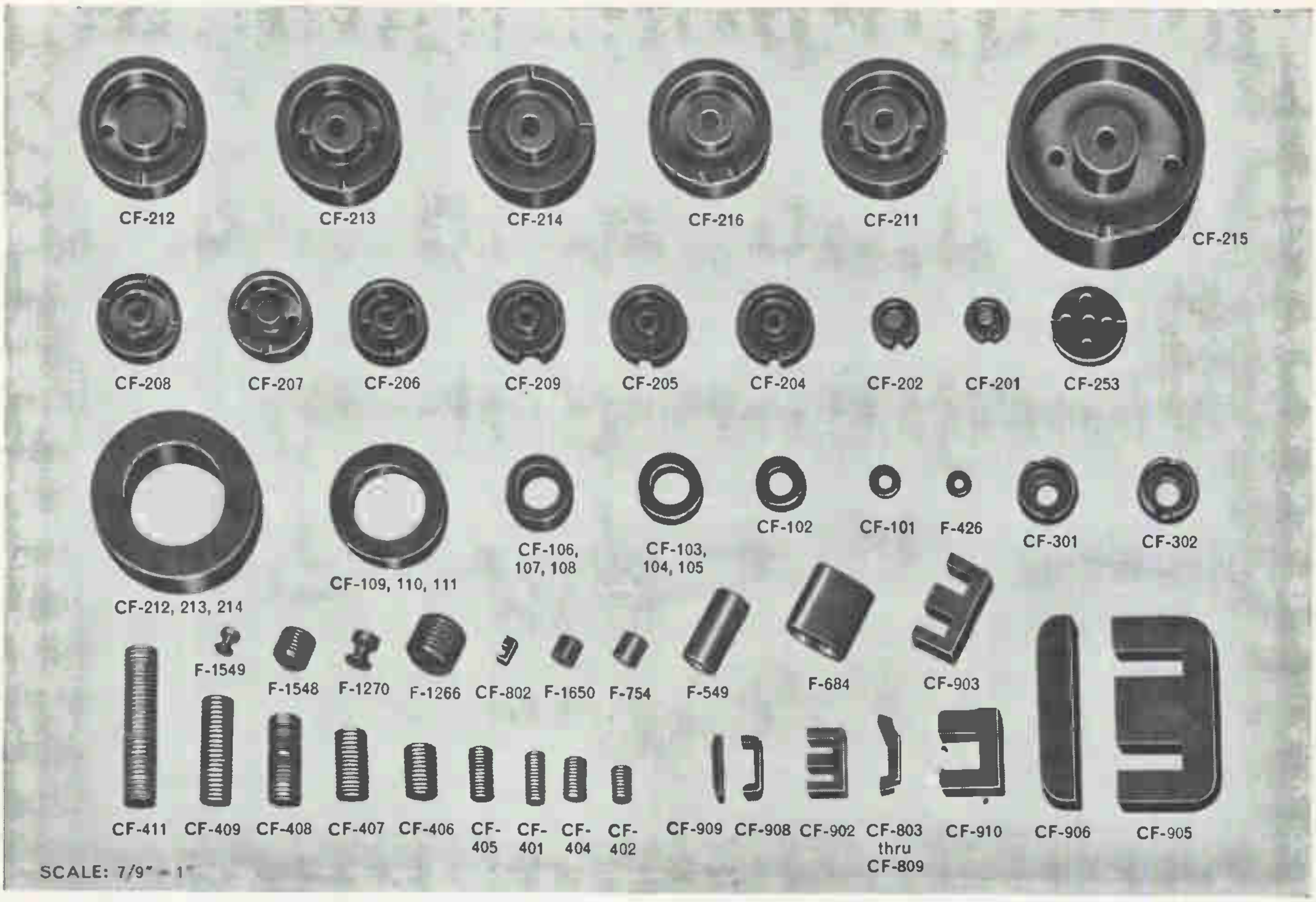

Now—delivery from stock on these special-purpose FERRAMIC® cores

Indiana General Ferrite cores are available in various materials for specific frequency bands from 1 kc to 225 mcs. Use the handy materials selector chart for quick reference.

APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRAMIC BODY	SHAPES
Filter Inductors	High μQ, magnetic stability, sometimes adjustable	Up to 200 kcs 200 kcs-10 mcs 10 mcs-60 mcs 50 mcs-225 mcs	"Q-3", "T-1" "Q-1" "Q-2" "Q-3"	Cup cores, toroids, C-cores, E-cores, slugs.
IF Transformers	Moderate Q, high μ, magnetic stability, adjustable	465 kcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
Antennae Cores	Moderate Q, high μ, magnetic stability	5-10 mcs 10-60 mcs	"Q-1" "Q-2"	Rods, flat strips
Wide Band Transformers	High μ, moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs 50 mcs-225 mcs	"Q-3", "T-1" "H" "Q-1" "Q-2" "Q-3"	Cup cores, toroids, C-cores, E-cores
Adjustable Inductors	High μ, moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
Tuners	High μ, moderate to high Q, magnetic stability, as much as 10-to-1 adjustability with mechanical or biasing methods.	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply.	Threaded cores or rods for mechanical tuning. Toroids, C-cores, E-cores for biasing methods.
Pulse Transformers	High μ, low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High μ, low loss, high saturation, resistance to wear	Audio, pulse	"H" "Q-3", "T-1"	

Fast service on sample quantities; prompt delivery on production lots. Call, wire or write for all the facts to Indiana General Corporation, Electronics Division, Keasbey, New Jersey. Ask for Catalog. 40K.

INDIANA GENERAL

DATA ACQUISITION WITH DYMEC SYSTEMS

CHOOSE THE INPUT SCANNER YOU NEED FOR AUTOMATED MEASUREMENT

Standard Dymec Data Acquisition Systems offer a wide choice of input capabilities, all derived from multichannel scanners. One scanner, the flexible DY-2901 Input Scanner/Programmer features a system programmer for on-demand measurement of mixed types and levels of inputs. The system can be commanded manually or remotely to measure one cycle, then stop; scan continuously; operate single-step; and repeat monitoring of a single channel.

The higher capacity (600 point) DY-2911 Guarded Crossbar Scanner offers single-scan measurement; continuous recording, single-step monitoring, and single-channel monitoring. Front-panel controls provide random access to any channel or group of channels for measurement. Guarding of the entire crossbar switch assembly complements the high common mode rejection of the associated DY-2401A Integrating Digital Voltmeter.

The DY-2010C Data Acquisition System, pictured here, records data on printed tape and incorporates the DY-2911 Guarded Crossbar Scanner. The system is equally suitable for measuring millivolt-level signals from thermocouple and strain gage bridge transducers, potentials of hundreds of volts and frequencies to 300 kc.

Advantages common to all systems of the DY-2010 Series are modest cost, fast delivery, high reliability derived from standard design and construction, and proved performance. You get a pre-designed, tested system. You don't have to wait—or pay—for "custom" engineering, fabrication or testing time.

Major characteristics of the 2010 Series standard systems are listed in the chart below. Other systems are available to fit many additional requirements.

Check for the system that meets your needs, then call your Hewlett-Packard/Dymec representative for complete information.

DY-2010C

	DY-2010A	DY-2010B	DY-2010E	DY-2010C	DY-2010D	DY-2010F
Scanner Input	Up to 25 3-wire signal sources; to 100 channels with slave scanners; programming capability permits measurement of mixed types and levels of signals			Up to 200 guarded 3-wire inputs; 300 2-wire; to 600 non-guarded 1-wire inputs		
Voltage Ranges	100 mv to 1000 v full scale; overranging to ±300% of full scale on four most sensitive ranges; 0.01% stability on four highest ranges					
Frequency Ranges	10 cps to 300 kc; sample period 0.01, 0.1 or 1 sec ; accuracy ± 1 digit ± time base accuracy					
Display	5 digits of data, range, function (polarity), channel number, all included in front-panel readout, logged on output recording device					
Measurement Speed	5 channels/sec	10 channels/sec	1 channel/sec	5 channels/sec	10 channels/sec	1 channel/sec
Effective Common Mode Rejection	105 db	105 db	105 db	130 db	130 db	130 db
Output	Printed paper tape	Perforated tape	Punched card (on IBM 526)	Printed paper tape	Perforated tape	Punched card (on IBM 526)
Price	$8675	$10,800	$9885	$10,965	$12,850	$12,175
Options	Time of day information, ac voltage and resistance measurements, 10 mv full-scale sensitivity, cabinet					

Data subject to change without notice. Prices f.o.b. factory.

DYMEC

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dy

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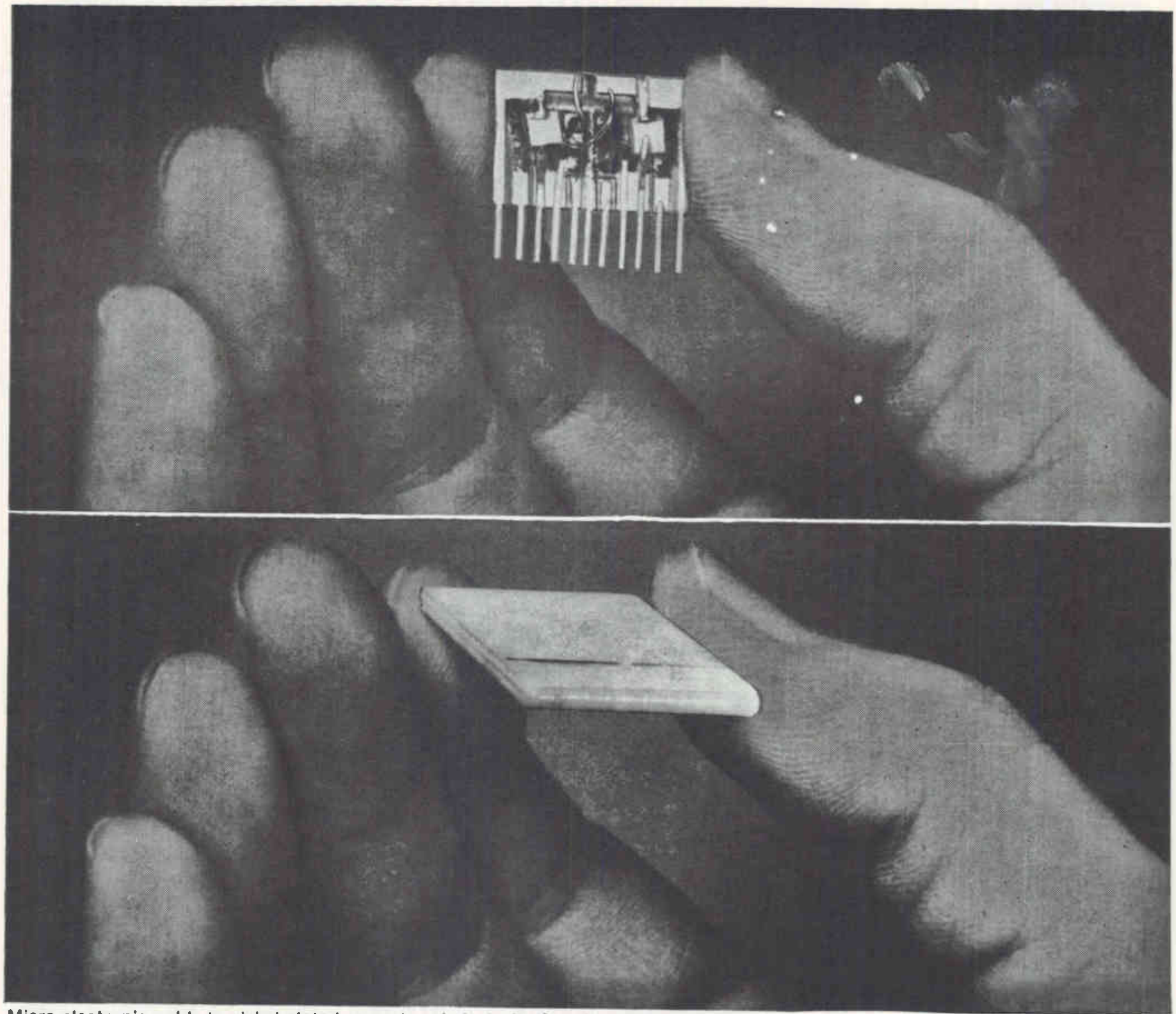


Micro-electronic welds to nickel-plated ceramic substrate (top) and two edge-welded aluminum oxide ceramic wafers (bottom) show versatility of Hamilton-Zeiss Welders.

ELECTRON BEAM WELDING . . .
a new world of design at your fingertips

Hamilton-Zeiss Electron Beam Welders produce ultra-precise microminiature welds which set new standards of connection reliability. They also permit fabrication with difficult-to-join materials such as ceramics, refractories, and titanium. The Hamilton-Zeiss process allows designers of micro-electronic circuits and components to achieve optimum packaging density, reduced weight, and increased reliability.

The three exclusive Hamilton-Zeiss features which make these advantages possible are:

- Small beam diameter with high power density (37½ million watts per square inch).
- Optical viewing system which shows exact position of the beam on the workpiece at all times (40 mag.).
- Precise, repeatable control of beam energy, position, and penetration.

The process also permits component encapsulation and contamination-free joints of high structural integrity because the work is performed in a vacuum.

For full technical data on Hamilton-Zeiss Electron Beam Welder, write or wire: Electron Beam Systems, Hamilton Standard Division, United Aircraft Corporation, Windsor Locks, Connecticut.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

The first 1.5 MC recorder delivered.

CEC's VR-3600... Highest performance in the industry.

FEATURES

- 1.5 MC Direct Frequency Response
- Linear Phase Vs Frequency Characteristics
- 7-or 14-Channel Record/Reproduce
- Vacuum/Ionization Tape Cleaner
- Utilizes RFI Design Techniques

CEC's VR-3600 Magnetic Tape Recorder/ Reproducer has proven its outstanding capability by outperforming all comparable instrumentation in the extremely wide bandwidth, multi-channel field—*with units built and delivered in quantity.* And it's the *first* 1.5 mc recorder sold to *working* specifications. This means specs that are practical from the users viewpoint—all met with one set-up of the tape system, not with separate adjustments before each test.

Each of the VR-3600's channels can be used for data storage in the 100 kc to 1.5 mc frequency range—with high signal-to-noise and low distortion characteristics.

The direct system has a full 1.4 mc bandwidth fully amplitude and phase equalized, with less than 2% harmonic distortion. No intermodulation product exceeds 0.75%, and phase response is held to within 0.2 usec.

In the tape transport, skew is under —.30 usec., flutter is less than 0.30% p-p at 120 ips, tape is constantly cleaned by a vacuum/ ionization device and tension is held smoothly constant by a closed-loop servo.

For *all* specifications, contact your local CEC sales representative, or write for Bulletin 3600-S.

CEC Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of **Bell & Howell** • Pasadena, California

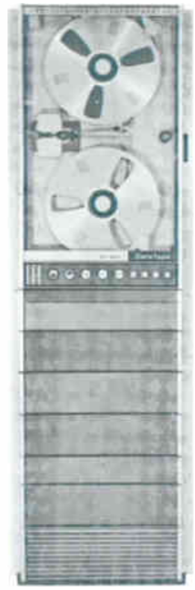
6 ways CEC reflects the "state-of-the-art" in recording

Wherever they're found — in laboratory, fixed base, mobile, shipboard, or blockhouse applications — you can be sure CEC recorder/reproducers represent today's most advanced products in the tape field. All incorporate the accuracy and reliability inherent in all CEC instrumentation ... prime reason for their success in applications involving the nation's most advanced missile/space programs. Below are 6 recorders in the CEC line that makes the company a single source for virtually all needs in the magnetic tape field.

PR-3300 combines low cost and portability with excellent performance. The complete 14-channel record and reproduce system can be unitized as a single portable system 29⅞ inches high weighing no more than 213 pounds. Direct, FM, or PDM techniques can be used singly or combined. CEC Bulletin 3300S.

VR-3300 is a wide band system for use in applications where portability is desirable. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques — or twice the bandwidth of standard telemetry records. Features include 6 speeds and all solid state electronics. Bulletin 3300VS.

DR-2700 is a high speed Vacuum-Buffered Digital Magnetic Tape System designed for on-line and off-line digital computer usage. A complete 16-channel digital write and read system can be housed in the unit's 72-inch-high RETMA cabinet. Outstanding reliability has been proven in critical military applications and in IBM compatible installations. Bulletin 2700S.



GR-2800 is solid state, a fully integrated recorder/reproducer system. A single standard 19-inch EMA rack with a 64-inch-high opening contains the complete 14-channel record and reproduce system. The one cabinet can mount 28 amplifiers (operating in Direct, FM or PDM modes), capstan power amplifier, and tape-speed control servo. Direct record response is 100 cps to 100 kc; FM response is 0-10 kc. Bulletin 2800S.

VR-2600 is an advanced design, multi channel wide band data recording and reproducing system designed to handle precision data in the frequency spectrum from d-c to 600 kc. Record and playback amplifiers in the 14-channel system can handle Direct, FM, and PDM data. 16 track PCM techniques can also be supplied. Bulletin 2600S.

VR-2800 is a wide band system for use in laboratory environments with Direct and FM electronics. Bandwidth of direct recording/reproducing is 100 cps to 200 kc; 0-20 kc with wide band FM techniques. The full 7- or 14-channel system, with 6 speed operation and plug-in electronics, can be packaged in a single, six-foot EMA cabinet. Bulletin 2800VS.

CEC Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of Bell & Howell • Pasadena, California

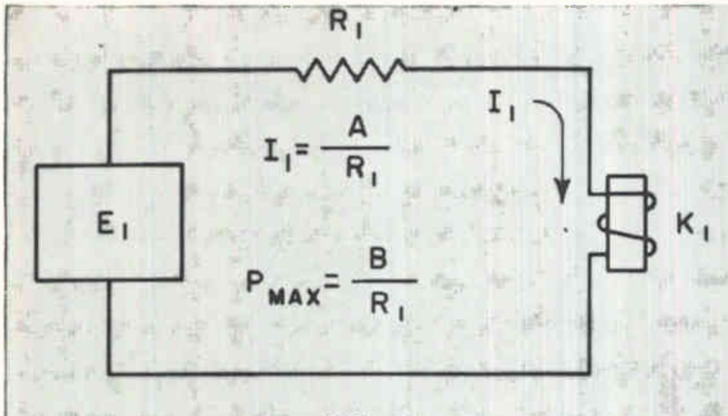


FIG. A

Figure A shows a relay circuit* which is considered operable if at least the one ampere required to actuate the relay (K_1) is provided. Assume K_1 is "perfect" and has no internal resistance.

2. Calculate the constant A
nominal value of R_1 for the 15%
tolerance case. (↑)=1.15 (↓
for both R_1 and E_1.
Given: E_1 = 10 volts (nominal)
Ans: 15% 5
A = (7.4) (6.7) A = 9.
R_1 = (6.6) (7.4) ohms R_1 = 9.

Method: Worst-case $I_1 = \frac{\downarrow}{\uparrow}$

Where: $A \frac{\downarrow E_1}{\uparrow} = \frac{.85(1}{1.15}$

We're running a design-tolerance contest. You should enter. Here's why:

You can't help but win a prize. We've got 51 of them—and everybody wins first prize. What's a contest without prizes, we always say.

Second prize is a free round trip to WESCON in San Francisco—maybe two free trips if you live in Palo Alto—*and* an RCA Victor TRENT Mark 8 color television set.

Third prize is a complete 8mm home movie outfit—KODAK Electric 8 Automatic Camera, KODAK Automatic 8 Projector, and screen.

48 more prizes are CORNING WARE® Electromatic skillets and roaster dish sets. They're nice, too.

First prize is more reliable circuits for fewer dollars!

The contest problems show you how to get this prize when you use *tight* design-tolerance CORNING resistors in worst-case design approach. This gives you a better product at less cost.

Knowing how to do this can earn you considerable professional benefit—raises, advancement, that sort of thing. They're nice, too.

Send us the coupon and we'll send you a CORNING Design Tolerance Contest Kit. It includes a detailed bulletin on our tight design-tolerance concept, a folder which gives you complete instructions and a worked-out sample problem (see above), and a pencil.

Mail the coupon today. Your contest entry must be postmarked no later than June 30, 1963.

Mail it even if contests leave you cold. You should have the bulletin if you're at all interested in greater equipment reliability at lower cost.

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3901 ELECTRONICS DR., RALEIGH, N. C.

CORNING ELECTRONICS
A DIVISION OF CORNING GLASS WORKS, 3901 ELECTRONICS DRIVE, RALEIGH, N. C.

Please send me the CORNING Design Tolerance Contest Kit.

Name .... *Title* ....

Company ....

Address ....

City .... *Zone* ...... *State*....................

DEFENSE SECRETARY *Robert McNamara takes seat in the National Military Command Center, in the Pentagon, with his deputy, Roswell Gilpatric, and Chairman of the JCS, Gen. Maxwell Taylor. This center will get new automated system*

USS NORTHAMPTON *is being equipped to serve as National Emergency Command Post Afloat in the event that the Pentagon post is knocked out* ▶

National Military Command

New system will provide centralized control of all U. S. military forces

By JOHN F. MASON
Senior Associate Editor

DEVELOPMENT of the National Military Command System (NMCS) is finally beginning to pick up steam, and may move into the R&D contract awards stage within a year. Plans for proceeding with the system will either be read into the fiscal year 1964 budget or the request for 1965. Once underway, the program will probably continue for from three to five years. Cost will be comparable to that for the Strategic Air Command's 465L system or for NORAD's 425L—$331.4 million has been expended to date on 465L.

Despite the urgent need for a system to provide the national command authorities with the means to direct the military forces under all conditions of peace and war, the NMCS has suffered a series of delays. Finally, last summer, Defense Secretary Robert McNamara got the program moving by establishing a centralized organization to develop the system (see chart).

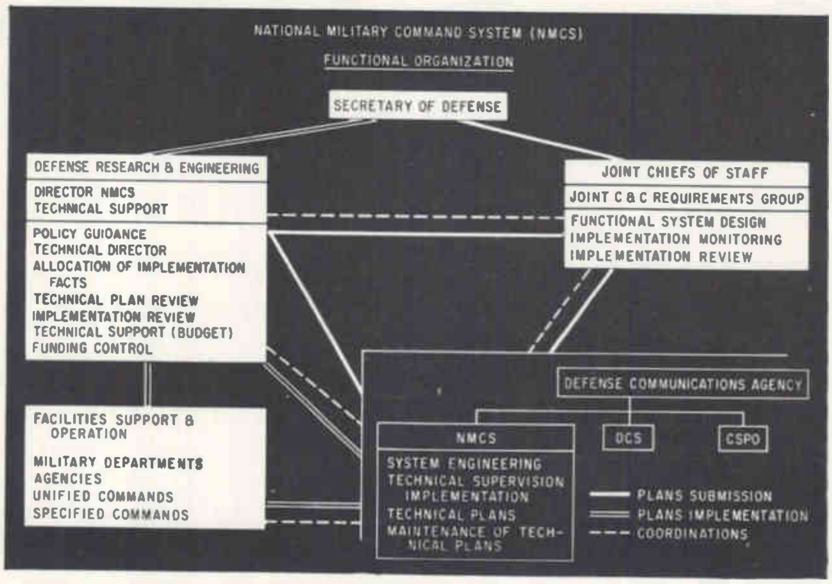
The Joint Chiefs will specify system requirements for the users: themselves, the Defense Secretary, the President, or their successors.

WORK BEGINS—Although DCA is still only 70 percent staffed, and the Secretary of Defense has not yet provided DCA with complete specifications, DCA has already given various agencies in the three military services the go-ahead to formulate plans for integrating data originating in their commands for transmission to the NMCS.

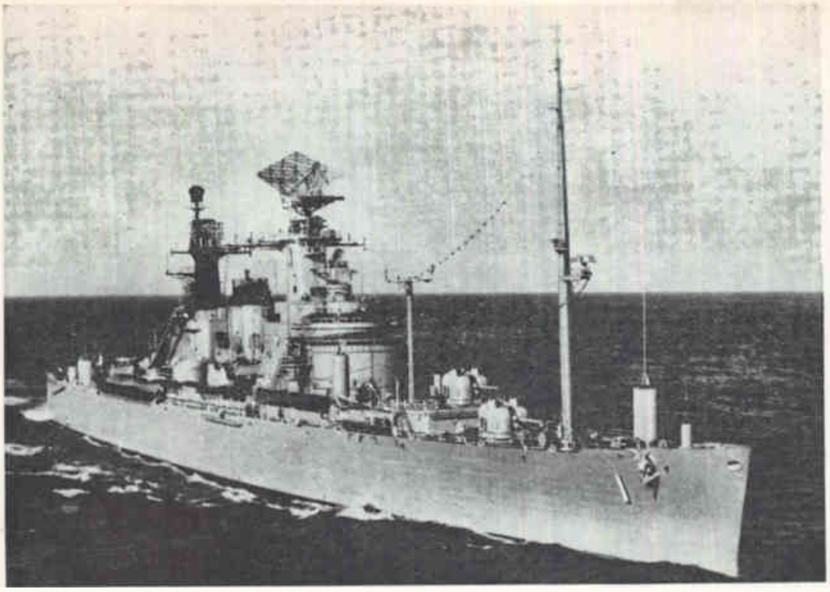
Mitre Corp. has begun to formulate plans for integrating USAF's command and control systems for USAF's Electronic Systems Division. DCA has also given the green light to the Naval Command Support Activity and the Naval Research Laboratory; and to the Army Electronics Command, Army's Command and Control Division of the Deputy Chief of Staff for Military Operations, and Stanford Research Institute.

Eventually, portions of the system will be farmed out by DCA and other parts by the Army, Navy, and Air Force.

HARDWARE—The NMCS consists of a primary and three secondary command centers with input and output links to the unified and specified commands, to the services, and to the Defense Department agencies.



CONTRACT AWARDS *will come from DCA, Army, Navy, and USAF*



System Moves Forward

Primary center is in the Pentagon. A hardened alternate center is at Army's Ft. Richie, Md.; a National Emergency Airborne Command Post, set up in KC-135 Turbojet tankers, is in operation; and a National Emergency Command Post Afloat, on board the heavy cruiser *USS Northampton*, is under development.

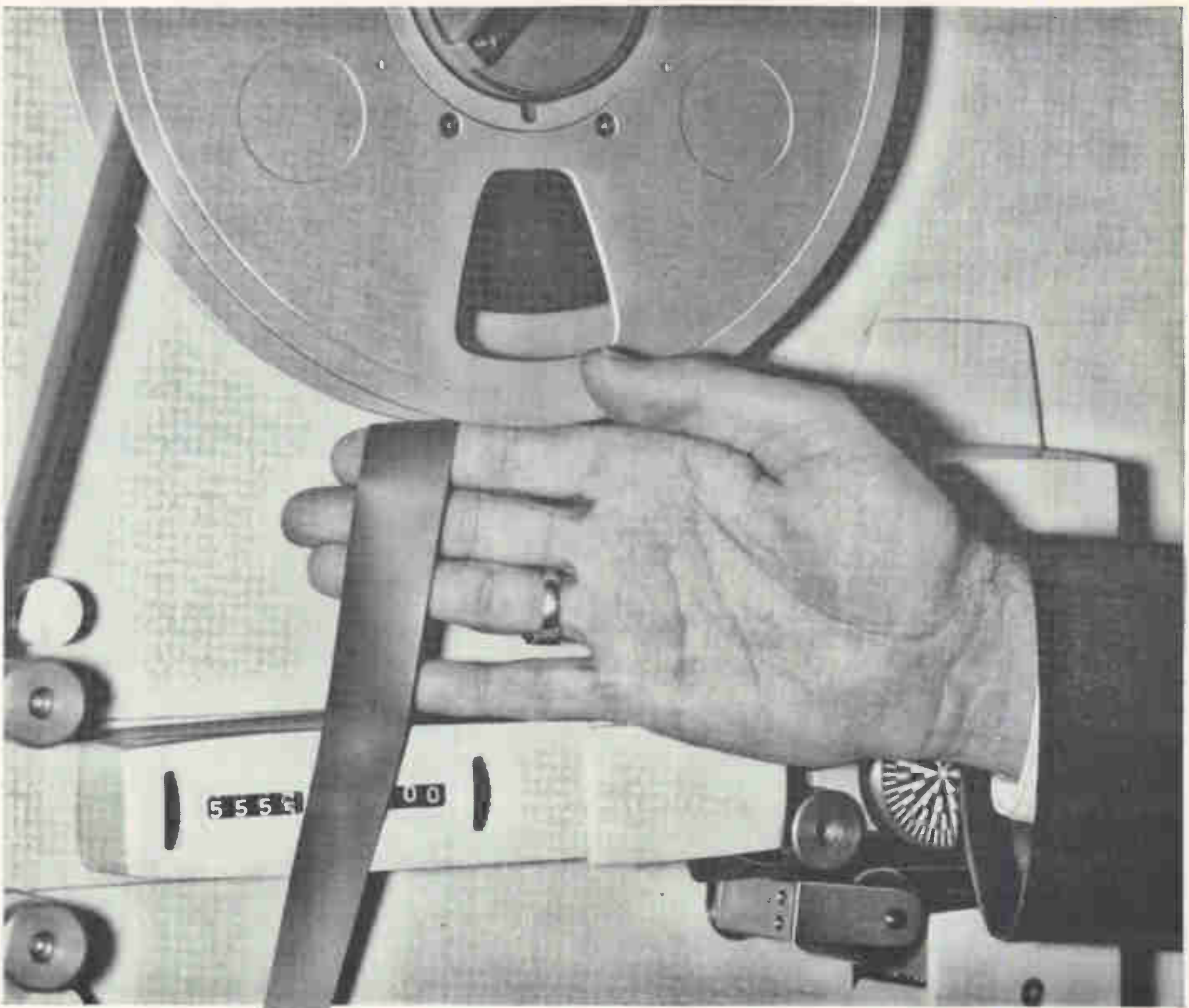
The three secondary centers will probably not provide information as complete as that planned for the Pentagon center. What should be summarized, and how it should be done, are questions still to be answered. Problems inherent in the design of all four centers include: how each one will be connected with the command and control systems of the individual commands and services, and how the connections will be made secure and survivable.

Techniques to achieve survivability include the use of vhf and microwave systems, broadband cable, h-f, ionospheric and tropospheric scatter, vlf, and the possible use of satellite and rocket communication. The communications complex will include not only military networks, but also a national nodal switched, distributed grid system operated by common carriers. Efforts to achieve a survivable transatlantic link are receiving priority attention now.

Security is a difficult problem. Present techniques are deficient. Part of the work in this area will be development of equipment that permits transmission of wideband messages—digital and voice—over links that are already secure.

TWO BREAKTHROUGHS—Mitre hopes to achieve two big advances in command and control tecnnology with the NMCS. In the same way that components have been standardized, Mitre hopes to define standard interfaces between major hardware subsystems. Such equipment would, for example, permit using any display with any computer. Thus, designers of one subsystem would not be limited by the capabilities of the subsystem with which it will be used. Also, during the lifetime of the system, improved subsystems could replace obsolescent equipment without upsetting the entire complex. The greater variety of equipment from which DCA can choose would, also, permit more competitive bidding.

Secondly, Mitre hopes to avoid the sad experience learned from Sage. After Sage was installed, the operator discovered that information he often needed was not available to him. It could not be requested, could not be displayed, nor was the computer able to produce it. By a series of new developments not yet disclosed, Mitre plans to design flexibility into the system, and into the programming of the system, that will make it automatically responsive to new, unforeseen requirements as they emerge. The system will be able to change itself as it operates.



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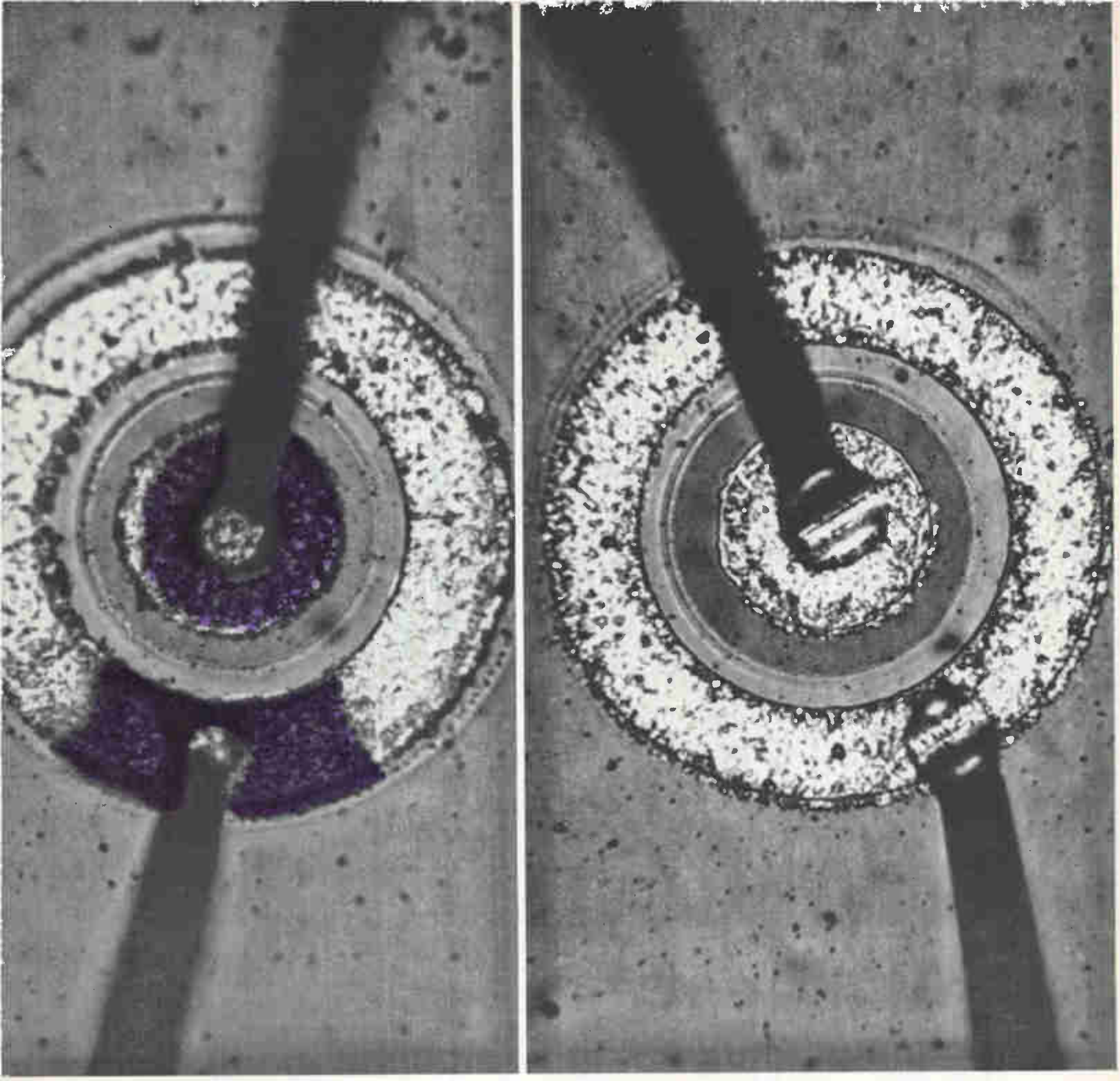

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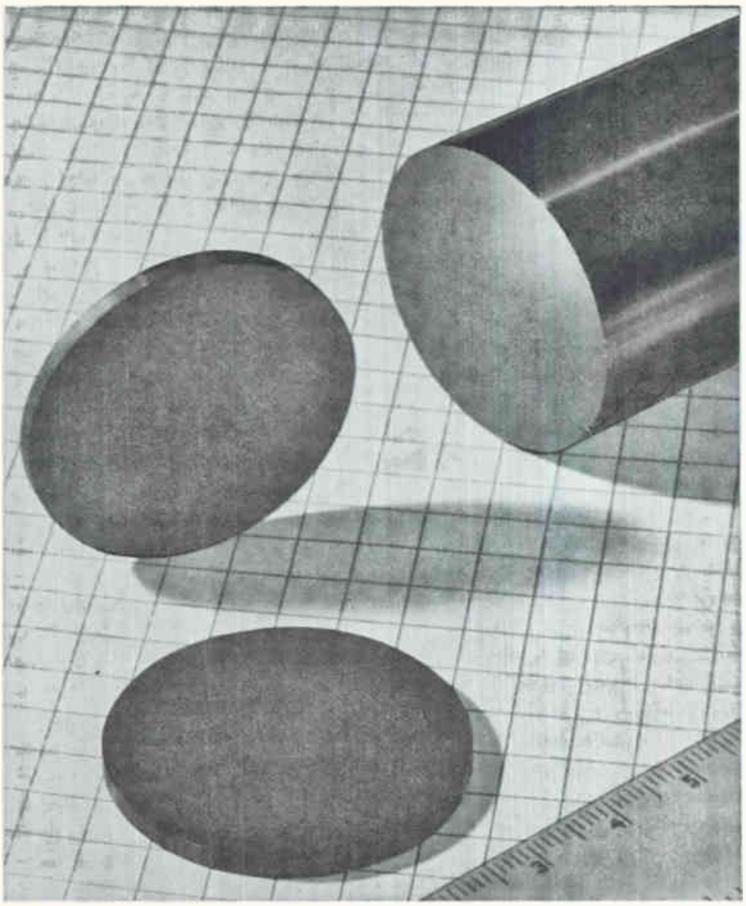

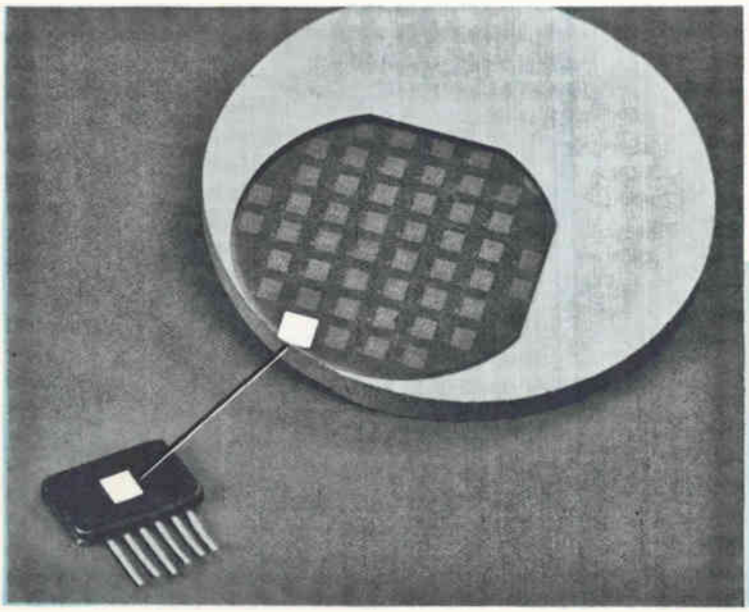

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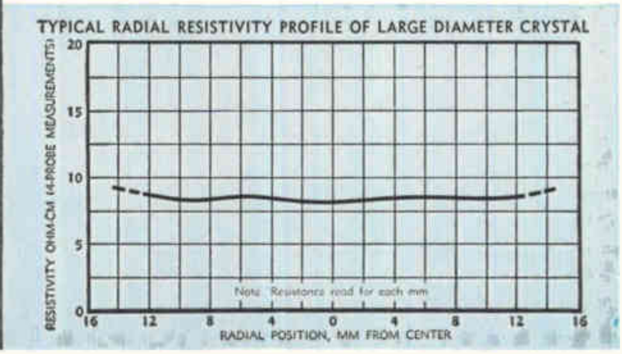

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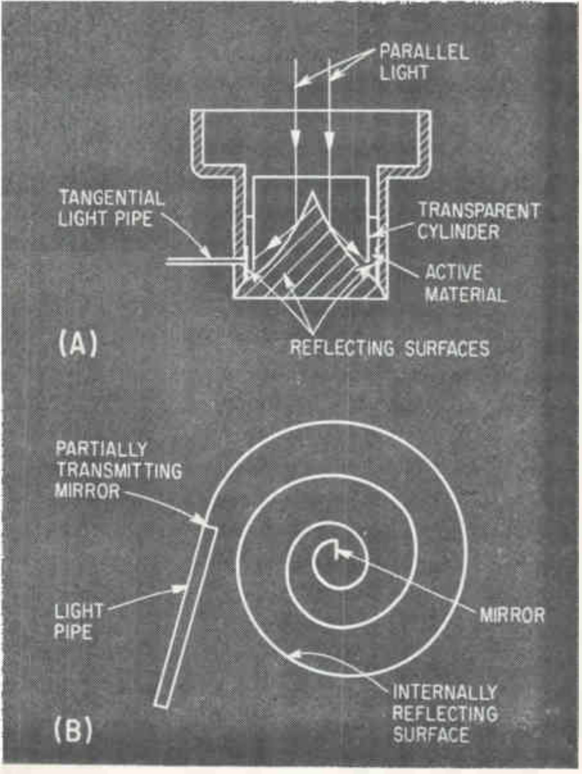

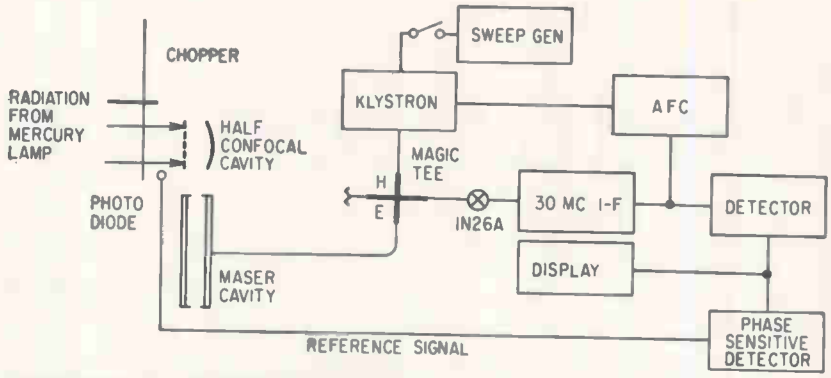

ATTEMPT TO DETECT *stimulated emission in far ir of 10^{-11} will be made with ammonia maser oscillator described by D. C. Laine of Keele University, England. If successful next step will be to determine feasibility of device for ultramicrowave oscillator*

IN CUSP LASER *built at Woolwich Polytechnic, parabolic reflector focuses light onto annulus of active material at wall of internally reflecting cylinder (A); proposed structure in (B) would use internal surface of spiral as reflector*

FIELD MODULATES LASER

Magnetic field modulates laser internally; output can be a-m, f-m or pulsed

By MICHAEL F. WOLFF
Senior Associate Editor

NEW YORK—Internal modulation of a dysprosium-doped, calcium-fluoride c-w laser was the big news at last week's optical maser symposium organized by Polytechnic Institute of Brooklyn. In a post-deadline paper, Z. J. Kiss, of RCA Labs, reported obtaining 100-percent amplitude modulation by using only small magnetic fields.

System uses a d-c magnetic field of less than 200 gauss to tune to cavity resonance. Amplitude modulation is then obtained by adding a 3-gauss inhomogeneous magnetic field along or across the crystal. This is possible because the extremely narrow linewidth permits a relatively small magnetic field to broaden the line, and, near threshold, amplitude is inversely proportional to linewidth. (Fluorescent linewidth at the 2.36-micron laser transition is approximately 100 Mc.)

Audio has been transmitted and 1-Mc bandwidths obtained. Bandwidth is only limited by the Q of the cavity. Upper limits in the gigacycle range are predicted.

Kiss told ELECTRONICS Q-switching has been accomplished by continuously applying a sinusoidally varying inhomogeneous field of 50 to 80 gauss. The Q-switching has been done up to 300-Kc repetition rates and 20-watt peak power outputs, with pulse rise times of 200 nsec. This makes the system practical for tracking and ranging, he said. Laser operates c-w with ½-watt average power out.

Pure f-m can be accomplished by using just the d-c magnetic field and a cavity with no sharp resonance modes. Combination f-m/a-m operation is also possible.

OTHER MODULATORS — Another internal modulation scheme was described by R. Muller, of Siemens and Halske. A four-mirror resonator with a "push-pull" pair of KDP modulators in the laser feedback path allows 100-percent a-m with a few hundred megacycles bandwidth and a few hundred watts modulating power.

New external modulation techniques reported in post-deadline papers are one using the magneto-optical Kerr effect in thin magnetic films and another where modulation is accomplished by a piezoelectric change in thickness of a quartz Fabry-Perot spacer. D. Chen, of Honeywell Research Center, proposed microwave modulation by applying a microwave field at the ferromagnetic resonance frequency of two facing magnetic films forming the reflecting surfaces in a slow-wave structure. Laser beam is directed through the structure and multiplely reflected enough for modulation. Chen said this would give a rugged, easily aligned system capable of 100-Mc bandwidths at 20 Gc.

B. O. Seraphin, of Michelson Laboratory, said his piezoelectric modulator was limited in bandwidth to a few megacycles but had the advantages of ruggedness and extremely low modulating power requirements—0.3 w per sq cm. With 6,328-Å line of a helium-neon laser, device produced 85-percent modulation depth at the 1.43-Mc resonance frequency of the quartz spacer.

IN ADDITION—Symposium high-lights in addition to those reported in our April 12 issue (p 22) included:

- Pulsed ruby laser with output monochromatic and stable to 2 parts in 10^7, described by A. L. Schawlow, of Stanford U. Improved ruby systems or inherently narrow-line materials like thulium and dysprosium may lead to more precise wavelength standards than gas lasers.
- High - repetition - rate pulsed laser that uses neodymium-doped materials (glass and calcium tungstate) described by W. R. Mallory of GE. With Nd-doped glass, laser gives 10 pps at 1-Kw peak and 0.03 joule per pulse; Nd-doped calcium tungstate laser gives 35 pps. Microcircuit machining and system scaling are potential applications.
- Possibility of laser action in aromatic organic compounds like benzophenone, seen by D. J. Morantz, of Woolwich Polytechnic, England. He reported no indication of spatial coherence or conclusive line narrowing but hopes to demonstrate laser action in cavities that use total internal reflection to get high Q (see illustration).
- Difference-frequency signal of 10^{-7} w at 5,150 Å obtained by mixing ruby laser harmonic with neodymium-glass laser output, reported by A. W. Smith, of IBM.
- Device that gives laser beam energy and peak power directly by measuring transverse voltage developed in quartz crystal, described by M. Subtramanian, of Purdue U.
- Amplifier using 6-inch resonant cavity filled with hydrogen cyanide gas yielded 8.5-db gain at 3.5 mm. Described by Benjamin Senitzky, of TRG, sideband amplification occurs when power absorbed by the resonant meduim becomes constant even though incident power increases. Amplifier works at room temperature without high-frequency pump; principle can be extended to optical frequencies.
- X-band ruby maser amplification and oscillation with ruby laser pump, observed at 78 deg K by A. Szabo, of National Research Council, Canada.
- Exothermic reactions between alkali metals and group II-B metallic halides (like $HgCl_2$) are chemiluminescent, might produce coherent light, according to Martin Hertzberg, of Republic Aviation.

MM Moon-Bounce Achieved

Radar probes moon with 8.6-mm signals at 12 watts power

WASHINGTON—An MIT Lincoln Laboratory team has bounced 8.6-mm radar signals off the moon, it was reported last week at the American Geophysical Union meeting.

The shortest wavelength previously reported for lunar radar reflections was 3.6-cm transmissions from a Lincoln Lab field site at Camp Parks, Calif.

The lab can now study the lunar surface over a 1,000:1 frequency range—including a 784-cm probe at El Campo, Texas. Availability of a wide range of frequencies is considered necessary to acquiring significant data.

The 8.6-mm system operated at peak power of 12 watts, essentially c-w. It operated with an effective transmitted pulse of 2.5 seconds, followed by a reception interval of 15 seconds. The spuncast, 28-foot parabolic reflector had a gain of 67.5 db.

The lunar reflections provided enough angular resolution to differentiate between mountainous regions and the maria (ELECTRONICS, p 41, Jan. 6, 1961; p 75, Nov. 10, 1961, and p 43, Oct. 12, 1962). Half-power antenna beamwidth of 4.3 minutes of arc provided angular resolution equal to one-seventh the lunar diameter.

At the AGU meeting, V. L. Lynn, M. D. Sohigian and E. A. Crocker reported that preliminary experimental results from the 8.6-mm bounce show no difference in the reflection characteristics of mountainous terrain and the maria, but the data is inadequate to permit any firm conclusions about the lunar surface.

Tentative results indicate that reflection in the millimeter band is principally due to diffuse scattering and is essentially independent of the gross type of terrain.

Bio-Satellite Study Begins Soon

NASA HAS SELECTED three companies for negotiation of study contracts under the first phase of the bio-satellite program.

The compaines are General Electric's Re-entry Systems Department, Lockheed Missiles and Space Co., and Northrop's Space Laboratories. Seven companies submitted proposals.

The contracts, each expected to be for about $80,000, will call for a six weeks study, with emphasis on the spacecraft. Studies will include environmental control and life support systems, spacecraft stabilization, reentry and recovery systems, sensing, recording and telemetry systems.

The bio-satellite program conceives of a recoverable earth-orbiting biological laboratory for experiments on effects of prolonged periods of weightlessness.

Second phase of the program, hardware development, depends on completion and evaluation of studies. The program will be administered by NASA's Ames Research Center, Moffett Field, Calif.

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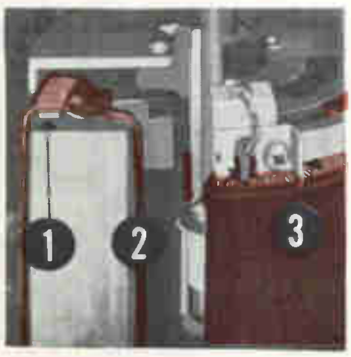

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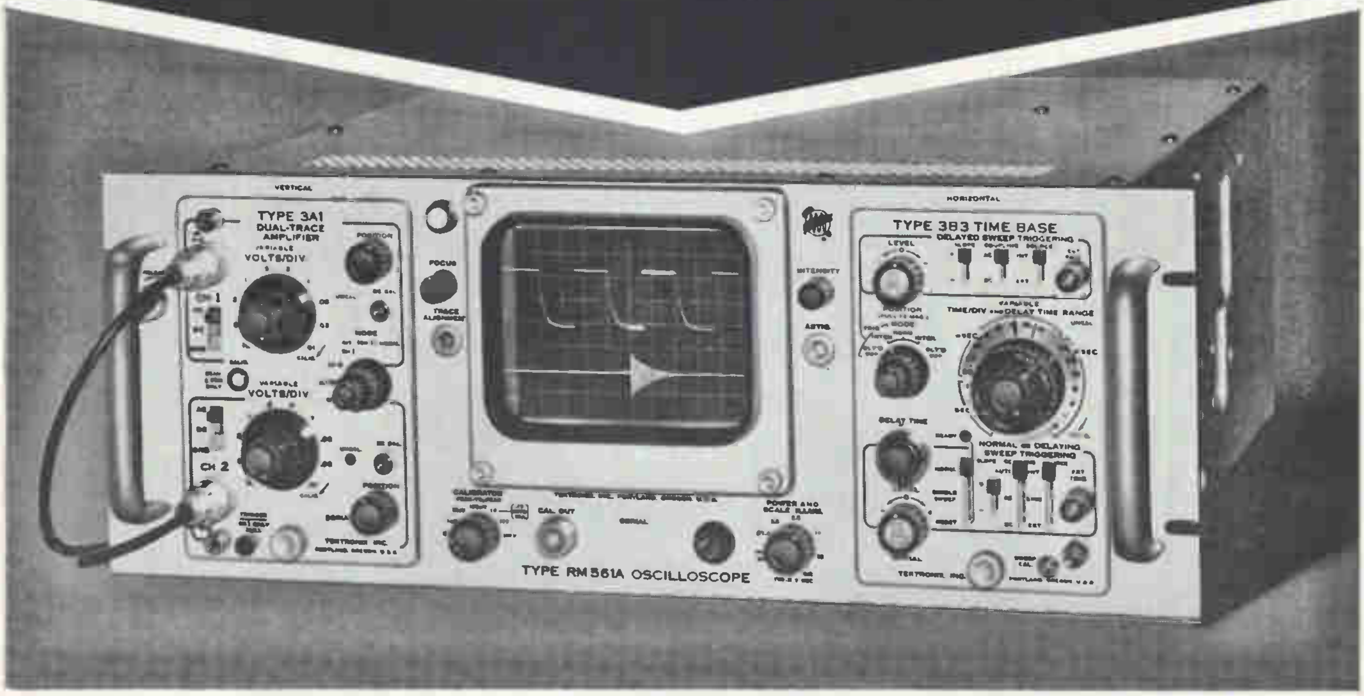

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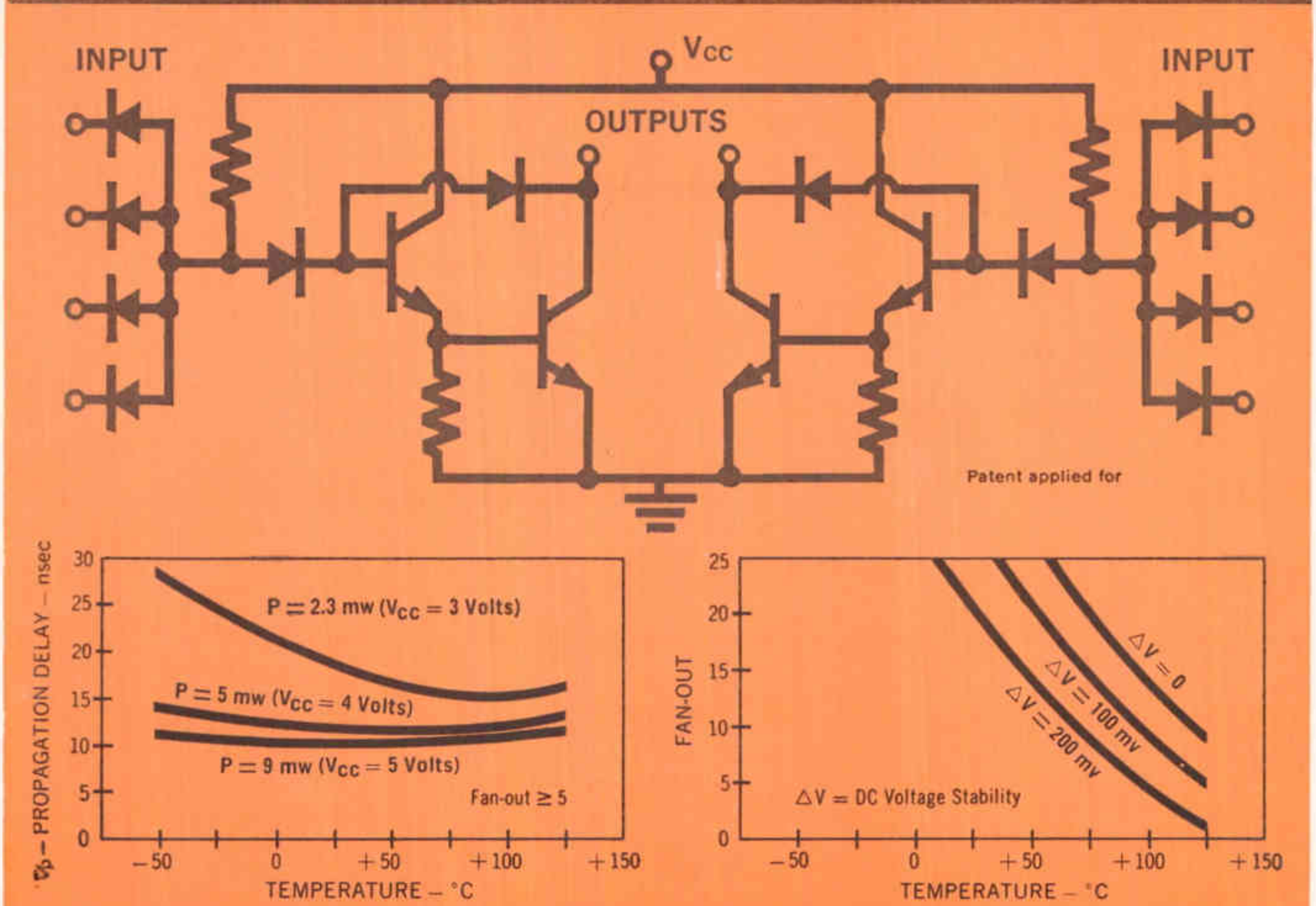

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Chelate Lasers Are Coming

Electrochemists also report on gas lasers and adaptive thin films

By MICHAEL F. TOMAINO
Associate Editor

PITTSBURGH — Rapid progress being made in the development of chelate lasers at several laboratories was apparent in papers on the subject presented last week at the Electrochemical Society meeting.

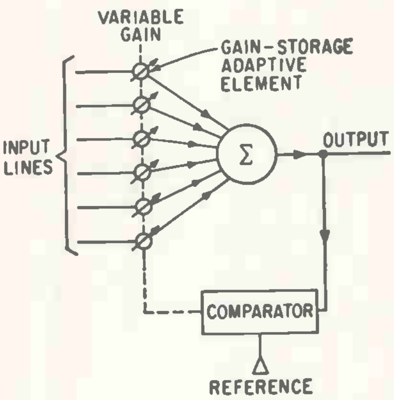
But this new class of lasers was only one of the technical newsmakers in a program that ranged from new thin-film adaptive devices, through new semiconductor fabrications techniques and a long list of other topics.

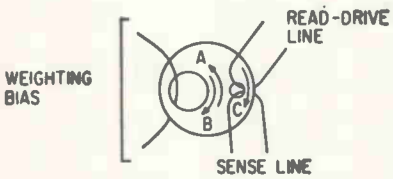
Some 195 regular papers were scheduled and, for last minute reports on new research, special sessions were conducted. Attendance was about 1,300.

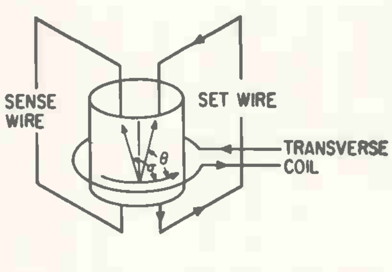
CHELATE LASERS—Rare earth chelates are considered one of the most promising candidates for laser application (ELECTRONICS, p 22, April 12). In chelates of interest, emission lines are bright, relatively few in number, with narrow bandwidths. Lifetimes are long and quantum efficiencies high. Optical and mechanical properties of polymeric matrices are good.

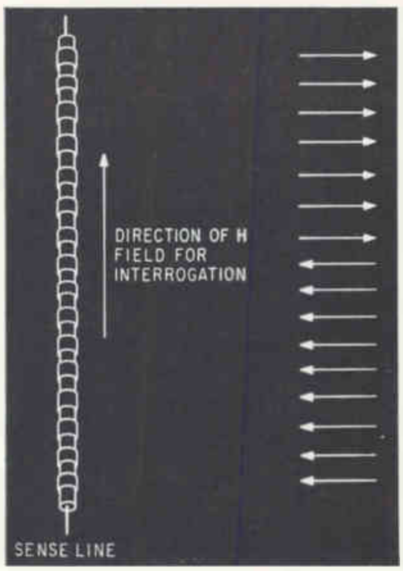
Chelates are also candidates for high-power, continuously operating liquid lasers. A. Lempicki, of General Telephone Labs, says optical properties are better in a viscous medium.

Particularly high fluorescence efficiency was reported by N. E. Wolff, of RCA Labs., for long filaments of a chelate complex of trivalent europium derived from trifluoro thenoyl acetone. Optical pumping is accomplished through an absorption band in the chelate portion of the molecule at 3,400 Å. Laser transition occurs at around 6,130 Å. Normal fluorescence lifetime at 77 degrees K is 1.5 μsec.









SELF-ADAPTIVE SYSTEM *described by G. R. Henderson and A. J. MacMillan, of Northrop, uses gain-storage device to weight inputs (top, left). In the two-aperture MAD device (left, center) storage-gain is accomplished by controlling the ratio of set-flux A to blocked flux B and thereby the readable flux available when switching leg C. Next diagrams show a basic thin-film adaptive device and a cylindrical assembly constituting an elemental adaptive system*

GAS LASERS—At an optical maser symposium, W. R. Bennett, Jr., of Yale University, a consultant to TRG, predicted that the range of gas-laser oscillating wavelengths will probably extend from far beyond 12 microns well into the ultraviolet.

Available gain varies roughly between the second and third power of the wavelength, and for some of the long wavelength lines is as large as approximately 20 db per meter. Conversely, available power varies roughly as the reciprocal of the wavelength. Power levels are several tens of milliwatts with some of the stronger transitions.

Bennett said there has been relatively little work on obtaining optimum power-output coupling. However, output of a few watts can probably be obtained by power amplifiers and/or mode-suppression techniques on a number of lines. Inherent spectral linewidths of less than 2 cps have been reported. Absolute a-f stability for short times have been obtained without negative feedback, and long-term stabilization seems possible for most of these systems. In a few cases, the gain appears high enough to permit construction of a gas laser with oscillation frequency independent of cavity dimensions to the first order.

William McMahan, of Martin Company, discussed a pulsed helium-neon gas laser excited with high voltage pulses. It uses transient phenomena in the gas and a rapid inversion technique. Peak power outputs are reported as significantly greater than the maximum c-w output achieved by conventional pumping.

The approach is to inject high-energy electrons under a high field, controlling electron energy by the magnitude of the field. Upper and lower levels are selectively populated. Populations of the two levels is inverted in time comparable to

On Strong

the spontaneous radiative lifetime of the upper level.

A system that produces about 2 mw of c-w power has been pulsed to produce a peak output of 100 mw. The output increase linearly with pump voltages from 14 Kv up to 20 Kv, the maximum attempted. Peak output power is constant with prf's up to at least 2.5 Kc.

A laser now being constructed is planned to operate at much longer wavelengths than is now attainable, with reduced transmission loss.

ADAPTIVE THIN FILMS—Magnetic thin-film elements for an adaptive system were described by G. R. Henderson and A. J. MacMillan, of Northrop Space Laboratories.

In a self-adapting system (see diagram), each input is weighted by a gain-storage device that can be set to a particular weighting or gain and will retain this weighting until it is deliberately altered. Output-error feedback alters the input weights until the system converges on the desired output.

Rudimentary elements for adaptive processes were shown by Henderson and MacMillan. A basic device, a cylinder electroplated with a Permalloy-type magnetic film, is binary in nature. It has two stable states for the magnetization, clockwise and counterclockwise around the circumference of the cylinder. After sensing, the magnetization elastically returns to its initial state thus retaining the information stored. Devices of this nature have produced outputs as high as 300 mw.

Northrop is working on second-generation thin-film devices that are linear, nondestructive, and where a single film serves as an entire weight. An adaptive element could be composed of a series of thin film devices, as illustrated.

COMPONENTS—C. J. Kircher, of Northwestern University, presented a protective-sputtering technique of making superconductive films of niobium, tantalum or vanadium for thin-film cryotrons. The method does not demand the ultrahigh vacuum of evaporation processes and films have consistent values.

A. H. Mones, of IBM Components division, discussed a class of materials for printing resistors at less cost than deposition. Materials, composed of palladium, silver and glass can be fabricated into resistors by processing at 750 C. Electrical and stability characteristics are said to compare favorably with deposited thin-film resistors.

Silica Masks Intermetallic

Silicon dioxide used as diffusion source and for masking

PITTSBURGH—Many of the diffusion and deposition problems of semiconductor device fabrication can be solved by using silica layers on the semiconductor surfaces—and not just on silicon.

Several speakers at a special session April 15 during the Electrochemical Society meeting told how silicon dioxide layers can provide precision, process control and surface protection for gallium arsenide.

DIFFUSION—S. R. Shortes, of Texas Instruments Incorporated, reported on diffusion into gallium arsenide from zinc-doped silicon-dioxide films. He said the technique provides effective control over surface concentrations and prevents surface deterioration during diffusion. Impurities are incorporated into a reactively sputtered silicon-dioxide film on gallium arsenide wafers. Diffused junctions obtained are uniform and reproducible. TI has constructed planar diodes using this technique. Work was supported by Air Force.

W. N. Carr, also of TI, reported that a gallium-arsenide laser diffused from a doped oxide film can achieve lower lasing thresholds and enhanced spectral purity in the lasing mode. The improvement is thought to be due to better junction polarity and reduced contamination, although the diffusion profile itself may be important.

MASKING—S. W. Ing, of General Electric, showed how silicon dioxide films were successfully used as masks for *p*-type impurity diffusion in gallium arsenide at temperatures of 600 to 800 C. The films are deposited by a glow-discharge technique onto the gallium arsenide surface. Ing gave brief rundown of approximate penetration rates of the diffusants — zinc, cadmium and manganese—through the deposited silicon dioxide films. Planar diodes were formed using this technique.

Her sputtering technique for growing silicon dioxide films or germanium and gallium arsenide was explained by Miss M. A. Hall, of Motorola. Miss Hall described use of protective films as diffusion masks, as delineating outlines for alloy regions, and as passivating films over diffused and alloyed junction areas in gallium arsenide and germanium.

T. H. Yeh, of IBM, told how a 2,000 to 2,500-Å layer of silicon monoxide is evaporated over the surface of a *p*-type gallium arsenide wafer. The technique prevents the formation of gallium-containing compounds of the wafer's surface during diffusion in gallium arsenide of selenium, sulphur and tellurium. This technique allows each *n*-type diffusant to diffuse into *p*-type gallium arsenide and to form an effective *n-p* junction.

Masking effects of silicon dioxide layers can be better understood by studying diffusion patterns of phosphorous in silicon, reported E. Kooi, of Philips Research Labs., Eindhoven.

Directional Beam Net Finished in Germany

BONN—NATO's $75-million, 6,200-mile-long directional-beacon station net, christened "Ace High" and stretching across the waist of Central Europe from northern Norway into Turkey, has just been completed in West Germany, reports ITT's German subsidiary SEL. The West German contribution to the system includes two troposcatter stations and for substations.

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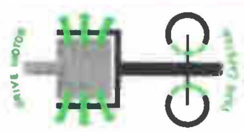
☐ ☐ ☐ There's much more to tell about the new 4700 Series . . . write, wire, or phone us for the complete story.



Unique capstan drive with no mechanical coupling isolates motor from capstan—an eddy current clutch is the secret. This vibration-free coupling system is combined with Sangamo's proven eddy current speed control in the only light-mass tape drive—another "first" for your instrumentation needs from Sangamo.

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WILL PLASMA OBSOLETE RADAR?

One of the possibilities broached at the magnetohydrodynamics symposium was that objects traveling through the ionosphere could be tracked without radar.

Prof. Floyd V. Schultz, of Purdue University, reported that plasma—ionized atmosphere—oscillates briefly in the wake of a moving object and sends out electromagnetic waves to earth.

Space vehicles could thus be tracked with only an antenna and receiver. Schultz' theoretical results are being investigated experimentally at other labs, it was reported

Plasma Accelerator Work Shows Promise

By GEORGE W. SUTTON
General Electric Space Sciences Laboratory, King of Prussia, Pa.

Progress in enthalpy heat content—and efficiency reported

BERKELEY, CALIF.—Significant progress in plasma propulsion systems, and a shift in emphasis from combustion-driven to nuclear MHD power generators highlighted the Fourth Symposium on Engineering Aspects of Magnetohydrodynamics.

Sponsored April 10 and 11 by ASME, AIAA and IEEE, the talks drew more than 300 scientists and engineers from around the world to the University of California.

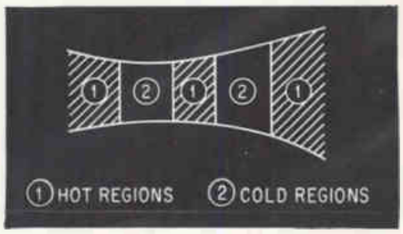
ACCELERATORS—In plasma accelerators, W. T. Hogan, of Avco-RAD, reported achieving enthalpies of 100,000 BTU per pound in an unconfined electric and magnetic crossed-field steady accelerator. Mass flow rate was 0.001 pound per second of nitrogen and efficiency of energy addition was 25 percent. Gas pressure was 3 mm of mercury.

For pulsed plasma accelerators, T. J. Gooding, of General Dynamics-Astronautics, found that 30 to 50 percent of the energy is lost during the first half-microsecond, presumably to create the plasma; that is, several hundred volts are consumed per electron-ion pair created.

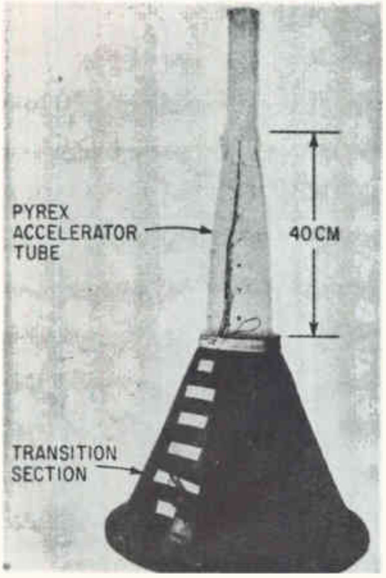
Per Gloerson, of GE Space Sciences Lab, reported on a two-stage coaxial plasma accelerator. The plasma is created in a low-energy discharge in the first stage. The accelerator has been mounted on a thrust stand to determine the specific impulse.

Thirty percent efficiency was claimed for a traveling-wave accelerator by G. S. Janes, of Avco-Everett Research Lab. However, this did not include losses in the traveling magnetic field or power supply. Surprisingly, the gas appears to attain its maximum velocity at a distance of one-third from the inlet, indicating that the device can be made much shorter without sacrificing performance.

POWER GENERATORS—Interest in combustion-driven MHD electrical power generators has decreased somewhat, as evidenced by only one paper giving experimental data: J. F. Louis, of Avco-Everett, who reported on the Mark II generator. Although 1.5 Mw were generated, the maximum measured adiabatic



MHD GENERATOR *suggested by Centre d'Etudes Nucleaires would have heated slugs of gas acting as electrical pistons*



SHORTENED VERSION *of Avco-Everett's traveling-wave plasma acellerator. Efficiency of 30 percent was reported*

efficiency was only 45 percent. To increase the magnetic interaction, P. Ricateau, French Centre d' Etudes Nucleaires, has suggested that alternate slugs of gas be heated electrically by an arc (see diagram); this slug would act as an electrical piston and extract energy from the less-conducting combustion gases.

On the other hand, 11 papers dealt with aspects of magnetically induced ionization that could be used in an MHD generator with a closed-cycle nuclear reactor. Although there were no reports of power generation by this technique, the calculations or experiments presented indicate that this form of MHD power generation appears possible. For example, S. Byron, of Ford Aeroneutronic, pointed out that by the proper choice of seed and carrier gas, a much higher electron temperature may be achieved than in a single gas.

Two different two-phase liquid metal MHD electrical power generators were described; a linear type by C. McNary, of Jet Propulsion Laboratory, and a novel vortex type by H. Weber, of GE Space Sciences Laboratory. In the latter, the two-phase accelerator, separator and generator are combined into a single unit which uses exit diffusor vanes to decrease end losses. Neither device has yet been operated. McNary calculated that for space power cycles efficiencies as high as 7 percent may be possible, while higher efficiencies may be possible with the cycle proposed by Weber.

REENTRY COOLING—In the field of magnetoaerodynamics, R. Levy and E. V. Locke, of Avco-Everett, have shown that in hypersonic flow, it is possible to have the entire shock-layer "stand-off" a magnetized body. Use of this technique could possibly reduce reentry heat transfer. This technique is quite different from that proposed several years ago in which the effect of the magnetic field was only to increase the boundary layer thick-

Is Ionospheric Pollution Good?

Rocket exhausts worry scientists; military eyes communications use

By WARREN KORNBERG
McGraw-Hill World News

WASHINGTON — Alterations in the makeup of the ionosphere—experimental, inadvertent and operational—are increasingly attracting the attention of scientists.

Some are concerned about the effects of "pollution." Others seek data on temporary effects of r-f and optical energy inputs.

And the military is considering atmospheric "pollution" to provide temporary communications paths.

ENERGY INPUT—Last week at the American Geophysical Union meeting, researchers from Space Technology Laboratories, discussed energy input possibilities.

Earlier experimenters, said Paul Molmud, failed to cause significant perturbation in the D layer because of inadequate power, excessive frequency, too short a pulse or excessive altitudes—50 miles seems to be the limit.

He and J. H. Gardner contend that the electron energy dependence in the D layer makes it susceptible to alteration by high-powered, ground-based, radio-transmitted heating or laser excitation.

In the altered regions, said Gardner, "radio waves may be scattered from blobs produced by turbulent mixing."

ROCKET POLLUTION—Inadvertent creation of an ionospheric "blanket" in the area of the E layer, making long-range radio communication as difficult at night as it now is during the day concerned scientists from Geophysics Corporation of America. They contend that by the 1970's enough contaminants can be spewed into the ionosphere from rocket trails to permanently alter its character.

Jerome Pressman, who supervised studies on high-altitude contamination for the Department of Defense, says the exhaust from single major rocket could contribute as much atomic hydrogen to the upper atmosphere as exists naturally.

The density of materials between 60 and 80 miles above the earth, he said, approximates a millionth to a billionth those at the surface, and even the introduction of a relatively minute quantity of sodium, cesium or other materials combining with ambient elements, could have widespread and long-lasting effects.

The electronic effects at high altitudes of the introduction of contaminants would be short-lived, said A. Dalgarno. But as the contaminants settle, it is likeliest that equilibrium will be achieved between 60 and 80 miles up—in the E layer.

The effect on the ionization in the layer, he said, will be to intensify it during the day and prevent its natural decay in the night. This, while it might improve reflective properties for short-range communication, will have a deleterious effect on long range transmission through the E layer.

MILITARY SEEDING—The Department of Defense has been interested for some time—possibly as far back as 1956—in chemicals as a deliberate contaminant (ELECness, thereby reducing the heat transfer only slightly.

For diagnostics, A. A. Dougal, University of Texas, proposed using a laser beam in a manner now used with microwave equipment. However, the effect of the plasma on the beam is very small and probably difficult to detect.

Or Is It Bad?

TRONICS, p 102, Oct. 23, 1959).

Single shots, perhaps detonation of a grenade carrying cesium or another chemical at a predetermined height, could either blank out an enemy's long range communication or provide a custom-built reflector for an Army's own short-range messages. The altitude of the detonation would help determine the angle of the bounce and the length of the communications path.

Army Signal Corps is reportedly buying equipment to test communications applications.

Transistors Change Gears in New Auto

RENAULT is making available on its 1963 Dauphine auto models an electronically controlled gear-changing system. The system shifts a standard manual transmission automatically. Control circuits in the $140 system employ transistors.

The system consists of a five-button dash control, a master control unit, an electronic coordinator, a throttle decelerator, a gear-change actuator and an electromagnetic clutch coupling unit.

The main control unit, linked to a magnetic spring on the speedometer drive, senses whether the car is accelerating or decelerating and signals the required gear change to the coordinator. The coordinator controls the other units.

Deceleration is handled by a solenoid-operated flap in the inlet manifold. The clutch is engaged by a coil that solidifies a ferromagnetic powder in an air gap between an outer drum and an inner hub.

CIRCLE 41 ON READER SERVICE CARD

MEETINGS AHEAD

ELECTRO-NUCLEAR CONFERENCE, IEEE; Desert Motor Inn, Richland, Wash., April 29-May 1.

ANALYSIS INSTRUMENTATION SYMPOSIUM, ISA; Rice Hotel, Houston, Texas, April 29-May 1.

URSI-IEEE MEETING, URSI and various Professional Technical Groups of IEEE; National Academy of Sciences, Washington, D. C., April 29-May 2.

GREAT LAKES DISTRICT MEETING, IEEE; Black Hawk Hotel, Davenport, Iowa, May 1-3.

MIDDLE MANAGEMENT COMMUNICATIONS COLLOQUIUM, IEEE-PTGEWS; Kellogg Center, Michigan State University, E. Lansing, Mich., May 2-3.

HUMAN FACTORS IN ELECTRONICS SYMPOSIUM, IEEE-PTGHFE: Marriott Twin Bridges Hotel, Washington, D. C., May 2-3.

TECHNICAL ASPECTS OF COMMUNICATIONS SATELLITES CONFERENCE, NASA, Illinois Institute of Technology, etc.; at IIT, Chicago, May 2-3.

AEROSPACE RELIABILITY & MAINTAINABILITY CONFERENCE, AIAA, SAE, ASME; Marriott Twin Bridges Motor Hotel, Washington, D. C., May 6-8.

NATIONAL AEROSPACE INSTRUMENTATION SYMPOSIUM, ISA; Jack Tar Hotel, San Francisco, California, May 6-9.

ELECTRONIC CONPONENTS CONFERENCE, IEEE, EIA; International Inn, 14th & M Streets, N. W., Washington, D. C., May 7-9.

EAST CENTRAL & ALLEGHANY OHIO VALLEY DISTRICT MEETING IEEE; Commodore Perry Hotel, Toledo, Ohio; May 8-10.

IMPACT OF MICROELECTRONICS CONFERENCE, Armour Research Foundation and ELECTRONICS Magazine; Illinois Institute of Technology, Chicago, Ill., June 26-27.

WESTERN ELECTRONIC SHOW AND CONFERENCE, WEMA, IEEE; Cow Palace, San Francisco, Calif., Aug. 20-23.

ADVANCE REPORT

MILITARY ELECTRONICS NATIONAL CONVENTION, IEEE-PTGME; *Shoreham Hotel, Washington, D. C., Sept. 9-11. May 1 is the deadline for submitting 500-word abstract and author biography to: J. J. Slattery, Technical Program Chairman, MIL-E-CON 7, Martin Company, Friendship International Airport 40, Md. Unpublished papers in following areas are of interest: lasers; masers; micro-miniaturization; cryogenics; radar; communication; instrumentation; propagation; guidance & navigation; man-machine relations; reliability; value engineering. Applications of particular interest are in: command control, limited warfare, ASW, and space.*

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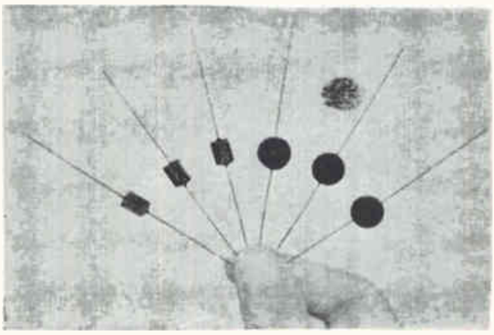
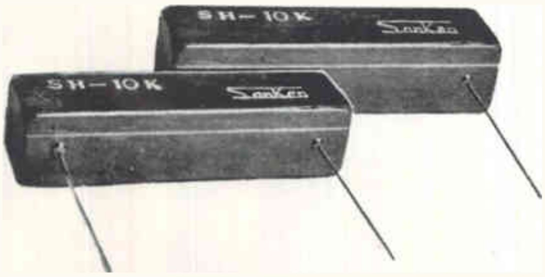
COMPLETELY PASSIVATED SANKEN DIFFUSED SILICON RECTIFIERS have highly stable and sharp zener breakdown characteristics. The diffused junction of each cell is completely protected against contamination during manufacture and against changes due to time.

More than 80% of All Japanese TV sets use SANKEN rectifier diodes.

General Purpose Diffused Silicon Rectifier Diodes

Type	PRV (V)	RMS (V)	I_f	I_f surge 10ms	Ir at PRV @ 25°C	V_f @ 25°C	Ta
SK-1 SK-1A SK-1B SK-1C	400 600 800 1000	280 420 560 700	250mA	25A	10 μA	1V at 0.5A	Operating 70°C Storage −60°C~+120°C
SD-1 SD-1A SD-1B SD-1C	400 600 800 1000	280 420 560 700	500mA	60A	10 μA	1V at 1.5A	Operating 60°C Storage −65°C~+100°C





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SH- 6K PRV 6000V DC 30mA

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Silicon Varistors
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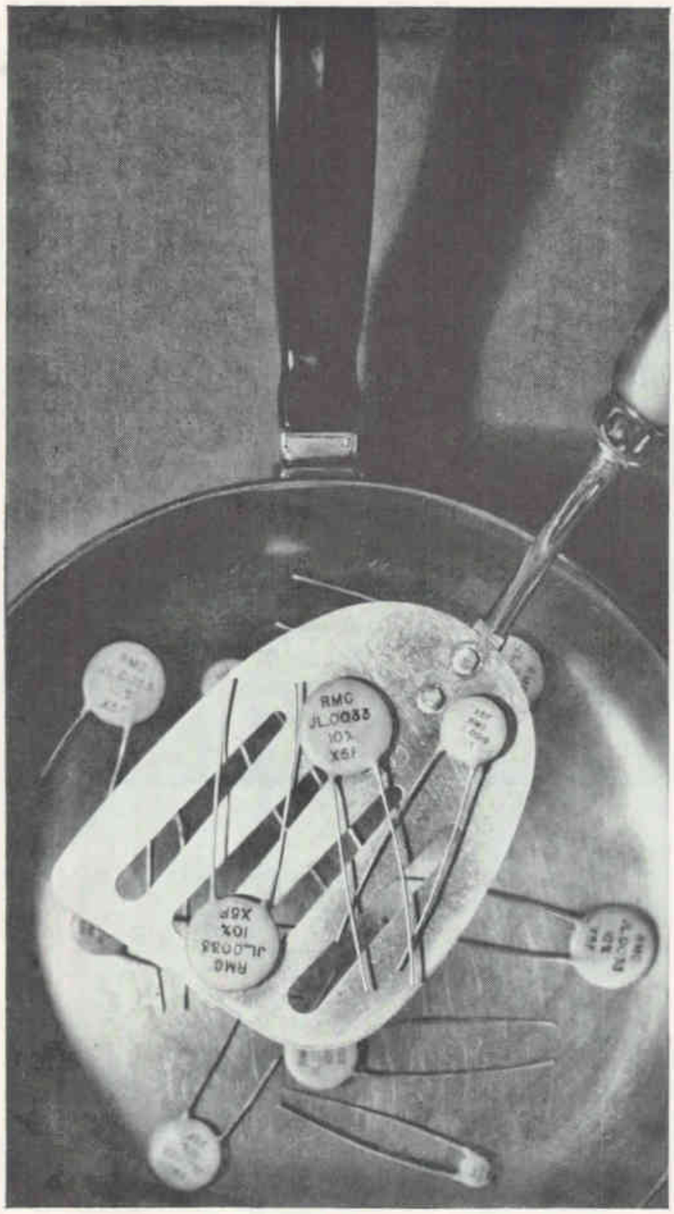
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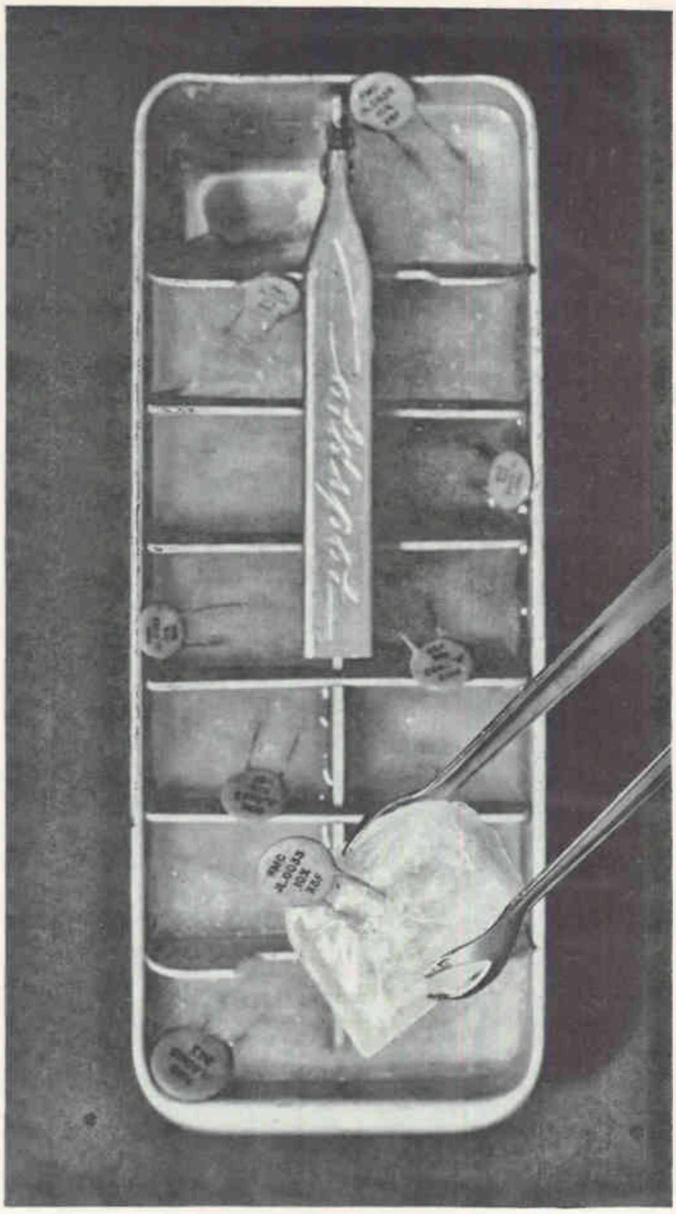

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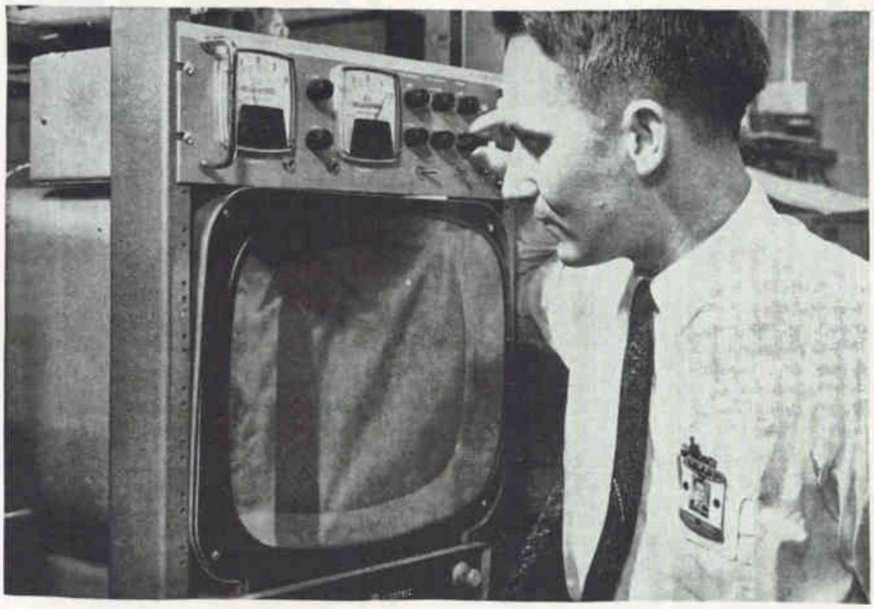
FAMILY TREE OF SEMICONDUCTORS

Smallest branches denote devices classified by number of p-n junctions (main branches). Roots are semiconductor materials. Annual rings summarize evolution of the semiconductor art

electronics

A McGraw-Hill Weekly *April 26, 1963*



AUTHOR *Poppelbaum adjusts controls of the tv camera-tube tracker*

AUTHOR'S PREDICTION

Progress in the development of camera tubes and television transistor circuits has created the preconditions for camera-tube tracker development. In time, camera-tube seekers and trackers will become as basic to optical tracking as radar has become to radio tracking

TV CAMERA TRACKER

Can It Detect Missile Decoys?

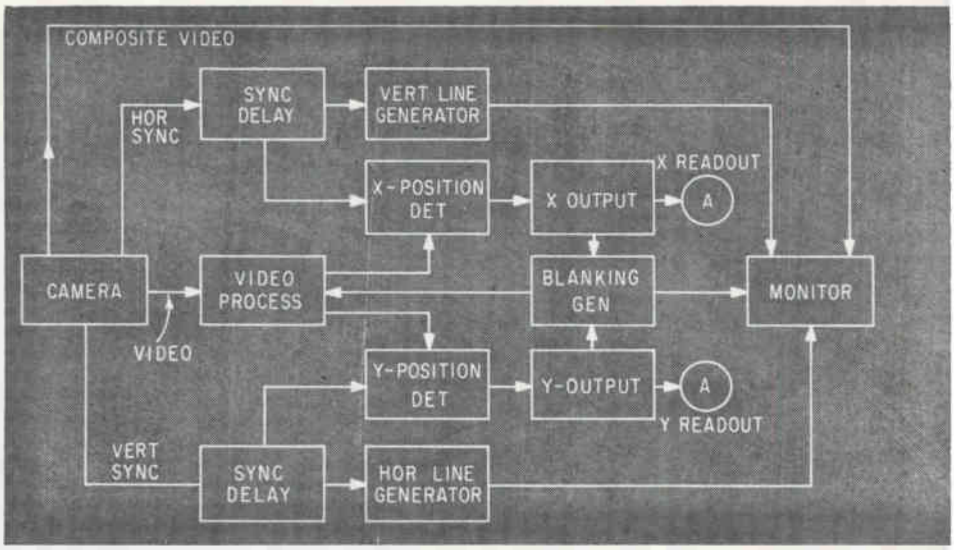
Modified vidicon camera supplies two-dimensional data about a tracked target by locating video information relative to the horizontal and vertical scans

By T. L. POPPELBAUM Light Military Electronics Dept., General Electric Co., Utica, New York

MOST PRESENT-DAY optical tracking systems use mechanical scanning techniques. Although many of these systems have performed satisfactorily in space, airborne and ground-based applications, their mechanical nature presents problems of weight, low angular tracking rates, difficulty of construction, alignment and maintenance. The experimental camera-tube tracker described here is not elaborate; however, it does serve to prove that many of the disadvantages of mechanical scanners can be overcome. Because it is electronic rather than mechanical, the camera-tube tracker offers high angular tracking rates and long-lived continuous operation in a low-mass package. Since the entire field of view is scanned continuously, video processing circuits can simultaneously perform acquisition and tracking functions. Additional versatility is provided by the variety of scan modes, optical systems and camera-tube characteristics available. The camera tubes may be image orthicons or vidicons with either electromagnetic or electrostatic deflection, and can be equipped with any number of photosensitive surfaces for use under various conditions such as visible light, infrared, ultraviolet, or low-light-level tracking.

The equipment uses a simple vidicon camera; however, a new and refined system using a transistor low-light-level image-orthicon camera has recently been constructed for a military customer.

Several applications of the camera-tube tracker have been explored, including missile-launch surveillance, battlefield missile control, and orbital rendezvous.



TRACKER CIRCUITS *most of which use general-purpose transistors in straightforward designs, such as flip-flops, amplifiers and one-shots—Fig. 1*

GENERAL DESCRIPTION—Basic purpose of the camera-tube tracker is to provide coordinate position information on a target image. This coordinate information must be based on a known reference, usually X and Y reference axes centered within the system field of view. To meet these basic requirements, a system needs only a camera tube with deflection circuits and the video-processing tracker circuits. However, in operation, it has been found advantageous to use components of a television camera chain, with slight modifications to accommodate the tracker functions.

A typical tracker will include a camera, tracker circuits, monitor, and, if it is desired to close the loop mechanically, a servo drive system. The use of a monitor is optional, although a visual presentation of the tracker's field of view has been found exceedingly useful. For special applications, accessories such as image intensifiers, telescopic lenses, optical filters, automatic iris and electronic exposure controls can be added to the system.

Target-position information is derived by locating video information relative to the raster scanned by the camera tube. Since the beginning of each vertical and horizontal scan is known, video information can be located by measuring the period of time from the start of each frame and line until the appearance of the video pulse. The video is located relative to reference generator outputs, which are synchronized with the horizontal and vertical sweep of the camera-tube circuits. Reference generator outputs can be adjusted to allow the X and Y reference axes to be positioned anywhere within the field of view.

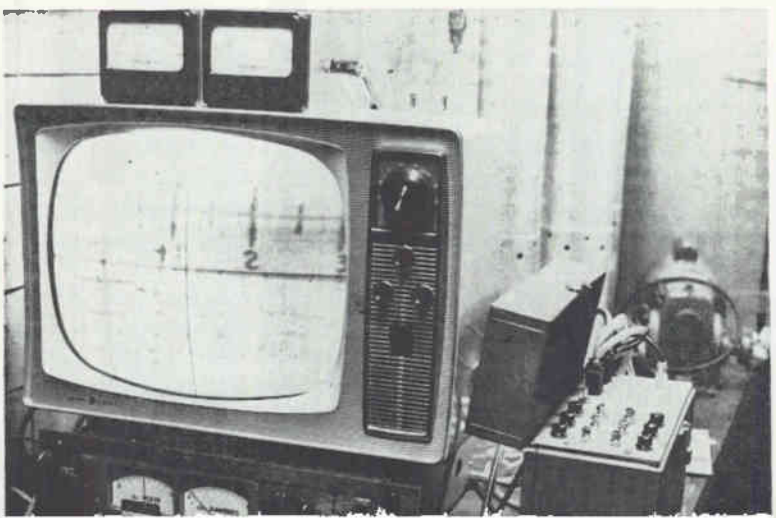
The reference generators also provide signals that create a monitor presentation of the X and Y reference axes.

Single-gate blanking can be used to blank out a large portion of the raster, thus permitting a primary target to be tracked while other targets or decoys are in the field of view. Blanking circuits are synchronized with target video, so that the video gate automatically tracks the target as it moves within the field of view.

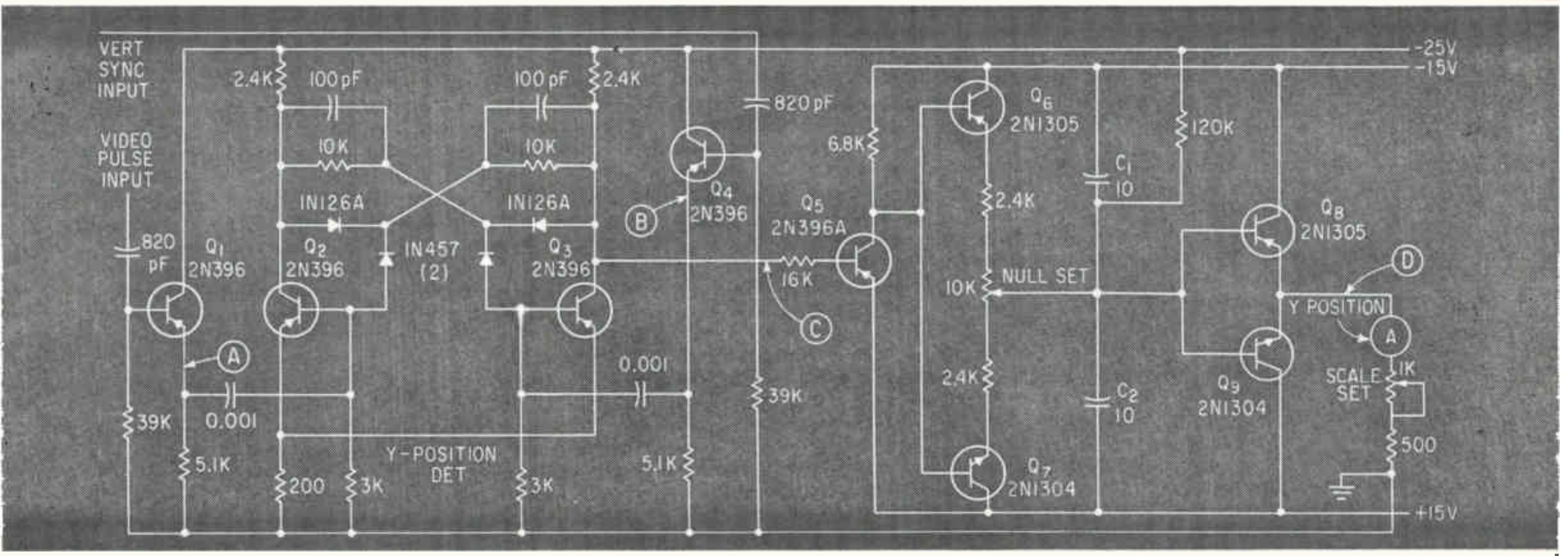
Coordinate information, relative to the X and Y axes, may also operate servo drive circuits.

CIRCUIT OPERATION—Four inputs (Fig. 1) are supplied by the camera: (1) composite video for the monitor; (2) video (which can also be composite) for the tracker video processing circuits; (3) horizontal synchronization for the X-reference generator and (4) vertical synchronization for the Y-reference generator.

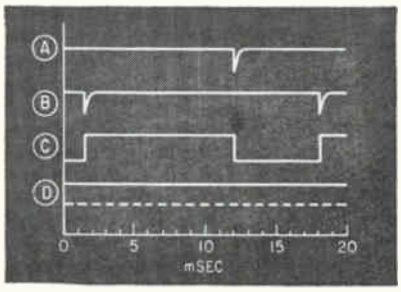
The reference generators provide horizontal- and vertical-sync signals to the X- and Y-position detectors, and generate the horizontal and vertical crosshairs. Sync information is delayed by monostable multivibrators and then fed to the position detectors and horizontal and vertical crosshair generators. The vertical crosshair generator is a single-shot oscillator which is triggered by delayed horizontal sync signal. The frequency of the oscillator tank circuit, including the



TV CAMERA-TUBE *tracker equipment—Fig. 3*



Y-POSITION DETECTOR *and output amplifier, with output signal read on a 10-0-10 milliammeter (above); waveforms (right)—Fig. 2*



effects of transistor parameters, establishes the width of the vertical crosshair at a fraction of a microsecond (or about 1/100 of a horizontal scan period). Both the horizontal and vertical crosshairs are positioned by adjusting the delay of the sync information; this is accomplished by unijunction-transistor timing circuits, which permit microsecond or millisecond delays to be controlled by simple variable resistors that can be front-panel controls.

The horizontal crosshair signal is generated by a fixed monostable multivibrator adjusted to produce an output pulse of about 60 μsec at the vertical-scanning rate. The crosshair outputs are injected into the monitor and produce the crosshairs by a straightforward blanking operation in the monitor video circuits.

Video processing consists of amplification, clipping of the blanking pulses, and removal of undesired background signals. In contrast systems, the target video is selected on the basis of amplitude relative to the background by clipping away the lower amplitude information. Video peaks are then amplified and used to trigger the position detectors.

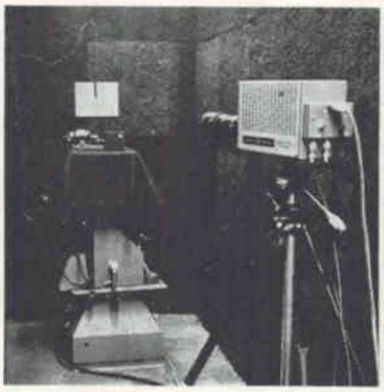
The Y-position detection is accomplished by a flip-flop that is triggered by processed video and the delayed sync signal (Fig. 2). Target-position information is carried by the pulse width of the flip-flop output. This pulse-width information is then integrated and amplified by the output circuits to provide a d-c voltage output proportional to the Y position of the target.

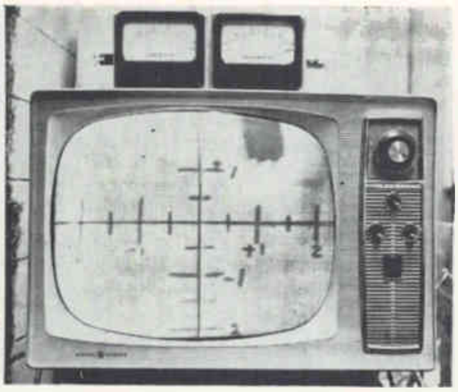
In the Y-position detector and output amplifier (Fig. 2), video pulse information triggers one side of the Y-position flip-flop (A); vertical sync information (B) triggers the other side of this flip-flop. Output of the flip-flop (C) is a pulse that is proportional in width to the vertical target position. Complementary emitter followers Q_6 and Q_7 are used with integrator capacitors C_1 and C_2 to convert the variable pulse width to a d-c output (D).

Because target video does not normally occur during each horizontal scan period, X-position detection presents problems not in the Y-position circuits. In the X-position circuits, processed video and the delayed horizontal-sync signal trigger an X-position detector flip-flop; this narrow pulse width (less than 55 μsec) is then integrated and stored for almost one vertical period. The X-position signal is then dumped or discharged, and the circuits are ready to store the next X-position signal. Since the X-position signal is essentially d-c, it requires only smoothing and amplification by the output circuits to provide a d-c output voltage proportional to the X-position of the target.

When the single-gate blanking circuits are used, video can be accepted from only a small portion of the raster. The small, video-gate region is generated by addition of the horizontal and vertical blanking signals. Vertical blanking is triggered by the first video of each frame; the period of blanking is adjustable, and is usually about 80 percent of the frame time. Thus the vertical blanking circuits create a gate, or horizontal slit of lines, on which video may be accepted. Once video has been acquired in this gate, it will continue to trigger the vertical-blanking circuits so that the gate will be locked on the video. Horizontal blanking is obtained similarly, except that, because target video normally occurs at the frame rate rather than the line rate, the video signal cannot be used directly for horizontal-blanking steering. Horizontal-position information is used to position horizontal blanking; the period of blanking is adjusted for some portion of a line, usually 70 to 80 percent. Coincidental action of the horizontal and vertical blanking generates a window gate in the raster.

Blanking information is also fed to the monitor for a visual display. On the monitor, the video gate appears as a gray rectangle that encloses the target. Target acquisition, gate tracking and gate size are





TEST SET-UP *(left); output signals and video (right)—Fig. 4*

all readily observable on the monitor display.

EXPERIMENTAL EQUIPMENT—The equipment includes a General Electric TE-6 closed-circuit television vidicon camera, a monitor (a 19-inch portable tv receiver) and the tracking circuits. The tracking circuits were designed to be compatible with the TE-6 camera and 19-inch monitor.

Aside from the addition of connector and cabling, no modifications were made to the TE-6 camera. The only modifications to the monitor were those necessary for the insertion of the reference-axis (electronic-crosshair) signals and the automatic-banking presentation.

Figure 3 shows the equipment used: the monitor, power supply, position-output meters and the box containing the tracker circuits.

The power supply provides 25 volts at about 400 ma to operate the tracker circuits. Target-position output signals relative to the X and Y axes are read out on the meters shown on top of the monitor. The tracker circuits themselves are completely transistor, and use about 100 (including circuits for use in controlling servos). Controls are provided so that reference-axis position, gate position and gate size can be adjusted manually.

Although the basic camera-tube tracker requires no moving parts, it has been successfully used for closed-loop operation. In addition, a heavy-duty Houston-Fearless pan-tilt unit was used and additional circuits were constructed to drive the servos from the seeker outputs. The addition of this mechanical device does offer advantages; however, the maximum tracking rate of the servos is lower by more than an order of magnitude than that of the camera-tube tracker itself.

Early servo-drive circuits consisted of a simple relay-operated system; however, servo hunting proved to be a problem for operation with the telephoto lens, and work is under way on a proportional system using silicon-controlled rectifiers for motor drive control.

In Fig. 4 (left), the TE-6 camera is shown set up for the optical tests. Two lenses were used during the tests: a general-purpose lens which offers a 20-degree field of view and the telephoto lens (shown on the camera) which allows a field of view of about 3 degrees. The small white rectangle at the end of the optical tunnel is the test pattern. The X and Y axes are calibrated in inches and marked off every half inch. Two test lamps, one movable and one fixed, are used to simulate target and decoy. Both the movable lamp (which can be controlled in intensity) and the fixed lamp use 120-mw type 49 panel-light bulbs.

SYSTEM OPERATION—Figure 3 shows the monitor presentation under the following conditions: (1) reference axes centered on the raster and field of view; (2) the test source (centered on the test pattern) located in the second quadrant of the monitor presentation; (3) the X- and Y-position readout meters indicating source position; (4) the blanketing circuits not in use.

Figure 4 (right) shows the system boresighted on the test pattern and the source located in the first quadrant. The meter readouts indicate the magnitude of UP and RIGHT position signals.

Figure 5 illustrates the use of the blanking circuits. Figure 5 (left) shows the source in the third quadrant. The meter readings confirm that the source video has been processed by the position circuits. The outline of a larger and deenergized decoy source can be made out in the first quadrant. (The object in the second quadrant is the toggle switch that controls the decoy source.) If the decoy source were energized, its video would be processed instead of the target video because the decoy video occurs first in the frame. No problem exists with decoys as long as the decoy video occurs after the target video. Unfortunately, targets are not always so cooperative, and the blanking technique must be used to improve the ability of the system to reject decoys.

Figure 5 (right) illustrates the automatic-tracking single-gate blanking technique. Even with the large decoy energized and producing video before the target video, target video is still processed by the position circuits as can be seen by the meter readings. The small rectangular area immediately above the target source is the video-gate presentation. The size and shape of this gate area can be varied by the operator. Because of the method used to synchronize the position of the gate with target video, the gate is not centered vertically, but encloses only the leading edge of the target image.

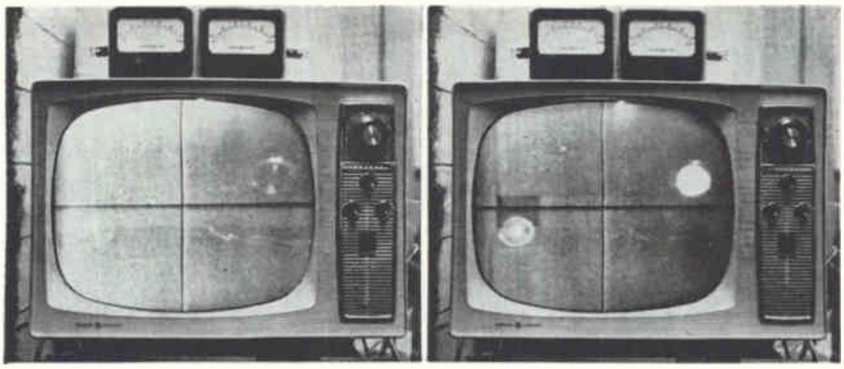
The table lists the performance data of the original experimental tracker. The angular tracking rate of the electronic equipment is probably higher than that indicated (the theoretical limit is in excess of 600 degrees per second for the frame rate used); but the testing equipment used was not capable of producing a higher rate.

The data were obtained experimentally and, therefore, should be considered subject to experimental variations. Equipment used in the system was not selected on the basis of performance, and improvement should be expected of future systems.

FUTURE WORK—Most of the applications of camera-tube trackers require positive contrast tracking or tracking a bright target against a dark background. Present work will allow black-on-white or negative contrast tracking; however, the problem of tracking a gray target against varying background remains to be satisfactorily solved. In general, one of the basic requirements of future systems will be the ability to identify a target in the presence of background clutter.

Another region of tracker development is that of optimum scan requirements for a particular application. While the standard rectangular television scan has been used for the present, it can not be expected to be best for all purposes. Modifications of standard rectangular scan patterns can provide limited design trade-offs of resolution and system bandwidth requirements. Exotic scan patterns such as spiral or concentric are also feasible; particularly so where the electrostatic-deflection camera tubes can be employed.

One of the most promising possibilities is that of the digital or incremental scan. If the standard ramp waveshapes of a camera-tube deflection circuit are replaced by staircase waveshapes, the field of view can be broken down into a number of resolution elements, each of which will have a specific location. By accurately controlling the position of the scan pattern and the number of steps in the staircase scan, these resolution elements of specific location can be assigned digital addresses—thus allowing video to be accurately located by identifying in which resolution elements the video is present. This digital technique lends itself to computer processing, which in itself presents many additional possibilities. Using scan-pattern stabilization and a sufficient number of resolution elements, this technique could be expected to offer higher accuracy and reliability than present analog schemes. However, as in analog systems, a trade-off must take place between the speed of the incremental circuits and the desired resolution or accuracy.



OUTPUT SIGNALS AND VIDEO: *system boresighted on test pattern, source in first quadrant (left); target in third quadrant, decoy in first quadrant, video gate in operation (right)—Fig. 5*

APPLICATIONS—Flexibility is a primary advantage of the camera-tube tracker. Almost any infrared, visual, or ultraviolet tracking problem can be approached with a camera-tube technique. A few of the avenues explored are listed in the following paragraphs.

Antitank missile guidance offers a straight-forward application. In this application, the tracker tracks the missile it is guiding. Thus, the missile is flown down the optical boresight to the target. In addition to simplicity, this system offers other advantages: (1) the operator can select targets regardless of their poor tracking characteristics; (2) low-light-level tubes can be used for night operation; and (3) the tv link can be used for battlefield surveillance when not used for missile tracking.

Air-to-air missile guidance could benefit greatly by camera-tube tracking. The position-output signals of the tracker have been used to experimentally operate the servo portion of a currently operational infrared tracking air-to-air missile. The fast warm-up time, low mass and long life of an electrostatic camera-tube tracker would offer welcome improvements over present mechanical scanning optical systems.

Missile-launch tracking offers an immediate application. Range-safety considerations require tv coverage of the early stages of missile launchings. The use of telephoto lenses makes manual tracking difficult; therefore, it would be of advantage to remove man from the servo loop. In addition, because the new large missile and space boosters will generate noise levels dangerous to unprotected operators; man, as part of the system may become a burden rather than an asset. The present closed-loop system is suitable for this application.

Sunseekers, horizon sensors and other space applications offer unlimited opportunities for camera-tube techniques. Specialized systems might use electrostatic camera tubes with various spectral-response characteristics, together with exotic scanning systems such as incremental and spiral scanning. Application to orbital rendezvous and docking would be particularly appropriate. The astronaut would be provided with an automatic tracking system which he could manually back up using the monitor presentation. Real-time video could also be transmitted to the ground for further back-up operation and monitoring.

PERFORMANCE DATA

Field of View	20 deg (wide-angle)
	3 deg (telephoto)
Angular Resolution	0.7 milliradian (wide-angle)
(Horizontal tracking accuracy)	0.15 milliradian (telephoto)
Electronic Response Time	33 msec (frame rate)
Angular Tracking Rate:	
Electronic	250 deg/sec (wide-angle)
Mechanical	15 deg/sec
Decoy-Rejection Method	Automatic-tracking video gate
Power Consumption (tracker transistor circuits)	12 watts

RADIO-INTERFERENCE

What it Means to Systems

By MIKE REVZIN, RFI Mgr., Loral Electronics Corp., Bronx, N. Y.

THE PROBLEM of controlling radio frequency interference (rfi) has become increasingly severe. Greater component-packing densities are combined with more sensitive circuits and low thresholds with high power levels; furthermore, equipment is installed in an electromagnetic environment that has grown in variety, complexity and radiated power. Therefore, it is no longer practical to add rfi control as an afterthought; it must be an integral part of the initial design. Failure to apply an rfi control program results in size, weight, cost and delivery penalties for both vendor and customer.

A typical rfi control program consists of four phases: proposal, system, design and test. When a proposal effort begins, a member of the rfi control group is assigned to the proposal team. He participates in the system discussions and analyzes various methods of attack from an rfi standpoint. His analysis is concerned with the interference and susceptibility potentials and the merit and cost of the rfi suppression approaches. This phase normally concludes with a section of the proposal discussing the rfi problems and recommended solutions.

The system phase begins with the receipt of an internal work order. The rfi manager participates in planning conferences, where estimates are prepared for manpower loading and phasing and test-equipment requirements. The systems group, which includes an rfi representative, performs a detailed analysis of the system, resulting in a complete set of unit and system specifications compatible with operational requirements. At the same time, the rfi control plan, which is required by the armed services, is worked out.

The rfi control plan, which is detailed for each unit, contains an estimate of the interference and susceptibility levels, the predicted amount of isolation, decoupling and filtering required, and mechanical construction data to obtain the desired shielding effectiveness.

During the design phase, system requirements are translated into hardware. As the units and modules are breadboarded, measurements are made and the rfi control plan is modified to include additional information. Information continually flows between the design and the rfi groups during this phase. Towards the end of the design phase, rfi test procedures are prepared for contractual approval. The procedures are prepared by the development group, supported by the rfi group.

The final phase of the program is devoted to compliance testing in accordance with the test procedures and the applicable rfi specification[1]. At this time modifications that are necessary to clear up unforeseen contingencies, are designed and installed. A complete test report is then furnished to the contractor. The rfi group then makes a critique of the entire program, to examine the predictions and their validity, the techniques developed, troublesome circuits and the lessons learned. Investigations may then be made to develop suppression devices, or to optimize those which have already been built. Results of each program are compiled and disseminated to the design groups.

ECM RECEIVER PROPOSAL — Suppose that an ecm (electronic countermeasures) receiver is being proposed. The system will consist of a tuner in the tail of an airplane and an analysis display in the forward section, about 100 feet away. The tuner may be either a superheterodyne, a trf (tuned radio frequency) or a parametric amplifier. The tuner output may be either r-f, i-f or video.

The major problem will be the long cable from the tuner to the

DOING SOMETHING ABOUT RFI

Most engineers concede that radio-frequency interference (rfi) is a major problem. But we seldom hear of concrete solutions.

This article stresses the importance of rfi control in systems design and then traces the design of an electronic counter-measures (ecm) receiver to illustrate how these principles were put into practice.

An important point: don't wait until the last minute to hook up all your black boxes; there may be rfi problems lurking

CONTROL Design

The rfi control group influences the design and development of a system from the initial proposal to the final testing. Case history of a countermeasures receiver project shows how rfi control works

display. This cable will be bundled with other cables, some of which may carry high currents or high signal and transient voltages. If the cable is to carry video frequencies, it will normally be coax, terminated in 50 or 90 ohms. The energy induced in a low impedance circuit is directly related to current, frequency, and length of cable run.[8] A typical value for power line frequencies for a 100-foot run is 55 millivolts from a 1-ampere line. Thus, for a minimum signal-to-noise ratio of 6 db, the minimum output from the video amplifier must be 110 mv. If an emitter follower is used to drive the cable, a minimum current swing (for a 90-ohm cable) of 1.22 ma will be required. Setting 200 ma as a practical current limit, the dynamic range is then 200/1.22 = 44 db. This ratio may be improved by specifying cable placement in the installation, but it is usually not advisable to impose such restrictions if they can be avoided.

Consider the problem of choosing an r-f or an i-f output from the tuner. The higher the frequency, the greater the cable losses and the smaller the shielding effectiveness. For an X-band receiver, the loss for RG-9/U coax is between 33 and 43 db, which is excessive. The alternative is to use waveguide; its losses are low, but installation is a problem because of flange leakage and mechanical mountings. If the receiver has an r-f amplifier, some design simplification would result from using a trf rather than a superhet. The trf receiver normally has poorer skirt selectivity and sensitivity, but does not have any difficulties with local oscillator radiation. If, however, a superhet receiver is selected, it is best to use an i-f output (Fig. 1A).

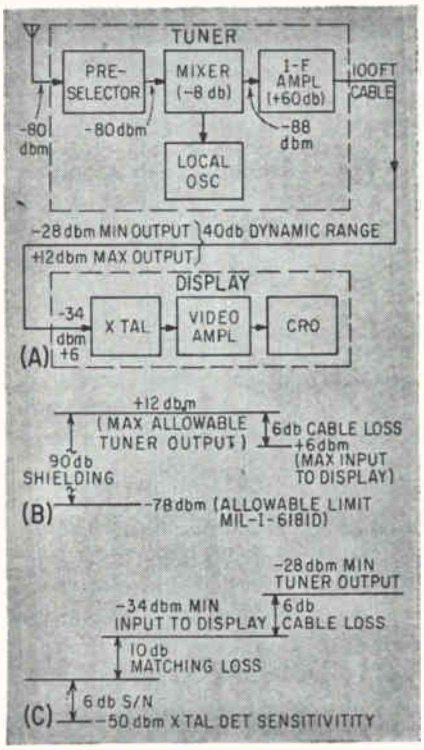
Some rfi limits will now be set up as levels (Fig. 1B). A high signal level at the tuner output causes a problem with i-f leakage, while a low signal level may cause a problem with noise and susceptibility. For example, assume an i-f of 160 Mc. The loss for 100 feet of RG-55/U cable at this frequency is 6 db. This 50-ohm cable has a shielding effectiveness of about 90 db. Specification MIL-I-6181D restricts the allowable radiation to a level of 29 db above 1 microvolt (or −78 dbm, where −dbm = db below 1 mw in 50 ohms) for c-w, and 55 db above 1 μv/Mc for pulse signals. Note that an X-band receiver is much more likely to detect pulsed, rather than c-w signals, but practical calculations can be based on the c-w signals. The sum of the shielding effectiveness and the specification limit determines the maximum signal level. Thus 90 + (−78) = +12 dbm, as shown in Fig. 1B. With a cable loss of 6 db, the signal level at the display is a maximum of +6 dbm. This is more than adequate. Note that the tuner must use some form of amplitude limiting for large input signals so that it's maximum output is +12dbm.

The next calculation determines how low a signal is required to establish a 6 db *S/N* at the video detector. Assuming a crystal with a tangential sensitivity of −50 dbm (Fig. 1C) and adding 6 db for desired *S/N*, and 10-db loss for impedance matching, the minimum required signal is −34 dbm. With a 6-db cable loss, this calls for a minimum tuner output level of −28 dbm. The required i-f amplifier gain is

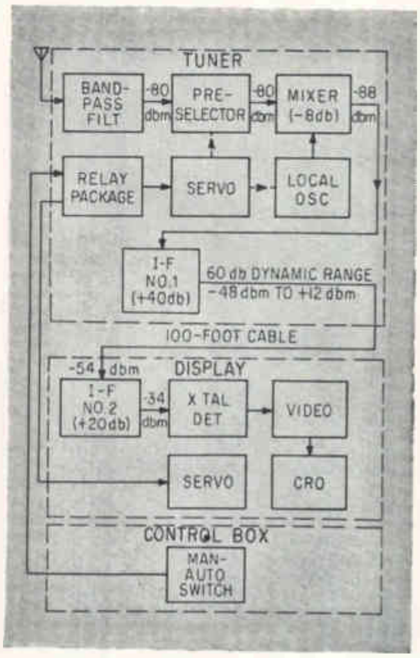
80 dbm + 8 db − 28 dbm = 60 db

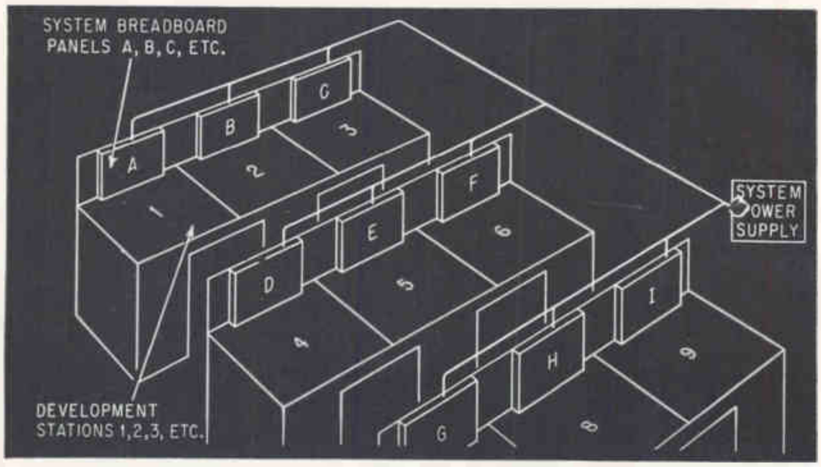
where 8 db = the mixer conversion loss (Fig. 1A).

The dynamic range, without exceeding the interference level, is +12 − (−28) = 40 db. Suppose, however, that the system group requires a 60-db dynamic range. The rfi engineer then proposes that the i-f amplifier be split between the tuner and display boxes (see Fig.



ECM TUNER *is in tail section of plane, display is in forward section (A). Maximum radiation (B) and minimum-signal (C) levels of ecm receiver—Fig. 1*





SYSTEM BREADBOARD *technique uses a common power supply for all breadboards to quickly spot mutually interferring black boxes under development—Fig. 3*

FINAL DESIGN *of ecm receiver splits the i-f amplification stages into two sections, one in the tuner, the other in the display—Fig. 2*

2). Then the tuner i-f amplifier will have a gain of 40 db with output range from +12 to −48 dbm. The display has an i-f amplifier with a gain of 20 db.

Subtracting the cable shielding effectiveness (−90 db) from the susceptibility test level given in MIL-I-6181D (−7 dbm) and comparing the result of the minimum input level to the display

$$-7 \text{ dbm} - 90 = -97 \text{ dbm}$$

shows the system is not susceptible. This level is much less than −54 dbm (the minimum signal level present along the cable) and less than −88 dbm (the lowest signal level to be found in the tuner). Thus, the tuner i-f output level is well within the interference and susceptibility levels over the dynamic range. The advantage of having rfi control is now evident.

The above example uses passive preselection. If an r-f amplifier were included, the i-f amplification could be reduced proportionately.

At the conclusion of the analysis recommendations are made to the proposal team, so that the system will be compatible with the applicable rfi spec.

SYSTEM PHASE — The primary aim of the rfi group in the system phase is to establish an interference control plan. The plan establishes the ground rules and the shielding and filtering philosophy. These are then fed to the program systems group to assist them in their planning. At this time, the system group is concerned with the specification of power, size and performance requirements of the system and the modules. During their discussions, the rfi engineer reviews f_o; f_o = frequency to which the preselector is tuned; and N = number of resonant circuits.

Assuming an i-f of 160 Mc, $N = 3$ tuned circuits, $\Delta f = 100$ Mc, then $Y = 37.5$ db.

The bandpass filter loss is significant only at the band edges, and can be ignored. The coupling loss between the l-o and the preselector is estimated at 16 db. The predicted aci is then

$$+10 - 37.5 - 16 = -43.5 \text{ dbm}$$

which exceeds the specification limit by 23.5 db. A ferrite isolator would add 25-db of rejection to the l-o signal in the back direction but only add 1 db in the forward or signal direction. This requirement is added to the plan.

The i-f amplifier may have a maximum output level of +12 dbm. The shielding requirement is 90 db. The simplest way to obtain this degree of shielding is to use a two-step approach. Therefore, the module shielding is set at 55 db and the overall tuner cover is used as an auxiliary shield to provide an additional 40 db. Shield design constants may be obtained from references 3, 4, 5 and 6.

The power leads to the i-f amplifier will require filtering to prevent conducted interference and to reduce susceptibility. The specification does not provide a limit for conducted interference above 25 Mc, but it is reasonable to assume that filtering requirements will be equal to the shielding, or 90 db. With this amount of filtering, and assuming a −7 dbm susceptibility test level, the susceptibility threshold is −97 and evaluates the various approaches for their rfi potential. As the black boxes are filled in, the control plan is elaborated.

The system is divided into several boxes: tuner, display, control box and power supply. Mechanical tuning is used for the preselector (Fig. 2). The tuning motor is driven by a servo from the display. Sector scanning and manual tuning provisions are to be incorporated.

The rfi analysis of the tuner begins with an evaluation of the submodules to predict interference and susceptibility levels and to lay out a plan for their control. The tuner modules consist of mechanically-driven preselector and local-oscillator (l-o) cavities, a bandpass filter, a mixer assembly, an i-f amplifier, a servo assembly, and a relay control package. The local-oscillator power level is set by the design group at +10 dbm, with the required shielding provided by the oscillator cavity. The problems requiring attention are the tuning rod openings, the tube socket and the power lead wiring. The control plan indicates the situation, but does not propose any solutions during this phase.

Specification MIL-I-6181D limits antenna-conducted interference (aci) to −67 dbm (100 μv in 50 ohms). To predict the aci, start with the l-o power and subtract the coupling loss to the preselector, the preselector insertion loss and the bandpass filter loss, to arrive at the l-o power present at the antenna terminal. The preselector insertion loss for N tuned stages is

$$Y = 20\,N \log\,(1 + \delta f/\Delta f)$$

where Y = insertion loss; δf = separation = twice the i-f for an l-o signal; Δf = 3-db bandwidth at dbm, which is more than adequate. Since interstage power decoupling will be necessary, this may be used to provide most of the filter requirements by proper construction. At the connector end, a similar filter will allow additional filtering without adding to size and weight. Low-frequency decoupling will be added to the input sections to reduce transient susceptibility.

The relay package provides sector scan and manual position control. The relay contacts will switch control voltages to the servo motor and amplifier. Since it is not desirable to complicate the design of the servo loop by adding reactive components, the relay contact leads are shielded and the relays packaged in a shielded compartment. A filter is required for the motor stator winding. Relay-coil transient suppression is provided in the control box, at the actuating switch.

The servo package is susceptible to power-line frequencies. The major concerns are the grounding system and the prevention of ground loops, which is best handled by using a single-point ground for the servo system and twisted-pair wiring.

DESIGN PHASE—At the outset of the design phase, the development team is given information on the interference control plan. Reasons for adequate rfi control are presented and discussed.

It often comes as a surprise to black box engineers that the system is not equal to the sum of all of its parts. When all the component modules and boxes are interconnected, a new family of problems arises due to common impedances, ground loops, and similar unforeseen complications. One solution is the system breadboard.

Normally, circuit models and breadboard set-ups are built on test benches in the engineering area and each engineer has a set of power supplies for his modules. Our method is to use one set of power supplies for the system development. The lines from the power supplies are cabled and run to distribution panels at each test station (Fig. 2). Line impedance stabilization networks or clamp-on probes may be installed in any power line to monitor conducted interference levels; the offending module may then be quickly found by shutting off various test stations. When the source is located, the circuit can then be modified to reduce or suppress the interference. Another condition may arise when one circuit interferes with another; this might not have been found until much later in the program if the system breadboard were not in use. Firm suppression solutions can be adopted with the assurance that they will not adversely affect other circuits by upsetting impedance levels, since all circuits are tied together by the power cabling. The system breadboard enables susceptibility to be checked down to the circuit level, by allowing broadband and c-w signals to be injected into the power lines.

Figure 4 shows an rfi-integrated tuner design. The module is constructed of gold-plated aluminum which has been perforated to reduce weight and increase cooling. The perforation aperture dimensions have been calculated[5,6,6] to provide maximum attenuation in the frequency range of interest. A separate compartment is used for all power wiring between stages. Ferrite feed-through filters are used in the first three stages and feed-through capacitors in the high signal-level stages. The r-f chokes have been chosen so that their self-resonant frequencies are much higher than the operating range of the tuner. Screw spacings and metal thickness have been selected to provide the required shielding effectiveness.

The design phase concludes with the preparation, submission, and acceptance of rfi test procedures. These procedures are prepared by the project test group, with the assistance of the rfi Group.

The test phase is initiated with the receipt of an accepted test procedure. The test is run in accordance with the procedure. Any problems that show up at this time are rectified. A complete test report is prepared for the contractor, including verified data sheets and graphs.

The author acknowledges the help given him by M. Brenner and M. Ginsberg of Loral.

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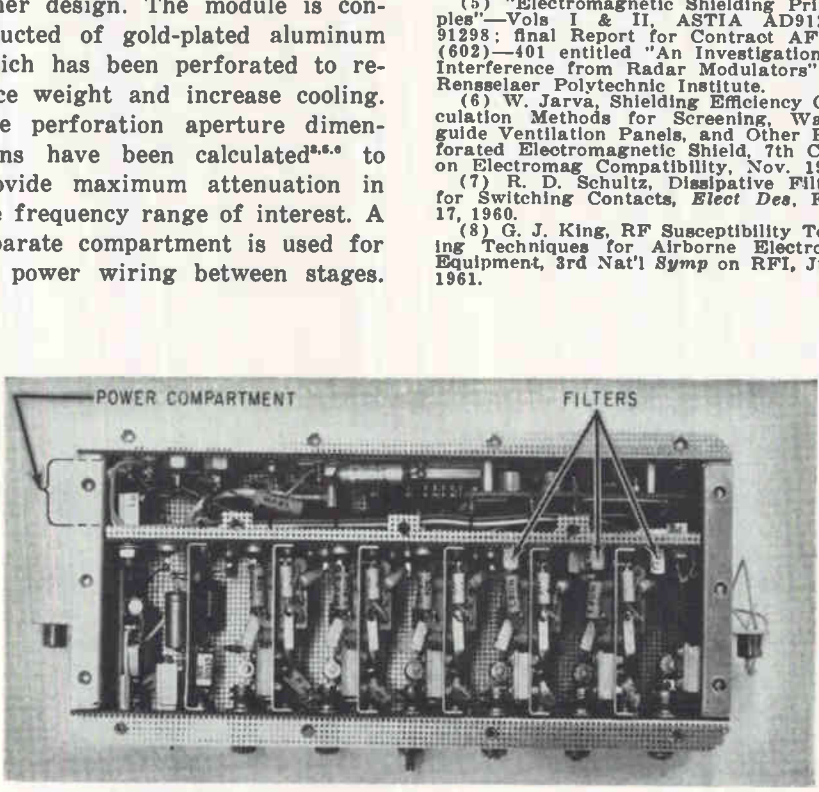


TUNER MODULE ***has rfi control integrated into its construction—Fig. 4***

GATE TURN-OFF—UNIQUE

Parameters and operating characteristics of a new solid-state pnpn switch with some promising applications.

CONTROLLING power, both a-c and d-c, is a unique capability of a new *pnpn* structure called the gate turn-off (GTO) switch. It differs from its counterpart, the silicon-controlled rectifier, in that conduction in the GTO can be stopped by applying a short-duration negative signal to the gate. With the SCR, conduction can be stopped only by interrupting the anode-cathode current.

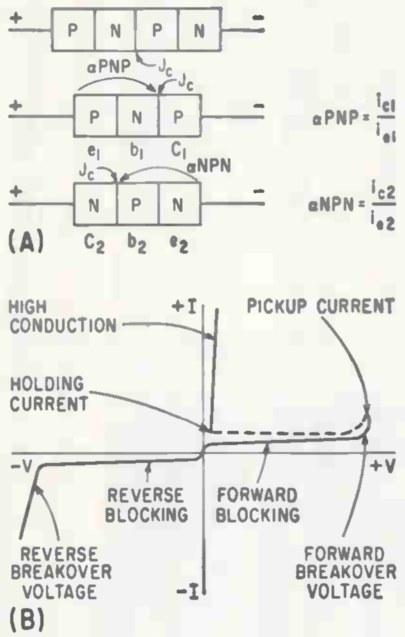
Operation of a *pnpn* structure can be described by considering a configuration consisting of a *pnp* and and an *npn* transistor with a common collector junction, Fig. 1A. The *pnp* section of the bar has an αpnp defined as a fraction of hole current injected at emitter 1 that reaches collector 1. The *npn* structure has an αnpn defined as a fraction of electron current injected at emitter 2 that reaches collector 2. By combining these two structures, the total current *I* flowing in a *pnpn* structure is the sum of the currents flowing in the individual transistor sections.

$$I = I_{J_e} = I\,\alpha pnp + I\,\alpha npn + I_{co}\ \text{(Leakage Current)} \quad (1)$$

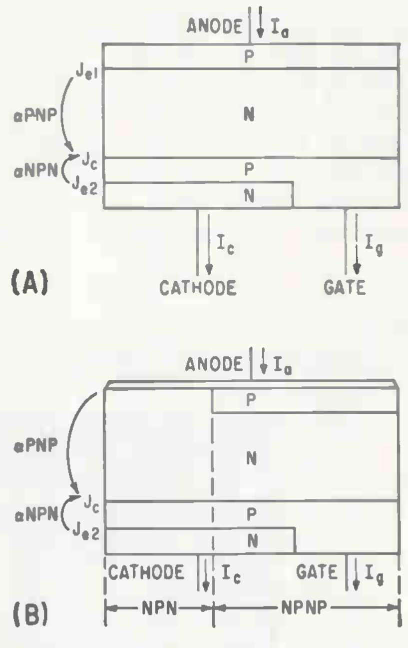
$$I = \frac{I_{co}}{1 - (\alpha pnp + \alpha npn)} \quad (2)$$

Thus, if I_{co} is small and ($\alpha pnp + \alpha npn$) is not close to unity, *I* will be small. Since I_{co} in a silicon *p-n* junction can be made very small, *I* will also be small. This corresponds to the OFF condition of the device. If $\alpha pnp + \alpha npn$ is close to unity, *I* is limited only by the external circuit. This corresponds to the ON condition of the device. Physically in the ON condition, the two center regions are saturated with carriers, making all three junctions have forward biases. The entire potential drop across the device will be about 1 volt, that of one forward biased *p-n* rectifier.

FIRING—Two methods can be used to increase alphas of the component junction transistors and thus fire the GTO. One method is to



TWO TRANSISTOR *analogy of a pnpn structure (A), and its typical operating characteristics (B)—Fig. 1*



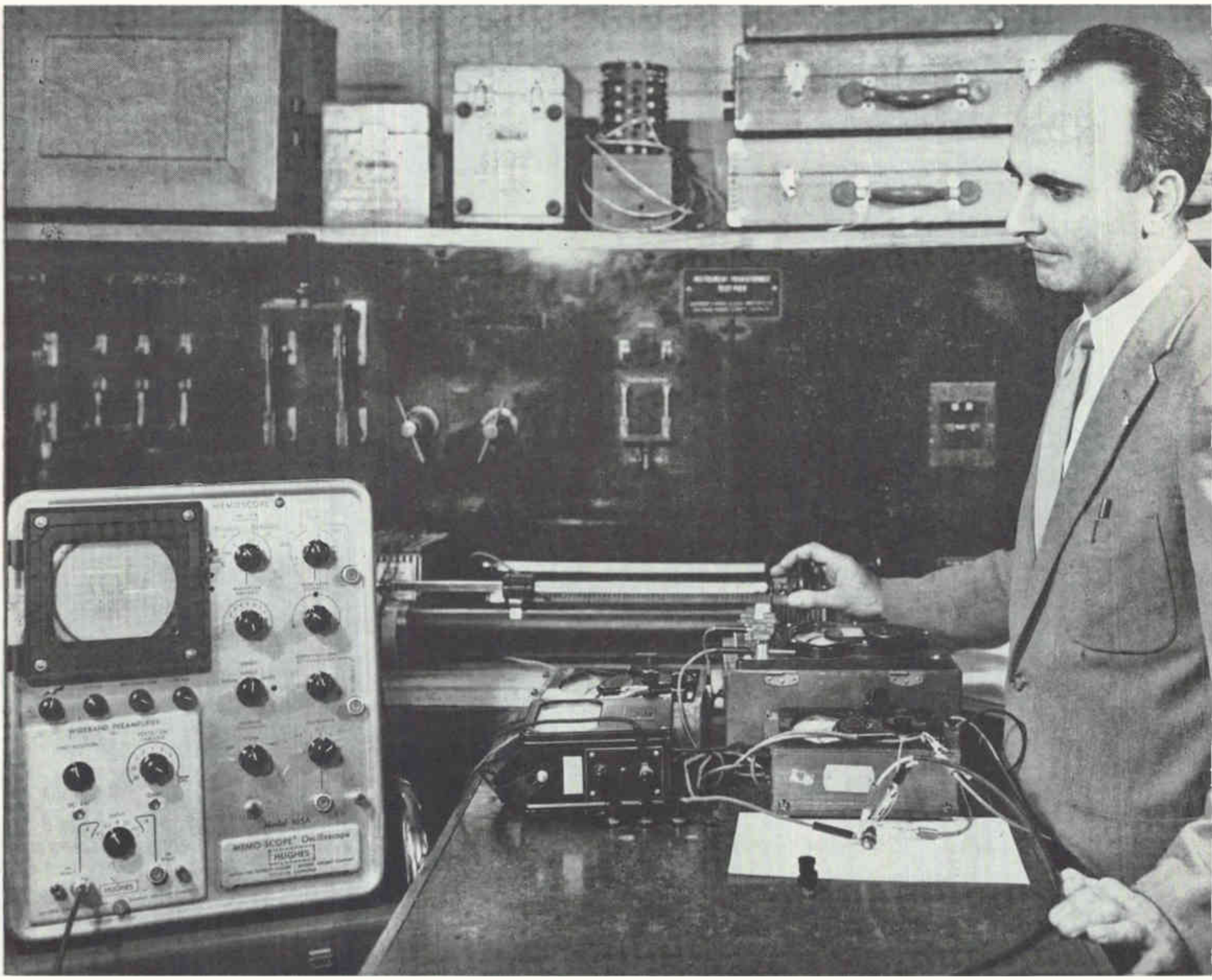
PNPN STRUCTURE *with wide n base and different p-base widths (A), and a more complex pnpn structure with a shorted anode emitter (B)—Fig. 2*

MEET THE GTO

Although still in the development stage, the gate turn-off switch shows signs of becoming as popular as the SCR. It does have the additional advantage of being able to control d-c. Technically, then, it can't be called a rectifier. Also the peak reverse voltage ratings are lower than the SCR. But it is new, and the author tells us that he has two patent applications on file for circuits designed to measure the dynamic characteristics of the gate turn-off switch

SOLID STATE SWITCH

By FRANK BRUNETTO, Material Laboratory, New York Naval Shipyard, Brooklyn, N. Y.

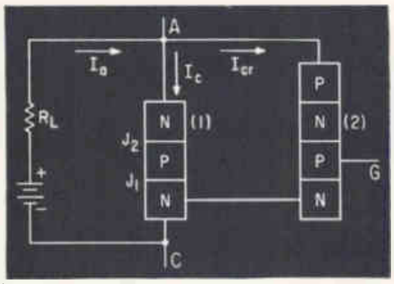


GATE TURN-OFF *switch under test has the same physical configuration as a silicon-controlled rectifier* increase collector to emitter voltage to a magnitude where the energy of carriers arriving at the collector *p-n* boundary dislodges additional carriers producing an avalanche breakdown analogous to a Townsend discharge in gases. The other, and the recommended method, is to increase emitter current by introducing current at one of the bases. In most typical silicon transistors, α is low at low emitter currents, but increases rapidly as emitter current is increased. This is because of special impurity centers in the silicon. The latter method of firing is recommended because of reliability and simplicity of design. It is possible to use a GTO having a forward breakover voltage higher than any that will be normally encountered in the circuit and needs only a moderate amount of trigger power to start high conduction. As soon as the total current is sufficient to maintain the sum of the α's $\geqq 1$, the device will go into the conducting state provided the current (through the device) remains greater than the minimum value. This current is called the holding current. If the current (through the device) drops below the holding current, the GTO will revert to the forward blocking state, Fig. 1B.

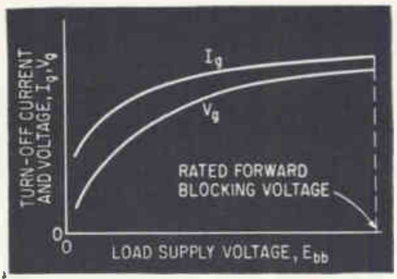
REVERSE BLOCKING—In the reverse direction the GTO is essentially two reverse biased *p-n* junctions in series. It exhibits characteristics similar to ordinary reverse biased silicon rectifiers. Care should be taken to see that reverse bias does not approach reverse breakover voltage because it may bring about destruction of the device.

TURN-OFF REQUIREMENTS—Construction of a device that can be turned off with a low energy pulse while carrying a relatively large amount of current is more difficult than the construction of a high turn-on gain device. This is because a *pnpn* structure in the conducting state has an inherent regenerative feedback mechanism that resists attempts to turn it off. Thus it is necessary to change the operation from regeneration to degeneration if high turn-off gains are to be realized.

In Fig. 2A, a four-region, wide *n*-base, three junction *pnpn* structure is shown with contacts applied to the two external regions, and a



TURN-OFF GAIN *can be increased by combining the gate turn-off switch with a transistor—Fig. 3*



VARIATION *of turn-off current and voltage with load supply voltage—Fig. 4*

gate contact attached to one of the base layers. Assuming charge neutrality, negligible multiplication at J_c, and saturation currents small compared to the gate current, the load current I_a can be presented by any one of the equations

$$I_a = I_a \alpha pnp + I_c \alpha npn \quad (3)$$

$$I_a = I_a \alpha pnp + I_a \alpha npn - I_g \alpha npn \quad (4)$$

$$I_a = I_g \frac{\alpha npn}{\alpha npn + \alpha pnp - 1} \quad (5)$$

These equations hold true only when ($\alpha npn + \alpha pnp - 1$) in Equ. 5 approaches zero. Once the unit is conducting, I_a is no longer determined by these equations but by the supply voltage and load resistance. To determine turn-off requirements, these equations can be considered to hold true if it is assumed that the alphas, αpnp and αnpn, adjust themselves so that the collector junction current I_{Jc} is equal to the anode current I_a.

$$I_{Jc} = I_a = I_a \alpha pnp + I_c \alpha npn \quad (6)$$

When gate current I_g is increased, $I_c \alpha npn$ decreases unless it can readjust itself to a higher value. Since each alpha has a maximum readjustment limit for a given load, $I_c \alpha npn$ will eventually start decreasing as gate current flow is increased. At this point, junction current I_{Jc}, will become smaller than load current I_a. This means that the the unit is limiting the current and is in the OFF state.

Turn-off gain can be denoted by

$$\frac{I_a}{I_g} = \frac{\alpha npn}{\alpha npn + \alpha pnp - 1} \quad (7)$$

Turn-off gain is defined as the ratio of load current turned off by gate current. It also tells what combination of alphas will result in a high turn-off gain, or ($\alpha npn + \alpha pnp - 1$) as small as possible with αnpn as large as possible.

TURN-OFF OPERATION — With simple *pnpn* structures, Fig. 2A, it is difficult to obtain relatively high gains and still maintain a reasonable holding current. More complex structures, Fig. 2B, are necessary.

Turn-off of this structure is achieved in the same manner as that already shown in Fig. 2A, i.e., by removing current through the gate load. In this structure, the middle *n*-region is attached to the same ohmic anode contact as is the *p*-region. During normal operation the *p-n* junction on the anode side is partially shorted causing sufficient electrons to flow parallel to this junction thus biasing the GTO into forward conduction.

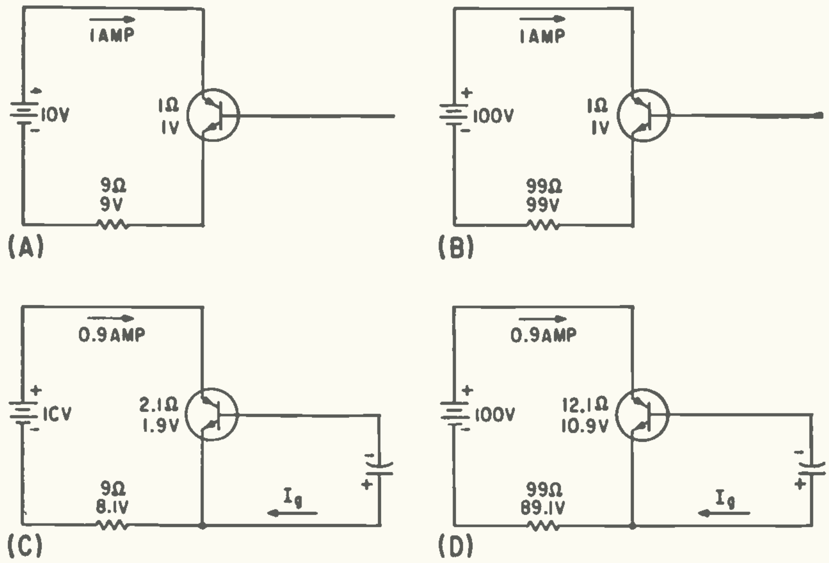
The thermal field built up on the left side of the structure by the electron majority carrier will cause the injected holes to be crowded towards the other side of the device. Since the base current for the *npn* consists of collected holes from the *pnp*, and since more holes are collected to the right side, more cathode *n*-region electrons are injected and collected near the right ridge of the cathode emitter.

When a negative gate current is introduced, the distribution of electron current density shifts to the left because the cathode junction nearer to the gate has less effective base hole current. This also reduces the lateral distance of biasing electron current in the *n*-type base, thus reducing its density in the region bordering the anode junction. Since the forward bias across this junction will lower, injection will drop and result in lower alpha sum. As the alpha sum drops below unity, the device will turn off.

INCREASING GAIN—To get turn-off gains greater than the capability of a GTO, it is possible to combine the GTO with a transistor, Fig. 3. Structure 2 is the GTO and is in series with the forward biased junction, J_1, of transistor 1. With sufficient positive bias to gate, G, the GTO will conduct. Junction J_2 of the transistor will be a high parallel impedance across the GTO because it is a reversed biased junction. Current I_{cr}, flowing through the GTO, will be acting as base current for transistor 1 and the forward drop across GTO 2 will be the collector bias for J_2. If the transistor has appreciable current gain, β, most of the load, I_a, will flow through transistor 1.

Collector current I_c for transistor 1 equals βI_{cr}. Assuming β equal to 50, then $I_a = I_c + I_{cr} = 50\ I_{cr} + I_{cr} = 51\ I_{cr}$.

If the GTO 2 has a turn-off gain of 25, it can turn off a current, I_{cr}, with a negative current of 0.04 I_{cr}. Since transistor 1 will not conduct any appreciable current without the base current, I_{cr}, a load current of 51 I_{cr} is turned off with a current of 0.04 I_{cr} and thus have a turn-off gain of 51/0.04 or 1275.



COMPARISON *of resistances and voltage drops of a GTO conducting the same load current at two different supply voltages. Conditions before turn-off (A) and (B), compared to conditions during turn-off (C) and (D) show an increase in circuit resistance—Fig. 5*

TEMPERATURE SENSITIVITY—Like any other semiconductor device, the GTO is sensitive to temperature variations. A rise in temperature will increase alpha and, conversely, a drop will bring about a corresponding reduction in alpha efficiency. Thus, a rise in temperature will increase the turn-on gain but reduce the turn-off gain. A relatively high junction temperature can reduce gain to a point where turn-off becomes unattainable and could destroy the device. It is important that the GTO or any other semiconductor device be operated within the temperature limits prescribed by the manufacturer which, for silicon, are usually never higher than 150C and never lower than −65C junction temperature.

RISE TIME—Other factors that affect the turn-off parameters of a GTO is the rise time of the triggering gate signal. Generaly, a smaller turn-off current gain can be expected when using a signal having a faster rise time because of the presence, in the load circuit, of higher peaking transient voltage and current. The transients are generated during turn-off by the rapid interruption of the load current. Their amplitudes are directly proportional to the rate of decay of the load current. The latter, in turn, is directly dependent upon the rise time of the triggering voltage.

Transient voltages are minmum when little or no inductance is present in the load circuit. If the circuit is in this condition and it is desired that the turn-off voltage, not the turn-off current, be kept at a minimum, it will then be advantageous to use a triggering signal having a relatively fast rise time.

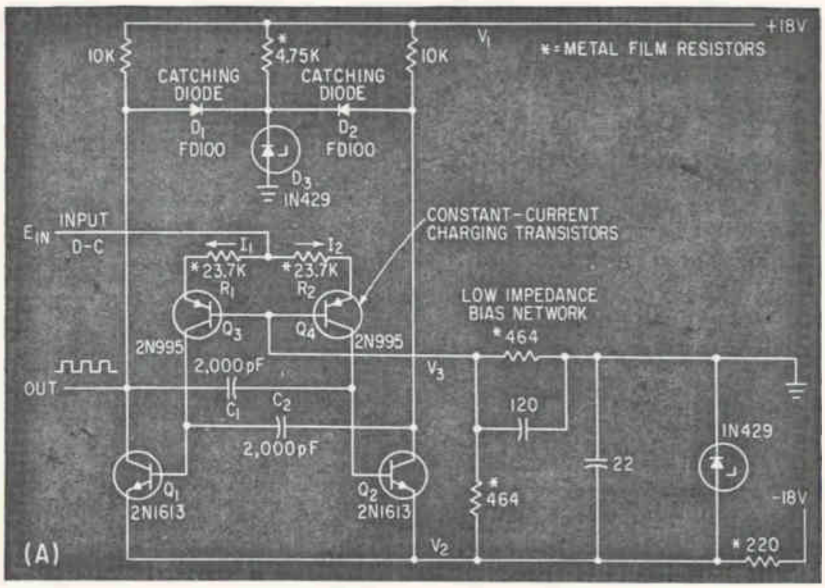
Inductance, however small, does appreciably affect the turn-off parameters of a GTO, especially when the triggering signal has a fast rise time. Since the GTO is triggered ON and OFF by the addition and removal of current through the gate, a low impedance voltage source or current source must be used for triggering the device.

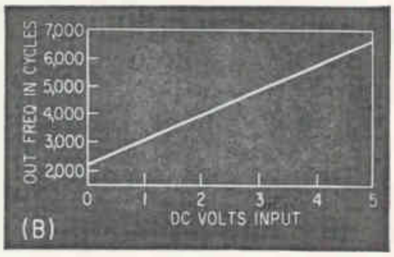
LOAD SUPPLY VOLTAGE—Although the junction temperature and triggering signal rise time influence the turn-off parameters of a GTO, their effects are insignificant when compared to that exerted by the magnitude of the load supply voltage, E_{bb}. Differences in the parameters by as much as 100 percent in turn-off current, I_g, and much more in voltage, V_g, are possible with the use of different magnitudes of supply voltages. The relationship, Fig. 4, which is one of more turn-off power for a higher magnitude of supply voltage, is explained by the fact that when operating under the latter condition the device must attain a larger internal resistance. With this, there is an equivalent reduction in load current.

In Fig. 5A and B, a GTO is shown conducting the same load current supplied by two different magnitudes of supply voltage. Since the current is limited only by load resistance, the resistance of the GTO as well as its forward voltage drop, are in both cases the same.

This, however, is not the case once the process of turn-off is initiated. If turn-off is considered as a continuous reduction of load current brought about by a corresponding increase in circuit resistance, then Fig. 5C and D show that with a larger supply voltage the GTO must attain a larger internal resistance for an equivalent drop in load current. This can only be accomplished by applying more negative power bias on the gate, a method somewhat analogous to imposing a more negative voltage bias on the control grid of a vacuum tube. The same condition applies if the supply voltage is unregulated.

The author thanks General Electric Company for granting permission to include material from the *General Electric Controlled Rectifier Manual* and from reports on Investigation of Electronically Controllable Turn Off Controlled Rectifiers. Thanks also to J. L. Flood, J. Moyson, J. Petruzella of General Electric, William Colletti of the Naval Material Laboratory, and Richard H. Grant of the Naval Material Laboratory for their assistance.





UPPER pnp transistors provide constant-current charging path for lower npn multivibrator pair (A), conversion characteristic is linear within 0.1 percent over 5:1 range (B), conversion error and sensitivity variation with temperature (C)

LATEST

By R. W. BIDDLECOMB
Martin Company, Baltimore, Maryland

Two extra transistors provide constant-current charging path for multivibrator timing

IN COMPUTER or data transmission work, need often arises for an inexpensive voltage-to-frequency converter. Commercially available items are normally expensive and are often inconveniently tailored to IRIG telemetry standards.

This unit is simple and easily constructed. Linearity is better than 0.1 percent at a 75F ambient for an input votlage of 0 to + 5 volts d-c, and output frequency 2,000 to 7,000 cps. Layout is noncritical and commonly stocked components are used.

OPERATION—The circuit (A) is a conventional capacitor-coupled astable multivibrator. The modification substitutes a constant-current charging method for the usual resistive exponential charging of cross-coupling capacitors, C_1 and C_2.

Since the bases of Q_3 and Q_4 are set at a voltage V_3 and the emitter-base diodes clamp their emitters to V_3, then $E_{in} + V_3$ is impressed across R_1 and R_2. The result is that currents I_1 and I_2 are constant and functions of V_3, R_1 or R_2, and E_{in}. This provides an extremely linear voltage control over the recharge rate of C_1 and C_2.

The collectors of Q_1 and Q_2 are clamped to a reference voltage to make the collector swings constant and independent of fluctuations in V_1. This also speeds the charging of C_1 and C_2 by charging them toward V_1 and "catching" them at V_{D3}.

Referring to (A), the zener diode and voltage divider are added to perform a shift of canstants, deriving voltages V_2 and V_3 from the −18-volt supply. This is necessary to accommodate a 0 to +5-volt input. Also, two capacitors are added for a-c decoupling. If noise pick-up on the input line is a problem, a capacitor can be added across the input terminals at the expense of response time.

Additionally, if symmetry of the output waveform is important, a balance potentiometer may be added at the juncture of R_1 and R_2.

FREQUENCY RANGE—If T_1 is defined as the period of a half cycle of the multivibrator, then considering the Q_1 side as just having turned off, let the voltage step that cut-off Q_1 be V_X

$$V_X = V_2 + V_{D3} + V_{D2} - V_{BEQ1} - V_{CE(sat)Q2}$$

which is the voltage at the base of Q_1 referred to its emitter. To clarify the symbology: V_{BEQ1} is the base-emitter voltage of Q_1; V_{D2} is the drop across D_2; and all voltages are treated as absolute values.

Now if T_1 = time for V_{BQ1} to reduce to a value such that Q_1 will conduct

$$T_1 = C_1 V_X / I_{in}$$

where $I_{in} = \alpha_{Q3}(E_{in} - V_{BEQ3} + V_3)/R_1$

and the critical parameters sufficient for the determination of an accurate constant T_1 are

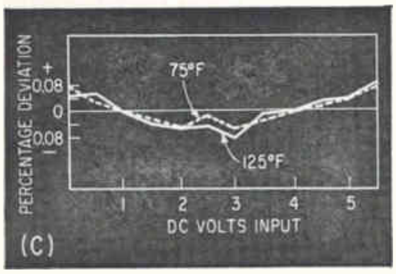
$$T_1 = R_1C_1 \frac{V_2 + V_{D3} + V_{D2} - V_{BEQ1} - V_{CE(sat)Q2}}{\alpha_{Q3}(E_{in} - V_{BEQ3} + V_3)}$$

This analysis is valid assuming that all transistors are high-speed silicon planar types with negligible I_{CBO}, I_{CEO}, and stable $V_{CE(sat)}$ and h_{FE}. It is also assumed that storage effects of Q_1 and Q_2 are small with respect to C_1 and C_2.

Since T_1 is the period of a half cycle, the frequency of operation

$$F = \frac{1}{2T_1} = 1 \Bigg/ \left\{ \frac{2R_1C_1[V_2 + V_{D3} + V_{D2} - V_{BEQ1} - V_{CE(sat)Q2}]}{\alpha_{Q3}(E_{in} - V_{BEQ3} + V_3)} \right\}$$

For simplification, since $\alpha \sim 1$ and $V_{CE(sat)Q2} \sim 0$



CIRCUIT ELEGANCE

It would be hard to find a simpler voltage-frequency converter with 0.1 percent linearity. One circuit (Magnetically Coupled Multivibrator: A Neglected Precision Circuit, ELECTRONICS, p 42 March 29, 1963) provides a 10:1 operating range with 0.1 percent linearity, but uses special stabilizing techniques. This circuit is assembled from off-the-shelf components

MULTIVIBRATOR IMPROVEMENT

Linear Voltage-to-Frequency Converter

network; charging rate is proportional to input control voltage

in the normal ranges of I_G and temperature

$$F = \frac{E_{in} - V_{BEQ3} + V_3}{2R_1C_1\,(V_2 + V_{D3} + V_{D2} - V_{BEQ1})}$$

This shows the output frequency to be a linear function of E_{in}.

SENSITIVITY — Since the frequency-versus-E_{in} characteristic is linear, sensitivity in cps per volt is determined by first finding ΔF and dividing it by ΔE_{in}.

$$\text{Sensitivity} = (F_{high} - F_{low})/\Delta E_{in}$$

$$\left\{\frac{[E_{in(high)} - V_{BEQ3} + V_3] - [E_{in(low)} - V_{BEQ3} + V_3]}{2R_1C_1\,(V_2 + V_{D3} + V_{BEQ1})}\right\} \Big/ (E_{in(high)} - E_{in(low)})$$

$$= 1/\{2R_1C_1\,(V_2 + V_{D3} + V_{D2} - V_{BEQ1})\}\ \text{cps/volt}$$

RESULTS—Figure B is a plot of output frequency versus input voltage, (C) shows the percent deviation from perfect linearity. For (C), the output frequencies at 1 volt and 4 volts are taken as a reference points and the errors are computed from a straight line through these points. Although no extensive effort was put into the temperature stabilization of the circuit, the $\Delta F/\Delta T$ linearity stability is good, but the sensitivity shifts with a change in temperature.

For example, for the circuit of (A), the 75F linearity is 0.08 percent and the sensitivity is 915 cps per volt. If the same circuit is operated at 125F, the linearity is 0.08 percent while the sensitivity is 913.3 cps per volt. Although the two curves of (C) are superimposed, they are plotted from different sensitivity bases. The curvature of these plots is attributable to the nonlinearity of the V_{BE} of Q_3 and Q_4 and may be compensated for if objectionable.

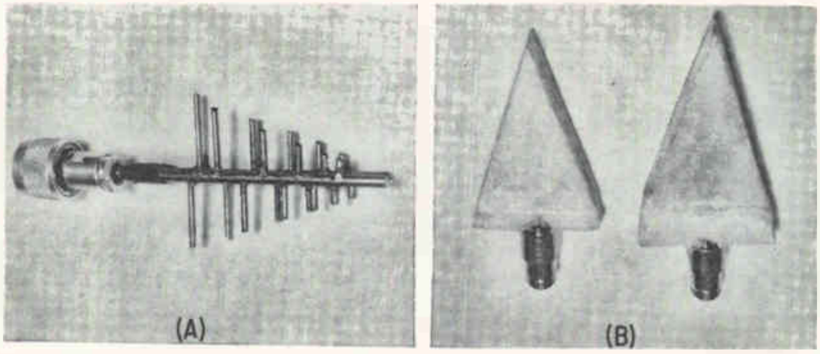
POWER VARIATIONS—Variations in the positive voltage supply of 10 percent affect the output frequency of the oscillator less than 0.4 percent. The recharge rates of C_1 and C_2 are affected slightly, but the clamp voltage V_{D3} stabilizes the collectors of Q_1 and Q_2. Variations in the negative supply of 10 percent contribute a frequency deviation of approximately 3 percent. This can be improved to better than 0.5 percent with additional zener regulation on the −18-volt input.

To have the voltage at the bases of Q_3 and Q_4 set by a resistive voltage divider, the impedance must be low. Since E_{in} varies from 0 to 5,000 millivolts, if there is an appreciable impedance for example 1,500 ohms, in the bases of Q_3 and Q_4, then a ΔV_B of about 10-50 millivolts will be seen. This would effect the linearity of the oscillator.

This circuit has given good results as both narrow and wide-range voltage-controlled oscillators. With parameter changes, the range has been extended to cover five octaves with sweep of 0 to 50 volts.

Additional applications might be wide-range square-wave generators without range switching, and swept signal generators. Also, with suitable modifications and additions, a simple analog-to-digital converter be made.

Acknowledgement is made of the basic method of transistor constant current charging of a capacitor for generation of linear voltage ramp, invented by R. Foerster, The Martin Company, 1957 (patent pending).



BASIC *arrowhead design uses 1/16 inch rod elements (A); two models using etched-circuit techniques are encapsulated in epoxy foam (B)—Fig. 1*

THE ARROWHEAD: Compact

Frequency-independent antennas such as the log periodic are finding wide use in commercial

This antenna is particularly interesting because it uses etched-circuit techniques and

INCREASING emphasis on airborne equipment has created a need for the fewest possible antennas to cover the communications needs of an aircraft or missile over any selected frequency range.

The arrowhead develops moderate directivity and nearly constant forward gain between 3 and 11 Gc. The antenna also is light, compact and reliable and requires no reconnections over its operational bandwidth.

DESIGN—The arrowhead is a linearly polarized, frequency-independent log periodic. Two basic types have been experimentally produced and are shown in Fig. 1. The model in Fig. 1A uses rod construction, and the two in Fig. 1B are of the dip-soldered, etched-board type, encapsulated in a low-loss foam. Both types weigh less than 3 ounces and have a nearly constant gain of about 4 db over a 3-to-1 frequency range. Moreover, these antennas have well defined coverage over the bandwidth with no pattern suck-out points and minimal beam degradation.

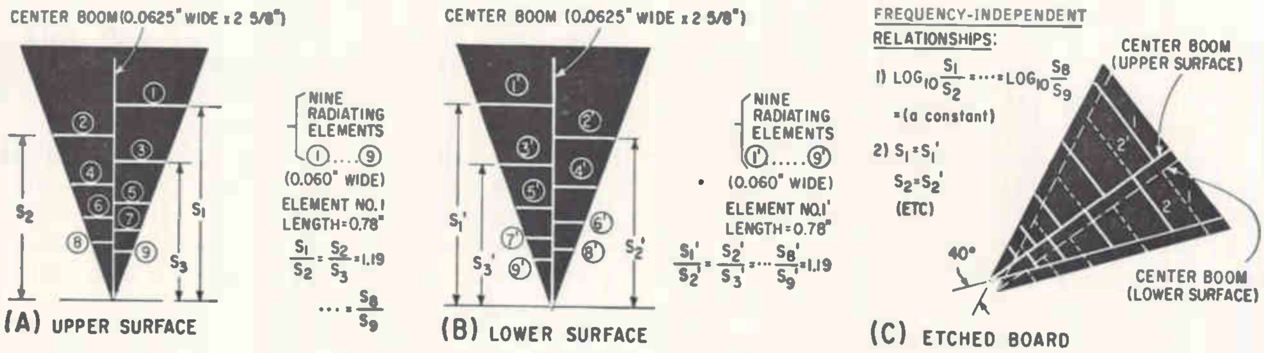
The frequency-independent design relationships between the elements and the complete layout of the upper and lower etched-pattern surfaces, are shown in Fig. 2.

On both surfaces, the layout is identical with the elements on the lower surface diametrically opposite the corresponding elements on the upper surface.

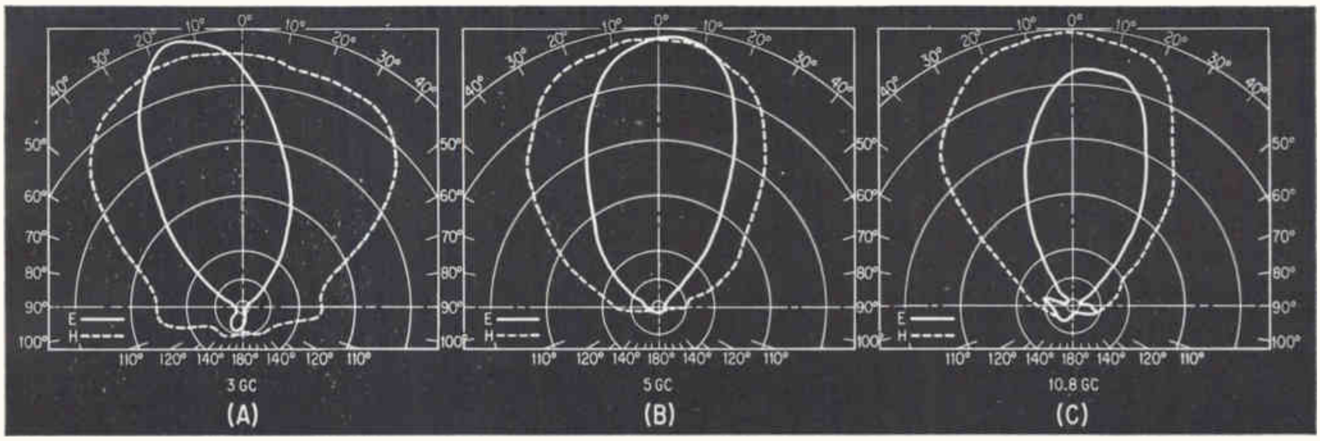
The actual size of element 1 was determined to assure quarter-wave resonance in free-space at 3.76 Gc. The addition of the dielectric board beneath the element, reduced its resonance so that satisfactory operation to 3 Gc resulted. The positions and lengths of the other elements can be found with the relationships given in Fig. 2.

The two models shown in Fig. 1B were constructed from 0.0028 inch copperclad, 1/16 inch EP-22 and G-10 boards.

The antenna with etched-circuit design has slightly less average gain than the rod model of Fig. 1A. This is due to loss in radiation efficiency or coupling from the feeder to the medium. The rod version appears to offer a better impedance match than the etched antennas, although the difference is not great. Also, it appears that the bandwidth of each radiating element is more uniform with rod construction; less impedance fluctuation will therefore be expected for the rod antenna.



ETCHED-BOARD *geometry. Upper surface at (A), lower surface (B) and dimensional drawing (C)—Fig. 2*



POLAR PLOTS *of a rod-type antenna taken at 3 Gc (A), 5 Gc (B) and 10.8 Gc (C)—Fig. 3*

New Telemetry Antenna

By GEORGE J. MONSER
American Electronic Labs, Colmar, Pa.

and military communications as the electromagnetic spectrum becomes more complex.

operates between 3 and 11 Gc with nearly constant gain

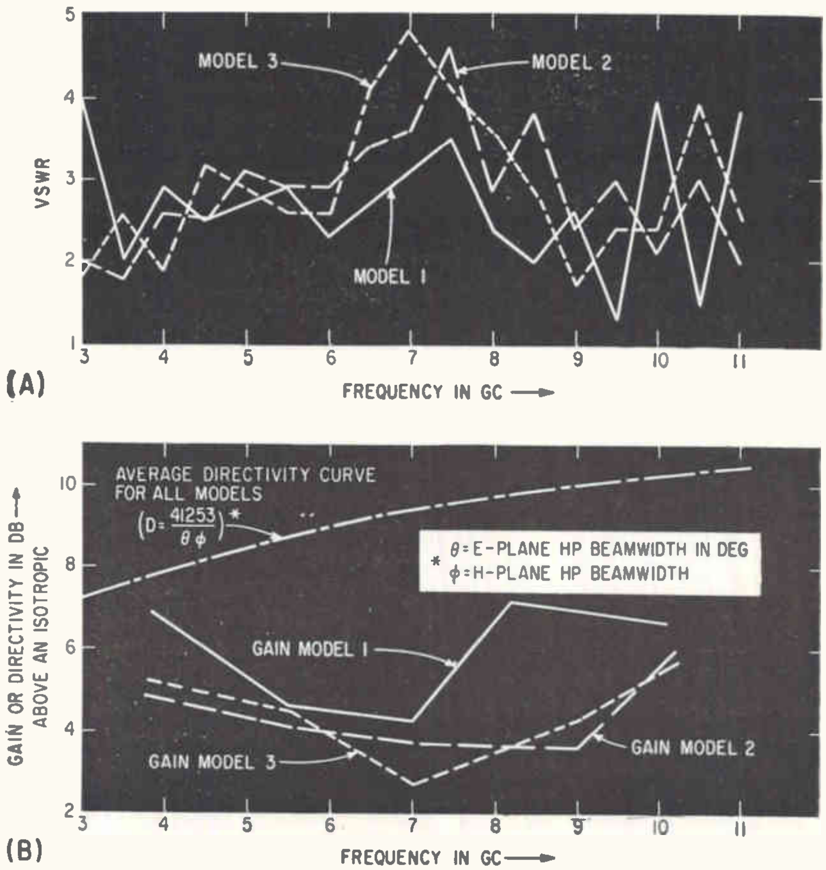
TRANSFORMER — In all three models, a suitable matching transformer was built into the type N connector to improve the match between the antenna and a 50-ohm line. This transformer represents a three-step transition from the RG-141 cable to the N fitting. Each step is nominally 50 ohms, with inner and outer radii selected accordingly.

A more sophisticated approach might include transforming the average gap (feed point) impedance to 50 ohms prior to using the matching transformer. However, since these units were experimental, and a reasonable match was noted, this sophistication was omitted.

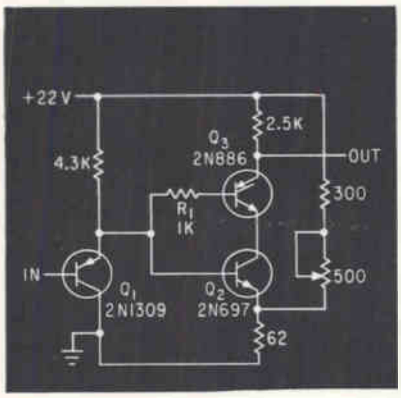
RESULTS—Typical linear power-plots for this antenna are shown in Fig. 3A, 3B and 3C. They are representative of the antennas operation at the low, medium and high portions of the bandwidth, respectively. In checking the three antennas over the bandwidth in 500-Mc steps, no pattern break-up or low-gain points were observed.

The average E-plane beamwidth of the arrowhead is about 62 degrees over the operating range; the H-plane beamwidth is about 125 degrees at 3 Gc, monotonically decreasing to about 90 degrees at 10.8 Gc. Average front-to-back ratio is 15 db.

Graphs of gain and vswr for the three models are shown in Fig. 4. The broken line above the gain curves is a universal curve of directivity for all models. The gain and directivity curves show that losses (difference between gain and directivity) are typically 3 to 4 db for the rod model and 4 to 5 db for the etched antennas.

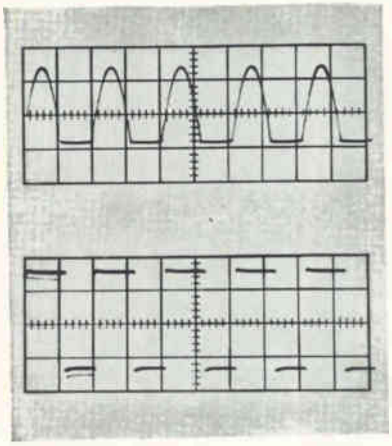


FORWARD GAIN *and directivity for all models (A) and plot of vswr for the same three antennas (B)—Fig. 4*



SCHMIDT AND SCHMITT

Lest there be any confusion with an article on bistable triggers by Schmidt, we would like to point out that our author's surname sounds the same as that of the inventor of the original device. O. H. Schmitt designed the original trigger, our Schmidt made an improved version



NOVEL *trigger can be used for waveform restoration, signal-level shifting, squaring sinusoidal or nonrectangular inputs and for d-c level restoration. Waveforms show input (top waveform) and output (lower) for 500 cps signal*

Improved SCHMITT TRIGGER Uses SCR

High-sensitivity circuit has lower hysteresis than a conventional Schmitt and triggering stability is held through an extremely large temperature variation

By MELVIN SCHMIDT
Design Engineer, Giannini Controls Corp., Duarte, California

A CONVENTIONAL Schmitt trigger is a regenerative bistable circuit whose state depends on the amplitude of the input voltage. The design variation shown in this article functions the same as the original trigger but its hysteresis is an order of 10 lower with typical hysteresis at ambient of 70 mv with a maximum of 150 mv at −60 C. Input can be any signal up to 200 Kc either a-c or d-c, input impedance ranges from 30,000 to 100,000 ohms and source impedance can be as high as 5,000 ohms and not affect output.

Triggering stability is held through extremely large temperature variations and triggering has continued with the device buried in dry ice (−85 C.). Some instability was noticed but this may have been due to condensation of moisture.

THEORY—The input at Q_1 base in relation to the d-c level at Q_2 emitter determines the state of the output. When the input exceeds Q_2 emitter level, the output switches to a level that is the summation of Q_3 and Q_2 saturation voltages plus the d-c level at Q_2 emitter. With the input below Q_2 emitter level, Q_3 and Q_2 are not conducting and the output is at +22 v. The output voltage is then digital (true or false) with voltage variation between 5 and 20 v, depending on bias level used.

Triggering action is made possible by the high-sensitivity of Q_3 and the use of Q_2 for turning off the current at the emitter of Q_3. Resistor R_1 from the gate of Q_3 to the base of Q_2 was chosen to provide stability at operating temperatures below 125 C. This resistor prevents undesired triggering by the *dv/dt* effect by providing a negative gate bias current.

For operation at high temperatures, a thermistor can be used in place of resistor R_1.

Maximum gate firing current required under worst operating conditions is 50 μa at −65 C. Maximum gate current in the 25 C region is 20 μa. Reliable operation between −60 and +70 C is practical with the use of higher beta germanium transistors although the 2N886 controlled rectifier continues to operate well even at low temperatures.

Device cost can be reduced by replacing the 2N866 controlled rectifier (SCR) with a 2N1883 and replacing both transistors with higher beta units to retain high sensitivity.

Three Simple Guides To...

The Key Role Of Profits In The American Economy

The American economy is as dependent on profits as the American automobile is on gasoline.

Profits — or better still the expectation of profits — are what motivate private citizens to put their savings into useful enterprise. Past profits provide the largest single source of funds for economic growth. And present profits — together with memories of profits past and hopes for profits yet to come — lead both men and machines into the jobs the community values most.

Dereliction Of Duty

But though we depend on profits to perform these vital tasks, we do not always comprehend them — what they are, how they are calculated or how they help keep the economy's wheels turning.

This is a dangerous dereliction of duty, especially on the part of those whose high place in government, labor or business makes it imperative that they do comprehend. For a failure to understand here can result in tax rates that impair our incentive and capacity to invest. It can lead to wage demands based on fancy rather than fact. It can result in the diversion of resources from efficient and constructive uses to wasteful uses. It can wreck the machinery by which production responds to changing consumer demands.

One of a series on profits, this editorial examines these dangers and suggests ways of reducing them. It explores the nature of profits, discusses how they should be calculated and shows how some of the fanciful thinking surrounding them might be eliminated.

Count All Costs

In both the truest and simplest sense, profits are what business has left over after paying all its bills. The important point — it might be called the first law of profits — is that all costs, and not just some of them, must be included.

This may seem an absurdly simple rule, and one might pass it by without further ado were it not for the fact that it has been so frequently violated — by government agencies, union officials and sometimes by businessmen as well.

Not long ago, for example, the staff of the U.S. Senate Subcommittee on Antitrust and Monopoly presented exhibits that were widely interpreted as showing U.S. drug companies to be earning fabulous returns. On some products, it was said, markups amounted to 1800% and even more.

But these figures were arrived at in a most curious way — by including some costs and excluding others. The costs of raw materials were duly counted, as were the costs of converting these into bulk powders. Many, however, were ignored. Among them were the costs of management, distribution and, most important of all, the research and development that made these products possible in the first place.

As a result profits were grossly exaggerated. Whether profits, properly calculated, would have been on the high side is beside the point. The point here is that it is a disservice both to public understanding and sensible public policy to torture profit figures up to fantastically high levels simply by ignoring important costs.

An Uncertain Undertaking

What might be called the second law of profits is that the quest for them is a highly uncertain undertaking, that even in the best of times many companies lose money.

Even during the prosperous 1950s, according to U.S. Treasury reports, over 40% of the nation's active corporations either failed to earn a net return or actually went in the hole. Frequently overlooked in the day-to-day wrangles over wages and taxes, this statistic helps underscore these basic points:

1. Business must not only work hard for whatever profits it makes, but work to satisfy consumers who are forever changing their minds.

2. Without hope of profit to offset the real possibility of losses, risk-takers will soon lose their gusto for contributing the research, new machines and working capital that provide more and better jobs for workingmen, more and better products for consumers.

Profits Vary

Because profit-making is a most hazardous occupation, the third law, which is that profits vary, is scarcely surprising. They vary from time to time, company to company, industry to industry.

That profits vary over time can be doubly confusing. On one side of the fence are people with a penchant for comparing today's profits with those of an unusually low year in the past. Their purpose is to show how well things are going now. On the other side are those who always compare current profits with an unusually high year—their purpose being just the reverse.

The only way to beat this numbers game is not to play. To find which way profits are really moving over the long run, one should compare fairly extended periods of time, preferably five-year averages such as 1947-51 with 1952-56 and with 1957-61. This technique reduces the frequently misleading emphasis on year-to-year changes. In addition, it helps reveal important long-run trends—as, for example, the great post-World War II squeeze on corporate profits, a development discussed in an earlier editorial in the current series.

The Key To The Economy

The variation of profits from company to company and industry to industry also opens a broad avenue for confusion and misinterpretation—an avenue often followed blindly to the conclusion that above-average company or industry profits are the result of conniving or monopoly. And to be sure, exceptionally high profits may, on occasion, reflect monopoly control or some sort of price fixing conspiracy.

But to assume, as a matter of course, as some Congressional inquiries have done, that unusually high profits are necessarily the result of skulduggery is to make the most grievous error of all about the role of profits. For differences in profits — as between companies and industries — provide the key to how they work to channel men and machines in the directions the community wants them to go.

When, in our competitive system, a company's or an industry's profits go above the norm it is because it is producing goods or services that are in keen demand relative to the cost of making them. And it is the hope of garnering these above-average profits that leads business into hiring additional labor and putting more capital into producing the things people want most.

An Essential Task

To forget this is to forget the essence of our free enterprise economy. To go further still and impose penalties on healthy profit-makers would damage not only businessmen but consumers, labor and Congressmen as well.

Avoiding these pitfalls is an absolutely essential task. The first, and perhaps most important, step we can take is to keep these three profit facts clearly in mind.

(1) In calculating profits all costs, not just some, must be included.

(2) The quest for profits is an uncertain undertaking. Even in the best of times a large portion of all companies operate at a loss.

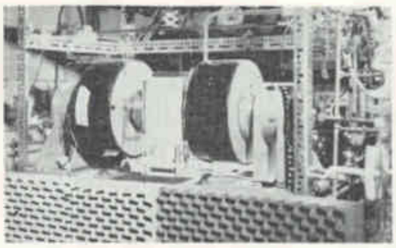
(3) Profits vary from time to time, company to company, and industry to industry, and in so doing perform their role, so crucial in a free society, of seeing that capital and labor are routed where free people want them to go.

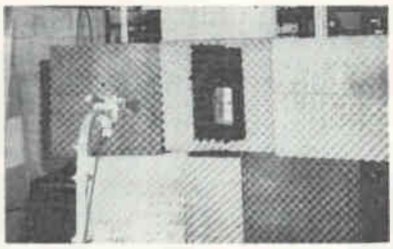
This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald C McGraw

PRESIDENT

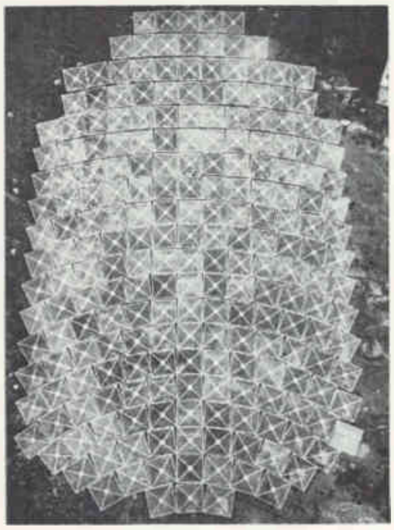
McGRAW-HILL PUBLISHING COMPANY





RADIATION PATTERNS *of plasma surrounded by magnetic field are studied in Electromagnetic Radiation Laboratory—Fig. 1*

TRAIL OF CHEMICALS *30 miles long, stretching from an altitude of 60 to 90 miles, over the Florida coast—Fig. 2*



BEAM-FORMING *field of plates as viewed from the feed horn—Fig. 3*

Air Force Research Aim: Detection Capabilities

Accent on space at AFCRL: Plasma, Firefly studies tackle re-entry riddles

By THOMAS MAGUIRE
New England Editor

BEDFORD, MASS.—The Air Force's conviction that it belongs in space is resoundingly indicated in the programs of one of its major scientific and engineering centers, AF Cambridge Research Laboratories.

A $70-million-a-year operation, AFCRL employs 1,100 people. It is an in-house research center, also has contractors doing R&D work throughout the U. S. and overseas.

The space theme is evident not only in the cluster of 14 laboratories in 19 permanent structures here at Hanscom Field, but also at the permanent and temporary field sites which range from north of the Arctic Circle to the South Pacific.

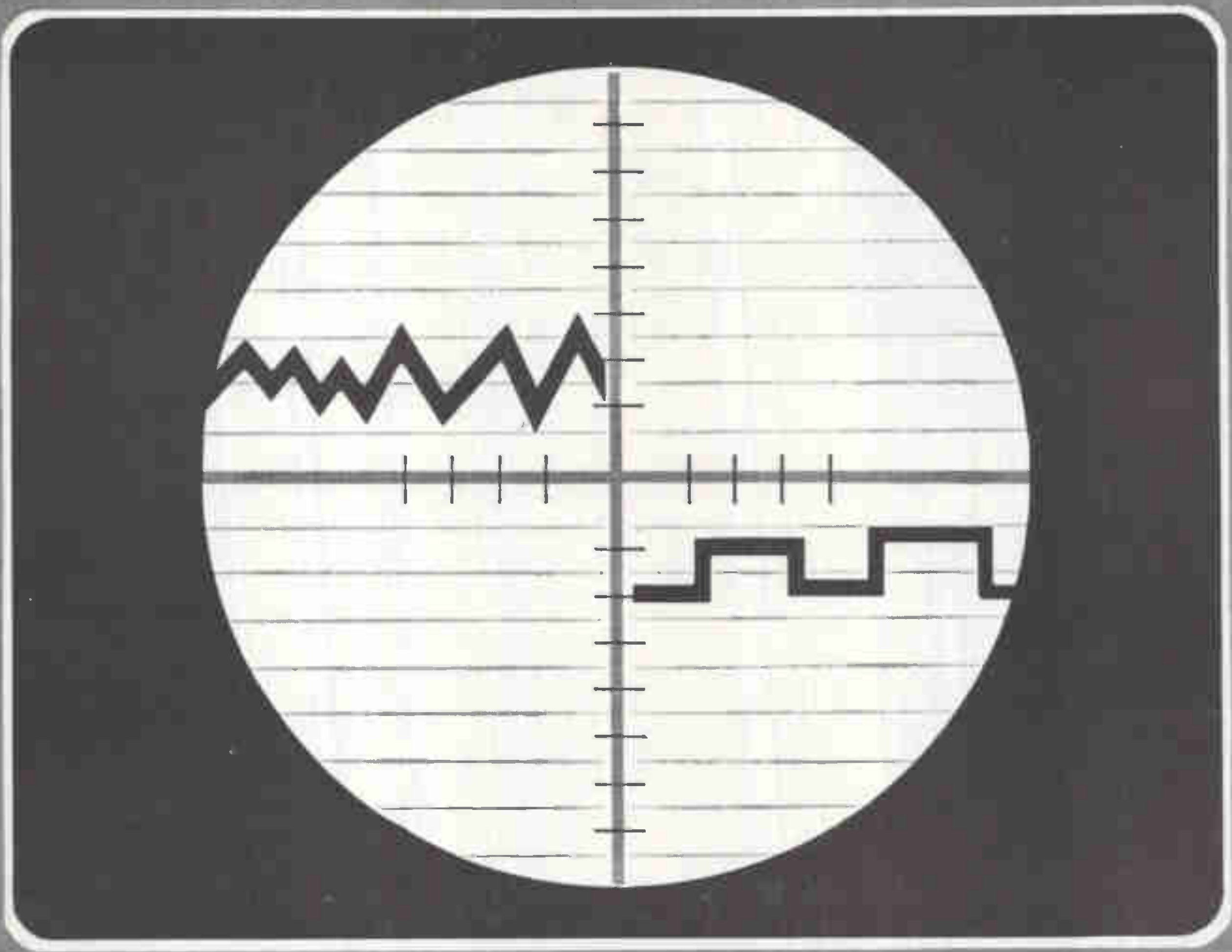
AFCRL has two major practical areas of interest in space: communications and detection.

But the underpinning for both is knowledge of the environment, the physics of space. And this is a field of extensive investigation at AFCRL.

Its scientists are preparing space referencing systems and charts of the moon and planets. And next month (May) AFCRL is sponsoring a conference on the lunar environment, particularly the availability of water and other resources for use of the moon as a refueling stop for interplanetary explorations.

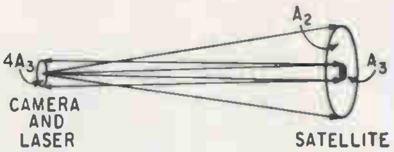
PLASMA RESEARCH—The plasma sheath, that shield of ionized gas surrounding re-entry vehicles, is a subject of intensive study at AFCRL. Of particular concern is the lengthy communications and telemetry blackout which would occur at the re-entry speed of superorbital vehicles like Apollo, and during the shallow glide type of re-entry characteristic of a Dynasoar-type vehicle. Among promising techniques to get through the plasma sheath is the use of static magnetic fields surrounding the sheath. (ELECTRONICS, p 20, May 11, 1962). Fig. 1 shows magnetic field experiments with a simulated plasma at the Electromagnetic Radiation Lab at AFCRL. In March of 1964, an instrumented payload from this lab will fly on a Trailblazer II vehicle which will make a powered re-entry at 20,000 ft. per sec. The flight is expected to give valuable information on radiation patterns in the plasma sheath, antenna mismatch, r-f noise and the degradations caused at various frequencies.

PROJECT FIREFLY — Information of significance to both communications and detection is being



gleaned from Project Firefly, in which AFCRL uses chemical seeding to create artificial clouds of electrons. A tv signal transmitted in Florida was bounced off one of these artificial clouds and picked up in Louisiana. The Firefly program, in which the Army Signal Corps, NASA and the National Bureau of Standards are also participating, has promising implications in producing a local, transient path for military communications in an emergency, and also in the possibility of modifying sections of the ionosphere. Firefly is also yielding information on electron density and temperature gradients in the ionosphere, which will be important for Dynasoar-type re-entry vehicles. The experiments also look promising for study of missile exhaust trails for detection techniques. Fig. 2 shows the trail of chemicals released from a rocket off the Florida coast.

For use in missile early-warning systems or satellite and space probe tracking, AFCRL is developing many new antenna techniques aimed at avoiding large and costly structures, at the same time providing greater range and resolution. Among these is the Mubis (Multiple Beam Interval Scanner) which gives simultaneous height and direction information. In its simplest form, it is a fixed antenna array generating a multiplicity of separate narrow beams spaced in azimuth over a 60-degree sector. The system can scan each separate beam, or the entire series, plus or minus half the angle between adjacent beams, so that all of the azimuth is covered. Mubis is still in



LASER BEAM *calculated to diverge and cover an area A_2 at the satellite, whose effective area is A_3. Area of the reflected beam at camera position will be $4A_3$—Fig. 4*

Precision UV-Visible Spectrometer

DIRECT-READING *spectrometer covers the entire ultraviolet and visible light region from 180 to 1,000 millimicrons. Developed by Hitachi-Perkin-Elmer, the instrument has an accuracy better than 0.5 millimicron and wavelength reproducibility better than 0.1 millimicron. It uses a diffraction grating, 30 by 32 millimeters, with 1,440 lines a millimeter, etched by Perkin-Elmer at Monrovia, Calif., to provide a narrow spectral bandpass and precise and stable wavelength measurement. Detector is a single high-sensitivity wide-range phototube made by Hitachi.*

the research and development stage.

Fig. 3 is a horn's-eye view of a prototype multiplate antenna, designed at AFCRL and now awaiting USAF approval for construction as a large-scale antenna facility (ELECTRONICS, p 42, Sept. 7, 1962). It could operate over range from 400 to 3,000 Mc, and track objects right down to the surface of the moon. The antenna facility would consist of hundreds of reflecting plates on the ground in the pattern of a four-leaf clover. R-f power would be sprayed downward from the feedhorn on a center tower, and the surface angles of the fields of reflecting plates would be remotely controlled to form the beams. Such a system would avoid the mechanical problems of large steerable dishes and the cost and complexity of phased arrays.

DETECTION RESEARCH—Over-the-horizon detection techniques are now being investigated on a systematic basis in one of the newest of the AFCRL sections, the Detection Physics Laboratory. Under a project whimsically called Came Bridge, field sites have been established to identify and measure electromagnetic sensing techniques which look promising for detection of enemy activities from beyond line-of-sight. Included will be such phenomena as artificially induced ionospheric disturbances, radar cross-sections of objects in space as enhanced by ionization, electromagnetic radiations from rocket engines, etc. Measurements at field sites are recorded on tapes for evaluation at the Detection Physics Laboratory. From the data, the scientists hope to be able to derive information on detection reliability, false alarm rates, interference, coverage and other factors.

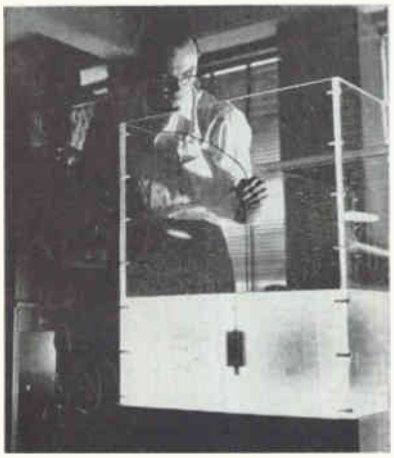
Although not designed specifically for the purpose, two major systems developed by AFCRL also have exceptional capabilities in detection and tracking. The Department of Defense Ionospheric Research Facility in Puerto Rico (ELECTRONICS, p 20, Jan. 27, 1961), with its 1,000-foot wide spherical dish, is by its nature a sensitive detector of natural or man-made perturbations in the ionosphere. And the Sagamore Hill Radio Astronomy Observatory (ELECTRONICS, p 26, Nov. 23, 1962) was the only station in the country that was locked onto Lunik II when it hit the moon. Early this month (April 5) it tracked Lunik IV in that vehicle's apparent attempt to land on the moon.

GEODETIC LASER—AFCRL scientists also use space to learn more about the earth. As a follow-up to the Anna satellite program, they are preparing to use laser beams for geodetic purposes, to help determine earth distances more accurately. In May, pulsed ruby laser beams will be fired from AFCRL to Mt. Wachusett, 30 miles away, in initial tests of Project Largos (Laser-Activated Reflecting Geodetic Optical Satellite). By the end of this summer, says Owen W. Williams, the AFCRL laser geodesy team hopes to be ready to bounce millisecond-pulse beams from a 150-joule ruby laser off NASA's S-66 geodetic satellite and detect the reflected beams with the PC-1000 geodetic stellar camera designed by AFCRL.

Principal problem in this stereo-triangulation technique will be steering the beam; this requires complicated communication, acquiring and tracking systems on the ground. But it will permit the use of one or more satellites as simple reflectors, and possibly use of them in conjunction with other experiments.

While the narrow divergence of a laser beam increases its intensity, it also greatly increases the requirement of knowing the exact position of the satellite, so that the beam can be aimed. Under the Largos concept, radar sites would track the satellite in orbit, and this information would be fed into a computer. Look angles would be computed for at least three ground stations whose positions are known approximately. This information would be flashed automatically from the computer to the tracking mounts and the ground stations to point the source lasers in the desired direction. These lasers would be triggered from a central control, most probably located at one of the ground stations. Adjustable time delays of millisecond magnitude would be required to compensate for various distances between stations, and between the station and the satellite. In Fig. 4, the light path of the beam is traced schematically.

Ultrasonic Thermometer Measures to 0.05 Deg F



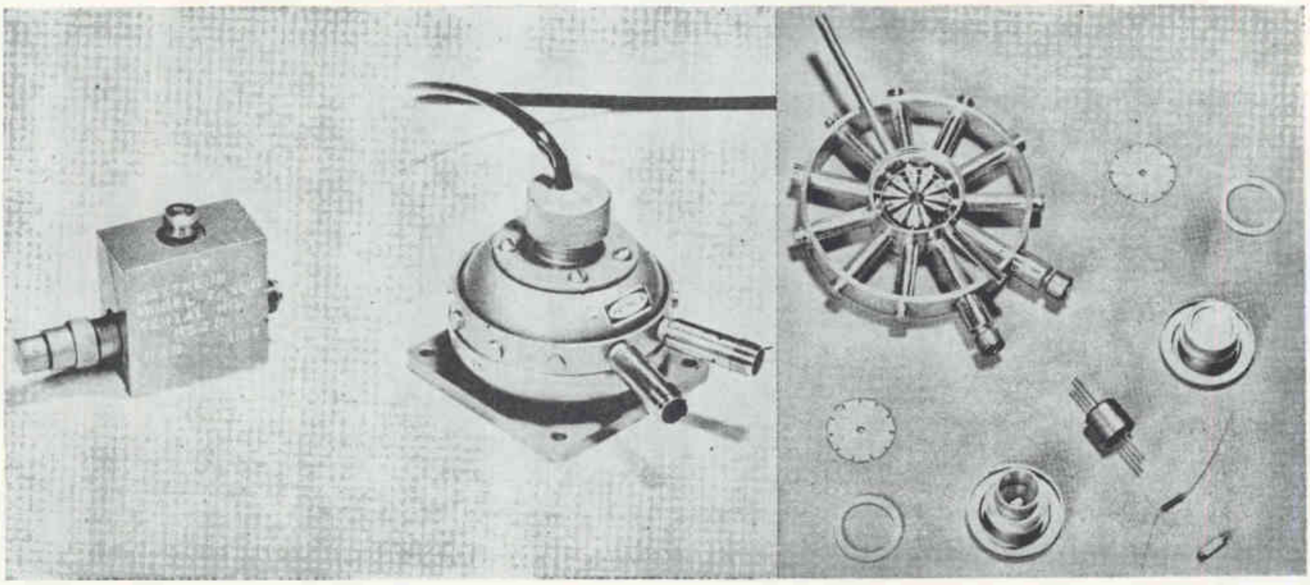
PINPOINTING UNDERWATER *temperatures accurately is important in submarine sonar systems, since the speed of sound is affected by temperature. New transducer determines temperature to within 0.05 deg F*

ULTRASONIC INSTRUMENT that can measure the temperature of sea water to an accuracy of 0.05 deg F has been developed by Westinghouse.

The new instrument uses an aluminum disk, about an inch in diameter, with a natural resonance frequency of about 40 Kc. The disk is excited by an electronic circuit; its natural resonance frequency however changes with the temperature. The vibrations are converted to electrical pulses and relayed up to the surface, where they are counted.

Only two wires connect the underwater transducer unit with the surface. They carry the necessary d-c power, and return back the vibration pulses. Accurate measurements appear feasible to depths of up to 10 miles, according to Arthur Nelkin, manager of electroacoustics research for Westinghouse's Research Laboratories.

Advantages of the new instrument are its ruggedness and high response to temperature changes, as well as the fact that the temperature information is produced in a digital form.



NEW *25-watt c-w S-band Amplitron with companion stripline circulator. Basic anode assembly of QK997 with parts necessary to complete vacuum envelope is shown at right*—*Fig. 1*

C-W Amplitrons for Space Telemetry

By W. W. TEICH, Staff Planning Engineer
W. C. BROWN, Associate Director of Engineering—Crossed Field Devices
L. L. CLAMPITT, Manager, High Power Tube Labs
Raytheon Company, Microwave and Power Tube Div., Spencer Lab., Burlington, Mass.

Compact tubes can work microwave spectrum with higher gain

POTENTIALITIES of the Amplitron as a space-borne transmitter have been evaluated by Raytheon's Spencer Laboratory. Aim was to develop a 25-watt c-w tube for the popular 2,300 Mc telemetry band.

Program was initiated to meet the unusual demands now placed on microwave tubes for space-application requirements, and to satisfy specific needs of microwave transmitters.

Basic simplicity and high efficiency of crossed-field continuous wave amplifiers developed make these Amplitrons attractive for space applications. The Amplitrons are not restricted to telemetry in the S-band, but can be scaled for effective operation throughout the microwave spectrum.

One of the most serious limitations of the pulsed Amplitron for telemetry has been its relatively low expected gain. Most pulsed devices have been built for extremely high power operating point, chosen to provide only 10 to 13 db gain.

Three Amplitrons, built at Spencer Laboratory, have operating lifetimes greater than 10,000 hours. Characteristics of new tubes developed are given in table. Work has shown that proper selection of the operating point and good r-f design can yield amplifiers which can be operated with 20-db gain.

HIGH GAIN—At S-band, this gain is sufficient to bring the output of a solid-state exciter to the 20 to 100-watt level in a single stage. When higher gains are required, additional Amplitron stages are practical, especially where efficient operation at several power output levels is desired.

Anode structures of the three tubes are nearly identical, but variations in the packing arrangement and the selected operating point adapt them to specific systems.

One rather unique feature of the Amplitron which makes it attractive for many telemetry applications is the absence of attenuation in the r-f structure. Required structures lend themselves well to conduction cooling at ground potential and to low mass and high rigidity which promise high resistance to modulation or damage from severe shock and vibration. High efficiency is reflected in low power consumption, and consequently in minimum size and weight of the associated power supply.

A packaged QKS997 Amplitron is shown in Fig. 1 along with a strip-

7½ TEST YEARS

CUT TO 18 MONTHS FOR

60 MILLION DATA TEST HOURS!

BETTER MEASURING FROM EI

In determinations of acceleration factors for metal and carbon film resistors for the high reliability MINUTEMAN Program, Electra Manufacturing Company uses an Automatic Resistor Data Logging System designed and built by Electro Instruments.

This system, in conjunction with other test equipment, has accumulated over 60 million resistor hours of data in the last 18 months. *Without this accelerated testing system, 7½ years of test time would have been required!* Most important, the EI system gives Electra the confidence that their products meet stringent government specifications.

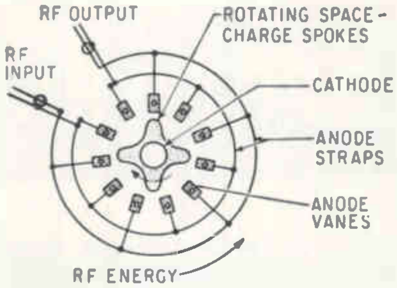
As in this EI system created for Electra, EI *all solid state* Digital Multimeters are the basis for *better measuring* at greater speed, higher reliability, significant cost savings and a much lower investment.

Whether your interest lies in spacecraft, electronic components or industrial processes, we can demonstrate to you the advantages of EI digital instruments in measuring DC volts, AC volts, DC ratios, resistance, capacitance, inductance and impedance. Let EI *all solid state* Digital Multimeters or Complete Systems provide swift, accurate, low cost solutions to your measurement and display problems!

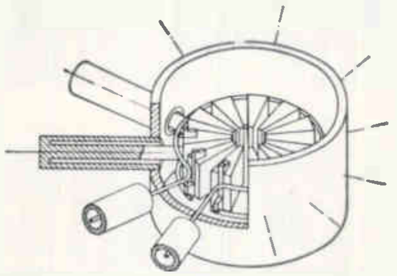
For full details on EI's individual digital instruments, or our complete capabilities in the field of measurement, display and recording—write direct to Electro Instruments, Inc.

Technician at Electra Manufacturing Company inserts test resistors in the Automatic Resistor Data Logging System designed and built by Electro Instruments. Over 60 million resistor hours of data were accumulated in 18 months.

Electro Instruments, Inc.
8611 Balboa Avenue, San Diego 12, California



AMPLITRON SCHEMATIC REPRESENTATION



ELEVEN-VANED *r-f circuit of QKS997 consists of a pair of straps forming a two-wire transmission line—Fig. 2*

line circulator with a two-watt termination. The tube weighs 20 ounces and fits within a 2.5-in. by 3.8-in. by 3-in. volume. Basic anode assembly, together with cathode, a ceramic mounting washer and one of the pole piece assemblies necessary to complete the vacuum envelope is also shown. An eleven-vane structure is employed to obtain electrical interaction with the n-4 space charge mode.

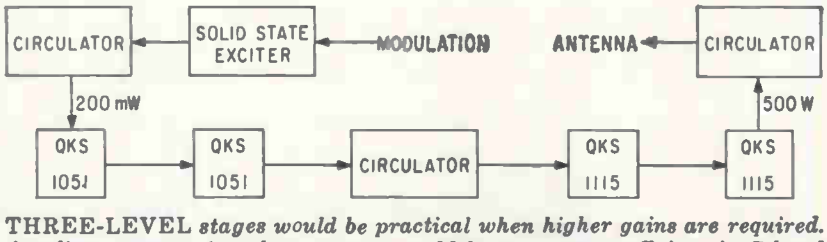
INSERTION LOSS—The r-f structure is shown in Fig. 2. With no voltage applied, the tube behaves as a bandpass filter with an electrical length of only a few half-wavelengths. Its insertion loss in either direction is of the order of 0.5 to 1 db. Most of the common failure modes, especially of low power tubes, leave this property intact. Effective redundancy can be obtained by placing two identical tubes in cascade and switching voltages to the one selected for operation at a particular time.

The feed-though feature also permits multilevel operation at high efficiency. In its simplest arrangement, the driver is allowed to feed through a single Amplitron stage providing two output levels differing by about 20 db.

The driver is protected by a circulator or isolator, since reflections from the Amplitron load pass through the tube unattended and unamplified. With a 20-db gain, the load would have to be kept below 1.1/1 vswr to prevent the driver from shorting, or worse. In addition, the Amplitron itself generates reverse directed power about 20 db

AMPLITRON CHARACTERISTICS

	QKS997	QKS1051	QKS1119
Anode voltage, V	1,800–2,000	1,800	2,400
Anode current, ma	25	22.2	50
Power output, W	20	22	70
Frequency, Mc	2,200–2,450	2,295	2,295
Plate efficiency	60%	55%	60%
Heater power (Run), W	0–4	0–4	0–3
Heater voltage preheat, V	6.3	6.3	6.3
Drive power, mw	250	156	1760
Cooling	Conduction	Conduction	Conduction
Weight	20 oz		24 oz



THREE-LEVEL *stages would be practical when higher gains are required. Amplitron stages for above system could be 60 percent efficient in S-band —Fig. 3* below the output signal, and a circulator will prevent this from affecting the driver performance.

A circuit has been suggested for providing low-frequency regulation at high efficiency and with minimal complexity. Stabilization is provided against input line variations as well as any changes in tube voltage arising from changes in frequency, temperature, magnetic field or the effects of life.

CATHODE WEAR—Much of the technology in space Amplitron developments has been generated by previous devices, and improved techniques have been incorporated into the new tubes. The most critical question is the wear-out phenomenon of the cathode—to what extent can the secondary emission which is generated be used to reduce the demands for primary emission and consequently high temperatures and evaporation rates.

When higher gains are required, additional Amplitron stages are practical, especially where efficient operation at several power output levels is desired. A system has been devised in which three levels would be available: a 200-mw level of the solid-state driver, 20-watt level of the driver Amplitron, and 500-watt level of the final Amplitron, see Fig. 3. The OKS1115 tube for this circuit is still under development. Both the Amplitron stages could be 60 percent efficient in the S-band. Ferrite isolators would be included to provide nonreciprocal attenuation at least equal to the power gain. Two tubes for each stage provides redundancy.

As mentioned, Amplitrons can be scaled for operation throughout the microwave spectrum. The magnetic field required for efficient operation increases directly with frequency and permanent magnet and pole pieces place a practical upper limit of frequency around 100 Gc. At L-band and lower frequencies, the competition with solid-state devices will limit the applications except for fairly high powers.

Units in the 100-watt to a few kilowatt range appear quite attractive at S, C and X-band and from a few watts to a few hundred watts in the higher bands.

Lower power units appear to be probable at the higher frequencies to match the output power available from solid state drivers. The upper limit on power output is a function more of spacecraft available power and of adequate cooling technique, as the basic interaction process has been shown to be capable of superpower generation.

New Tube Envelope

PYROCERAM and an associated solder-glass seal can be used as a tube envelope material, according to Westinghouse.

Of particular interest is the development of a new form of Pyrceram that is hydrogen inert. This material can be metallized and subsequently brazed.

Possible use could be in stacked types of tubes. Should the demand for a large volume of ceramic tubes evolve, the potential low cost of Pyroceram parts could be important.

Integrated Power Device

TRIPLE-DIFFUSED interdigitated planar technology will be used to switch 2 to 5 amps in less than 2 microseconds. Integrated circuit will combine function of a 2N2102 transistor, a power transistor and a planar diode. Current gain is 1,500 at 2 amps.

Contract for device has been awarded to RCA by Autonetics. (See ELECTRONICS, Feb 15, p 26.) Radial leads make unit adaptable to cordwood and other miniaturized packaging. Primary aim is improved power for Minuteman.

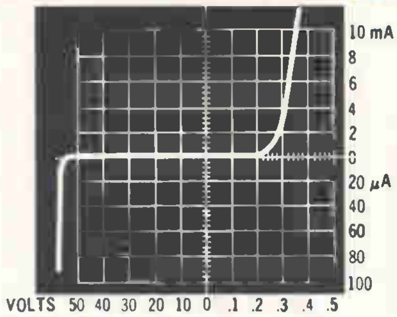
Thin Film Ceramics

FEASIBILITY of constructing multilayer Cerafil capacitors (see ELECTRONICS, Oct. 5, 1962, p 68) with thin dielectric films has been established by Aerovox. Capacitors of this type, with three dielectric layers, each 0.0015-in. thick have been rated at 30 v. Capacitance increase is 7 to 7.5 more when compared to standard 100-v Cerafil capacitors of similar size. Three-layer units may be safely rated at 30 v at temperatures up to 85 C. At 20 v, safe ratings are for temperatures up to 125 C.

Work indicates that dielectrics fabricated from fine materials are

TRANSITRON'S EXCLUSIVE GERMANIUM PLANAR MICRO DIODES

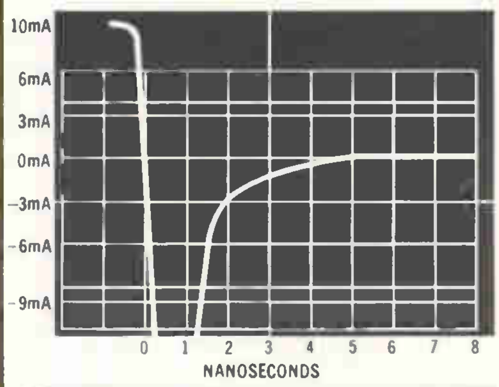
NOW AVAILABLE IN THE POPULAR SUBMINIATURE GLASS PACKAGE



Trace of new GPD-1 shows its extremely low leakage current, sharp breakdown voltage, and low forward voltage drop. GMD-1 planar micro-diode produces identical trace.
(Trace shown taken from Tektronix Type 575 Curve Tracer.)

IMPROVED SPECIFICATIONS	
SPECIFICATIONS @ 25° C	GPD-1 GMD-1
Maximum Forward Voltage @ 10 mA	0.45V
Maximum Inverse Current @ −10V	1.0μA
Minimum Inverse Voltage @ 5μA	40V
Maximum Capacitance @ −3V	2pf
Maximum Recovery Time (5mA to −20V, Recovery to −25KΩ)	0.3μsec

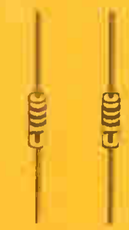
...AND ALL OFFER SPECIFICATIONS SUPERIOR TO ANY GERMANIUM DIODE NOW IN USE



Trace of new high speed GPD-5 shows its very fast recovery. GMD-5 planar micro-diode produces identical trace.
(Trace shown taken from Lumatron Model 12-AB Oscilloscope.)

SPECIFICATIONS @ 25° C	GPD-5 GMD-5
Maximum Forward Voltage @ 10mA	0.45V
Maximum Inverse Current @ −20V	10.μA
Minimum Inverse Voltage @ 100μA	30V
Maximum Capacitance @ −3V	2pf
Maximum Recovery Time (10mA to −6V, Recovery to −3mA)	4nsec

GMD-1 GMD-5



GPD-1 GPD-5

TRANSITRON — industry's sole source of germanium planar micro-diodes — now adds two new subminiature glass planar equivalents to its highly regarded family of germanium diodes: GPD-1 offers superior DC characteristics and very low leakage . . . GPD-5 offers exceptionally fast switching and inverse recovery.

Hermetically sealed in a DO-7 glass package and capable of handling greater power than their micro-equivalents, the GPD-1 and the GPD-5 replace a wide range of germanium and silicon diodes presently used in computer applications — adding planar construction for increased reliability. The new diodes are regarded as a technical achievement, serving to narrow significantly the performance gap between silicon and germanium. The GPD and GMD units offer all the advantages of germanium forward conductance, while closely approaching the inverse characteristic of silicon.

Both of these diodes are now available for your own immediate evaluation.

Transitron's recently introduced GMD-1 and GMD-5 microminiature germanium planar diodes have also been upgraded to achieve the same high specifications.

Produced by advanced "batch" and automated production techniques, these dependable planar diodes offer substantial savings to volume OEM users. Both are now available in quantity — from Transitron's Wakefield facility, or through your Transitron Distributor. All units are also available in multiple semiconductor assemblies and multiple chip arrays. Special types may be readily designed for your own individual requirements.

Write Transitron, Wakefield, Massachusetts, for more complete information.

Transitron T

electronic corporation

wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U.S.A. AND EUROPE · CABLE ADDRESS TRELCO easier to fire at high density. Maturing range is widened, and maturing temperature is somewhat lowered.

Microwave Windows Can Pass 1 Megawatt

CRITICAL point in the microwave power production chain will be at the r-f windows, according to spokesmen from Advanced Research Projects Agency.

Windows separate the evacuated interior of the tube from the often pressurized waveguide which carries the energy to its point of radiation.

Present state of the art will support the practical design of r-f windows capable of passing power as high as one million watts average at frequencies through X-band. Statement was made by Eimac's D. H. Priest at High Power Microwave Tube Window Seminar held at Palo Alto, Calif.

Seminar was called to further the understanding of high power r-f vacuum windows, and included sessions on window materials, design, performance and failure mechanisms.

Semiconductor Potting

THIXOTROPIC silicone material with high thermal conductivity can rapidly dissipate heat from transistor junction. Junction is protected by absorbing moisture trapped within assembly during baking cycle.

Two potting compounds have been developed by Dow Corning, 16 and 18. Latter differs only in having better centrifuge stability and is less thixotropic.

Thermal conductivity of both compounds is 0.0015 gm cal/(sec) (cm^2) (C/cm).

Field-Effect Amplifier As "Reactance Tubes"?

PROGRESS in field-effect devices at Hughes shows the feasibility of designing active devices with a high input impedance and a high transconductance. This can open door to devices that have reactance tube characteristics similar to RC resonant devices.

According to Hughes, RC-type networks in combination with high input impedence amplifiers are easier to control with respect to production and temperature stability. They are extremely compatible with thin-film technology.

At present, company is examining the silicon surface channel field-effect device which has a high input impedance and may have sufficiently high transconductance. There is a question as to whether good pentode-like characteristics are attainable.

In case this device does not give the desired characteristics, Hughes plans using CdS thin-film transistors.

How Does Moisture Affect Polymers?

WASHINGTON—Dielectric characteristics of polymers are affected by long-term exposure to moisture, National Bureau of Standards says. The effects, it said, "May be relevant to the use of polyethylene as insulation for underwater telephone and telegraph cable." Humidity effects are reversible and "no aging effect occurs because there is no overall unidirectional drift of property values."

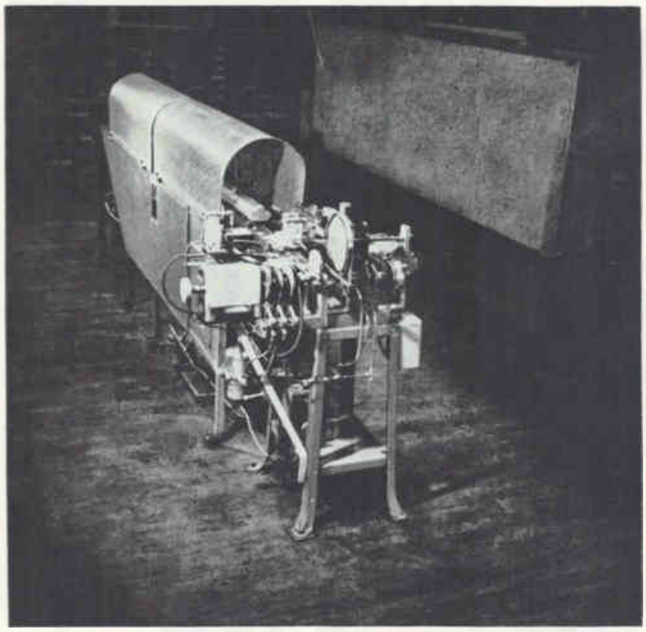
Polyethylene showed less than a 0.1-percent change in dielectric constant in 3 years' exposure to humid conditions, but the dissipation factor increased 700 to 800 percent. Dielectric constant of polystyrene rose about 0.4 percent, with smaller rise in dissipation factor.

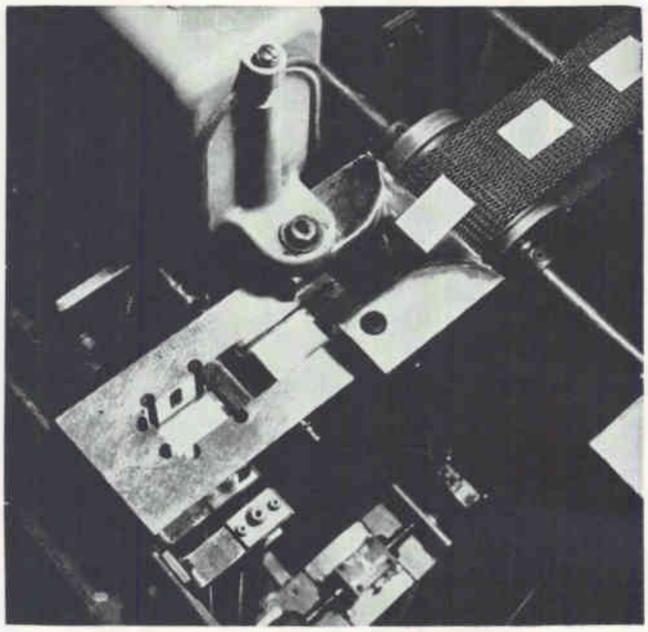
Porous Substrate Resistor

CHEMICAL deposition process, developed by Weston, produces metal film resistors on porous substrates. Study is now being directed in adapting process to microminiature circuits.

Porous materials for substrates include plastics as well as glass and ceramics.

Preliminary investigation has resulted in acceptable deposition of several samples. Tests indicate that minimum pore size for substrates will be 25 microns.





AUTOMATIC *processing machine takes individual mica films from an input magazine, silver coats and dries them before depositing films in an output magazine (right)*

Machine Coats Films Automatically

3,000 mica films per hour silk-screened with silver paste

BY R. N. CAMPAIGNE
D. A. ESTABROOKS
Western Electric Company
North Andover, Mass.

MICA LAMINAS (films) used in Bell Systems capacitors are silver coated by an automatic process that may have other applications in the electronics industry such as screen printing of circuits on phenolic or ceramic substrates.

At heart of process is a commercially-available machine used to print labels on curved surfaces of bottles, etc. This machine provided "skeleton" on which was built a fully-automatic machine for silk-screen application of silver paste to mica films. Accepting films individually from an input magazine, machine coats them on one side, dries coatings, and deposits coated films in an output magazine. Only manual operation needed is loading and unloading of input and output magazines. Process completes 3,000 films per hour; process is repeated to silver other side.

PROCESS NEED — Historically, silver paste had been applied with a brush with eventual graduation to spraying through a stencil and to manual pressing (with a squeegee) of paste through unmasked areas in a fine stainless steel screen—the so-called silk-screen printing process. With latter process, an operator could screen a grand total of 16 films in one batch. In addition to slowness, process had other disadvantages that hamper meeting increasing capacitor reliability and tolerance requirements: (1) multiple-opening screens for masking mica-film margins did not accurately locate silvered areas to desired degree and (2) manual pressure applied as squeegee traveled across screen varied considerably to produce feathered edges and inconsistent density in silvered areas on films.

Same basic technique is used in automated process. But, by reducing screen openings to one and controlling speed and pressure of squeegee mechanically, vast improvements regarding accurate location, sharp edges, and uniform density of silver coatings have been

SILVERING FOR PERFORMANCE

Silvering of mica lamina films in mica capacitors dates from an early improvement stabilizing capacitor performance—silver strips act as capacitor plates. Increasingly stringent capacitor performance requirements continue to demand improvements in depositing silver giving rise to process described here. Process may have other electronics applications

NEW

No.	Vcex Icex=5ma	Vce Sustaining	hFE Ic=5A	Ic=10A	Vce Sat. Ic=5A	Ic=10A	Vbe Sat. Ic=5A	Ic=10A
2N2580	400	325v	10 min. 40 max.		0.7v		1.5v	
2N2581	400	325v	25 min. 65 max.	10 min.		1.0v		1.7v
2N2582	500	325v	10 min. 40 max.		0.7v		1.5v	
2N2583	500	325v	25 min. 65 max.	10 min.		1.0v		1.7v

New from Delco Radio! Silicon power transistors with Vceo, Vcbo and Vces of 400 and 500 volts in two gain ranges. This new line of high power transistors permits never-before-possible simplification of design in a wide area of applications. Available at all Delco Radio distributors or through our sales offices. Right now.

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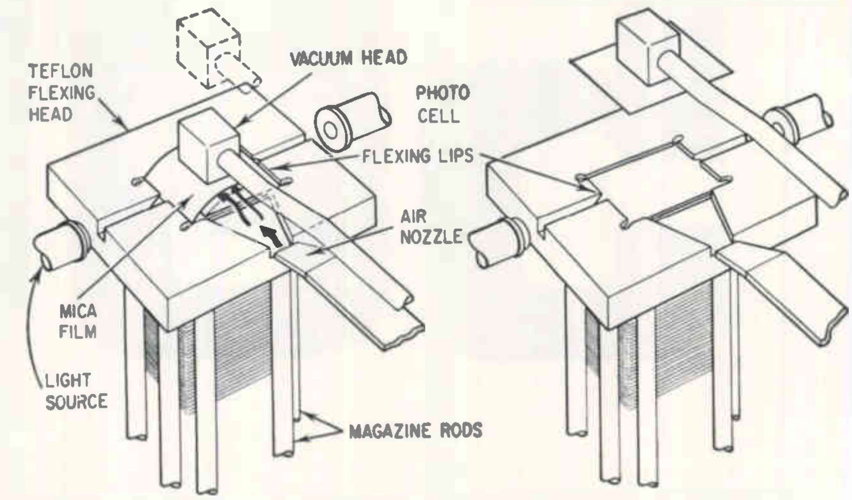
GLadstone 2-8211, Ext. 500
AREA CODE 317

CIRCLE 87 ON READER SERVICE CARD

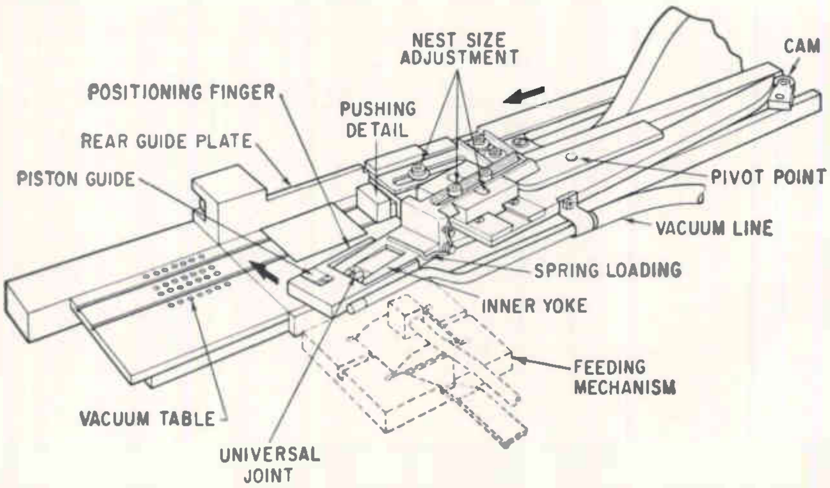
achieved. Increased **speed has also** reduced unit cost.

GENERAL FEATURES — Control of operation is maintained by a system of sequentially-actuated cams together with associated pneumatic and vacuum valves. Power is supplied by several fractional horsepower motors. Accepting either of two standard film sizes after minor adjustment, machine picks up top film from a stack of about 9,000 in the input magazine with a vacuum head that then inserts film into positioning mechanism. This slides film into position on a vacuum table so that it is accurately located under unmasked area of screen. Then as positioning mechanism returns to its starting position, vacuum table rises to within 1/16 inch of screen, and a small measured amount of silver paste is pumped onto top of screen. A squeegee is then mechanically moved across the screen to press paste through the fine screen mesh onto surface of film. If for any reason, no film is presented on vacuum table, a vacuum differential valve, sensing resulting pressure condition of the vacuum table, prevents squeegee action to protect machine from silver paste drippings.

After coating of film, vacuum table is lowered to its original position, holding vacuum is released, and an ejection finger mechanism moves film onto a conveyor belt that carries it under two strip heaters which dry film in about one minute.



TOP FILM *in input magazine is separated from others, after being picked up by vacuum head, using flexing and air blast flutter techniques simultaneously. Light and photo cell are part of system maintaining top of film stack just below flexing lips—Fig. 1*



POSITIONING *mechanism insures that film does not move out of position prior to application of vacuum hold. Film cannot slide underneath positioning finger since finger's outer yoke is kept absolutely flat by its connection through a universal joint to a spring-loaded inner yoke—Fig. 2*

During film ejection from vacuum table, positioning mechanism moves next film into position.

A collecting chute and high-speed secondary belt take film from end of its conveyor ride to a collecting or output magazine, which when filled trips a microswitch shutting off machine. Operator removes filled magazine inverts it so unsilvered side of films is up and uses it as input magazine in repeating process to silver other side.

SPECIAL FEATURES—Extreme light weight of mica films and its tendency to acquire an electrostatic charge, causing adherence of films to one another, produced special problems requiring special equipment features: separating mica films during removal from input magazine, accurate positioning under unmasked area of screen, proper stacking in output magazine.

FILM SELECTION — If two or more adhering films enter processing sequence, the upper film will stick to steel screen's under surface preventing coating of subsequent films. To insure against this, an air blast is used with the vacuum head as shown in Fig. 1 to separate top film from remainder of stack. As vacuum head picks up films, it is flexed between the lips of a Teflon flexing head at top of magazine. During flexing, air blast blows across thin edge of mica causing it to flutter. Simultaneous fluxing and fluttering makes it highly certain that only one film is actually picked by vacuum head—probability of additional films has been reduced to one chance out of 5,000. A photo cell-motor combination maintains top of stack at necessary distance below flexing lips.

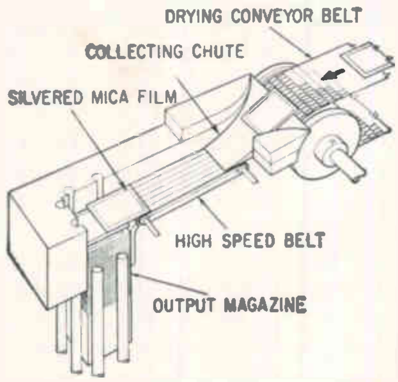
FILM POSITIONING — Feather weight of films complicated accurate positioning of film, which was a greater problem than film selection. It was difficult to move film into position without its sliding out of place. Numerous designs culminated in positioning mechanism shown in Fig. 2 that provides a four-sided positioning nest. The sides sequentially orient film as it is moved into position to control silver borders to within ±0.005 inch:

As shown, the four "sides" consist of a pushing detail, a hinged positioning finger, a fixed plate rear guide, a sequentially-operated vacuum piston guide housed in front end of positioning finger.

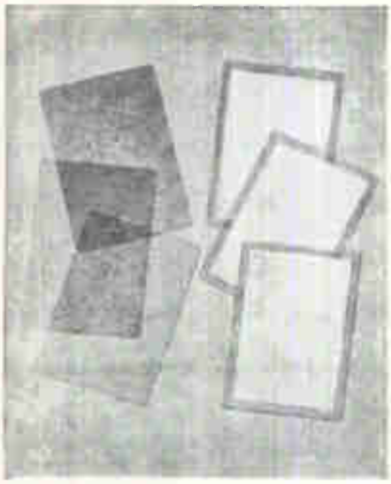
Pusher detail has film deposited in front of it on a fixed table by vacuum head. Entire positioning mechanism moves forward toward vacuum table underneath screen. As this happens, pusher detail contacts film and slides it toward vacuum table while positioning finger pivots inward to move film against rear guide. Piston guide is then projected out of positioning finger along leading edge of film to complete nest.

Nest continues forward until cam-predetermined position on vacuum table is reached. Vacuum is now applied to: (1) table to hold film and (2) piston guide to withdraw it prior to cam withdrawal of entire positioning mechanism.

OUTPUT STACKING—Unavoidable slight vibration of drying conveyor belt tended to shift films out of alignment with one another to cause jamming in output magazine's collecting chute. This was resolved by using a steep, highly polished, vibrating chute and interposing a fast-moving horizontal rubber belt between chute and the vertically-mounted magazine as shown in Fig. 3. Wide mouth-to-narrow neck chute configuration reorients films as they drop while steep angle, vibration, and smooth surface prevent adherence to chute. High-speed belt then throws films horizontally into magazine so that



KINETIC ENERGY *imparted to mica films by stacking mechanism overcomes effect of film's light weight and static friction so that films can be uniformly stacked—Fig. 3*



MICA FILMS *before and after silvering—Fig. 4*

they stack-up properly. Acquired kinetic energy overcomes effect of films' light weight and static friction so that stacking operation remains consistently uniform.

Top of stack must be kept ¼ inch below high-speed belt. This is done by a highly sensitive spring-loaded motorized drive arrangement activated by increasing weight of filling film magazine. When full, spring-loaded mechanism activates a switch stopping machine. Lowering of stack is done at a rate controlled by a variable speed changer associated with spring-loaded mechanism and preset to conform to thickness of films processed. Fig. 4 shows silvered films received by output magazine.

Optics Positions Drill For Missile PC Boards

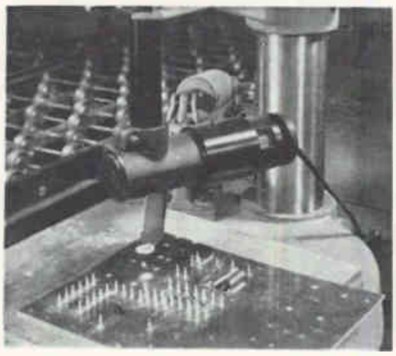
OPTICAL system which magnifies work area provides a simple technique for precision drilling of holes in printed circuit boards.

Equipment in Raytheon Missile Systems Division plant in Andover, Mass., was developed by Stocker & Yale Inc., of Marblehead, Mass., working with Raytheon engineers.

Printed circuit drill press unit reportedly banishes guesswork by magnifying work area and assuring positive visual accuracy. Rework has been reduced sharply, and drill jig and other tooling has been eliminated by unit.

Optical projector is mounted on an arm which may be traversed on

OPERATOR *locates target holes in terminal board in platter fabrication section of Raytheon missile plant. Holes will then guide drilling of additional holes*



TERMINAL BOARD *just prior to having three target holes located and drilled. Target-hole radius of 0.003 inch is centered by cross-hair reticle in comparator, which is struck by a point of light*

a vertical column for focusing. Work table has a pneumatic drill mounted to its underside and a clamp mounted above. Drill point is lined up on cross hairlines of projector screen. Printed circuit board is placed on work surface of table under projector. Desired hole location dots are projected on screen and lined up in center of hairlines pre-aligned with drill.

Machine control is then actuated, bringing clamp down to secure board, and drill comes up through drill bushing and printed circuit board. Degree of accuracy can be chosen by adjusting magnification of optical system anywhere from 10X to 31.25X.

For gang drilling, a quantity of boards can be placed in a fixture, referenced from register holes.

DA VINCI, CIRCA 1500

a dream comes true

GYRODYNE, 1963

Systems Engineers: Experienced in integration of equipment with sub-systems, produced by subcontractors, into airborne and ground control support systems, 5 years experience in any of the following fields: avionics, auto-pilots, flight controls, lorelei, transistor circuitry. Background in digital/analog computers and telemetry devices desirable. EE, ME, AERO or Physics major.

Instrumentation Engineers: Design or establish specification for airborne, ground control and support instrumentation for development flight test activity. Must have background in system design, signal conditioning, transducer calibration, PAM and PDM telemetry and oscillograph recording. EE background.

Flight Test Engineers: For development testing of complete aircraft and components. Full scale flight testing and ground test-rig operations with emphasis on helicopter flying qualities. Minimum of 5 years experience in planning, execution and reporting of complete developmental flight and ground test program. Engineering degree required.

Quality Control Engineers: Electronic Systems reliability, test analysis, statistical sampling, subcontractor resident liaison programs. Positions available at L. I. Plant, Phoenix, Santa Monica, Cleveland locations. Minimum of 5 years heavy experience and EE degree required.

Structures Engineers: Establish criteria for helicopter design, stress and vibration analysis of structure and mechanical components. Conduct test analysis program. Minimum 5 years experience and ME/AE degree required.

Test Analyst Engineers: Conduct electronic, mechanical, electronic testing programs on all types of components including airframe structures, transmissions, power plant, blades, electronic ground equipment, avionic equipment, etc. Minimum 5 years experience plus Engineering degree.

Field Service Engineers: DASH Program support activities involving Drone helicopters and shipboard control equipment. East or West coast assignments. Perform troubleshooting, reliability investigation and analysis. Minimum five years field experience. Familiar with auto-pilot, flight controls, transistor circuitry, analog/digital computers, electronic systems. EE, AE, Physics major. Training and orientation, on full salary and per diem, at main N. Y. Plant.

Transmissions Engineers: Design and layout of complete transmissions, complex mechanisms and

Leonardo da Vinci, equally famous for his engineering genius as well as for his Mona Lisa painting, visualized the helicopter concept. Unfortunately, his machine did not successfully fly. The reason — he worked alone. He did not have the opportunity to enjoy the engineering teamwork such as exists at GYRODYNE.

Here, our engineering team developed, designed and is now producing the QH-50C highly maneuverable, pilotless helicopter which operates from a U.S. destroyer flight deck. Guided by remote controls, it flys to a submarine target area, drops its torpedoes and returns to the ship for reloading and relaunching.

The absence of engineering teamwork in the early days, retarded man's progress in science and technology for centuries. We can only conjecture that such frustrations to da Vinci possibly led to his painting Mona Lisa.

We think da Vinci would have liked it here — Maybe you would too.

Explore our challenging opportunities. Send your confidential resume to our Personnel Director, St. James, L. I., New York.

Gyrodyne
COMPANY OF AMERICA, INC.
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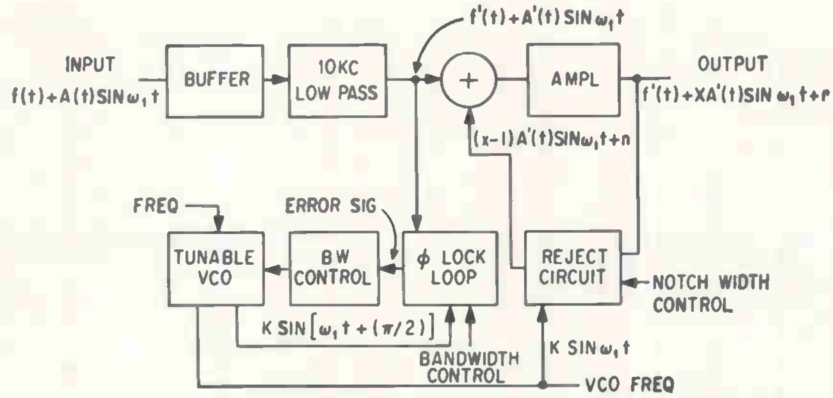
Tunable Notch Is 1 Cycle Wide

Active phase-lock loop produces narrow rejection within 0 to 10 Kc range

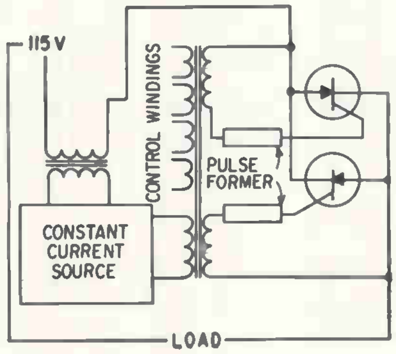


IT IS now possible to reject by 30 db, a spectral component at 1,000 cps without affecting other equal amplitude components at 990 and 1,010 cps and with minor retuning, achieve rejection bandwidths of 1 cps for frequencies below 500 cps with the NF-1000 tunable notch filter made by Correlated Data Systems Corp., 1007 Air Way, Glendale 1, California. This can be accomplished despite the fact that the objectionable frequency component is influenced by amplitude, frequency or phase-modulation. Using a phase-coherent active filter technique, the device has a bandpass from d-c to 10 Kc, notch tunable from 5 cps to 5 Kc and notch bandwidth adjustable to more than 30 cps. A simplified block diagram is shown in the sketch. The vco is tuned to the desired rejection frequency and the phase-lock loop acquires the signal. Once locked, the loop generates two sine waves of the frequency to be rejected. These are in quadrature to each other. One signal is in phase with the signal component to be rejected and is used to generate the $(X-1)\ A'(t)\ \sin\ \omega_1\ t$ term which is added to the signal from the 10 Kc low-pass filter. The difference term $XA'(t)\ \sin\ \omega_1\ t$ indicates notch depth of the filter while η is the noise generated in the rejection circuit.

CIRCLE 301 READER SERVICE CARD

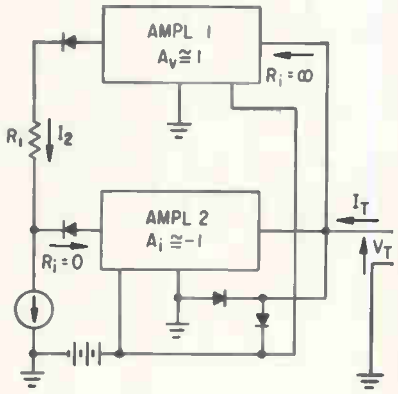
Phase Shifter Has Multiple Uses

CONTROLLING load current to the limits of the scr used, the Model SCR-100A phase shifter, designed by International Research Associates, Inc., 2906 Birch Street, Franklin Park, Illinois, has been provided with multiple inputs for series or parallel hookups, and can also be used to perform logic operations such as differentiation, integration and summation. It also may be used as a bistable device to simulate switching and relay action. The device produces a uniform and constant-amplitude output pulse to fire the scr's, has a phase shift from 0 to 180 degrees, produces a narrow pulse with straight leading edge of sufficient duration to fire the scr's without gate overloading and has linear control from 0 to 180-degrees angle of conduction. Sensitivity of the multiple control windings range from 3 to 6 ma, and the extremely linear transfer characteristic offers an accurate and linear control between input and output. A typical full-wave a-c proportional control with current limiting is shown in the sketch. (302)



Negative-Resistance Element In Small Package

NEGATIVE resistance elements exhibiting predictable, highly-stable, linear negative-resistance characteristics has been announced by Hughes Aircraft Co., Florence Avenue and Teale St., Culver City, California. The NRE is 0.72-inches in diameter and 0.88-in. high for the plug-in version and 0.5 by 0.5 by 0.75-in. for the wire-in version. The device is available with controlled negative-resistance values anywhere between 100 and 100,000 ohms for use with either positive or negative supply voltages with ratings of 30 v. It may be used in linear applications such as



Q-multipliers, oscillators and filters or in non-linear applications such as d-c switches, circuit breakers and astable and monostable multivibrators. Sketch (p 94) shows equivalent circuit for a positive-voltage family of NRE. Two power amplifiers are used in a feedback arrangement with amplifier 1 having unity voltage gain applying a voltage equal to terminal voltage across feedback resistor R_1 (which may be internal or external). This produces a current opposite to bias current I_1. With zero terminal voltage, no feedback current exists and input to amplifier 2 is current equal to I_1. Since current gain is approximately -1, amplifier 2 output is $-I_1$. As terminal voltage is increased, feedback current increases linearly reducing net current to amplifier 2. Thus, an increase in applied terminal voltage produces a decrease of terminal current and a negative resistance is produced.

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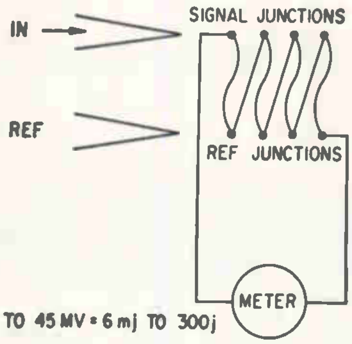
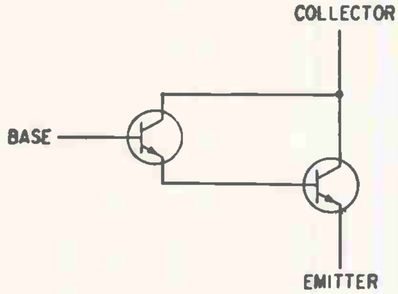


Calorimetric Measurement Of Optical Pulses

HIGH-POWER laser beams can drastically affect composition and resultant performance of certain materials on which the light beam impinges. The model 100 ballistic thermopile, manufactured by TRG Inc., 2 Aerial Way, Syosset, New York, minimizes destructive effects by using a Mendenhall wedge to insure efficient energy distribution, has a ballistic (integrating) time constant of 7 seconds, equivalent noise level at 1 cps of 100 μjoules, sensitivity of 150 μv per joule minute and maximum energy input of 300 joules. An output signal of 1 volt per joule at 1 megohm impedance is available at a connector. Output rise time is 4 ns. The thermopile comprises two bright nickel-plated silver cones as receiver and reference with series-connected iron-constantin thermocouples attached to the outside surfaces of the cones, near their bases. Pulsed laser output is directed into the receiver cone aperture where it is completely absorbed by the Mendenhall wedge. Cone peak temperature rise is measured by an externally-connected microvoltmeter and converted to pulse energy equivalent. The device may also be fitted with an oscilloscope readout. Each unit is individually calibrated with NBS source. (304)

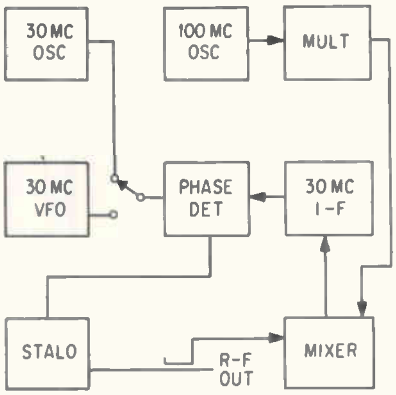


Darlington Amplifier is Photo Sensitive

COMBINING a lens window with an integral light sensing amplifier, the RM3002 photo Darlington is manufactured by Raytheon Co., Semiconductor Division, 350 Ellis St., Mountain View, California. Operating with collector-to-base voltage of 60 v, collector-to-emitter voltage of 40 v, and emitter-to-base voltage of 7 v, the npn silicon planar photo sensitive device has a dark current from 10 na to 100 μa, a collector dark current from 10 na to 15 μa and a light-current sensitivity of 25 μa per foot candle. Maximum sensitivity falls within a 20-degree cone whose axis coincides with the central axis of the lens. (305)

Stabilizing Klystron Frequency to 12.4 Gc

REFLEX klystrons operating between 1 and 12.4 Gc can be stabilized to better than 1 part in 10^6 per week and f-m residual reduced to 5 parts in 10^9 with the model 241 microwave oscillator synchronizer introduced by Laboratory for Electronics, Inc., 1079 Commonwealth Avenue, Boston 15, Massachusetts. Short-term stability of the resultant output averaged over a second is one part in 10^9. F-m deviations

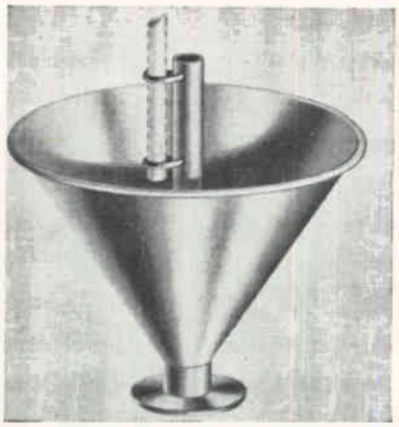


up to 1 Mc at rates of zero to 50 Kc may be applied to the klystron. To obtain stability, the synchronizer multiplies an r-f crystal reference to the desired frequency range and mixes it with a klystron power sample. The resultant i-f is amplified, phase detected and compared to a 30 Mc oven-controlled crystal. Detected phase error is fed to the klystron reflector in series with the power supply voltages. The device also has remote or local tuning provisions with a variable-frequency oscillator. When in this mode, long- and short-term stability is not deteriorated. Provision can be made for an external i-f reference. **(306)**

Ultrasonic Solder Pot With Built-in Heaters

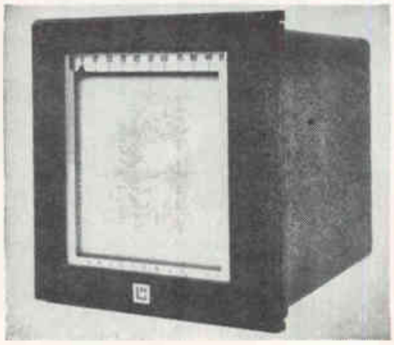
ULTRASONIC solder pot can be used for many tinning applications such as, tinning of component leads, making hermetic seals and coating semiconductor materials without the use of flux. Unit is complete with built-in heaters, automatic temperature control and dial temperature indicator for solder bath. The design makes it adaptable for automation. Cavitation of the liquid bath is caused by one or more ultrasonic transducers driven by an appropriate generator. The cavitating solder will erode the soils and oxides from the parts to be tinned, thus permitting a fluxless coating of solder. Ultrasonically tinned components permit heavier

coating on the leads, thus extending shelf life and increasing solderability. The Redford Corp., 1092 Catalyn St., Schenectady 3, N. Y.
CIRCLE 307, READER SERVICE CARD



Discone Antennas Are Vertically Polarized

FOUR vertically polarized discone antennas are designed collectively to cover from 75 to 1,200 Mc. Depending on specific model, types F-12, F-13, F-14 and F-15, these omnidirectional units are constructed of welded aluminum, either of solid sheet, perforated, or mesh design. Technical Appliance Corp., Sherburne, N. Y. (308)



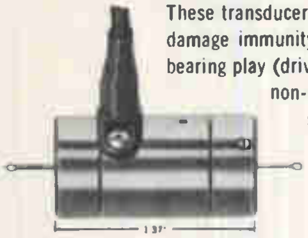
Compact Recorder Offers Versatility

DESIGNED for use in research and testing laboratories, this compact recorder can be used to plot numerous emf variables including temperature, stress, strain, position, vibration, and gas chromatography. With the control panel mounted internally and the zero span circuits powered by mercury cells, the short-door AZAR H (Adjustable Zero, Adjustable Range) recorder has a zero circuit adjustable from −50

MEASURE FORCES AS LOW AS ±1 GRAM FULL SCALE

in studies of bearing torque. weight, small angles, liquid levels, surface tension, etc.

New, miniature **Microforce** transducers provide an economical way to measure uni- or bidirectiona' forces with infinite resolution, extremely high linearity and low hysteresis. These transducers have excellent overload damage immunity. low tracking force, no bearing play (drive rod spring-suspended), non-linearity only 0.2% of full scale, excellent thermal stability. Temp. range 0° to 170° F. Excitation: 5 V, 2.4 KC nominal.



MODEL	FORCE* (f.s., grams)	DISPLACEMENT (f.s., inches)	SENSITIV. (f.s., mv per volt of excit.)	NAT. FREQ. (approx. cps)	PRICE (FOB Waltham, Mass.)
FTA-1-1	±1	±0.010	8	65	$200
FTA-3-1	±3	±0.010	8	110	200
FTA-10-1	±10	±0.010	8	130	200
FTA-30-1	±30	±0.010	8	210	200
FTA-100-1	±100	±0.010	8	390	200

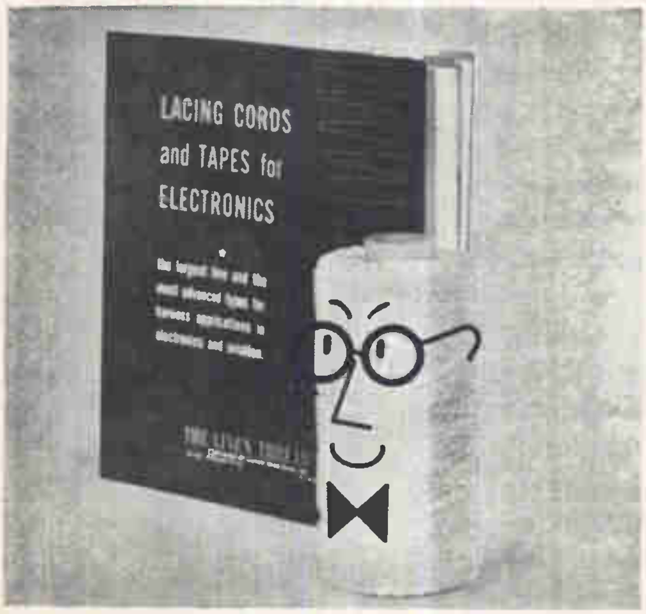
*Working range; usable range at least 2x f.s. range.

TRANSDUCER DIVISION

SANBORN COMPANY

175 Wyman St., Waltham 54, Mass.

CIRCLE 200 ON READER SERVICE CARD



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For catalog, write:

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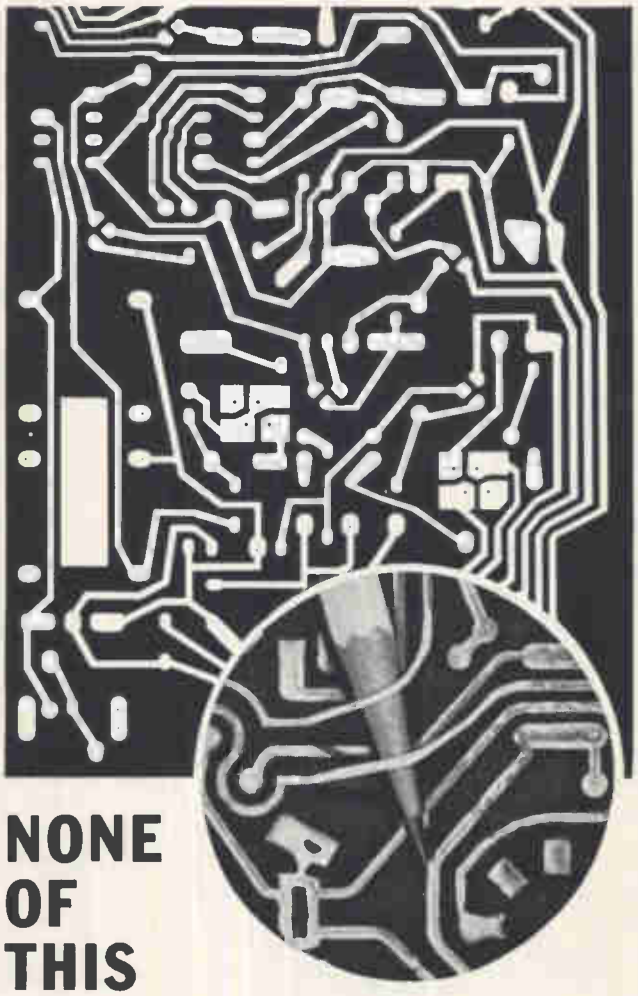
Blue Mountain, Alabama

A DIVISION OF INDIAN HEAD MILLS, INC.

CIRCLE 201 ON READER SERVICE CARD

Printed circuits that STAY STUCK



NONE OF THIS

Printed circuits may pull away from the laminate during the soldering operation. To reduce this possibility—to practically eliminate it—Synthane produces a special glass epoxy base grade of copper clad—G-10R—with high HOT PEEL STRENGTH (2 to 4 lbs. per inch of width after immersion for 15 secs. at 500°F* as compared with the usual 0.1 to 0.2 lbs. per inch of width). G-10R also meets or exceeds NEMA and MIL specs for Room Temperature Peel Strength. Write for folder of all Synthane metal-clad grades.

*Tests made on 1/16" and 1/8" wires.

SYNTHANE

CORPORATION OAKS, PENNA.

GLendale 2-2211 (Area Code 215) TWX 215-666-0589

Synthane-Pacific, 518 W. Garfield Ave., Glendale 4, Calif. TWX 213-240-2104U

Synthane Corporation, 36 River Rd., Oaks, Pa.

Gentlemen:

Please send me your latest folder on Synthane G-10R and other Synthane copper-clad laminates.

Name ____________

Address ____________

City ____________ Zone ______ State ____________

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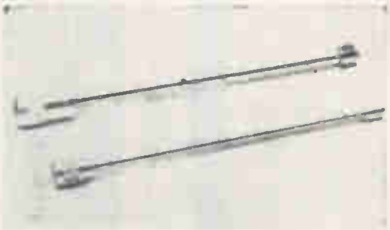
mv to +50 mv and a span circuit from 50 mv down to 300 μv. Calibration is internal through the use of a run-calibration switch or external against a precision potentiometer. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.

CIRCLE 309 READER SERVICE CARD



Coax Terminations For Use from 1 to 12.4 Gc

SERIES of wide-band coaxial terminations for applications from 1 to 12.4 Gc are announced. Power capacity is 10 w c-w (minimum). Typical vswr over the operational bandwidth is 1.03. The terminations can be used from + 150 C down to liquid nitrogen temperatures with insignificant change in the termination characteristic. Standard input connectors include type N, TNC, 7/8 in. (46.4), 7/8 in. (EIA), TM and LT. CoaX DeviceS, Box 234, Chelsea 50, Mass. (310)

Magnet Power Supply With Regulator System

PRECISE DIALING of any desired field intensity in a laboratory magnet air gap is possible with the new magnet power supply, featuring the Fieldial magnetic field regulator. This regulator is said to improve magnetic field control a full order of magnitude over conventional current regulation techniques. The direct field readout feature eliminates the need for additional field measuring equipment in most applications. The Fieldial system utilizes a field sensor based on the Hall-effect principle. It provides truly linear field sweeps calibrated in gauss, eliminating the need to calculate width and position of field sweeps. Varian Associates Instrument Div., Palo Alto, Calif. (311)

Thermistor Probes Withstand High Shock

RUGGEDIZED thermistor probes consist of miniature thermistor beads hermetically sealed in shock-resistant glass. Approximately the same size and configuration as ¼-w resistors, the thermistors are easy to mount, and are well suited to p-c applications. Units are designed to withstand extremely high shock and vibration loads. They are available with resistance values from 100 ohms to 10 megohms. Typical dissipation constant is 1 mw/deg C. Fenwal Electronics, Inc., 63 Fountain St., Framingham, Mass. (312)

Low-Pass Filter Handles 40 W C-W

MODEL FV-104 low-pass filter was designed to prevent spurious telemetry signals from interfering with the command receiver equipment in space vehicles. Power handling capacity is 40 w c-w at any altitude. The pass band (215 Mc to 260 Mc) has an insertion loss of 0.25 db (max), and the unit provides more than 60 db rejection in the stop band (400 Mc to 1,000 Mc) region. Unit measures 6½ by 1⅝ by 1¼ in. overall and weighs 7 oz. Rantec Corp., Calabasas, Calif. (313)

Delay Line Packages Are Epoxy-Encased

DESIGNED for mounting in standard 0.100 in. grid p-c boards, two new delay line packages are encased in flame-retardant epoxy, with a raised bearing surface which prevents moisture trapping. Both have an impedance of 93 ohms, max distortion of 10 percent, and operate at temperatures from −40 C to +85 C. One contains eight individual lines, and delays from 10 nsec to 1,270 nsec can be achieved in 10 nsec increments. The other, a 5-line unit, offers delays from 5 nsec to 155 nsec in 5 nsec increments. General Instrument Corp., F. W. Sickles Division, Chicopee, Mass. **(314)**

Waveguide Coupler Has Short Length

MODEL 665-10 coupler is 5 in. long and has four type N female connectors. Unit operates in range of 8.2 to 10.0 Gc. It couples 10 db ± 1 db with a directivity of 15 db minimum across the band. Guide Mfg. Co., 8218 Lankershim Blvd., North Hollywood, Calif. **(315)**

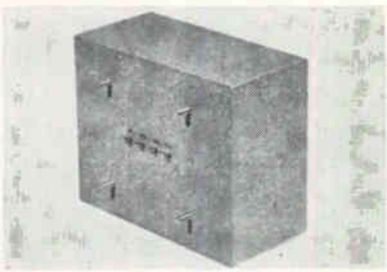
Solid State Relay Features Long Life

SERIES 700 solid state relays in crystal can size are designed for use as power and dry circuit switches in transistor circuits or as logic circuit elements which have a life of 100 million operations. They will switch from 250 ma up to 50 v with complete isolation between the input and output circuits. Spdt and dpdt versions are available. Complete operation may be maintained up to 85 C and input may be 5 v a-c or d-c. For ease in trouble shooting large systems, indicating lights in the top of the can indicate position of relay at all times. White Avionics Corp., Terminal Drive, Plainview, N.Y.

CIRCLE 316, READER SERVICE CARD

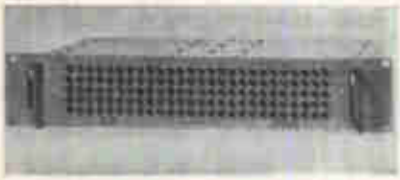
Voltage Comparator Has Two Channels

CONSOLIDATED AIRBORNE SYSTEMS, INC., 900 3rd Ave., New Hyde Park, N. Y., announces type MV-89 dual channel voltage comparator for commercial and military use. Each channel is capable of comparing a d-c input signal to a reference signal and provides a go-no-go information in the form of output relay actuation. Both leads of each input channel are brought through the connector and both channels operate completely independent of each other. External limit adjustments are available to pre-set the reference voltage level. Unit can be used to monitor most transducers or voltages and provide switching to indicate when a critical pre-set level has been attained. (317)



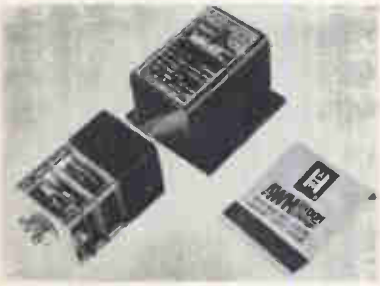
Delay Line for Critical Computer Use

MODEL CTC-2031 delay line has the following performance characteristics: delay, 64 μsec ± 0.5 percent reflected; rise time, 1.6 μsec max; impedance, 1000 ohms; attenuation, 1 db max. Featured is a delay stability of ±0.075 percent vs dynamic current range of 0 to 64 ma. Unit's temperature coefficient of d-c resistance is reduced by an order of magnitude to 400 ppm/deg C. Volume of a hermetically sealed case is about 90 cu in. Columbia Technical Corp., Woodside 77, N. Y. (318)



A-F Delay Line With 125 Tap Points

THE DA412 audio frequency delay line provides long delay with a high degree of phase linearity over a wide frequency range. Delay is 5 millisec with 125 tap points spaced evenly every 40 μsec with tap accuracy better than ±1 percent. Phase linearity over a frequency range of 100 cps to 2.5 Kc is within ±¼ percent and ±¾ percent up to 3.5 Kc. Insertion loss is less than 2 db and attenuation is ±0.5 db from 100 to 2,500 cps; 3 db max at 3.5 Kc and cutoff is at 5 Kc. Impedance is 1,000 ohms ±10 percent. Computer Devices Corp., 6 W. 18 St., Huntington Sta., N. Y. (320)



Tiny Timer Uses High Speed Motors

THE A. W. HAYDON CO., 232 North Elm St., Waterbury 20, Conn. Microminiature adjustable interval timer has 151 separate parts arranged within 3 cu in. Weighing 6 oz, the densely packed timer unit has two high speed motors, a transistorized inverter (47 parts), a gear train (30 parts), two rotary printed disks and 70 other components. Each motor's diameter is $\frac{1}{32}$ in. less than that of an aspirin tablet, and only twice as thick. Motors operate at 3,000 rpm from 115 v, 400 cycle current. The timer is designed for precision control of certain devices on the manned space vehicle.

CIRCLE 321, READER SERVICE CARD

Power Transistors With Diffused Base

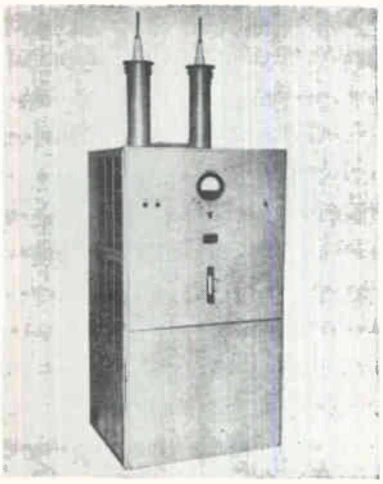
A SERIES of 25 ampere diffused alloy power transistors, 2N2285-2N2287, are now in production. The germanium *pnp* DAP transistors are designed for efficient high-current switching at fast switching times. The diffused base gives very low input resistance and high cutoff frequency while maintaining high breakdown voltage. The transistors are capable of switching up to 1,600 w in 1 to 5 μsec over a wide temperature range. Bendix Semiconductor Division, The Bendix Corp., Holmdel, N. J. **(322)**

Triode Signal Source Is Self Contained

A SERIES of self contained microwave pulsed signal sources with models centered every 500 Mc to 6,000 Mc are announced. They include ceramic triode oscillators and modulator with variable pulse width and repetition rate. Peak power output of 2 Kw is available up to 5,000 Mc and 1 Kw at 6,000 Mc. Pulse width is continuously variable from 1 to 6 μsec and repetition rate from 200 to 4,000 pps. Max duty cycle is 0.0033 for models below 2,000 Mc and 0.001 for 2,000 Mc and above. Applied Microwave Laboratory, Inc., 106 Albion St., Wakefield, Mass. (323)

Tunable R-F Coils Are Encapsulated

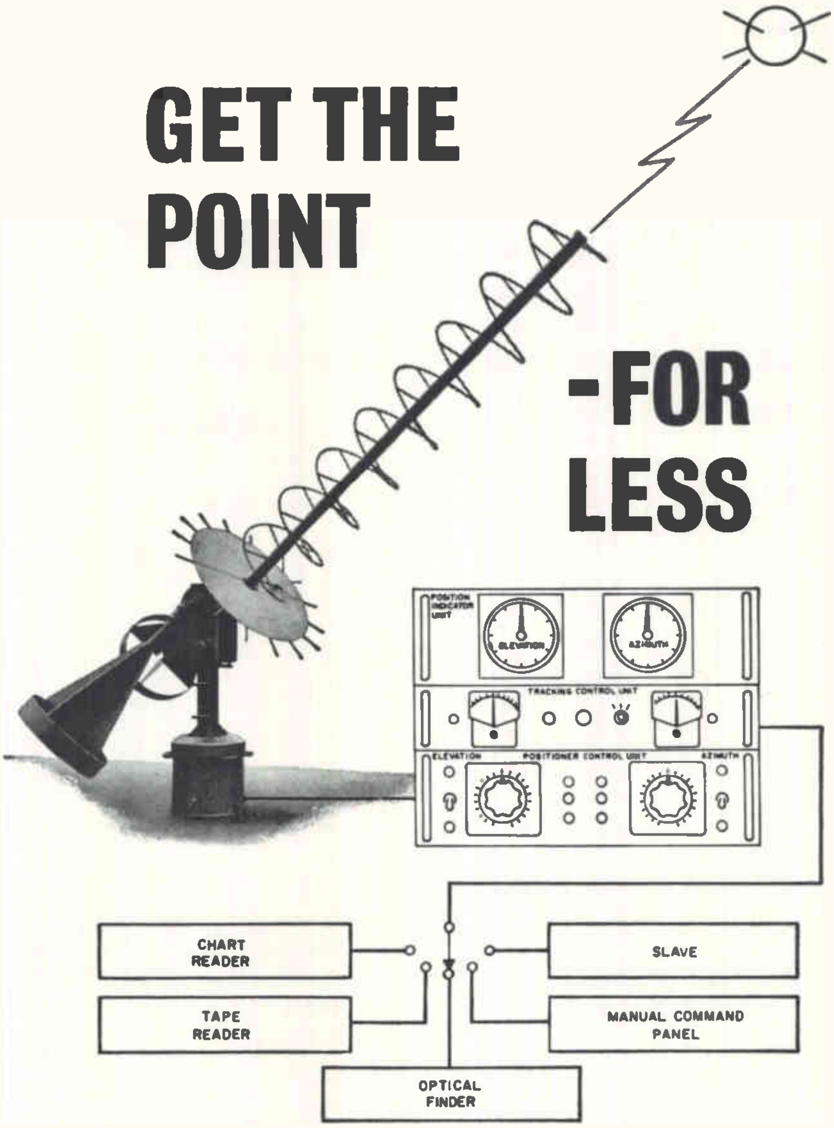
RELCOIL PRODUCTS CORP., a division of Hi-G, Inc., Windsor Locks, Conn. Series RC tunable r-f coils are available in either permanent mounts, or plug-in types. Max temperature coefficient of inductance is + 100 ppm. Inductance values from 0.1 μh to 15,000 μh are available in overlapping tuning ranges. Units meet precise military and industrial requirements. They provide reliable operation over a range of −55 C to +125 C. (324)



Dummy Loads Cover 0.1 to 30 Mc

A SERIES of high power dummy loads for 600 ohm, 300 ohm and 150 ohm balanced twin line has been developed. Power dissipating capabilities range from 1 Kw to 50 Kw in a completely self-contained and self-cooled unit. Novel r-f matching

GET THE POINT -FOR LESS



Scientific-Atlanta telemetry antenna position systems offer a unique, economical answer to the problem of following satellites, missiles, aircraft or astronomical targets with medium gain antennas. Such systems provide tracking rates of 6 degrees per second or higher and pointing errors of no more than 3 degrees. Yet, these systems are modestly priced at less than $10,000.

The two-axis antenna pedestals are "militarized" versions of standard Scientific-Atlanta antenna pattern range positioners, giving an extra margin of reliability even beyond the proven performance of these mounts. Control is provided by Scientific-Atlanta's augmented manual tracking equipment.

Features include two-axis tracking from programmed or slaved sources as well as manual control and continuous position indication; accessories such as optical finders, tape readers, chart readers, manual position command panel, and other input devices; use of solid state units for reliability and compactness (complete control/indication systems in 14" of rack space) and integration of standard Scientific-Atlanta instrumentation wherever possible throughout the system.

Rugged and reliable, these systems meet the environmental requirements of MIL-E-4158 and the RFI shielding requirement of MIL-I-26600.

We invite your request for more information. Please address Scientific-Atlanta, Inc., P. O. Box 13654, Atlanta 24, Georgia. Phone: (404) 938-2930.

SA

SCIENTIFIC-ATLANTA, INC.

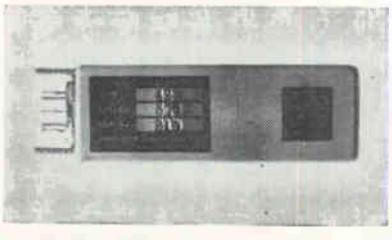
24

technique makes a vswr of 1.25 max over the entire frequency range (0.1 to 30 Mc) without the use of baluns. Electro Impulse Laboratory, Inc., 208 River St., Red Bank, N. J.

CIRCLE 325, READER SERVICE CARD

Super-Flexible Cable Features Durability

THE ULTRA-FLEX, super-flexible flat bonded cable comes in gages No. 18 Awg to No. 30 Awg. Special PVC resin used in its manufacture permits additional flexibility. This process eliminates use of excess plasticizers in the formula. Tests have proven that after 50 million 180 deg bends, the cable still operates without noise introduction. Uses include memory drums, charting and graphing recorders, drawer pull-out and many other functional applications. Spectra Strip Wire & Cable Corp., P. O. Box 415, Garden Grove, Calif. **(326)**

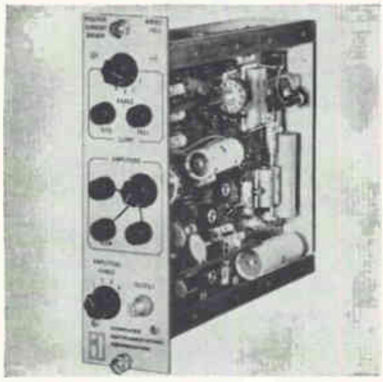


Optical Chopper Requires Less Power

OPTICAL CHOPPER has been developed for use in circuits and instruments in which the source is either light or radiation ranging from ultraviolet to infrared. Type 42 uses a tuning fork as its balance vibrating member. This offers such advantages as reduced power requirement, no need for lubrication, and higher reliability. Electromechanical specifications include a range of fork frequencies available from 10

to 1,000 cps. Input power required is 150 mw at 28 v. Accuracy of type 42 is 0.05 percent in an operating temperature range of −55 to 85 C. Bulova Watch Co., Inc., 61-10 Woodside Ave., Woodside 77, N. Y.

CIRCLE 327, READER SERVICE CARD

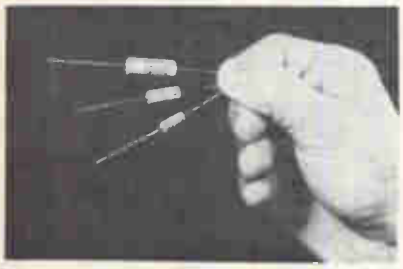


Current Drivers Feature High Speed

MODELS 1453 and 1454 positive and negative high speed linear current pulse drivers have been developed for use in ferrite and metallic core research, solid state studies, high speed memory development, and production testing of memory cores and arrays. Current pulse amplitude is 50 ma to 1,000 ma, continuously variable through four ranges. Duty cycle is 20 percent max at 1 amp into a short circuit load. Rise and fall time are both independent, linear and continuously variable from 50 nsec to 2 μsec. Computer Instrumentation Corp., Route 38, Cherry Hill, N. J. (328)

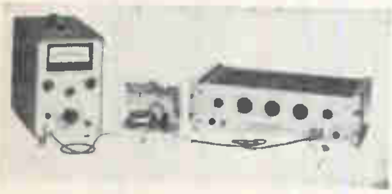
Film Resistors Are Pelletized

PELLETIZED film resistors are 0.063 in. thick by 0.100 in. diameter, and they can be supplied in resistance values from 10 ohms to $2\frac{1}{2}$ megohms. They are rated up to $\frac{1}{4}$ w at 125 C with proper packaging. Resistance changes during 1,000 hr of load life are generally less than 2 percent. Temperature coefficients between −65 C and ±150 C are less than 300 ppm/deg C for most of the resistance values. P. R. Mallory & Co. Inc., Indianapolis 6, Ind. (329)



R-F Chokes Have Epoxy Encapsulation

MINIATURE r-f chokes meet MIL-C-15305A, Grade 1, Class B. The epoxy encapsulated inductors come in three sizes to fit most design requirements: 90 in. long by 0.31 in. diameter (inductance values from 1.0 to 10,000 μh), 0.60 in. long by 0.25 in. diameter (values from 1.0 to 1,000 μh), and 0.44 in. long by 0.188 in. (from 0.10 to 100 μh). Units have a low d-c resistance, are resistant to immersion and moisture and operated from −55 C to +125 C. Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J. (330)



System Measures Resistivity

MODEL 6105 resistivity adaptor, used in conjunction with model 240 high voltage d-c supply and 610A multi-range electrometer, permits volume resistivity tests from 10^3 to over 10^{16} ohm-cm and surface resistivity tests from 10^3 to over 10^{18} ohms. These three instruments comprise a system for the easy measurement of flexible insulation samples, with accuracies of 4 percent and 5 percent and with test potentials from 1 v to 1,000 v. Keithley Instruments, 12415 Euclid Ave., Cleveland 6, O. (331)

Literature of the Week

TEST CHAMBER Tenney Engineering, Inc., 1090 Springfield Road, Union, N. J. Bulletin describes a compact, mechanically refrigerated bench model high-low temperature precision test chamber.
CIRCLE 332, READER SERVICE CARD

NUCLEAR ELECTRONIC PRODUCTS General Electric Co., Schenectady 5, N. Y. Brochure GET-3127 describes the complete line of nuclear instrumentation components. **(333)**

SEMICONDUCTOR DEVICES Transitron Electronic Corp., 168 Albion St., Wakefield, Mass. Catalog TE-1340E covers a line of silicon and germanium semiconductor devices. **(334)**

FRAME-GRID WELDER Kahle Engineering Co., 3322 Hudson Ave., Union City, N. J. Catalog sheet illustrates and describes the No. 3770 automatic frame-grid welding machine. **(335)**

SOLID-STATE INVERTERS Power Sources, Burlington, Mass. Booklet describes solid-state inverters that supply instantaneous or standby a-c power and precise frequency and voltage regulation. **(336)**

TACHOMETER TRANSDUCER Airpax Electronics Inc., Fort Lauderdale, Fla. Bulletin F-111-1 describes the TDS 6 self-generating transducer designed to provide an electrical signal linearly proportional to the rotational speed of the shaft to which it is attached. **(337)**

DIGITAL TELEMETRY SYSTEM Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J. The veradat, a solid state digital telemetry system for high veracity data acquisition, is described in bulletin C13. **(338)**

SCIENTIFIC ABBREVIATIONS Automatic Electric Co., 400 N. Wolf Road, Northlake, Ill., has available a 32-page booklet, "1,001 Technical and Scientific Abbreviation". **(339)**

SILICON POWER STUD RECTIFIERS Atlantic Semiconductor, Inc., 905 Mattison Ave., Asbury Park, N. J., offers a brochure entitled "Double Diffused Avalanche Regulated Silicon Power Stud Rectifiers." **(340)**

HARD MATERIAL FABRICATION Insaco Inc., Box 422, Quakertown, Pa., has published a 4-page brochure describing its facilities for fabrication of sapphire, quartz, spinel, steatite, zircon and alumina. **(341)**

PHOTOELECTRIC CONTROLS Autotron, Inc., 3627 N. Vermilion, Danville, Ill., announces an 8-page transistor photoelectric control catalog, No. 263. **(342)**

SNAP-ACTION SWITCHES Micro Switch, Freeport, Ill. Issue No. 32 of *Micro Tips* shows methods for using snap action switches to control industrial processes, increase safety and prevent machine damage. **(343)**

SPRAY DRYING Nichols Engineering & Research Corp., 80 Pine St., New York 5, N. Y., offers a 6-page reprint showing the part played by spray drying in automated ceramic production. (344)

RIBBON CABLE HARNESS WELDING Digital Sensors Inc., 6443 N. Figueroa St., Los Angeles 42, Calif. Single-sheet brochure describes a ribbon cable harness welding technique that increases reliability through elimination of breakage at point of connections. (345)

ENVIRONMENTAL EQUIPMENT Cincinnati Sub-Zero Products, Inc., 3930 Reading Rd., Cincinnati 29, O., offers a 16-page guide to multi-chamber environmental equipment for simultaneous comparative testing of electronic and electromechanical devices. (346)

ELFCTROMANOMETER SYSTEM Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Bulletin 1156A discusses a miniature electromanometer system which features secondary-standard accuracies. (347)

MACHINE MEASUREMENT The Sheffield Corp., Dayton 1, O., has available a 12-page catalog on hole and surface measurement, layout and inspection with the Sheffield-Ferranti coordinate measuring machine. (348)

RECORDING INSTRUMENTS Techni-Rite Electronics, Inc., 65 Centerville Road, Warwick, R. I. A 4-page general brochure describes high speed, direct writing recording instruments. (349)

LOGARITHMIC AMPLIFIER Kay Electric Co., Maple Ave., Pine Brook, N. J., has issued a flyer on the Logafier 1025-A, a 200 Kc to 220 Mc logarithmic amplifier. (350)

MAGNETIC RECORDING HEADS Electrodynamic Instrument Corp., 1841 Old Spanish Trail, Houston 25, Texas. Catalog contains data on 20 single and multi-track model magnetic recording heads. (351)

QUARTZ CRYSTALS Electronic Crystals Corp., 2400 Diversified Way, Orlando, Fla. Catalog describes standard military and custom oscillator crystals. (352)

DIPPED MICA CAPACITOR Sangamo Electric Co., Springfield, Ill. Bulletin 2323 covers a line of dipped mica capacitors. (353)

FACILITIES Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa. Facilities brochure describes the defense oriented organization and capability of the company's Communications and Electronics division. (354)

PANEL METERS Assembly Products, Inc., Chesterland, O. Bulletin 34 announces a family of indicating panel meters and pyrometers incorporating design features that permit prices about 20 percent below those of former models. (355)

TRG Erecting $2-Million Facility

TRG, INCORPORATED of Syosset, L.I., N.Y., Boston, Mass., and Menlo Park, Calif., has broken ground for a 100,000-square-foot, $2-million building in Huntington, L.I., N.Y. Estimated date of completion is September of this year.

The new facility will enable the company to consolidate its Long Island activities under one roof, making for more efficient overall operation. About one-third of the building will be used for laboratory, one-third for manufacturing, and one-third for office space. Provision has also been made for continued expansion, and sufficient land is available to increase space in the new building to 200,000 square feet.

Research facilities at the new plant will include fully equipped optics, chemistry, and electronic tube laboratories. The production area will include machine shops and electronic fabrication facilities that will enable TRG to manufacture electronic products of all types.

TRG, which was incorporated in 1957, is engaged in basic scientific research in the area of lasers, sonar, aircraft navigation and collision avoidance, materials research, nuclear shielding, electromagnetics and dynamics, hydrodynamics, quantum electronics, antennas, parametric amplifiers, solid-state receivers, etc. The company is also manufacturing a diverse line of devices ranging from complicated simulator systems for the Navy and Signal Corps to a complete line of millimeter microwave equipments.

Sprague Establishes New Division

THE Sprague Electric Company has consolidated its radio interference filter, wave filter, and electromagnetic interference control activities in a new filter division. The division will have its headquarters at the company's North Adams, Mass., plant and will be headed by Frederick S. Scarborough (picture) as division manager.

Scarborough has been connected with Sprague since 1948 in various engineering, sales, and management capacities, most recently as the manager of the interference control field service department, which has been absorbed in the new filter division.

General Electric Promotes Pinkerton

DAVID C. PINKERTON has been named manager of engineering for General Electric's Communication Products Department, Lynchburg, Va.

In his new position, he will have design and development responsibility for mobile radio, microwave, power line carrier current devices, tropospheric scatter equipment, and tiny pocket transmitters and receivers.

Pinkerton has had nearly 24 years of experience with GE in both research and application engineering.

GI Magne-Head Fills Key Engineering Post

APPOINTMENT of Robert Frierson as manager for magnetic tape and drum head engineering of General Instrument Corporation's Magne-Head division, Hawthorne, Calif., has been announced.

Frierson was formerly chief engineer of the Applied Magnetics Co., Goleta, Calif.

Simmonds Precision Names Dubner

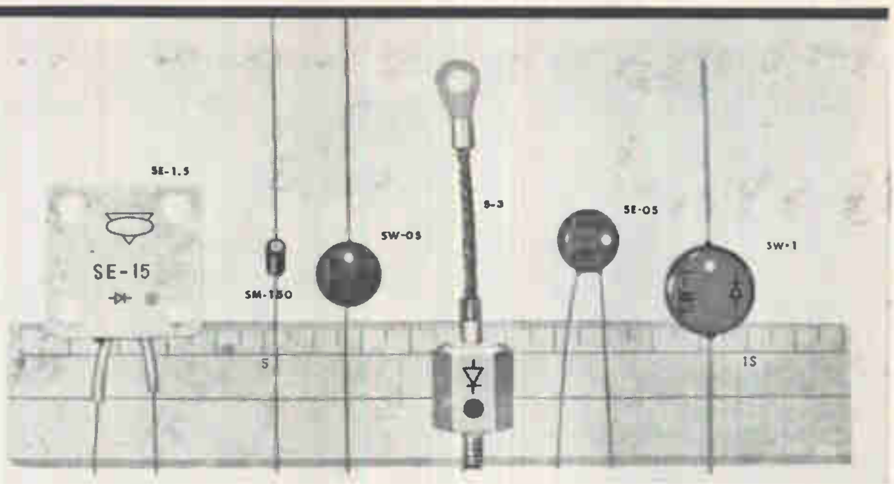
HARVEY A. DUBNER has been appointed vice president of engineering for Simmonds Precision Products, Inc., Tarrytown, N.Y. He will have complete responsibility for the firm's product design and engineering, as well as for company and customer sponsored research and development programs.

Prior to joining Simmonds, Dubner was chief of advanced design for the Electronics division of Curtiss-Wright Corp.

Simmonds manufactures fluid

Origin

Technology Assures Maximum Reliability in Semiconductors



SE-1.5: Available in 4 physical configurations. PIV: 400V-1000 Volts. Max. AC input voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Reverse Leakage Current (PIV) 10μA Max. Average Rectified Current (Single-phase, half-wave) 1.5A. Surge Current (for 1 cycle) 20A.

S-500: Available in 9 physical configurations. PIV: 200V-1000 Volts. Max. AC input voltages (RMS) of 140, 210, 280, 350, 420, 490, 560, 630 and 700 Volts. Max. Average Rectified Current (3-phase Full-wave bridge circuit) 500 A.

SM-150: Available in 4 physical configurations. PIV: 400V-1000 Volts. Max AC input voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Reverse Leakage Current (PIV) 10μA. Max. Average Rectified Current (Single-phase, half-wave) 150mA. Surge Current (for 1 cycle) 10 A.

SW-05 (SE-05): Available in 4 physical configurations. PIV: 400V-1000 Volts. Max. AC input Voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Average Rectified Current (Single-phase, Half-wave) 500mA. Surge Current (for 1 cycle) 16 A.

S-3: Available in 5 physical configurations. PIV: 300V-1000 Volts. Max. AC input Voltages (RMS) of 210, 280, 420, 560 and 700 Volts. Max. Average Rectified Current (Single-phase, half-w ave) 3A. Surge Current (for a half cycle) 300 A.

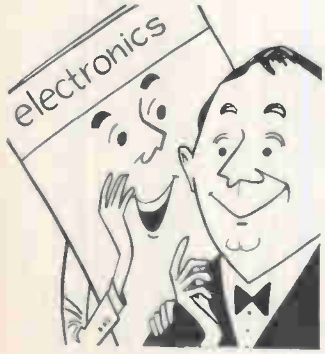
SW-1: Available in 4 physical configurations. PIV: 400V-1000 Volts. Max. AC input Voltages (RMS) of 280, 420, 560 and 700 Volts. Max. Average Rectified Current (Single-phase half-wave) 1 A. Surge Current (for 1 cycle) 30 A.

Ambient temperature operating range is −55 to +130°C for all types.

ORIGIN ELECTRIC COMPANY LTD.

1-195 Takadaminami-cho, Toshima-ku, Tokyo, Japan
Cable Address "ORIGINELE TOKYO"

CIRCLE 210 ON READER SERVICE CARD



electronics IS EDITED TO KEEP YOU FULLY INFORMED *—a "well-rounded" engineer*

What's your *present* job in electronics? Do you work on computers? (electronics ran 158 articles on computers between July, 1961 and June, 1962!) Are you in semiconductors? (For the same period, electronics had 99 articles, not including transistors, solid-state physics, diodes, crystals, etc.) Are you in military electronics? (electronics had 179 articles, not including those on aircraft, missiles, radar, etc.)

In all, electronics' 28-man editorial staff provided more than 3,000 editorial pages to keep you abreast of all the technical developments in the industry. No matter where you work today or in which job function(s), electronics will keep you fully informed. Subscribe today via the Reader Service Card in this issue. Only 7½ cents a copy at the 3 year rate.

electronics

INTEGRATING ACCELEROMETER

NUMBER OF PULSES IS PROPORTIONAL TO DISTANCE TRAVELED / OUTPUT FREQUENCY IS PROPORTIONAL TO VELOCITY

4⅝" x 2" x 2"

Globe's Integrating Accelerometer is a compact, proven, and relatively low cost device for use in missiles, aircraft, and ground vehicles where you need a direct output signal (easily telemetered) that yields distance and velocity. Accuracies are in the 2% to .3% range of distance traveled, depending on temperature and whether standard or special design is required.
Uses are in safe-arming switches, missile sled tracks, ejection seats—any application where position distance or velocity measurement is required rather than simply time or acceleration. The Globe Integrating Accelerometer bridges the gap between the fancy hardware and the G-measuring types. Request Bulletin D-900 from **Globe Industries Inc., 1784 Stanley Avenue, Dayton 4, Ohio.**

GLOBE

CIRCLE 113 ON READER SERVICE CARD

measurement and display systems for aircraft, missile, and space vehicle applications. The company also manufactures special purpose communications systems (SARAH) used in the nation's space programs.

GD/Astronautics Names Yoshihara

HIDEO YOSHIHARA has been appointed manager of the Space Science Laboratory at General Dynamics/Astronautics, San Diego, Calif.

Yoshihara, who has been leader of the fluid physics and hypersonic group for the past year, succeeds A.E.S. Green, who has accepted a post as graduate research professor at the University of Florida.

Schantz Takes New Sylvania Post

APPOINTMENT of Joseph D. Schantz as manager of planning at the eastern operation of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc., Waltham, Mass., is announced.

Schantz joined the Sylvania division in 1959 as director of engineering at its laboratories in Waltham. He was named manager of the ZMAR program in 1962.

Lockheed Electronics Appoints Benner

ARTHUR H. BENNER has been named director of engineering-military systems, Lockheed Electronics Co., Plainfield, N.J. He will report to E. M. Pritchard, general manager of military systems and vice president of Lockheed Electronics, a division of Lockheed Aircraft Corp.

Before assuming his new position,

Benner served as section manager of RCA's advanced systems and techniques in Camden. He was responsible for advanced development work in communications, radar, electronic countermeasures, undersea warfare and electro-optical systems.

Baswell Joins Motorola Overseas

CHARLES P. BASWELL has been named president of Motorola Overseas Corp. In this position he will direct activities in the international market on behalf of Motorola's Communications, Consumer, Automotive, and Military divisions.

Baswell brings to his new position 15 years of experience in international operations with the Radio Corp. of America.

Oelkers Accepts New Position

WILSON H. OELKERS has joined International Resistance Co., Philadelphia, Pa., as vice president of operations. In this newly-created post, he will have operating responsibility for all IRC divisions and participate in the general management of the company.

Oelkers was formerly vice president-general manager of Philco's Lansdale division.

Davis Heads AGA Space Division

FRANK E. DAVIS has been named director of the Space division at Aero Geo Astro Corp., College Park, Md. He was previously employed at Airtronics, Inc., as assistant to the president and manager of the engineering and manufacturing departments.

The AGA space division designs and manufactures instrumentation and circuitry for a number of space programs, primarily those under the direction of NASA's Goddard Space Flight Center, Greenbelt, Md.

Alpha Wire Elects Jack Kirschbaum

ELECTION of Jack Kirschbaum as executive vice president of Alpha Wire Corp., New York City, is announced.

Formerly vice president-sales, Kirschbaum has been associated with Alpha, a subsidiary of Loral Electronics Inc., for more than 8 years.

Leibowitz Takes New Post

BERNARD LEIBOWITZ has been named chief engineer of Polarad Electronic Instruments, a division of Polarad Electronics Corp., Long Island City, N.Y. He was formerly a product manager of the Industrial Product division in charge of all engineering and production aspects of Polarad's signal generator, receiver, rfi meters, and microwave tube lines.

Bendix Radio Promotes Heller

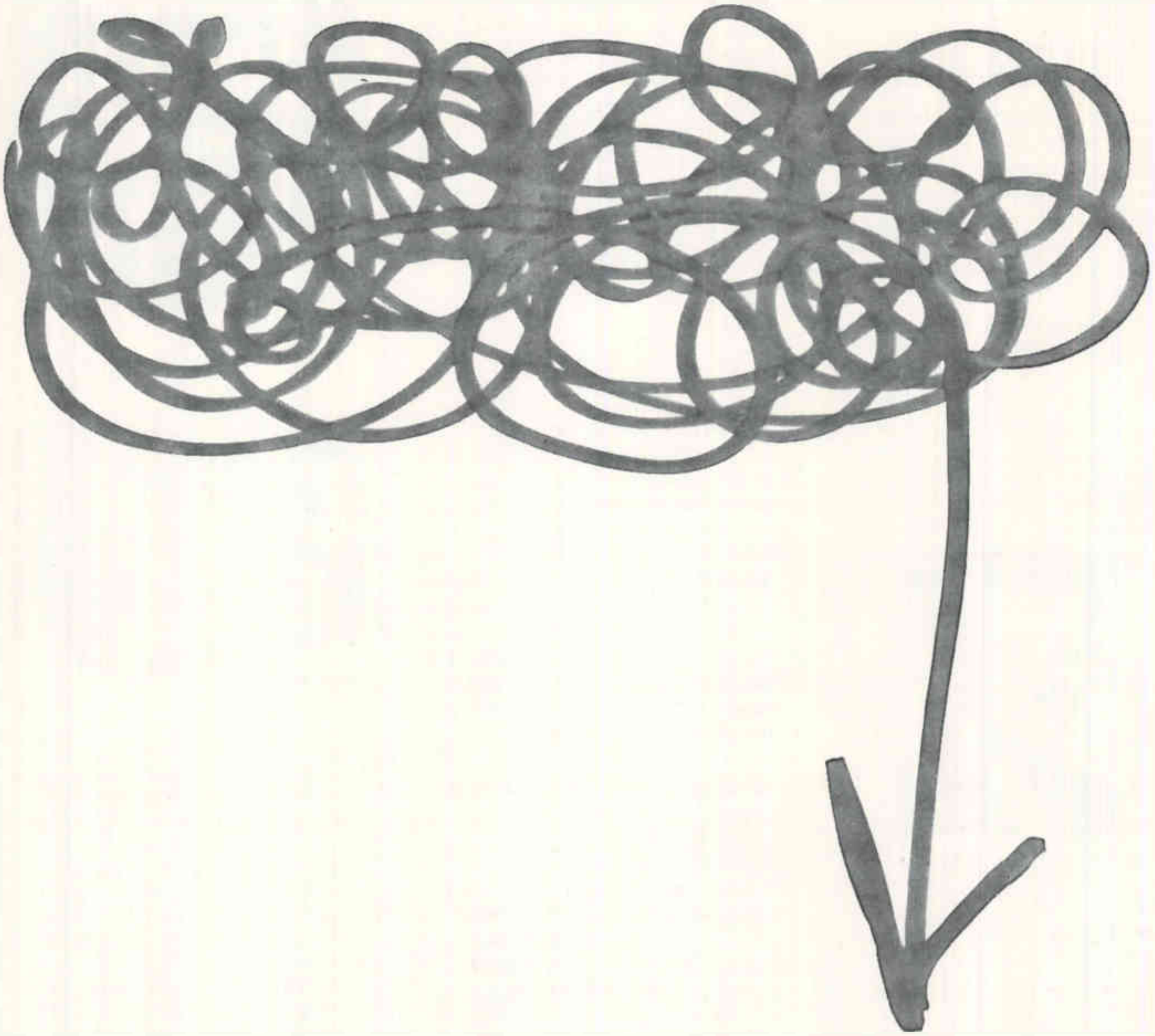
DOUGLAS M. HELLER has been promoted to general manager of the Radio division of the Bendix Corp., Baltimore, Md. He succeeds A. E. Abel who has resigned.

Prior to the appointment, Heller was assistant general manager of the Radio division, and also manager of the division's government products group.

PEOPLE IN BRIEF

Julius Tischkewtisch advances to chief engineer for the Filter div. of ESC Electronics Corp. **Stanley L. Katten** leaves Lundy Electronic and Systems, Inc., to join Loral Electronics Corp. as mgr., Western operations. **Charles R. Fisher** moves up to chief of advanced development for Stromberg-Carlson. Ess Gee, Inc., promotes **Michael T. Pappas** to associate chief engineer. **Monte M. Toole**, ex-Continental Device Corp., named section head for quality assurance engineering and reliability at Fairchild Semiconductor's diode mfg. plant. He replaces **Robert Busch** who was appointed senior engineer in product engineering. System Development Corp. ups **Milton G. Holmen** to director of system applications and **Saadia M. Schorr** to director of planning. **Donald D. Mallory**, formerly with Hughes Aircraft Co., now corporate director of engineering for United ElectroDynamics, Inc. **Keith Famulener**, previously with General Aniline & Film Corp., appointed mgr. of the Ampex Corp. magnetic tape laboratory. **Joseph I. Davis** from Hoffman Electronics Co., and **William A. Wilkinson**. from Automation Electronics, named v-p's, engineering and manufacturing, respectively, for Arnoux Corp. **Otto A. Schulze** advances to divisional v-p of American Machine & Foundry's Advanced Products Group. Organizational changes at Hi-G, Inc.: **Robert H. Wood**, exec v-p, named g-m; **Michael M. Lanes**, mgr. of relay engineering, gets the added title of asst. to the president.

out of the jumble of electronics buying directories



emerges the direct-route directory: electronics BUYERS' GUIDE

63,000 electronics engineers and purchasing agents use the **electronics** Buyers' Guide to specify products, day after day throughout the year. It's the only directory of products they need. And that's all right with them.

There are many, many purchasing directories for the electronics market. Some of them are complicated. The **electronics** Buyers' Guide is simple to use. Some of them are cryptic. The **electronics** Buyers' Guide is clear. Some of them force the user to go all around Robin Hood's barn to find the product he needs. The **electronics** Buyers' Guide, through sensible product groupings, lets the purchaser "spec-shop" for his product (your product?) quickly.

Closes May 1

The **electronics** Buyers' Guide closes for plates on May 1. If your electronic product is not already represented in its pages, it should be. Call your nearest **electronics** Buyers' Guide representative now:

Atlanta: 675-0523: M. H. Miller, R. C. Johnson / **Boston:** COngress 2-1160: Wm. S. Hodgkinson, D. R. Furth / **Chicago:** MOhawk 4-5800: H. Wernecke, R. M. Denmead / **Cleveland:** SUperior 1-7000: P. T. Fagley / **Dallas:** Riverside 7-9721: Frank LeBeau / **Denver:** ALpine 5-2981: J. W. Patten / **Houston:** Riverside 8-1280: Joseph Page, Jr. / **Los Angeles:** HUntley 2-5450: Wm. Gries / **New York:** LOngacre 4-3000: D. H. Miller, H. M. Shaw, George Werner / **Philadelphia:** LOcust 8-4330: W. H. Gardner, W. Boyle / **San Francisco:** DOuglas 2-4600: R. C. Alcorn

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
ARMOUR RESEARCH FOUNDATION Illinois Institute of Technology Chicago, Illinois	96*	1
ATOMIC PERSONNEL INC. Philadelphia, Penna.	96*	2
GENERAL ELECTRIC COMPANY Apollo Support Department Daytona Beach, Florida	95*	3
GYRODYNE COMPANY OF AMERICA INC. St. James, L. I. New York	93	4
HONEYWELL St. Petersburg, Fla.	82*	5
NATIONAL SECURITY AGENCY Ft. Geo. G. Meade, Maryland	122	6
NORDEN Div. of United Aircraft Corp. Norwalk, Conn.	96*	7
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick AFB, Fla.	94*	8
REPUBLIC AVIATION CORPORATION Farmingdale, L. I. N. Y.	97*	9

* These advertisements appeared in the April 19th issue.

(cut here) **electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE** (cut here)

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY ....................ZONE.......STATE............

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 42663

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

EMPLOYMENT OPPORTUNITIES

NATIONAL COVERAGE

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc. Look in the forward section of the magazine for Additional Employment Opportunities advertising.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

—RATES—

DISPLAYED

The advertising rate is $40.17 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

UNDISPLAYED

$2.70 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send NEW ADS to CLASSIFIED ADV. DIV. of ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.

NATIONAL SECURITY AGENCY

OFFERS CAREER OPPORTUNITIES FOR ______________

- Research and Development Engineers
- Communications Systems Engineers
- Data Systems Engineers

◆◆ COLLEGE DEGREE REQUIRED ◆◆

Starting salaries will be commensurate with education and experience. NSA employees receive all benefits of Federal employment. U. S. Civil Service certification is not required. All applicants must be a U. S. citizen. If interested—

MAIL FEDERAL APPLICATION FORM (SF-57) TO:

DIRECTOR
NATIONAL SECURITY AGENCY
FORT GEORGE G. MEADE, MARYLAND
ATTN: M342

An Equal Opportunity Employer

WANTED

Ingenious and Ambitious Engineers and Scientists

To form the technical nucleus of a new industrial applied research laboratory. Positions are available for Inorganic Chemists, Physical Chemists, Solid-State Physicists, Electrical Engineers. Opportunities and advantages are:

1) Freedom to initiate areas of investigation
2) Responsibility for technical programs
3) Top salaries for qualified people
4) Northern New Jersey location

CALL COLLECT
(201)—HU 5-2100, Ask for Dr. Kaufman

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES
EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

OVER 2,000,000
RELAYS
IN STOCK!

Send for Catalog SS
Universal RELAY CORP.
42 WHITE ST., N.Y. 13, N.Y. • WAlker 5-6900

CIRCLE 950 ON READER SERVICE CARD

RADIO RESEARCH INSTRUMENT CO.

AUTO-TRACK & TELEMETRY ANTENNA PEDESTALS
3 & 10 CM. SCR 584 AUTOTRACK RADARS.
AN/TPS-1D SEARCH. AN/TPS-10 HT. FINDERS.
AN/FPN-32GCA. AN/APS-10 NAVIG. & WEATHER.
AN/APS-15B PRECISION. AN/APQ-35B PRECISION.
AN/APS-31A SEARCH. DOZENS MORE.
5-1-2 MEGAWATT HIGH POWER PULSERS.

RADIO RESEARCH INSTRUMENT CO.
550 Fifth Ave., New York   Judson 6-4691

RADAR SYSTEMS & COMPONENTS/ IMMEDIATE DELIVERY

CIRCLE 951 ON READER SERVICE CARD

LOOKING FOR

USED/SURPLUS ELECTRONIC EQUIPMENT/COMPONENTS?

For an up-to-date listing of such equipment see Searchlight Section of April 12th issue.

INDEX TO ADVERTISERS

■

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

INDEX TO CLASSIFIED ADVERTISERS

■

• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

electronics

Audit Bureau of Circulation — Associated Business Publications

Audited Paid Circulation

JAMES T. HAUPTLI
Advertising Sales Manager

BEN ANELLO
Market Services Manager

DAVID CUNNIFF
Promotion Manager

■

Electronics Buyers' Guide

R. S. QUINT
General Manager

■

RICHARD J. TOMLINSON
Business Manager

ADVERTISING REPRESENTATIVES

ATLANTA (9):
Michael H. Miller, Robert C. Johnson
1375 Peachtree St. N.E., Trinity 5-0523
(area code 404)

BOSTON (16):
William S. Hodgkinson, Donald R. Furth
McGraw-Hill Building, Copley Square,
Congress 2-1160 (area code 617)

CHICAGO (11):
Harvey W. Wernecke, Robert M. Denmead
645 North Michigan Avenue, Mohawk 4-5800
(area code 312)

CLEVELAND (13):
Paul T. Fegley
55 Public Square, Superior 1-7000
(area code 216)

DALLAS (1):
Frank Le Beau
The Vaughn Bldg., 1712 Commerce St.
Riverside 7-9721 (area code 214)

DENVER (2):
John W. Patten
Tower Bldg., 1700 Broadway,
Alpine 5-2981 (area code 303)

HOUSTON (25):
Joseph C. Page, Jr.
Prudential Bldg., Halcombe Blvd.,
Riverside 8-1280 (area code 713)

LOS ANGELES (17):
Ashley P. Hartman, John G. Zisch,
William C. Gries
1125 W. 6th St., Huntley 2-5450
(area code 213)

NEW YORK (36):
Donald H. Miller, Henry M. Shaw,
George F. Werner
500 Fifth Avenue, LO-4-3000
(area code 212)

PHILADELPHIA (3):
Warren H. Gardner, William J. Boyle
6 Penn Center Plaza, LOcust 8-4330
(area code 215)

SAN FRANCISCO (11):
Richard C. Alcorn
255 California Street, Douglas 2-4600
(area code 415)

LONDON W1:
Edwin S. Murphy Jr.
34 Dover St.

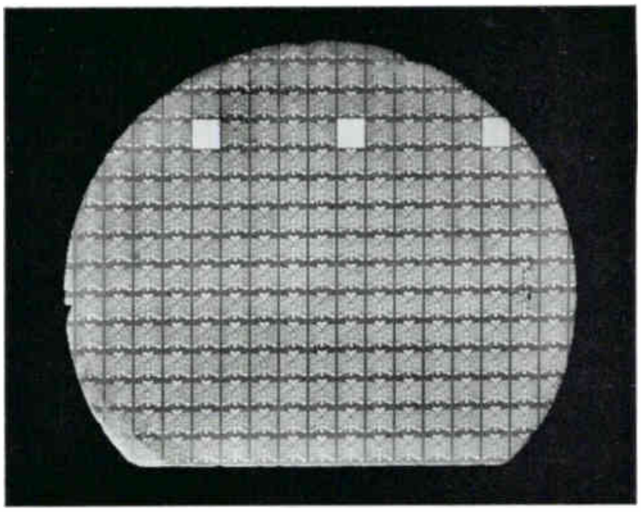
FRANKFURT/Main:
Matthée Herfurth
85 Westendstrasse

GENEVA:
Michael R. Zeynel
2 Place du Port

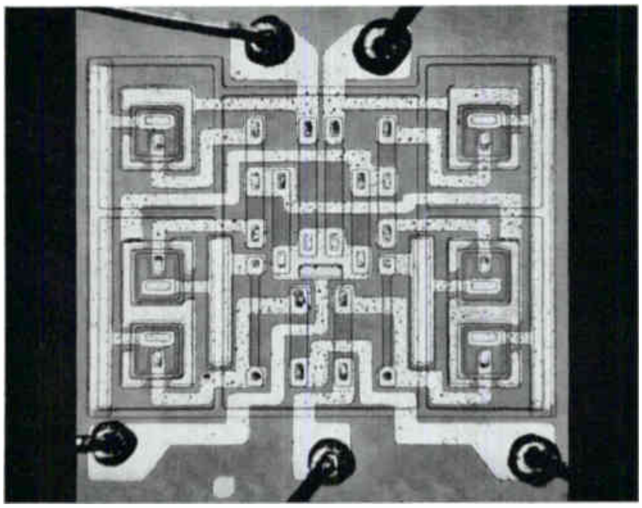
TOKYO:
George Olcott,
1, Kotohiracho, Shiba, Minato-ku

PRODUCTION MICROCIRCUIT...IN 5 WEEKS

MASK MAKING From Litton's pre-tested circuit, Fairchild engineers designed and made the masks used to photo-etch precisely indexed patterns for the multi-diffusion process. Fairchild's highly developed photo-optical techniques are the result of five years experience in producing semiconductor devices, including two years of microcircuit production.



MULTI-DIFFUSION Next, the processing of silicon wafers was begun: etching and triple diffusion followed by deposition of the evaporated metal-over-oxide intraconnections*. Fairchild's Planar* process was utilized: a protective layer of silicon dioxide is grown into the wafer *before* any junctions are formed. Production begins after several trial diffusion runs in which run-to-run variations of performance parameters are established.



FIVE WEEK DELIVERY By December 20, 1962, five weeks after receiving firm specifications, Fairchild delivered an initial shipment to Litton—50 *production* microcircuit toggles—seven weeks before the promised date. The microphotograph above is the finished circuit mounted in a TO-5 can with cap removed. Actual size of the chip is .060" square.

This case history demonstrates Fairchild's "maximum circuits per wafer" concept. Made possible by the Planar* process, it is the key to reliability and economy. The Litton toggle—like every custom microcircuit produced by Fairchild—was a separately processed product from start to finish. Fairchild manufactures custom microcircuits this way because only through complete customizing can individual design goals be met efficiently—with the highest reliability at lowest cost.

*Patented Fairchild processes.

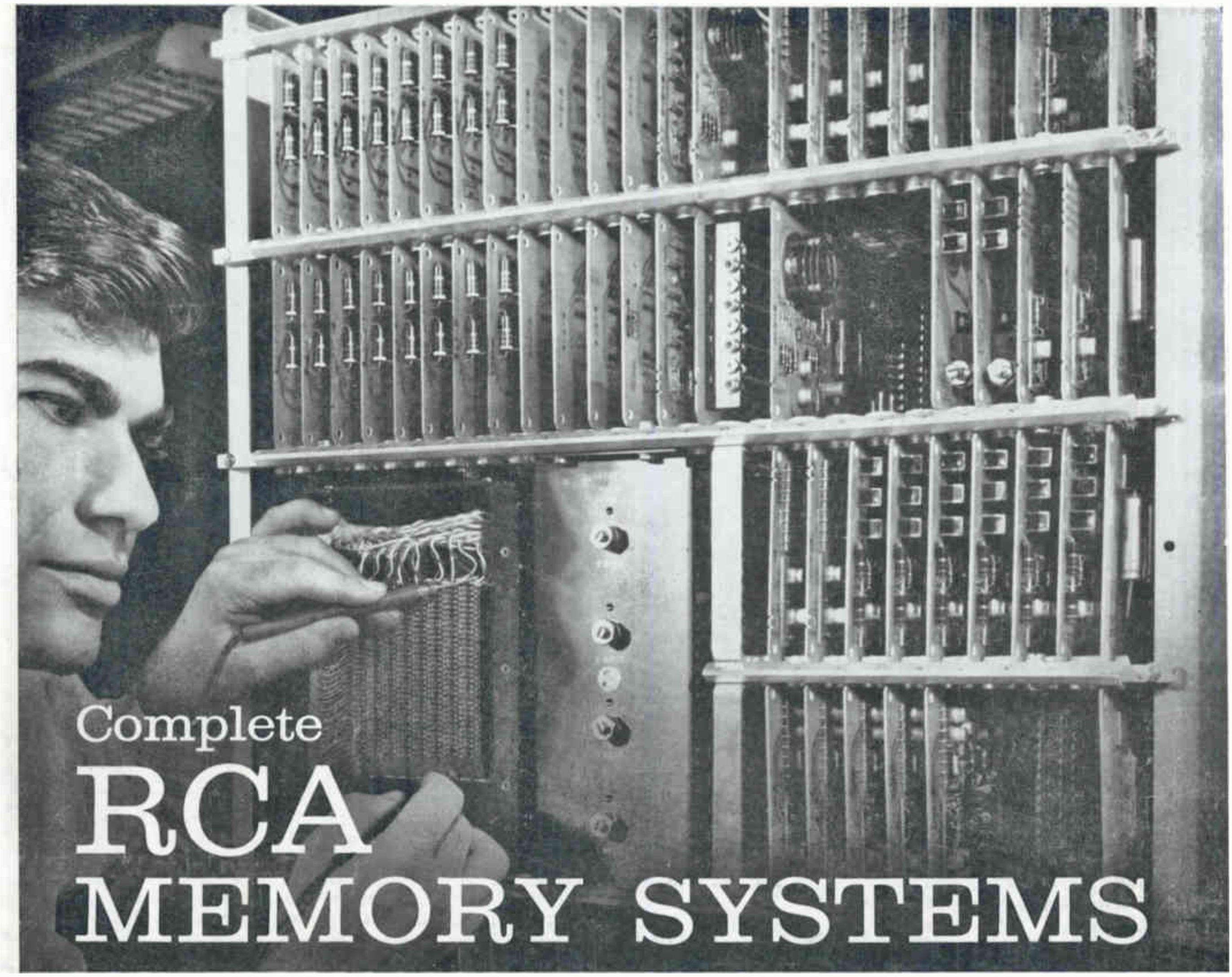
FAIRCHILD

SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

545 WHISMAN RD., MOUNTAIN VIEW CALIF. • YORKSHIRE 8 8161 • TWX 415 969 9165

CIRCLE 901 ON READER SERVICE CARD



with specified extra wide safety margins

Standard or custom systems, incorporating RCA ferrite and semiconductor devices, are designed, built, and tested by memory-circuit specialists—at RCA's newly expanded memory products operation in Needham Heights, Mass.

Here is the new answer to memory-system design and production, offering new latitude to the computer engineer, new solutions to your system production problems—complete RCA Memory Systems. Designed and produced by RCA from ferrite cores to entire packaged systems, these precision units are pre-tested to broad operating limits and are delivered ready for immediate use in computer designs.

Here are some of the outstanding features of complete RCA Memory Systems:

- **Specified Wider Margins of Operations**...Up to 8 percent...to cope with broad variations in power levels.
- **Custom Design Service**...RCA's engineering staff will custom-design a memory system to your specifications.
- **Superior Reliability**...Components and circuits proved by the long, dependable service of over 150 systems now in use.
- **Complete Information Retention**... even in case of full power loss.
- **Wide Temperature Range**...0°C to 50°C.

For Systems Engineering Service—Call your RCA Office. For further technical information on RCA Memory Systems, write Dept. FN4-4, RCA Memory Products Dept., 64 "A" St., Needham Heights 94, Massachusetts.

STANDARD RCA MEMORY SYSTEMS

Capacity	128 to 32,768 words, 4 to 64 bits per word.
Speed	Complete Read-Write cycle times: 0.375 to 12usec.
Modes of Operation	Read-Regenerate/Read-Modify/Write Only/Read Only/Master Clear.
Reliability	Acceptance tests made with all power supply voltages varied both plus and minus 8 percent from their nominal values while the system is being temperature cycled.

ADDITIONAL OPTIONAL FEATURES

- Self Checking—with simulated worst-case conditions.
- Information Retention—prevents loss of stored and in-process information in the event of primary power failure.
- Indicator Lights—for memory address register and memory information register.
- Interlace Register—permitting simultaneous read and write operations.

The Most Trusted Name in Electronics

RCA SEMICONDUCTOR AND MATERIALS DIVISION FIELD OFFICES...**EAST:** 32 Green St., Newark 2, N. J., HU 5-3900 • 731 James St., Room 402, Syracuse 3, N. Y., GR 4-5591 • 605 Marlton Pike, Erlton, N. J., HA 8-4802 • Greater Baltimore Area, 1725 "K" Street, N.W., Washington 6, D. C., FE 7-8500 • **NORTHEAST:** 64 "A" St., Needham Heights 94, Mass., HI 4-7200 • **SOUTHEAST:** 1520 Edgewater Dr., Suite No. 1, Orlando, Fla., GA 4-4768 • **CENTRAL:** Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., 527-2900 • 2132 East 52nd St., Indianapolis 5, Ind., CL 1-1405 • 5805 Excelsior Blvd., Minneapolis 15, Minn., WE 9-0676 • 714 New Center Bldg., Detroit 2, Mich., TR 5-5600 • 7905 Carpenter Freeway, Dallas 7, Texas, ME 1-9720 • Continental Terrace Bldg., 2785 North Speer Blvd., Room 346, Denver 11, Colo., 477-1688 • **WEST:** 6801 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361 • 1838 El Camino Real, Burlingame, Calif., OX 7-1620 • 2250 First Avenue, So., Seattle 4, Wash., MA 2-8816 • **GOVERNMENT:** 224 N. Wilkinson St., Dayton 2, Ohio, BA 6-2366 • 1725 "K" Street, N.W., Washington 6, D. C., FE 7-8500.

CIRCLE 902 ON READER SERVICE CARD